Contaminant Report Number: R6/801M/1998

**United States Fish and Wildlife Service**

Region 6

Environmental Contaminants Program

# CONTAMINANT RESIDUE ANALYSIS OF FISH TISSUES FROM MARAIS des CYGNES NATIONAL WILDLIFE REFUGE - KANSAS

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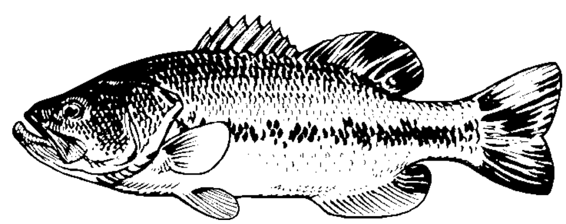

February 2000

# CONTAMINANT RESIDUE ANALYSIS OF FISH TISSUES FROM MARAIS des CYGNES NATIONAL WILDLIFE REFUGE - KANSAS

by


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## ABBREVIATIONS AND CONVERSION FACTORS

BDL=Below Detection Level
CGC-Capillary Gas Chromatograph
DL=Detection Level
GC/MS-Gas Chromatograph/Mass Spectrometer
HPLC-High Performance Liquid Chromatography
KDHE - Kansas Department of Health and Environment
NOAA = National Oceanographic and Atmospheric Administration
NWR - National Wildlife Refuge
PCBs = Polychlorinated Biphenyls
PAHs = Polycyclic Aromatic Hydrocarbons

Centigrade (C) = (F-32)(5/9)
Hectares (ha) = Acres x 0.4047
Meters (m) = Feet / 3.2808
Millimeters (mm) = Inches x 25.4
Parts Per Million (ppm) = milligrams of analyte per kilogram of mass (mg/kg)

SUMMARY

Marais des Cygnes National Wildlife Refuge (Refuge) was added to the National Wildlife Refuge system in 1992. During public involvement in acquisition planning, the Service committed to opening the Refuge to recreational fishing. There are several water bodies on the Refuge which would provide recreational fishing opportunities. These include abandoned coal strip mines, small man-made farm ponds, and the Marais des Cygnes River and several tributaries to the river. As part of the obligation to provide safe recreational opportunities, an investigation of fish tissues was conducted to ensure that the fish are not contaminated by inorganic or organic pollutants, and to establish that it is appropriate for the Service to open the Refuge to public fishing.

We collected edible tissue (fillet) samples from several species of fish from 13 sites at the Refuge. These samples were analyzed for trace element, chlorinated hydrocarbon, and total petroleum hydrocarbon residues. Numerous elements and compounds were detected in the fish tissues. Mean concentrations were calculated and compared to consumption values established for the protection of human health. Based on the results of this study, consumption advisories do not need to be established for the waterbodies sampled in 1998 for trace elements or chlorinated hydrocarbons. The results for total petroleum hydrocarbons should be considered provisional, pending additional examination.

# ACKNOWLEDGMENTS

The author would like to thank Dr. George Allen and Susan Blackford of the U.S. Fish and Wildlife Service-Kansas Field Office for their preliminary design of, and obtaining funding for the study. Larry Gamble and Patty Stevens of the U.S. Fish and Wildlife Service-Region 6 Office assisted with completing the technical design of this study. Susan Blackford, Richard Duncan, and Vernon Tabor of the U.S. Fish and Wildlife Service-Kansas Field Office provided assistance collecting the samples. Jerre Gamble, Bruce Freske, and Bill Peterson of Marais des Cygnes National Wildlife Refuge assisted with site selection and access, and provided reviews of interim proposals and the final report. Steve Cringan of the Kansas Department of Health and Environment conducted the fish tissue safety evaluation, and provided a technical review of the draft report. Mark Wilson and Jim Dwyer of the U.S. Fish and Wildlife Service-Missouri Field Office, and Larry Gamble provided technical review of the draft report. This project was funded by the U.S. Fish and Wildlife Service-Division of Environmental Contaminants On-Refuge Contaminant Study program, Project Number 1261-6N39.

# INTRODUCTION

Marais des Cygnes National Wildlife Refuge (Refuge) was added to the National Wildlife Refuge system in 1992. The Refuge occupies approximately 2,550 ha of bottomland hardwoods habitats along the Marais des Cygnes River in Linn County, Kansas.

During public involvement in acquisition planning, the Service committed to opening the Refuge to recreational fishing. There are several water bodies on the Refuge which would provide recreational fishing opportunities. These include abandoned coal strip mines, small man-made farm ponds, and the Marais des Cygnes River and several tributaries to the river. Fish have been established in the coal mine and farm ponds either through human stocking efforts or by occasional flooding by the Marais des Cygnes River. As part of the obligation to provide safe recreational opportunities, an investigation of fish tissues was conducted to ensure that fish are not contaminated by heavy metals or other pollutants, and to establish that it is appropriate for the Service to open the Refuge to public fishing.

Previous efforts investigated contaminant concerns prior to acquisition of the Refuge (Allen and Nash 1992, Allen *et al.* 1995). These efforts showed no evidence of major contaminant concerns on the Refuge. However, the evaluations did not include all bodies of water on the Refuge that might be opened to fishing. The water in the impoundments originates from watersheds that extend beyond the boundaries of the Refuge, and, as a result, may be influenced by various land uses, including agricultural runoff, urban point and non-point sources, and unauthorized dumping. Other water bodies are fed by ground water, which also may be impacted by anthropogenic or natural sources.

Tissue samples collected in 1998 were analyzed for trace element, chlorinated hydrocarbon, and total petroleum hydrocarbon residue concentrations. While several contaminants were detected in many samples, none of the mean concentrations from any sample were sufficient to require creation of consumption advisories at the Refuge.

# METHODS

During a pre-sampling site visit, we selected 10 waterbodies which were more likely to be used by anglers. Some of the variables that influenced site selection included proximity to roads or trails, size, permanence of water, and type (pit lake, farm pond, or river).

From each site, we attempted to collect 3 individuals of both largemouth bass (*Micropterus salmoides*) and channel catfish (*Ictalurus punctatus*). These species were selected in order to compare the results to existing fish tissue data collected by the Kansas Department of Health and Environment (KDHE). We collected only adult fish. In order to ensure age similarity between the 3 individuals of each group, the smallest fish was required to be at least 75% of the total length of the largest fish (S. Cringan, KDHE, pers. comm.). In the event that we could not capture a suitable number of largemouth bass to comprise a sample, we captured white crappie (*Pomoxis annularis*) as a surrogate. In the event that we could not capture a suitable number of channel catfish, common carp (*Cyprinus carpio*), river carpsucker (*Carpiodes carpio*), flathead catfish *(Pylodictis olivaris*), or brown bullhead (*Ameiurus nebulosus*) were substituted as surrogates. Those species of fish also were collected by Allen and Nash (1992) in their preacquisition survey of contaminants.

We attempted to collect at least one complete sample (i.e., 3 individuals of a single species) from each waterbody. If we could not collect a complete sample, another waterbody was selected. In seven (7) cases, we were not able to collect a complete sample from each waterbody, and data from incomplete samples is presented. It should be noted that mean concentrations were not calculated for these samples, and only individual results are presented. We were unable to collect any fish from one (1) pond, and this pond was removed from the study.

We collected the fish using a single panel gill net (15 m x 2 m, 5 cm bar mesh) set for approximately 4 hours. We also used recreational angling gear with artificial lures to capture most of the bass and crappie, and we used live baits (worms [*Lumbricus terrestris*] or gizzard shad [*Dorosoma cepedianum*]) to collect many of the catfish. We recorded the length and weight of each fish, and conducted a basic external appearance survey, noting any lesions, parasites, or other general indications of health (Albers 1995). We collected boneless, skinless fillets from each fish. Both fillets from each fish were weighed, wrapped in hexane-rinsed aluminum foil, placed in a Whirl-Pak® storage bag, placed on ice in the field, and stored at -20C upon return to the laboratory. Residue analysis was conducted on each individual sample, and the results were pooled for each species from each site.

Dissection equipment (knives, etc.) were cleaned in Alconox® solution and rinsed in deionized water between each fish. The fillet knife required sharpening at least once between each group of three fish, sometimes more often. The knife was cleaned as described above after sharpening and before filleting the next fish. Alconox® solution was discarded after use at each sampling location, deionized water was discarded after each use.

**Analytical Methodology**

The fillets were analyzed for trace elements, total petroleum hydrocarbons and chlorinated hydrocarbons at the Geochemical & Environmental Research Group (GERG) at Texas A&M University. The tissue samples were extracted using the NOAA Status and Trends Method (MacLeod et al., 1985) with minor revisions (Brooks et al., 1989; Wade et al., 1988). Briefly, the tissue samples were homogenized with a Teckmar Tissumizer. A 1 to 10-gram sample (wet weight) was extracted with the Teckmar Tissumizer by adding surrogate standards, Na2SO4, and methylene chloride in a centrifuge tube. The tissue extracts were purified by silica/alumina column chromatography to isolate the aliphatic and PAH/pesticide/PCB fractions. The PAH/pesticide/PCB fraction was further purified by HPLC in order to remove interfering lipids. The quantitative analyses were performed by capillary gas chromatography (CGC) with a flame ionization detector for aliphatic hydrocarbons, CGC with electron capture detector for pesticides and PCB's, and a mass spectrometer detector in the SIM mode for aromatic hydrocarbons (Wade et al., 1988).

The analytical methodology for trace elements reported concentrations for the following analytes: aluminum, arsenic, boron, barium, beryllium, cadmium, chromium, copper, iron, magnesium, manganese, mercury, molybdenum, nickel, lead, selenium, strontium, vanadium, and zinc. The analytical methodology for chlorinated hydrocarbons reported concentrations for the following compounds: aldrin, alpha-BHC, alpha-chlordane, beta-BHC, cis-nonachlor, delta-BHC, dieldrin, endosulfan II, endrin, gamma-BHC, gamma-chlordane, HCB, heptachlor, heptachlor epoxide, mirex, o,p'-DDD, o,p'-DDE, o,p'-DDT, oxychlordane, p,p'-DDD, p,p'-DDE, p,p'-DDT, total PCBs, toxaphene, and trans-nonachlor. Analytical quality assurance/quality control (QA/QC) was performed by the Patuxent Analytical Control Facility according to existing contracts.

Mean contaminant concentrations were calculated for each sample group from each pond. Mean concentrations for inorganic and chlorinated hydrocarbons were calculated and presented on a wet weight basis. Analysis of contaminant concentrations on a wet weight basis provides a more accurate measure of human exposure to consumption of contaminated fish (EPA 1995). Means were only calculated if at least three of the individual fish comprising each sample group had concentrations greater than the reported detection limit (DL). These means were then compared to values reported in EPA (1994) to determine the necessity of establishing fish consumption advisories.

In addition, EPA (1995) recommends calculating the total chlordane and total DDT concentrations when evaluating contaminant data for fish consumption advisories. Total chlordane is estimated by combining the results for the *alpha*- and *gamma*- isomers of chlordane, the *cis*- and *trans*- isomers of nonachlor, and oxychlordane. Total DDT is estimated by combining the *o,p'*- and *p,p'*- isomers of DDD, DDE, and DDT. EPA further recommends establishing proxy values of ½ the reported detection limit for data that is reported as Below Detection Limits (BDL). Proxy values were not calculated if greater than 50% of the combined results for each sample group were below detection limits.

# STUDY AREA AND SITE DESCRIPTIONS

**Poison Ivy1**

This pond is a flooded coal strip mine pit lake located in T21S, R25E, Section 10. Poison Ivy 2 is located approximately 50 m to the South, and the two ponds are separated by a shallow saddle. The surface area of this pond is approximately 1.5 ha. The pond is steep sided, and the slopes extend well above and below the waters edge around most of the perimeter. The shallowest, and most approachable banks are at the north and south ends. This pond drains a relatively small area, and is filled primarily by groundwater or flood waters from the Marais des Cygnes River, located approximately 200m SW of the pond. Fish gain access to this pond either during flood events, or by unmanaged stocking efforts. This pond is in the closed area of the Refuge, and consumptive fishing is not normally allowed, except for special events. We observed only common carp and largemouth bass in this pond, although the sampling gear was biased towards larger fish. The two samples from this pond were comprised of 2 common carp, and 3 largemouth bass.

**Poison Ivy 2**

This pond is also a flooded coal strip pit lake located immediately South of Poison Ivy 1 in T21S, R25E, Section 10. The surface area of this pond is approximately 2 ha. There are steep banks along the northern portion of the pond, although the banks are generally less than 1 m above waters edge. Banks along the southern edge of the pond are steep, and generally extend more than 2 m above waters edge. This pond drains a relatively small area, and is filled primarily by groundwater or flood waters from the Marais des Cygnes River, located approximately 150 m West of the pond. Fish gain access to this pond either during flood events, or by unmanaged stocking efforts. This pond is in the closed area of the Refuge, and consumptive fishing is not normally allowed, except for special events. We observed common carp, carpsucker, largemouth bass, white crappie, longnose gar, and channel catfish in this pond, although our sampling gear was biased towards larger fish. Freshwater turtles are also present in this pond, as was evidenced by scavenged fish captured in the gill nets. The two samples collected from this pond were comprised of 1 common carp and 2 carpsuckers, and 2 largemouth bass and 1 white crappie.

**Stateline Pond**

This pond is located in the SE 1/4 of T21S, R25E, Section 12, along the State Line Road. This pond is approximately 8 ha in surface area and drains a relatively large area which was used as pasture lands prior to being purchased by the Refuge. Management efforts are currently underway to restore these lands to a more natural habitat. The pond is formed by the construction of a earthen dam located on the west side of the lake. The western half of the pond is deeper (greater than 2 m) while the eastern half can be quite shallow (less than 0.5 m). The banks are shallow around the entire perimeter (except at the dam), and slightly overgrown by the grass species present. The shallowness of the eastern edge contributes to the more turbid water quality of this pond. We observed channel catfish, largemouth bass, white crappie and several shortnose gar in this pond, although our sampling gear was biased towards larger fish. Fish gain access to this pond primarily by unmanaged stocking efforts. Only one complete sample of 3 channel catfish was collected. We also collected 1 largemouth bass.

**Turkey Foot Pond**

Turkey Foot Pond is a large coal strip mine pit lake in T21S, R25E, Section 14, near the Marais des Cygnes River. This pond drains a relatively large area which includes tailing piles, an abandoned human dwelling, and other anthropogenic disturbances. The pond is connected to 2 other small ponds located to the southwest of Turkey Foot Pond by narrow channels. These 2 smaller ponds are approximately 2.0 ha in surface area each, but are shallow (less than 0.5 m) and therefore turbid. We did not sample these ponds because of their shallowness and turbidity. Surface and ground water flow into the smaller 2 ponds over or through tailings piles, then into Turkey Foot Pond. The outlet to Turkey Foot Pond is a narrow wall formed from the surrounding topography by mining operations. This outlet drains into the Marais des Cygnes River, approximately 50 m west of the pond. The outlet channel is experiencing significant head-cutting, and the base of the “dam” is less than 10m wide, and approximately 5 m high.

Turkey Foot Pond has three physically distinct sections, and was sampled as three separate sites. The main portion of the lake is oriented NE-SW, with two separate arms extending to the east and south. This section has steep banks which extend well above and below the waterline. The water in this section is relatively clear. Turkey Foot-East is located at the NE end of the lake, and extends from that point to the SE. The eastern bank is less than 1m high, and is overgrown with vegetation and has areas of undercut banks. The western bank is similar to other sections of the lake, with steep, rocky banks extending well above the waterline. This section of the lake is relatively shallow, with maximum depths of approximately 2 m. The water in this section of the lake is more turbid than other sections of the lake. Only one complete sample consisting of 3 carpsuckers was captured from this part of the pond. We also captured 1 largemouth bass.

Turkey Foot-Mid is directly south of the outlet, and is oriented N-S. The channel is approximately 50m wide, with steep, rocky banks extending well above and below waters edge. A small intermittent stream drains into this section from the south. Turkey Foot -West is the southwest extension of the main portion of the lake. This section receives inflow from the two small ponds to the southwest. The three samples collected from this pond consisted of 3 channel catfish, 3 largemouth bass, and 3 white crappie. In addition, 1 common carp and 1 carpsucker were also collected.

Turkey Foot -West has a combination of physical characteristics found in the other two sections of the lake. The channel is approximately 50m wide, with steep, rocky banks extending well above waters edge, but the water depth is only approximately 10 m. This depth is more than in Turkey Foot -East, but much less than Turkey Foot -Mid. The lake is shallowest at the inlet, and somewhat turbid. Water depth increases and water clarity improves closer to the main part of the lake. Numerous trees have fallen into this part of the lake which interfered with the use of gill nets. The two samples collected from this site were comprised of 1common carp and 2 carpsuckers, and 2 largemouth bass and 1 white crappie.

**Farm Pond 1**
This is a small manmade pond of approximately 0.5 ha in T21S, R25E, Southwestern Section 1. This is the upper of two ponds. This pond has shallow banks surrounded with dense stands of wild rose (*Rosa multiflora*). We were not able to set the gill nets in this pond, and therefore were unable to determine depth. We captured 3 largemouth bass as a sample from this pond. We also observed numerous sunfish, primarily bluegill (*Lepomis macrochirus*) and unidentifiable hybrids between bluegill and another *Lepomis* species (V. Tabor, USFWS, pers. comm.). Several of the sunfish captured were >330 mm (13 inches). Only one sample comprised of three largemouth bass was collected from this site.

**Farm Pond 2**
This is the lower and larger of the two ponds in T21S, R25E, SE Section 1. This manmade pond is approximately 1.0 ha, has shallow, grassy banks which are somewhat undercut. Much of the bank is accessible with relatively minor stands of willow and wild rose. The pond is greater than 10 ft deep, with maximum depth near the dam. We collected two samples comprised of three channel catfish and three largemouth bass at this site. Both samples were collected using recreational gear.

**Farm Pond 3**
This small pond is located in the NE corner of T21S, R25E, Section 3, near the northern boundary of the refuge. This pond is shallow, with maximum depths of less than 2 m. This pond is in the closed area of the Refuge, and consumptive fishing is not normally allowed, except for special events. We were able to capture only two brown bullheads with gill nets.

**Section 4 Pond**
This small farm pond is a shallow depression in the NE corner of SE 1/4 T21S, R25E, Section 4. Maximum depth of this pond is approximately 2 m. This pond is in the closed area of the Refuge, and consumptive fishing is not normally allowed, except for special events. The water at

the time of sampling was highly turbid. We collected three brown bullhead with recreational angling gear. The turbid water quality is most likely due to the presence of the bullhead, and most likely precludes the presence of sight-feeding, predatory fish species.

**Southside Pond 1**

This pond is located at T21S, R25E, Section 26 along the southern edge of the refuge. This pond has very steep, rocky banks extending well above and below waters edge around most of perimeter. Most of the banks are heavily overgrown with vegetation. Access is limited to the northwest corner or by canoe. The pond is V-shaped, and was sampled as two sites although the sites were physically similar. The water was very clear with abundant vegetation. We observed several size classes of bluegill, including young-of-the-year individuals, and largemouth bass, although our sampling gear was biased towards larger individuals. All fish were captured with recreational gear. Two samples, consisting of four largemouth bass each, were captured from the two portions of the pond. Water clarity probably results from absence of carp or other bottom-dwelling species.

**Marais des Cygnes River**

We sampled the Marais des Cygnes River in the eastern half of T21S, R25E, Section 14. At this location, the river has steep, silty banks greater than 3 m above the waters edge. We observed common carp and flathead catfish at this site, and both were captured with recreational gear. We were only able to collect one common carp and one flathead catfish at this site.

# RESULTS

Appendix A contains descriptive field data for all fish collected during this study. Most fish appeared healthy and were in good flesh. All *Ictalurids* had varying numbers of subcutaneous parasites which were plainly visible, both externally and within the fillets. Most of the bass had varying numbers of *Ascarid* parasites within the body cavity. These were generally located around the liver and intestines.

**Trace Elements**

The following elements were not detected in a sufficient number of samples at any site to provide for a detailed statistical evaluation: arsenic, boron, beryllium, cadmium, and lead. Only intermittent detections of the remaining elements were reported for each site. Nickle and molybdenum were detected in one sample each. Chromium and vanadium were only detected in samples from Turkey Foot Pond. Copper was detected in samples from all the pond sites, but not from the Marais des Cygnes River. Strontium was detected in samples from Turkey Foot and Poison Ivy 2, both of which are coal strip pit ponds. It is noted that five of the six reported mean strontium concentrations were from samples including bottom-feeding fish, the other sample was of white crappie. Mercury, selenium, and zinc were detected in samples from all sites and of all trophic types. The reported concentration means vary over an order of magnitude across all sites. With the exception of the single molybdenum result in Table 2, all results are within the range of background concentrations.

Table 1 shows mean concentrations of selected trace elements from fish tissues at the Turkey Foot Pond sites. Analytical data for all trace elements in fish at these sites is presented in Appendix B-1. In addition to the elements which were not detected in any sample, molybdenum was not detected in any samples from the Turkey Foot Pond sites.

Table 1: Mean concentrations of trace elements detected in fish tissues at Turkey Foot Pond sites, Marais des Cygnes NWR, 1998. Concentrations are reported in mg/kg wet weight.

| Site | spp | Al | Cr | Cu | Hg | Ni | Se | Sr | V | Zn |
|---|---|---|---|---|---|---|---|---|---|---|
| **AL-E** | Carpsucker | | | 3.447 | | | 0.510 | 0.592 | | 4.823 |
| **AL-M** | Channel catfish | 3.057 | 0.124 | 1.184 | 0.042 | | 0.308 | | | 5.763 |
| | Largemouth bass | | | 2.273 | 0.225 | | | | | 5.447 |
| | White crappie | | 0.13 | 0.21 | | | 0.52 | | 0.34 | 5.41 |
| **AL-W** | Common carp and Carpsucker | | 0.131 | 0.238 | 0.051 | | 0.510 | 1.337 | 0.296 | 5.703 |
| | Largemouth bass and White crappie | | | 0.20 | | | 0.66 | | | 6.72 |
| **AL-Sum*** | Carpsucker | 0.947 | 0.161 | 1.881 | | | 0.522 | 1.079 | 0.213 | 4.715 |
| | Channel catfish | 3.057 | 0.124 | 1.184 | 0.042 | | 0.308 | 0.236 | 0.124 | 5.763 |
| | Carpsucker, Channel catfish and common carp | 1.532 | 0.148 | 1.408 | 0.777 | | 0.468 | 0.751 | 0.219 | 5.765 |
| | Largemouth bass | | 0.121 | 1.233 | 0.173 | 0.217 | 0.616 | | 0.298 | 6.243 |
| | White crappie | | 0.111 | 0.197 | 0.034 | | 0.513 | 0.207 | 0.269 | 5.348 |
| | Largemouth bass and White crappie | | 0.117 | 0.819 | 0.117 | | 0.575 | | 0.287 | 5.885 |

* - AL-Sum values are corrected to include BDL values (DL/2) for each species group

Table 2 shows mean concentrations of selected trace elements from fish tissues at the Farm Ponds. Analytical data for all trace elements in fish at these sites is presented in Appendix B-2. In addition to the elements which were not detected at any site, barium, chromium, strontium, and vanadium were not detected in a sufficient number of samples from the Farm Pond sites to provide for statistical evaluation. Also, samples from site FP3 did not have a sufficient number of reported concentrations of any element to perform a statistical evaluation.

Table 2: Mean concentrations of trace elements detected in fish tissues from man-made farm ponds at Marais des Cygnes NWR, 1998. Concentrations are reported in mg/kg wet weight.

| Site | spp | Al | Cu | Mo | Hg | Se | Zn |
|---|---|---|---|---|---|---|---|
| **FP1** | Largemouth bass | | 0.124 | | 0.254 | 0.231 | 5.973 |
| **FP2** | Channel catfish | | 1.034 | | 0.127 | | 7.287 |
| | Largemouth bass | 1.81 | | | 0.169 | 0.294 | 4.363 |
| **MMP** | Channel catfish | | 0.200 | | | 0.265 | 5.690 |
| **S4P** | Black bullhead | | 0.242 | 0.373 | 0.078 | | 4.253 |

Table 3 shows mean concentrations of selected trace elements from fish tissues at the Farm Ponds. Analytical data for all trace elements in fish at these sites is presented in Appendix B-3. In addition to the elements which were not detected at any site, aluminum, barium, chromium, and vanadium were not detected in a sufficient number of samples from these sites to provide for a statistical evaluation.

Table 3: Mean concentrations of trace elements detected in fish tissues from coal mine strip pit lakes at Marais des Cygnes NWR, 1998. Concentrations are reported in mg/kg wet weight.

| Site | spp | Cu | Hg | Se | Sr | Zn |
|---|---|---|---|---|---|---|
| **PI1** | Largemouth bass | 0.17 | 0.30 | 0.27 | | 6.28 |
| **PI2** | Common carp and Carpsucker | 0.262 | 0.113 | 0.364 | 0.453 | 6.097 |
| | Largemouth bass and White crappie | 0.181 | 0.294 | 0.302 | | 4.367 |
| **SS1** | Largemouth bass | 0.276 | 0.325 | | | 3.888 |
| **SS2** | Largemouth bass | | 0.313 | 0.257 | | 0.187 |

Table 4 shows individual concentrations of selected trace elements from fish tissues of both fish collected from the Marais des Cygnes River site. Analytical data for all trace elements in fish at this site is presented in Appendix B-4. In addition to the elements which were not detected at any site, aluminum, barium, chromium, molybdenum, nickel, strontium, and vanadium were not detected in either, or both fish at this site.

Table 4: Concentrations of trace elements detected in fish tissues from the Marais des Cygnes River, Marais des Cygnes NWR, 1998. Concentrations are reported in mg/kg wet weight.

| Site | Species | Hg | Se | Zn |
|---|---|---|---|---|
| **River** | Common carp | 0.192 | 0.504 | 7.03 |
| **River** | Flathead catfish | 0.258 | 0.135 | 4.35 |

## Chlorinated Hydrocarbons

The only compounds which were detected in a sufficient number of samples at any site to provide for a detailed statistical evaluation were a-chlordane, dieldrin, p,p'-DDE, total PCBs, toxaphene, and trans-nonachlor. The reported concentrations for each compound vary within an order of magnitude across all sites. All reported concentration means are less than those considered to be background concentrations.

Table 5 shows the mean and summed concentrations of detected chlorinated hydrocarbons from fish tissues from all sites. Analytical data for all chlorinated hydrocarbons in fish collected for this study are presented in Appendix C, Tables C1- C4.

Table 5: Mean and summed concentrations of chlorinated hydrocarbons detected in fish tissues from all sites at Marais des Cygnes NWR. Concentrations are reported in mg/kg wet weight.

| Site | spp | a-Chlordane | trans-nonachlor | Total Chlordane (Adjusted)* | dieldrin | ppDDE | total PCBs | toxaphene |
|---|---|---|---|---|---|---|---|---|
| **AL-E** | Carpsucker | | | 0.0056 - 0.0064** | | | | 0.00487 |
| **AL-Sum (adjusted)*** | Carpsucker | 0.00090 | 0.00124 | | 0.00331 | 0.00177 | 0.00944 | 0.00315 |
| **MMP** | Channel catfish | | | | | 0.00462 | 0.0091 | |
| **SS2** | Largemouth bass | | | | | | 0.0072 | |
| **River** | Flathead catfish | | | 0.00633*** | | | | |

* - AL-Sum and Total Chlordane values are corrected to include BDL values (DL/2)
** - two fish, range presented
*** - One fish, adjusted total residue presented

EPA (1995) recommends calculating total chlordane and total DDT concentrations to evaluate the necessity of establishing human consumption guidelines. EPA also recommends establishing proxy values for data that is reported as Below Detection Limits (BDL). However, proxy values were not calculated if greater than 50% of the combined results for each sample group were below detection limits. Only two carpsuckers from Turkey Foot -East, and the flathead catfish from the Marais des Cygnes River had a greater than 50% detection rate of the chlordane compounds. This value is presented in Table 5. p,p'-DDE was the only compound in the DDT group (of the six DDT compounds) that was detected at reportable concentrations from any site; therefore, no total DDT concentrations were calculated.

# DISCUSSION

**Trace Elements**

Copper, iron, magnesium, manganese, and zinc are essential macronutrients for fish, although elevated concentrations of several of these elements have been shown to elicit adverse physiological reactions in fish and humans. Concentrations of these elements reported here should be evaluated recognizing their role as essential nutrients as well as a potential toxin.

Copper is an essential element for numerous physiologic processes, such as enzyme-catalyzed reactions, glycoprotein formation, nervous system maintenance, and hemoglobin synthesis (Sorenson 1991). Copper concentrations detected in fish samples are within reported background ranges (Sorenson 1991). Iron also is an essential macronutrient in the formation of hemoglobin, and in numerous enzyme systems (Cole 1975). Manganese is essential for the utilization of vitamin B1.

Chromium tends to be selectively absorbed in the gill, liver, kidney, and digestive tract of fish. Under laboratory conditions, chromium is mutagenic, carcinogenic, and teratogenic to a wide variety of organisms. Chromium exists in the environment in primarily two ionic states, $Cr^{+3}$ and $Cr^{+6}$, as the metallic Cr atom, and as several biologically relevant organochromium compounds. Based on existing data, the $Cr^{+6}$ ion is the most biologically active form, although data gaps for the other forms are acknowledged (Eisler 1986). At higher concentrations, Cr+6 is associated with abnormal enzyme activities, altered blood chemistry, lowered resistance to pathogenic organisms, behavioral modifications, disrupted feeding, histopathology, osmoregulatory upset, alterations in population structure and species diversity indices, and inhibition of photosynthesis in various aquatic species. Not all sublethal effects observed were permanent, but the potential for acclimatization of organisms to Cr is not well documented. High accumulations of Cr have been recorded among organisms from the lower trophic levels, but there is little evidence of biomagnification through food chains. Chromium has been associated with mutations and malignancy (Leonard and Lauwerys 1980; Norseth 1981). Chromium tends to accumulate in brain, kidney, and myocardial tissues in mammals, although accumulation, storage, retention, and depuration depend heavily on its chemical form, route of entry, and amount administered (Yamaguchi et al. 1983). Chromium concentrations measured for this study are at the low end of reported background concentration in freshwater fish muscle samples from North America (Eisler 1986).

Mercury has no known physiological function (EPA 1985). In humans and other mammals, the fetus is the most sensitive life stage: it causes teratogenic, mutagenic, and carcinogenic effects (Eisler 1987). Methylmercury irreversibly destroys the neurons of the central nervous system. At high sublethal doses in man, mercury causes cerebral palsy, gross motor and mental impairment, speech disturbances, blindness, deafness, microcephaly, intestinal disturbances, tremors, and tissue pathology (Chang 1979; EPA 1980a, 1985; Elhassani 1983; Clarkson et al. 1984). Pathological and other effects of mercury may vary from organ to organ, depending on factors such as the effective toxic dose in the organ, the compound involved and its metabolism within the organ, the duration of exposure, and the other contaminants to which the animal is concurrently exposed (Chang 1979).

The chemical form of mercury greatly affects biological uptake and distribution. In one example, Ribeyre and Boudou (1984) immersed rainbow trout in solutions containing 0.1 µg Hg/l, as methylmercury. Bioconcentration factors (BCF) ranged from 28,300 for brain, 30,000 for muscle, 36,000 for whole fish, 102,000 for blood, 110,000 for liver, 137,000 for kidney, 163,000 for gill, and 238,000 for spleen. When mercury was presented as inorganic mercuric ion at 0.1 µg/l for a similar time period, BCF values were usually lower: 2,300 for muscle; 6,800 for brain; 7,000 for whole trout; 14,300 for blood; 25,000 for liver; 53,000 for kidney; 68,600 for gill; and 521,000 for spleen. It should be noted from these two studies that while BCF values for fish muscle, which is the tissue to which humans would most likely be exposed through a dietary pathway, are significant, both organic and inorganic forms of mercury tend to accumulate in other tissues, thereby minimizing potential exposure. Mercury concentrations measured for this study are within the range of background concentrations reported by Eisler (1987) and are not considered a concern for human consumption.

Molybdenum is generally more toxic to teleosts in fresh water than in seawater and more toxic to younger fish than to older fish. Molybdenum has been shown to bioconcentrate through aquatic food chains (Short et al. 1971). Although conclusive evidence that Mo is required by humans is lacking, there is general agreement that it should be considered as one of the essential trace elements. The absence of any documented deficiencies in man indicates that the required level is much less than the average daily intake of 180 µg Mo in the United States (Chappell et al. 1979). Human discomfort has been reported in workers from copper-molybdenum mines, and in those eating food products containing 10 to 15 mg Mo/kg and <10 mg Cu/kg and grown on soils containing elevated molybdenum of 77 mg/kg and 39 mg Cu/kg. The typical human adult contains only 9 mg of molybdenum, primarily in liver, kidney, adrenal, and omentum (Goyer 1986). Most of the ingested molybdenum is easily absorbed from the gastrointestinal tract and excreted within hours or days in urine, mostly as molybdate; excesses may be excreted also by the bile, particularly as hexavalent molybdenum (Friberg et al. 1975; Goyer 1986; Friberg and Lener 1986). At high dietary levels molybdenum reportedly prevents dental caries (Schroeder et al. 1970), but this requires verification.

Eisler (1989) reported background molybdenum concentrations from over 150 species of fish that ranged from 0.1 mg/kg to 0.6 mg/kg on a fresh weight basis. Only one sample from Section 4 Pond had mean detectable residues at 0.373 mg/kg on a fresh weight basis.

Selenium in food is generally found as organo-selenium compounds and associated with proteins. Selenium is easily absorbed through the gastrointestinal tract and stored primarily in the liver and kidneys, and to a lesser extent in blood, lungs, heart testes, and hair (ATSDR 1989). Results of laboratory studies and field investigations with fish, mammals, and birds have led to general agreement that elevated concentrations of selenium in diet or water were associated with reproductive abnormalities including congenital malformations, selective bioaccumulation by the organism, and growth retardation. Not as extensively documented, but nevertheless important, are reports of selenium-induced chromosomal aberrations, intestinal lesions, and behavioral modifications (Eisler 1985). In mammals, acute and chronic exposures to selenium causes numerous physiological impacts to the heart, liver, gastrointestinal tract, central nervous system, and bones (EPA 1994). Selenium concentrations are within the range of reported background tissue burdens for several species of freshwater fish from North America (Eisler 1985).

Zinc is an essential trace element for all living organisms. As a constituent of more than 200 metalloenzymes and other metabolic compounds, zinc assures stability of biological molecules such as DNA and of biological structures such as membranes and ribosomes (Vallee 1959; National Academy of Sciences [NAS] 1979; Casey and Hambidge 1980; Mason et al. 1988; Llobet et al. 1988b; Leonard and Gerber 1989). Eisler (1993) provides an excellent review of the numerous beneficial properties of zinc in aquatic and terrestrial biota. Zinc concentrations measured for this study are within background concentrations reported for freshwater fish (Eisler 1993).

None of the reported mean tissue concentrations for the trace elements discussed above exceeded levels established for the protection of human health, using basic consumption estimates as established by KDHE (S. Cringan, KDHE, written comm.).

**Chlorinated Hydrocarbons**

Technical chlordane is a complex mixture of about 45 compounds, primarily cis-chlordane (19%), trans-chlordane (24%), heptachlor (10%), cis- and trans-nonachlor (7%), and various chlordane isomers (22%) (Eisler, 1990). The environmental stability of the various compounds differs, but widespread historic use and environmental transport has resulted in low level contamination of most fish and wildlife, and human populations. EPA suspended all registrations for chlordane in 1988. Concern over the biological effects related to chlordane exposure is centered around its carcinogenicity in mice, *Mus* sp. (Ewing et al. 1985). Chlordane produced liver cancer in both sexes of two different strains of domestic mice (EPA 1980b; WHO 1984; Tojo et al. 1986). A dose-dependent incidence of hepatocellular carcinoma was evident in mice fed chlordane in their diets; frequency of liver carcinomas was not significantly different from controls at dietary levels of 5 mg/kg and lower but were greatly elevated (i.e., 70% frequency) at dietary levels of 50 mg/kg and higher (EPA 1980b). In contrast to mice, chlordane was not a hepatic carcinogen in rats at dietary levels up to 64 mg/kg ration (WHO 1984; EPA 1988); however, a dose-related increase in follicular cell thyroid neoplasms and malignant fibrous histocytomas was recorded in chlordane-exposed rats (Ohno et al. 1986). In humans, no increased evidence of cancer was proven among employees in chlordane manufacturing facilities, although there was a statistically significant increase in death rate from cerebrovascular disease in that group (Klaassen et al. 1986). All total chlordane concentrations measured for this study are below the Food and Drug Administration “action level” of 0.3 mg/kg, wet weight.

Dieldrin is a organochlorine insecticide of the cyclodiene family. Its is closely related to the pesticide aldrin, and to the other cyclodienes isodrin, endrin, and telodrin. Dieldrin was introduced to the environment both as a “parent” compound and as a metabolite of aldrin. As with most organochlorine pesticides, dieldrin is highly lipophilic and has a relatively long half-life under most environmental conditions. Dieldrin is readily absorbed through the gut and skin and is originally stored in fat, kidneys, liver, and brain. Dieldrin has been measured in breast milk, and will ultimately be stored in those tissues with higher fat content, such as adipose tissue and skin.

Physiological impacts resulting from chronic exposures to dieldrin are similar for all organochlorine compounds, although the effects of the cyclodiene compounds are more related to central nervous system impacts. These types of impacts includes interference with axonic transmission of nerve impulses, which alters the functioning of the entire nervous system, primarily the brain (EPA 1994). Reproductive, developmental, mutagenic, and carcinogenic impacts have all been associated with chronic exposure to dieldrin. The single reported dieldrin concentration measured for this study is below all EPA risk based guidance concentrations for the protection of human health, using standard intake assumptions as developed by KDHE (EPA 1994).

DDT, and its metabolites DDD and DDE, are relatively stable lipophilic compounds which are readily absorbed and bioaccumulated by wildlife. As these compounds are so closely related, EPA recommends pooling analytical data and using the sum DDT concentration when evaluating human health consumption advisories (EPA 1994). The metabolite DDE is best known for its impacts to avian reproduction, although other physiologic impacts are related to this compound. Chronic exposure to DDT has been associated with reproductive, mutagenic, and carcinogenic impacts in numerous species of wildlife, laboratory animals, and humans.

Because of the historic widespread use of DDT and its relative stability under environmental conditions, it is now ubiquitous in nature and may be found in abiotic and biotic samples far removed from application areas. The reported DDT concentrations measured for this study are below all EPA risk based guidance concentrations for the protection of human health (EPA 1994).

Toxaphene is a relatively stable organochlorine insecticide composed of a mixture of structurally similar compounds and isomers. Toxaphene has a tendency to adsorb on sediments and to bioaccumulate in aquatic organisms. Toxaphene degrades more rapidly than other chlorinated pesticides, such as DDT and dieldrin (Eisler 1985). Warm-blooded organisms are relatively resistant to toxaphene, as determined from results of short-term tests involving oral, dermal, and dietary routes of administration. In acute oral toxicity tests with birds and mammals, LD-50 values ranged between 10 and 160 mg/kg body weight. The acute oral toxicities of toxaphene to rats, mice, dogs, guinea pigs, cats, rabbits, cattle, goats, and sheep extended from 25 to 270 mg/kg body weight (Pollock and Calgary 1978; EPA 1980a); rats, mice, dogs, deer, sheep, and cattle are all relatively resistant to toxaphene. However, carcinogenic responses have been induced in mice and rats by toxaphene when residues in the diet exceeded 50 mg/kg during lifetime exposure (EPA 1980a).

Eisler (1986) reported concentrations of toxaphene in channel catfish from Arroyo Colorado, Texas ranging from 0.8-19.5 mg/kg wet weight. This site was characterized as highly contaminated with toxaphene and other organochlorine pesticides, and had numerous sources which included cotton fields where toxaphene was used and a chemical plant where toxaphene was manufactured. Higher concentrations were also observed in other *Ictalurid* species. Toxaphene was also detected in fish-eating birds collected in this area, indicating the ability of this compound to be mobilized through food chains. Toxaphene concentrations measured in these birds were reported to be biologically insignificant. The reported toxaphene concentrations measured for this study are below all EPA risk based guidance concentrations for the protection of human health, using standard intake assumptions as developed by KDHE (EPA 1994).

PCBs are extremely stable compounds, and slow to chemically degrade under environmental conditions. The number and position of the chlorine atoms on the biphenyl rings affects the rate of microbial degradation and biological properties of the compound. Biological availability and uptake of individual PCBs from aqueous solution are influenced primarily by two factors: the partition coefficient (Kow); and steric factors resulting from different patterns of chlorine substitution. PCBs are usually taken up by animals and stored in lipids under circumstances of increasing lipid content in organs (Eisler 1986). In mammals, PCBs are readily absorbed through the gut, respiratory system, and skin. Biological activities of PCBs differ substantially. Initially, PCBs concentrate in liver, blood, and muscle; eventually, accumulations are highest in adipose tissue and skin. Susceptibility of individual PCB isomers to metabolism is a function of the number of chlorine atoms present on the biphenyl rings and their arrangement. In general, most readily metabolized PCBs are also rapidly excreted in urine and bile. The highly chlorinated isomers are difficult to metabolize and accumulate almost indefinitely. However, recent studies with marine fishes indicate that PCB components remain mobilizable from organs whose lipid contents increased (Boon et al. 1984). PCBs can be transferred to young mammals either transplacentally or in breast milk. Retention of PCBs is highly species specific: nonhuman primates, for example, retained PCBs more efficiently than rodents (EPA 1980d).

PCBs elicit a variety of biologic and toxic effects including skin lesions, a wasting syndrome, immunotoxicity, reproductive toxicity, genotoxic and epigenetic effects, hepatomegaly and related liver damage, and the induction of hepatic and extrahepatic drug-metabolizing enzymes. PCB accumulations from the diet and from other sources are high, and retention is lengthy in fatty tissues. Interspecies differences in sensitivity to PCBs are large, even between species that are closely related taxonomically. Mutagenic, carcinogenic, and teratogenic properties of PCBs are documented. In general, mutagenic activity tends to decrease with increasing chlorination (EPA 1980d). The carcinogenic effects of PCBs have been established in mice and rats with various Aroclor and Kanechlor PCBs and these, in turn, may enhance the carcinogenicity of other chemicals (EPA 1980d). Experimental data clearly shows that commercial PCBs cause liver damage which leads to putative preneoplastic changes and hepatocellular carcinomas; however, these lesions are observed only after lengthy (11 to 21 months) exposures to relatively high doses (100 to 1,200 ppm in diets) of these chemicals (NAS 1979; Safe 1984).

PCB concentrations in the environment are usually a mixture of the 209 possible congeners of chlorinated biphenyls. These congeners have differing toxicities and bioavailabilities, based on the number and location of chlorine atoms in the molecular structure. Risk-based consumption guidance criteria developed by EPA (1994) for PCBs are based on a particular commercial PCB mixture, Aroclor 1254. This mixture has a relatively greater percentage of individual compounds that are more bioavailable, hence these compounds are more rapidly absorbed than other congeners. Therefore, the criteria developed by EPA should be viewed as based upon the most biologically available forms of PCBs, and not upon the ratio of PCB congeners typically found in the environment. If the entire concentrations measured for this study were composed of Aroclor 1254 congeners, then some consumption advisories may required in those ponds where PCBs were detected. However, if one assumes a more realistic mixture of more PCB congeners in these samples, the measured concentrations are below those established for the protection of human health. Finally, the low detection rate of total PCBs in individual fish (35%) and the low number of sites where composite results were reportable (3 of 13) support this conclusion.

In summary, none of the reported mean tissue concentrations for the chlorinated hydrocarbon compounds discussed above exceeded levels established for the protection of human health, using basic consumption estimates as established by KDHE (S. Cringan, KDHE, written comm.).

**Petroleum Hydrocarbons**
PAH levels in fish are usually low because this group rapidly metabolizes PAHs (Lawrence and Weber 1984); furthermore, higher molecular weight PAHs, which include the largest class of chemical carcinogens, do not seem to accumulate in fish (West et al. 1984). Raw fish from unpolluted waters usually do not contain detectable amounts of PAHs, but smoked or cooked fish contain varying levels. The concentration of benzo(a)pyrene in skin of cooked fish was much higher than in other tissues, suggesting that skin may serve as a barrier to the migration of PAHs in body tissues (EPA 1980c). PAH concentrations in fish tissues follow an established pattern of rapid accumulation at the onset of exposure, followed by rapid metabolism and depuration (Nava and Englehardt 1980). PAHs are metabolized by liver mixed-function oxidases to epoxides, dihydrodiols, phenols, and quinones. The intermediate metabolites have been identified as the mutagenic, carcinogenic, and teratogenic agents (Sims and Overcash 1983, Tan and Melius 1986).

Eisler (1987) reported background concentrations from numerous species of fish from numerous sites of 1 -536 mg/kg fresh weight. Some of these sites may have anthropogenic sources of petroleum hydrocarbons, so it is difficult to determine if these concentrations are indicative of natural conditions. Also, analytical methods for measuring these types of compounds vary, further confusing comparison of results.

The analytical method used for this study reports results as “Total Petroleum Hydrocarbons” (TPH). This method does not determine concentrations of the individual constituents which may comprise this group, and may also include concentrations of naturally occurring aromatic and or aliphatic compounds (J. Moore, USFWS-PACF, pers. comm). It is, however, a useful screening tool to detect the presence of elevated total petroleum hydrocarbons, and to indicate if additional

PAH specific analysis is warranted. Analytical results from fish sampled for this project are indeterminate. As discussed above, adult fish from a water body contaminated with PAHs should have low PAH residues, as these compounds are readily metabolized and excreted. In addition, one would expect physiological manifestations of exposure to subacute concentrations of PAHs (e.g., skin lesions), especially in adult fish. No obvious health impairments were observed beyond the parasitic infections in catfish and bass, and the carpsuckers with the highest reported TPH residues had no obvious signs of physiological impairment. Of the 60 individual fish collected, 11 did not have measurable concentrations (<1.0 mg/kg wet weight); no fish had concentrations between 1.0 and 10 mg/kg; 20 had concentrations between 10 and 100 mg/kg; 25 had concentrations between 100 and 1000 mg/kg; and 4 had concentrations greater than 1000 mg/kg (maximum concentration of 48,700 mg/kg). Further, 11 of the fish collected for this study had higher TPH residues than the highest concentration reported as background, even though other individual fish from the same water body had substantially lower concentrations. Indeed, three of the results were substantially higher (two orders of magnitude) than the highest reported LC50 concentration for any individual PAH. Finally, there were no indications of a sufficient amount of petroleum hydrocarbons in the ponds (i.e., slicks or sheens) to have resulted in these concentrations, and all fish appeared in good health. It is suggested that these values be considered questionable, and that they be confirmed by an additional examination of petroleum hydrocarbon residues in fish tissues prior to determining the necessity of consumption guidelines.

# CONCLUSION

We collected edible tissue (fillet) samples from largemouth bass, white crappie, common carp, carpsucker, channel catfish, black bullhead, and flathead catfish from 13 sites at Marais des Cygnes National Wildlife Refuge. These samples were analyzed for trace element, chlorinated hydrocarbon, and total petroleum hydrocarbon residues to determine if it is appropriate to allow consumptive fishing at the refuge. Numerous elements and compounds were detected in the fish tissues. Mean concentrations were calculated and compared to consumption values established for the protection of human health. Based on the results of this study, consumption advisories do not need to be established for the waterbodies sampled in 1998 for trace elements or chlorinated hydrocarbons. The results for total petroleum hydrocarbons should be considered provisional, pending additional examination. We anticipate that this question will be resolved in 1999.

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Appendix A

Table A-1: Field Data for samples collected from the Turkey Foot Pond sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Length (mm) | Weight (g) | Sample Weight | Sample Matrix | % Moisture | % Lipid |
|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carpsucker | 313 | 425 | 126.1 | Muscle | 81.5 | 0.30 |
| ALECS2 | Turkey Foot-East | Carpsucker | 399 | 900 | 318.7 | Muscle | 72.7 | 10.80 |
| ALECS3 | Turkey Foot-East | Carpsucker | 389 | 950 | 296.6 | Muscle | 72.7 | 9.00 |
| ALELMB1 | Turkey Foot-East | Largemouth bass | 271 | 300 | 80.4 | Muscle | 79.8 | 0.20 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | 347 | 550 | 86.1 | Muscle | 80.8 | 0.20 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | 393 | 1000 | 344.4 | Muscle | 73.9 | 7.00 |
| ALMIP1 | Turkey Foot-Mid | Channel catfish | 300 | 200 | 47.6 | Muscle | 82.7 | 0.80 |
| ALMIP2 | Turkey Foot-Mid | Channel catfish | 280 | 150 | 46.6 | Muscle | 82.2 | 0.30 |
| ALMIP3 | Turkey Foot-Mid | Channel catfish | 275 | 150 | 42.2 | Muscle | 81.9 | 0.20 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | 353 | 650 | 166.0 | Muscle | 80.6 | 0.20 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | 471 | 1350 | 309.6 | Muscle | 81.9 | 0.10 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | 460 | 1600 | 410.8 | Muscle | 79.5 | 0.40 |
| ALMWC1 | Turkey Foot-Mid | White crappie | 220 | 125 | 31.3 | Muscle | 78.8 | 0.60 |
| ALMWC2 | Turkey Foot-Mid | White crappie | 245 | 150 | 34.8 | Muscle | 80.7 | 0.20 |
| ALMWC3 | Turkey Foot-Mid | White crappie | 264 | 300 | 90.2 | Muscle | 78.5 | 0.70 |
| ALWCC1 | Turkey Foot-West | Common Carp | 354 | 650 | 155.2 | Muscle | 80.1 | 0.40 |
| ALWCS1 | Turkey Foot-West | Carpsucker | 321 | 450 | 160.4 | Muscle | 81.2 | 0.30 |
| ALWCS2 | Turkey Foot-West | Carpsucker | 321 | 500 | 150.0 | Muscle | 80.4 | 0.20 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | 430 | 1150 | 267.9 | Muscle | 79.9 | 0.20 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | 270 | 250 | 63.6 | Muscle | 79.8 | 0.10 |
| ALWWC1 | Turkey Foot-West | White crappie | 203 | 100 | 26.8 | Muscle | 78.0 | 0.20 |

Table A-2: Field Data for samples collected from the farm pond sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Length (mm) | Weight (g) | Sample Weight | Sample Matrix | % Moisture | % Lipid |
|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth bass | 200 | 265 | 71.8 | Muscle | 79.6 | 0.10 |
| FP1LMB2 | Farm Pond 1 | Largemouth bass | 200 | 265 | 43.2 | Muscle | 79.9 | 0.10 |
| FP1LMB3 | Farm Pond 1 | Largemouth bass | 150 | 245 | 43.6 | Muscle | 1.5 | |
| FP2IP1 | Farm Pond 2 | Channel catfish | 568 | 2050 | 413.0 | Muscle | 78.5 | 2.10 |
| FP2IP2 | Farm Pond 2 | Channel catfish | 573 | 1850 | 318.7 | Muscle | 78.4 | 2.20 |
| FP2IP3 | Farm Pond 2 | Channel catfish | 511 | 1900 | 399.8 | Muscle | 79.9 | 1.10 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | 361 | 650 | 166.3 | Muscle | 79.8 | 0.10 |
| FP2LMB2 | Farm Pond 2 | Largemouth bass | 327 | 500 | 138.3 | Muscle | 80.2 | 0.20 |
| FP2LMB3 | Farm Pond 2 | Largemouth bass | 290 | 300 | 95.6 | Muscle | 79.6 | 0.20 |
| FP3BLB1 | Farm Pond 3 | Bullhead | 362 | 650 | 79.0 | Muscle | 87.6 | 0.10 |
| FP3BLB2 | Farm Pond 3 | Bullhead | 385 | 1250 | 285.7 | Muscle | 87.6 | 0.20 |
| MMPIP1 | Manmade Pond | Channel catfish | 547 | 1850 | 460.1 | Muscle | 82.2 | 1.50 |
| MMPIP2 | Manmade Pond | Channel catfish | 494 | 1050 | 181.5 | Muscle | 80.6 | 0.90 |
| MMPIP3 | Manmade Pond | Channel catfish | 529 | 1400 | 226.6 | Muscle | 83.8 | 0.50 |
| MMPLMB1 | Manmade Pond | Largemouth bass | 425 | 1400 | 391.2 | Muscle | 77.3 | 0.20 |
| SEC4BLB1 | Section 4 | Bullhead | 245 | 250 | 35.7 | Muscle | 79.7 | 0.20 |
| SEC4BLB2 | Section 4 | Bullhead | 295 | 400 | 80.9 | Muscle | 79.6 | 0.30 |
| SEC4BLB3 | Section 4 | Bullhead | 300 | 450 | 106.2 | Muscle | 80.8 | 0.40 |

Table A-3:Field Data for samples collected from the pit lake sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Length (mm) | Weight (g) | Sample Weight | Sample Matrix | % Moisture | % Lipid |
|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common Carp | 332 | 500 | 78.2 | Muscle | 80.6 | 0.200 |
| PI1CC2 | Poison Ivy 1 | Common Carp | 345 | 450 | 124.3 | Muscle | 78.7 | 0.300 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | 362 | 650 | 184.9 | Muscle | 78.2 | 0.200 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | 320 | 450 | 118.7 | Muscle | 78.7 | 0.300 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | 285 | 300 | 86.2 | Muscle | 79.3 | 0.300 |
| PI2CC1 | Poison Ivy 2 | Common Carp | 347 | 500 | 114.6 | Muscle | 79.8 | 0.200 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | 337 | 550 | 139.9 | Muscle | 79.0 | 0.400 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | 291 | 375 | 96.5 | Muscle | 79.4 | 0.200 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | 415 | 1150 | 284.1 | Muscle | 78.0 | 0.100 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | 445 | 1275 | 376.3 | Muscle | 79.0 | 0.100 |
| PI2WC1 | Poison Ivy 2 | White crappie | 301 | 350 | 96.6 | Muscle | 79.2 | 0.200 |
| SSP1LMB1 | Southside Pond 1 | Largemouth bass | 391 | 900 | 243.7 | Muscle | 78.6 | 0.200 |
| SSP1LMB2 | Southside Pond 1 | Largemouth bass | 391 | 800 | 213.6 | Muscle | 78.4 | 0.100 |
| SSP1LMB3 | Southside Pond 1 | Largemouth bass | 371 | 700 | 215.7 | Muscle | 78.8 | 0.100 |
| SSP1LMB4 | Southside Pond 1 | Largemouth bass | 387 | 800 | 245.9 | Muscle | 79.1 | 0.100 |
| SSP2LMB1 | Southside Pond 2 | Largemouth bass | 392 | 900 | 264.1 | Muscle | 79.2 | 0.100 |
| SSP2LMB2 | Southside Pond 2 | Largemouth bass | 297 | 400 | 124.5 | Muscle | 79.6 | 0.100 |
| SSP2LMB3 | Southside Pond 2 | Largemouth bass | 365 | 650 | 189.7 | Muscle | 78.6 | 0.100 |
| SSP2LMB4 | Southside Pond 2 | Largemouth bass | 373 | 550 | 143.2 | Muscle | 80.6 | 0.100 |

Table A-4: Field Data for samples collected from the Marais des Cygnes River, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Length (mm) | Weight (g) | Sample Weight | Sample Matrix | % Moisture | % Lipid |
|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common Carp | 505 | 1350 | 244.3 | Muscle | 78.9 | 0.100 |
| RIVRFHC1 | River | Flathead catfish | 640 | 3350 | 530.0 | Muscle | 79.0 | 0.600 |

Appendix B: Trace Elements

Table B-1: Trace element data from the Turkey Foot Pond sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Al | As | Bo | Ba | Be | Cd |
|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carp Sucker | <0.913 | <0.091 | <0.365 | 0.639 | <0.018 | <0.018 |
| ALECS2 | Turkey Foot-East | Carp Sucker | 1.48 | <0.142 | <0.57 | <0.285 | <0.028 | <0.028 |
| ALECS3 | Turkey Foot-East | Carp Sucker | 1.43 | <0.135 | <0.541 | <0.27 | <0.027 | <0.027 |
| ALELMB1 | Turkey Foot-East | Largemouth Bass | <0.979 | <0.097 | <0.392 | <0.196 | <0.019 | <0.019 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | 1.68 | <0.095 | <0.38 | 0.259 | <0.259 | <0.019 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | 1.41 | <0.127 | <0.509 | 0.272 | <0.272 | <0.025 |
| ALMIP1 | Turkey Foot-Mid | Channel Catfish | 3.83 | <0.085 | <0.343 | <0.172 | <0.172 | <0.017 |
| ALMIP2 | Turkey Foot-Mid | Channel Catfish | 3.08 | <0.087 | <0.35 | <0.175 | <0.175 | <0.017 |
| ALMIP3 | Turkey Foot-Mid | Channel Catfish | 2.26 | 0.085 | <0.341 | <0.17 | <0.17 | <0.017 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | <0.951 | 0.101 | <0.38 | <0.19 | <0.19 | <0.019 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | <0.92 | <0.092 | <0.368 | <0.184 | <0.184 | <0.018 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | <0.992 | 0.126 | <0.397 | <0.198 | <0.198 | <0.019 |
| ALMWC1 | Turkey Foot-Mid | White crappie | <0.97 | <0.097 | <0.388 | <0.194 | <0.194 | <0.019 |
| ALMWC2 | Turkey Foot-Mid | White crappie | 0.957 | 0.104 | <0.365 | <0.182 | <0.182 | <0.018 |
| ALMWC3 | Turkey Foot-Mid | White crappie | <1.04 | <0.104 | <0.418 | <0.209 | <0.209 | <0.020 |
| ALWCC1 | Turkey Foot-West | Common Carp | <0.932 | <0.093 | <0.373 | <0.186 | <0.018 | <0.018 |
| ALWCS1 | Turkey Foot-West | Carpsucker | <0.882 | <0.088 | <0.353 | 0.492 | <0.017 | <0.017 |
| ALWCS2 | Turkey Foot-West | Carpsucker | <0.927 | <0.092 | <0.371 | 0.612 | <0.018 | <0.018 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | <1.00 | <0.1 | <0.401 | <0.201 | <0.020 | <0.020 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | <0.976 | <0.097 | <0.39 | <0.195 | <0.019 | <0.019 |
| ALWWC1 | Turkey Foot-West | White crappie | 1.86 | <0.099 | <0.397 | <0.199 | <0.019 | <0.019 |

Table B-1: Continued.

| Sample Number | Site | Species | Cr | Cu | Fe | Mg | Mn | Hg |
|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carp Sucker | <0.091 | 0.280 | 3.40 | 314 | 1.29 | <0.036 |
| ALECS2 | Turkey Foot-East | Carp Sucker | 0.174 | 0.590 | 5.56 | 280 | 0.524 | <0.057 |
| ALECS3 | Turkey Foot-East | Carp Sucker | 0.349 | 9.47 | 6.34 | 299 | 0.714 | <0.054 |
| ALMLMB1 | Turkey Foot-East | Largemouth Bass | 0.114 | 0.143 | 2.12 | 310 | <0.196 | 0.087 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | 0.124 | 0.320 | 7.86 | 304 | 0.709 | 0.065 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | 0.168 | 0.557 | 6.53 | 286 | 0.801 | <0.050 |
| ALMIP1 | Turkey Foot-Mid | Channel Catfish | 0.112 | 3.05 | 5.63 | 237 | 0.319 | 0.043 |
| ALMIP2 | Turkey Foot-Mid | Channel Catfish | 0.152 | 0.259 | 5.14 | 248 | 0.354 | 0.046 |
| ALMIP3 | Turkey Foot-Mid | Channel Catfish | 0.107 | 0.244 | 4.29 | 260 | 0.556 | 0.037 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | <0.095 | 0.354 | 2.98 | 280 | <0.19 | 0.178 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | 0.133 | 0.924 | 2.16 | 278 | <0.184 | 0.282 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | 0.28 | 5.54 | 3.13 | 297 | <0.198 | 0.215 |
| ALMWC1 | Turkey Foot-Mid | White crappie | 0.151 | 0.184 | 1.47 | 304 | 0.293 | <0.038 |
| ALMWC2 | Turkey Foot-Mid | White crappie | 0.137 | 0.202 | 2.32 | 273 | <0.182 | 0.054 |
| ALMWC3 | Turkey Foot-Mid | White crappie | 0.107 | 0.240 | 1.66 | 332 | <0.209 | 0.042 |
| ALWCC1 | Turkey Foot-West | Common Carp | 0.164 | 0.326 | 6.40 | 281 | 0.242 | 0.042 |
| ALWCS1 | Turkey Foot-West | Carpsucker | 0.132 | 0.213 | 2.49 | 293 | 1.37 | 0.046 |
| ALWCS2 | Turkey Foot-West | Carpsucker | 0.096 | 0.176 | 2.80 | 312 | 1.67 | 0.062 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | <0.1 | 0.158 | 1.69 | 310 | <0.201 | 0.171 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | .099 | 0.277 | 2.24 | 314 | <0.195 | 0.103 |
| ALWWC1 | Turkey Foot-West | White crappie | <0.099 | 0.163 | 3.26 | 321 | 0.336 | <0.039 |

Table B-1: Continued.

| Sample Number | Site | Species | Mo | Ni | Pb | Se | Sr | V | Zn |
|---|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carp Sucker | <0.365 | <0.091 | <0.091 | 0.461 | 0.997 | 0.411 | 4.74 |
| ALECS2 | Turkey Foot-East | Carp Sucker | <0.57 | <0.142 | <0.142 | 0.556 | 0.285 | <0.142 | 4.19 |
| ALECS3 | Turkey Foot-East | Carp Sucker | <0.541 | 1.25 | <0.135 | 0.514 | 0.495 | <0.135 | 5.54 |
| ALELMB1 | Turkey Foot-East | Largemouth Bass | <0.392 | <0.097 | <0.097 | 0.493 | <0.097 | <0.097 | 6.13 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | <0.38 | <0.095 | <0.095 | 0.562 | 0.943 | 0.200 | 10.0 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | <0.509 | 0.158 | <0.127 | 0.606 | 0.819 | 0.399 | 4.54 |
| ALMIP1 | Turkey Foot-Mid | Channel Catfish | <0.343 | <0.085 | 0.424 | 0.247 | 0.118 | <0.085 | 6.53 |
| ALMIP2 | Turkey Foot-Mid | Channel Catfish | <0.35 | <0.087 | <0.087 | 0.362 | <0.087 | 0.107 | 5.35 |
| ALMIP3 | Turkey Foot-Mid | Channel Catfish | <0.341 | <0.085 | <0.085 | 0.315 | 0.546 | 0.223 | 5.41 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | <0.38 | <0.095 | <0.095 | 0.672 | <0.095 | 0.375 | 4.63 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | <0.368 | 0.145 | <0.092 | 0.501 | <0.092 | 0.466 | 5.94 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | <0.397 | 0.341 | <0.099 | 0.547 | <0.099 | <0.099 | 5.77 |
| ALMWC1 | Turkey Foot-Mid | White crappie | <0.388 | <0.097 | <0.097 | 0.468 | 1.36 | 0.171 | 5.19 |
| ALMWC2 | Turkey Foot-Mid | White crappie | <0.365 | <0.091 | <0.091 | 0.594 | 0.137 | 0.334 | 6.11 |
| ALMWC3 | Turkey Foot-Mid | White crappie | <0.418 | <0.104 | <0.104 | 0.500 | <0.104 | 0.522 | 4.92 |
| ALWCC1 | Turkey Foot-West | Common Carp | <0.373 | <0.093 | <0.093 | 0.538 | 0.132 | 0.561 | 7.83 |
| ALWCS1 | Turkey Foot-West | Carpsucker | <0.353 | <0.088 | <0.088 | 0.487 | 2.42 | 0.104 | 4.74 |
| ALWCS2 | Turkey Foot-West | Carpsucker | <0.371 | <0.092 | <0.092 | 0.505 | 1.46 | 0.224 | 4.54 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | <0.401 | <0.1 | <0.1 | 0.864 | <0.1 | 0.146 | 4.79 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | <0.39 | 0.166 | <0.097 | 0.620 | 0.174 | 0.705 | 10.2 |
| ALWWC1 | Turkey Foot-West | White crappie | <0.397 | <0.099 | <0.099 | 0.490 | 0.433 | <0.099 | 5.17 |

Table B-2:Trace element data from the farm pond sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Al | As | Bo | Ba | Be | Cd |
|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth Bass | <0.99 | <0.099 | <0.396 | <0.198 | <0.019 | <0.019 |
| FP1LMB2 | Farm Pond 1 | Largemouth Bass | <0.958 | <0.095 | <0.383 | <0.192 | <0.019 | <0.019 |
| FP1LMB3 | Farm Pond 1 | Largemouth Bass | <0.951 | <0.095 | <0.38 | <0.19 | <0.019 | <0.019 |
| FP2IP1 | Farm Pond 2 | Channel catfish | <1.05 | <0.105 | <0.421 | <0.21 | <0.021 | <0.021 |
| FP2IP2 | Farm Pond 2 | Channel catfish | <1.05 | <0.105 | <0.422 | <0.211 | <0.021 | <0.021 |
| FP2IP3 | Farm Pond 2 | Channel catfish | <0.98 | <0.098 | <0.392 | <0.196 | <0.019 | <0.019 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | 2.18 | <0.092 | <0.372 | <0.186 | <0.018 | <0.018 |
| FP2LMB2 | Farm Pond 2 | Largemouth bass | 1.79 | <0.096 | <0.387 | <0.193 | <0.019 | <0.019 |
| FP2LMB3 | Farm Pond 2 | Largemouth bass | 1.46 | <0.098 | <0.393 | <0.197 | <0.019 | <0.019 |
| FP3BLB1 | Farm Pond 3 | Bullhead | 1.65 | <0.064 | <0.259 | 0.431 | <0.013 | <0.013 |
| FP3BLB2 | Farm Pond 3 | Bullhead | <0.846 | <0.084 | <0.338 | <0.169 | <0.016 | <0.016 |
| MMPIP1 | Manmade Pond | Channel catfish | <0.974 | <0.097 | <0.39 | <0.195 | <0.019 | <0.019 |
| MMPIP2 | Manmade Pond | Channel catfish | 1.79 | <0.090 | <0.361 | <0.181 | <0.018 | <0.018 |
| MMPIP3 | Manmade Pond | Channel catfish | <0.835 | <0.083 | <0.334 | <0.167 | <0.016 | <0.016 |
| MMPLMB1 | Manmade Pond | Largemouth bass | <1.01 | 0.111 | <0.404 | <0.202 | <0.020 | <0.020 |
| SEC4BLB1 | Section 4 Pond | Bullhead | <0.952 | <0.095 | <0.381 | <0.19 | <0.019 | <0.019 |
| SEC4BLB2 | Section 4 Pond | Bullhead | <0.943 | <0.094 | <0.377 | <0.189 | <0.018 | <0.018 |
| SEC4BLB3 | Section 4 Pond | Bullhead | <0.901 | <0.090 | <0.36 | <0.18 | <0.018 | <0.018 |

Table B-2: Continued.

| Sample Number | Site | Species | Cr | Cu | Fe | Mg | Mn | Hg |
|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth Bass | <0.099 | 0.115 | 1.87 | 311 | 0.347 | 0.294 |
| FP1LMB2 | Farm Pond 1 | Largemouth Bass | 0.814 | 0.109 | 5.34 | 314 | <0.192 | 0.259 |
| FP1LMB3 | Farm Pond 1 | Largemouth Bass | 0.118 | 0.148 | 1.80 | 302 | 0.510 | 0.210 |
| FP2IP1 | Farm Pond 2 | Channel catfish | <0.105 | 0.686 | 4.74 | 243 | 0.429 | 0.095 |
| FP2IP2 | Farm Pond 2 | Channel catfish | <0.105 | 0.887 | 5.75 | 253 | 0.320 | 0.185 |
| FP2IP3 | Farm Pond 2 | Channel catfish | 0.102 | 1.53 | 5.13 | 232 | 0.253 | 0.099 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | <0.092 | <0.092 | 2.35 | 256 | <0.186 | 0.220 |
| FP2LMB2 | Farm Pond 2 | Largemouth bass | 0.114 | <0.096 | 2.40 | 280 | <0.193 | 0.155 |
| FP2LMB3 | Farm Pond 2 | Largemouth bass | 0.11 | <0.098 | 2.22 | 281 | 0.560 | 0.132 |
| FP3BLB1 | Farm Pond 3 | Bullhead | <0.064 | 0.114 | 11.5 | 156 | 0.161 | 0.145 |
| FP3BLB2 | Farm Pond 3 | Bullhead | 0.098 | 0.171 | 7.92 | 208 | <0.169 | 0.036 |
| MMPIP1 | Manmade Pond | Channel catfish | <0.097 | 0.216 | 4.22 | 207 | <0.195 | <0.039 |
| MMPIP2 | Manmade Pond | Channel catfish | <0.090 | 0.210 | 6.23 | 193 | <0.181 | 0.063 |
| MMPIP3 | Manmade Pond | Channel catfish | <0.083 | 0.174 | 6.06 | 184 | <0.167 | 0.078 |
| MMPLMB1 | Manmade Pond | Largemouth bass | <0.101 | 0.829 | 2.09 | 291 | <0.202 | <0.040 |
| SEC4BLB1 | Section 4 Pond | Bullhead | <0.095 | 0.196 | 4.19 | 269 | 0.280 | 0.130 |
| SEC4BLB2 | Section 4 Pond | Bullhead | 0.104 | 0.307 | 8.46 | 268 | 0.209 | 0.045 |
| SEC4BLB3 | Section 4 Pond | Bullhead | <0.090 | 0.223 | 9.37 | 247 | 0.187 | 0.057 |

Table B-2: Continued.

| Sample Number | Site | Species | Mo | Ni | Pb | Se | Sr | V | Zn |
|---|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth Bass | <0.396 | <0.099 | <0.099 | 0.167 | 0.279 | <0.099 | 5.98 |
| FP1LMB2 | Farm Pond 1 | Largemouth Bass | <0.383 | <0.095 | <0.095 | 0.216 | <0.095 | <0.095 | 5.94 |
| FP1LMB3 | Farm Pond 1 | Largemouth Bass | <0.38 | <0.095 | <0.095 | 0.310 | 0.24 | <0.095 | 6.00 |
| FP2IP1 | Farm Pond 2 | Channel catfish | <0.421 | <0.105 | <0.105 | 0.110 | <0.105 | <0.105 | 8.21 |
| FP2IP2 | Farm Pond 2 | Channel catfish | <0.422 | <0.105 | <0.105 | <0.105 | <0.105 | <0.105 | 8.80 |
| FP2IP3 | Farm Pond 2 | Channel catfish | <0.392 | <0.098 | <0.098 | <0.098 | <0.098 | 0.406 | 4.85 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | 0.584 | <0.092 | <0.092 | 0.299 | <0.092 | <0.092 | 3.51 |
| FP2LMB2 | Farm Pond 2 | Largemouth bass | <0.387 | <0.096 | <0.096 | 0.304 | <0.096 | <0.096 | 4.52 |
| FP2LMB3 | Farm Pond 2 | Largemouth bass | <0.393 | <0.098 | <0.098 | 0.279 | 0.832 | <0.098 | 5.06 |
| FP3BLB1 | Farm Pond 3 | Bullhead | <0.259 | <0.064 | <0.064 | 0.102 | 0.171 | <0.064 | 4.33 |
| FP3BLB2 | Farm Pond 3 | Bullhead | 0.348 | <0.084 | <0.084 | 0.131 | <0.084 | 0.149 | 3.85 |
| MMPIP1 | Manmade Pond | Channel catfish | 0.45 | <0.097 | <0.097 | 0.284 | <0.097 | <0.097 | 5.46 |
| MMPIP2 | Manmade Pond | Channel catfish | <0.361 | <0.090 | <0.090 | 0.229 | <0.090 | <0.090 | 6.00 |
| MMPIP3 | Manmade Pond | Channel catfish | <0.334 | <0.083 | <0.083 | 0.282 | <0.083 | 0.165 | 5.61 |
| MMPLMB1 | Manmade Pond | Largemouth bass | <0.404 | <0.101 | <0.101 | 0.424 | <0.101 | 0.247 | 3.78 |
| SEC4BLB1 | Section 4 Pond | Bullhead | 0.381 | <0.095 | <0.095 | <0.095 | <0.095 | 0.143 | 4.54 |
| SEC4BLB2 | Section 4 Pond | Bullhead | 0.377 | <0.094 | <0.094 | <0.094 | <0.094 | 0.257 | 4.40 |
| SEC4BLB3 | Section 4 Pond | Bullhead | 0.360 | <0.090 | <0.090 | 0.118 | <0.090 | <0.090 | 3.82 |

Table B-3: Trace element data from the pit lake sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Al | As | Bo | Ba | Be | Cd |
|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common carp | 9.36 | <0.097 | <0.391 | 0.248 | <0.019 | <0.019 |
| PI1CC2 | Poison Ivy 1 | Common carp | 4.44 | <0.097 | <0.39 | 0.265 | <0.019 | <0.019 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | <0.996 | <0.099 | <0.398 | <0.199 | <0.019 | <0.019 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | 1.00 | 0.134 | <0.4 | <0.2 | <0.02 | <0.02 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | <0.957 | <0.095 | <0.383 | <0.191 | <0.019 | <0.019 |
| PI2CC1 | Poison Ivy 2 | Common carp | 2.67 | <0.094 | <0.376 | <0.188 | <0.018 | <0.018 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | <0.89 | <0.089 | <0.356 | 0.537 | <0.017 | <0.017 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | 1.92 | <0.089 | <0.358 | 0.648 | <0.017 | <0.017 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | <0.972 | <0.097 | <0.389 | <0.194 | <0.019 | <0.019 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | <0.955 | <0.095 | <0.382 | <0.191 | <0.019 | <0.019 |
| PI2WC1 | Poison Ivy 2 | White crappie | 4.80 | <0.096 | <0.384 | <0.192 | <0.019 | <0.019 |

Table B-3: Continued.

| Sample Number | Site | Species | Cr | Cu | Fe | Mg | Mn | Hg |
|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common carp | <0.097 | 0.330 | 14.2 | 269 | 0.445 | 0.142 |
| PI1CC2 | Poison Ivy 1 | Common carp | 0.109 | 0.368 | 9.91 | 263 | 0.421 | 0.073 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | <0.099 | 0.141 | 2.60 | 283 | <0.199 | 0.368 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | <0.1 | 0.168 | 2.18 | 296 | <0.2 | 0.292 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | <0.095 | 0.205 | 1.92 | 312 | <0.191 | 0.238 |
| PI2CC1 | Poison Ivy 2 | Common carp | <0.094 | 0.243 | 5.97 | 271 | 0.536 | 0.121 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | <.089 | 0.278 | 3.87 | 260 | 0.849 | 0.121 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | 0.1 | 0.265 | 6.48 | 265 | 0.558 | 0.097 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | <0.097 | 0.115 | 2.54 | 275 | <0.194 | 0.329 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | <0.095 | 0.319 | 2.62 | 282 | <0.191 | 0.399 |
| PI2WC1 | Poison Ivy 2 | White crappie | 0.106 | 0.109 | 5.20 | 260 | 0.505 | 0.154 |

Table B-3: Continued.

| Sample Number | Site | Species | Mo | Ni | Pb | Se | Sr | V | Zn |
|---|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common carp | <0.391 | <0.097 | <0.097 | 0.245 | 0.375 | <0.097 | 11.0 |
| PI1CC2 | Poison Ivy 1 | Common carp | <0.39 | <0.097 | <0.097 | 0.244 | 0.355 | 0.154 | 8.33 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | <0.398 | <0.099 | <0.099 | 0.278 | <.099 | 0.124 | 5.76 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | <0.4 | <0.1 | <0.1 | 0.286 | <0.1 | <0.1 | 6.78 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | <0.383 | <.218 | <0.095 | 0.258 | 0.354 | 0.603 | 6.29 |
| PI2CC1 | Poison Ivy 2 | Common carp | <0.376 | <0.094 | <0.094 | 0.464 | 0.258 | <0.094 | 8.45 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | <0.356 | <0.089 | <0.089 | 0.254 | 0.706 | <0.089 | 4.78 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | <0.358 | <0.089 | <0.089 | 0.373 | 0.396 | 0.094 | 5.06 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | <0.389 | <0.097 | <0.097 | 0.219 | <0.097 | 0.175 | 4.55 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | <0.382 | 0.107 | <0.095 | 0.333 | <0.095 | 0.277 | 4.13 |
| PI2WC1 | Poison Ivy 2 | White crappie | <0.384 | <0.096 | <0.096 | 0.354 | <0.096 | <0.096 | 4.42 |

Table B-4: Trace element data from the Marais des Cygnes River site, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | Al | As | Bo | Ba | Be | Cd |
|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common carp | <0.974 | <0.097 | <0.389 | 0.345 | <0.019 | <0.019 |
| RIVRFHC1 | River | Flathead catfish | 1.39 | <0.096 | <0.386 | <0.193 | <0.019 | <0.019 |

Table B-4: Continued.

| Sample Number | Site | Species | Cr | Cu | Fe | Mg | Mn | Hg |
|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common carp | <0.097 | 0.199 | 5.96 | 280 | 0.522 | 0.192 |
| RIVRFHC1 | River | Flathead catfish | <0.096 | 0.392 | 3.77 | 248 | <0.193 | 0.258 |

Table B-4: Continued.

| Sample Number | Site | Species | Mo | Ni | Pb | Se | Sr | V | Zn |
|---|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common carp | <0.389 | <0.097 | <0.097 | 0.504 | 1.20 | <0.097 | 7.03 |
| RIVRFHC1 | River | Flathead catfish | <0.386 | <0.096 | <0.096 | 0.135 | <0.096 | <0.096 | 4.35 |

# Appendix C: Organic Data

Table C-1: Chlorinated hydrocarbon data from the Turkey Foot Pond sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | aldrin | a-BHC | a-Chlordane | b-BHC | c-Nonachlor | d-BHC |
|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carp Sucker | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| ALECS2 | Turkey Foot-East | Carp Sucker | <0.00097 | <0.00097 | 0.00147 | <0.00097 | 0.00098 | <0.00097 |
| ALECS3 | Turkey Foot-East | Carp Sucker | <0.00096 | <0.00096 | 0.00159 | <0.00096 | 0.00112 | <0.00096 |
| ALELMB1 | Turkey Foot-East | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | <0.00097 | <0.00097 | 0.00103 | <0.00097 | <0.00097 | <0.00097 |
| ALMIP1 | Turkey Foot-Mid | Channel Catfish | <0.00088 | <0.00088 | <0.00088 | <0.00088 | <0.00088 | <0.00088 |
| ALMIP2 | Turkey Foot-Mid | Channel Catfish | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMIP3 | Turkey Foot-Mid | Channel Catfish | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| ALMWC1 | Turkey Foot-Mid | White crappie | <0.00187 | <0.00187 | <0.00187 | <0.00187 | <0.00187 | <0.00187 |
| ALMWC2 | Turkey Foot-Mid | White crappie | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALMWC3 | Turkey Foot-Mid | White crappie | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 |
| ALWCC1 | Turkey Foot-West | Common Carp | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| ALWCS1 | Turkey Foot-West | Carpsucker | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| ALWCS2 | Turkey Foot-West | Carp Sucker | <0.00081 | <0.00081 | <0.00081 | <0.00081 | <0.00081 | <0.00081 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | <0.00092 | <0.00092 | <0.00092 | <0.00092 | <0.00092 | <0.00092 |
| ALWWC1 | Turkey Foot-West | White crappie | <0.00249 | <0.00249 | <0.00249 | <0.00249 | <0.00249 | <0.00249 |

Table C-1: Continued.

| Sample Number | Site | Species | Dieldrin | Endosulfan II | Endrin | g-BHC | g-Chlordane | HCB |
|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carp Sucker | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| ALECS2 | Turkey Foot-East | Carp Sucker | 0.0064 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | 0.00142 |
| ALECS3 | Turkey Foot-East | Carp Sucker | 0.00629 | <0.00096 | <0.00096 | <0.00096 | 0.00098 | <0.00096 |
| ALELMB1 | Turkey Foot-East | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | 0.00578 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| ALMIP1 | Turkey Foot-Mid | Channel Catfish | <0.00088 | <0.00088 | <0.00088 | <0.00088 | <0.00088 | <0.00088 |
| ALMIP2 | Turkey Foot-Mid | Channel Catfish | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMIP3 | Turkey Foot-Mid | Channel Catfish | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| ALMWC1 | Turkey Foot-Mid | White crappie | <0.00187 | <0.00187 | <0.00187 | <0.00187 | <0.00187 | <0.00187 |
| ALMWC2 | Turkey Foot-Mid | White crappie | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALMWC3 | Turkey Foot-Mid | White crappie | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 |
| ALWCC1 | Turkey Foot-West | Common Carp | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| ALWCS1 | Turkey Foot-West | Carpsucker | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| ALWCS2 | Turkey Foot-West | Carp Sucker | <0.00081 | <0.00081 | <0.00081 | <0.00081 | <0.00081 | <0.00081 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | <0.00092 | <0.00092 | <0.00092 | <0.00092 | <0.00092 | <0.00092 |
| ALWWC1 | Turkey Foot-West | White crappie | <0.00249 | <0.00249 | <0.00249 | <0.00249 | <0.00249 | <0.00249 |

Table C-1: Continued.

| Sample Number | Site | Species | Heptachlor | Hept. epoxide | Mirex | op-DDD | op-DDE | op-DDT | Oxychlordane |
|---|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carp Sucker | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| ALECS2 | Turkey Foot-East | Carp Sucker | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| ALECS3 | Turkey Foot-East | Carp Sucker | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| ALELMB1 | Turkey Foot-East | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| ALMIP1 | Turkey Foot-Mid | Channel Catfish | <0.00088 | <0.00088 | <0.00088 | <0.00088 | <0.00088 | <0.00088 | <0.00088 |
| ALMIP2 | Turkey Foot-Mid | Channel Catfish | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMIP3 | Turkey Foot-Mid | Channel Catfish | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| ALMWC1 | Turkey Foot-Mid | White crappie | <0.00187 | <0.00187 | <0.00187 | <0.00187 | <0.00187 | <0.00187 | <0.00187 |
| ALMWC2 | Turkey Foot-Mid | White crappie | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALMWC3 | Turkey Foot-Mid | White crappie | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 |
| ALWCC1 | Turkey Foot-West | Common Carp | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| ALWCS1 | Turkey Foot-West | Carpsucker | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| ALWCS2 | Turkey Foot-West | Carp Sucker | <0.00081 | <0.00081 | <0.00081 | <0.00081 | <0.00081 | <0.00081 | <0.00081 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | <0.00092 | <0.00092 | <0.00092 | <0.00092 | <0.00092 | <0.00092 | <0.00092 |
| ALWWC1 | Turkey Foot-West | White crappie | <0.00249 | <0.00249 | <0.00249 | <0.00249 | <0.00249 | <0.00249 | <0.00249 |

Table C-1: Continued.

| Sample Number | Site | Species | pp-DDD | pp-DDE | pp-DDT | PCBs | Toxaphene | t-Nonachlor | TPH |
|---|---|---|---|---|---|---|---|---|---|
| ALECS1 | Turkey Foot-East | Carp Sucker | <0.00093 | <0.00093 | <0.00093 | <0.00466 | 0.00466 | <0.00093 | 70.9 |
| ALECS2 | Turkey Foot-East | Carp Sucker | <0.00097 | 0.00321 | <0.00097 | 0.0173 | 0.00486 | 0.00217 | 48728.0 |
| ALECS3 | Turkey Foot-East | Carp Sucker | <0.00096 | 0.00358 | <0.00096 | 0.0189 | 0.00484 | 0.00221 | 39101.0 |
| ALELMB1 | Turkey Foot-East | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00486 | <0.00486 | <0.00097 | 130.0 |
| ALMCC1 | Turkey Foot-Mid | Common Carp | <0.00098 | <0.00098 | <0.00098 | <0.00491 | <0.00491 | <0.00098 | 37.7 |
| ALMCS1 | Turkey Foot-Mid | Carpsucker | <0.00097 | 0.00248 | <0.00097 | 0.0137 | <0.00486 | 0.00175 | 28169.0 |
| ALMIP1 | Turkey Foot-Mid | Channel Catfish | <0.00088 | 0.00143 | <0.00088 | 0.0075 | <0.00444 | <0.00088 | 253.0 |
| ALMIP2 | Turkey Foot-Mid | Channel Catfish | <0.00099 | <0.00099 | <0.00099 | <0.00499 | <0.00499 | <0.00099 | 75.9 |
| ALMIP3 | Turkey Foot-Mid | Channel Catfish | <0.00095 | <0.00095 | <0.00095 | <0.00479 | <0.00479 | <0.00095 | 54.6 |
| ALMLMB1 | Turkey Foot-Mid | Largemouth bass | <0.00099 | 0.001 | <0.00099 | 0.0057 | <0.00499 | <0.00099 | 37.9 |
| ALMLMB2 | Turkey Foot-Mid | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00496 | <0.00496 | <0.00099 | 37.7 |
| ALMLMB3 | Turkey Foot-Mid | Largemouth bass | <0.00094 | 0.00128 | <0.00094 | 0.005 | <0.00473 | <0.00094 | 142.0 |
| ALMWC1 | Turkey Foot-Mid | White crappie | <0.00187 | <0.00187 | <0.00187 | <0.00933 | <0.00933 | <0.00187 | 70.1 |
| ALMWC2 | Turkey Foot-Mid | White crappie | <0.00098 | <0.00098 | <0.00098 | <0.00491 | <0.00491 | <0.00098 | 125.0 |
| ALMWC3 | Turkey Foot-Mid | White crappie | <0.00090 | <0.00090 | <0.00090 | 0.0064 | <0.00454 | <0.00090 | 359.0 |
| ALWCC1 | Turkey Foot-West | Common Carp | <0.00095 | <0.00095 | <0.00095 | <0.00479 | <0.00479 | <0.00095 | 76.7 |
| ALWCS1 | Turkey Foot-West | Carpsucker | <0.00096 | <0.00096 | <0.00096 | <0.0048 | <0.0048 | <0.00096 | <1.0 |
| ALWCS2 | Turkey Foot-West | Carp Sucker | <0.00081 | <0.00081 | <0.00081 | <0.00407 | <0.00407 | <0.00081 | 47.2 |
| ALWLMB1 | Turkey Foot-West | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00493 | <0.00493 | <0.00098 | 19.7 |
| ALWLMB2 | Turkey Foot-West | Largemouth bass | <0.00092 | <0.00092 | <0.00092 | <0.00464 | <0.00464 | <0.00092 | 37.1 |
| ALWWC1 | Turkey Foot-West | White crappie | <0.00249 | <0.00249 | <0.00249 | <0.0124 | <0.0124 | <0.00249 | 149.0 |

Table C-2: Chlorinated hydrocarbon data from the farm pond sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | aldrin | a-BHC | a-Chlordane | b-BHC | c-Nonachlor | d-BHC |
|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth Bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| FP1LMB2 | Farm Pond 1 | Largemouth Bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| FP1LMB3 | Farm Pond 1 | Largemouth Bass | <0.0152 | <0.0152 | <0.0152 | <0.0152 | <0.0152 | <0.0152 |
| FP2IP1 | Farm Pond 2 | Channel catfish | <0.00089 | <0.00089 | <0.00089 | <0.00089 | <0.00089 | <0.00089 |
| FP2IP2 | Farm Pond 2 | Channel catfish | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP2IP3 | Farm Pond 2 | Channel catfish | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP2LMB2 | Farm Pond 2 | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| FP2LMB3 | Farm Pond 2 | Largemouth Bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP3BLB1 | Farm Pond 2 | Bullhead | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP3BLB2 | Farm Pond 2 | Bullhead | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| MMPIP1 | Manmade Pond | Channel catfish | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| MMPIP2 | Farm Pond 2 | Channel catfish | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| MMPIP3 | Farm Pond 2 | Channel catfish | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| MMPLMB1 | Farm Pond 2 | Largemouth bass | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| SEC4BLB1 | Section 4 Pond | Bullhead | <0.00229 | <0.00229 | <0.00229 | <0.00229 | <0.00229 | <0.00229 |
| SEC4BLB2 | Section 4 Pond | Bullhead | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| SEC4BLB3 | Section 4 Pond | Bullhead | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |

Table C-2: Continued.

| Sample Number | Site | Species | Dieldrin | Endosulfan II | Endrin | g-BHC | g-Chlordane | HCB |
|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth Bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| FP1LMB2 | Farm Pond 1 | Largemouth Bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| FP1LMB3 | Farm Pond 1 | Largemouth Bass | <0.0152 | <0.0152 | <0.0152 | <0.0152 | <0.0152 | <0.0152 |
| FP2IP1 | Farm Pond 2 | Channel catfish | <0.00089 | <0.00089 | <0.00089 | <0.00089 | <0.00089 | <0.00089 |
| FP2IP2 | Farm Pond 2 | Channel catfish | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP2IP3 | Farm Pond 2 | Channel catfish | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP2LMB2 | Farm Pond 2 | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| FP2LMB3 | Farm Pond 2 | Largemouth Bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP3BLB1 | Farm Pond 2 | Bullhead | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP3BLB2 | Farm Pond 2 | Bullhead | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| MMPIP1 | Manmade Pond | Channel catfish | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| MMPIP2 | Farm Pond 2 | Channel catfish | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| MMPIP3 | Farm Pond 2 | Channel catfish | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| MMPLMB1 | Farm Pond 2 | Largemouth bass | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| SEC4BLB1 | Section 4 Pond | Bullhead | <0.00229 | <0.00229 | <0.00229 | <0.00229 | <0.00229 | <0.00229 |
| SEC4BLB2 | Section 4 Pond | Bullhead | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| SEC4BLB3 | Section 4 Pond | Bullhead | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |

Table C-2: Continued.

| Sample Number | Site | Species | Heptachlor | Hept. epoxide | Mirex | op-DDD | op-DDE | op-DDT | Oxychlordane |
|---|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth Bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| FP1LMB2 | Farm Pond 1 | Largemouth Bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| FP1LMB3 | Farm Pond 1 | Largemouth Bass | <0.0152 | <0.0152 | <0.0152 | <0.0152 | <0.0152 | <0.0152 | <0.0152 |
| FP2IP1 | Farm Pond 2 | Channel catfish | <0.00089 | <0.00089 | <0.00089 | <0.00089 | <0.00089 | <0.00089 | <0.00089 |
| FP2IP2 | Farm Pond 2 | Channel catfish | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP2IP3 | Farm Pond 2 | Channel catfish | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP2LMB2 | Farm Pond 2 | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| FP2LMB3 | Farm Pond 2 | Largemouth Bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP3BLB1 | Farm Pond 2 | Bullhead | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| FP3BLB2 | Farm Pond 2 | Bullhead | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| MMPIP1 | Manmade Pond | Channel catfish | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| MMPIP2 | Farm Pond 2 | Channel catfish | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| MMPIP3 | Farm Pond 2 | Channel catfish | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| MMPLMB1 | Farm Pond 2 | Largemouth bass | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |
| SEC4BLB1 | Section 4 Pond | Bullhead | <0.00229 | <0.00229 | <0.00229 | <0.00229 | <0.00229 | <0.00229 | <0.00229 |
| SEC4BLB2 | Section 4 Pond | Bullhead | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| SEC4BLB3 | Section 4 Pond | Bullhead | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |

Table C-2: Continued.

| Sample Number | Site | Species | pp-DDD | pp-DDE | pp-DDT | PCBs | Toxaphene | t-Nonachlor | TPH |
|---|---|---|---|---|---|---|---|---|---|
| FP1LMB1 | Farm Pond 1 | Largemouth Bass | <0.00095 | <0.00095 | <0.00095 | 0.0059 | <0.00479 | <0.00095 | 69.0 |
| FP1LMB2 | Farm Pond 1 | Largemouth Bass | <0.00099 | <0.00099 | <0.00099 | <0.00495 | <0.00495 | <0.00099 | 37.6 |
| FP1LMB3 | Farm Pond 1 | Largemouth Bass | <0.0152 | <0.0152 | <0.0152 | <0.0758 | <0.0758 | <0.0152 | <1.0 |
| FP2IP1 | Farm Pond 2 | Channel catfish | <0.00089 | 0.00129 | <0.00089 | 0.0077 | <0.00448 | <0.00089 | 1277.0 |
| FP2IP2 | Farm Pond 2 | Channel catfish | <0.00096 | <0.00096 | <0.00096 | 0.0061 | <0.0048 | <0.00096 | 941.0 |
| FP2IP3 | Farm Pond 2 | Channel catfish | <0.00094 | <0.00094 | <0.00094 | <0.00471 | <0.00471 | <0.00094 | 188.0 |
| FP2LMB1 | Farm Pond 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00483 | <0.00483 | <0.00096 | 54.0 |
| FP2LMB2 | Farm Pond 2 | Largemouth Bass | <0.00097 | <0.00097 | <0.00097 | <0.00489 | <0.00489 | <0.00097 | 90.1 |
| FP2LMB3 | Farm Pond 2 | Largemouth Bass | <0.00096 | <0.00096 | <0.00096 | <0.00481 | <0.00481 | <0.00096 | 192.0 |
| FP3BLB1 | Farm Pond 2 | Bullhead | <0.00096 | <0.00096 | <0.00096 | <0.00484 | <0.00484 | <0.00096 | 194.0 |
| FP3BLB2 | Farm Pond 2 | Bullhead | <0.00098 | <0.00098 | <0.00098 | <0.00494 | <0.00494 | <0.00098 | 198.0 |
| MMPIP1 | Manmade Pond | Channel catfish | <0.00098 | 0.00582 | <0.00098 | 0.01 | <0.00494 | <0.00098 | 286.0 |
| MMPIP2 | Farm Pond 2 | Channel catfish | <0.00093 | 0.00399 | <0.00093 | 0.006 | <0.00468 | <0.00093 | 656.0 |
| MMPIP3 | Farm Pond 2 | Channel catfish | <0.00093 | 0.00405 | <0.00093 | 0.0113 | <0.00468 | <0.00093 | 749.0 |
| MMPLMB1 | Farm Pond 2 | Largemouth bass | <0.00093 | 0.00142 | <0.00093 | <0.00466 | <0.00466 | <0.00093 | 931.0 |
| SEC4BLB1 | Section 4 Pond | Bullhead | <0.00229 | <0.00229 | <0.00229 | <0.0115 | <0.0115 | <0.00229 | <1.0 |
| SEC4BLB2 | Section 4 Pond | Bullhead | <0.00099 | <0.00099 | <0.00099 | 0.0052 | <0.00498 | <0.00099 | <1.0 |
| SEC4BLB3 | Section 4 Pond | Bullhead | <0.00098 | <0.00098 | <0.00098 | 0.0075 | <0.0049 | <0.00098 | 59.4 |

Table C-3: Chlorinated hydrocarbon data from the pit lake sites, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | aldrin | a-BHC | a-Chlordane | b-BHC | c-Nonachlor | d-BHC |
|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common carp | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| PI1CC2 | Poison Ivy 1 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| PI2CC1 | Poison Ivy 2 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| PI2WC1 | Poison Ivy 2 | White crappie | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| SSP1LMB1 | Southside Pond 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| SSP1LMB2 | Southside Pond 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| SSP1LMB3 | Southside Pond 1 | Largemouth bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| SSP1LMB4 | Southside Pond 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| SSP2LMB1 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| SSP2LMB2 | Southside Pond 2 | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| SSP2LMB3 | Southside Pond 2 | Largemouth bass | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 |
| SSP2LMB4 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |

Table C-3:Continued.

| Sample Number | Site | Species | Dieldrin | Endosulfan ii | Endrin | g-BHC | g-Chlordane | HCB |
|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common carp | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| PI1CC2 | Poison Ivy 1 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| PI2CC1 | Poison Ivy 2 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| PI2WC1 | Poison Ivy 2 | White crappie | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| SSP1LMB1 | Southside Pond 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| SSP1LMB2 | Southside Pond 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| SSP1LMB3 | Southside Pond 1 | Largemouth bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| SSP1LMB4 | Southside Pond 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| SSP2LMB1 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| SSP2LMB2 | Southside Pond 2 | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| SSP2LMB3 | Southside Pond 2 | Largemouth bass | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 |
| SSP2LMB4 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |

Table C-3:Continued.

| Sample Number | Site | Species | Heptachlor | Hept. epoxide | Mirex | op-DDD | op-DDE | op-DDT | Oxychlordane |
|---|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common carp | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| PI1CC2 | Poison Ivy 1 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| PI2CC1 | Poison Ivy 2 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| PI2WC1 | Poison Ivy 2 | White crappie | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| SSP1LMB1 | Southside Pond 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 | <0.00098 |
| SSP1LMB2 | Southside Pond 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| SSP1LMB3 | Southside Pond 1 | Largemouth bass | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 | <0.00097 |
| SSP1LMB4 | Southside Pond 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 | <0.00095 |
| SSP2LMB1 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |
| SSP2LMB2 | Southside Pond 2 | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 | <0.00099 |
| SSP2LMB3 | Southside Pond 2 | Largemouth bass | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 | <0.00090 |
| SSP2LMB4 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 | <0.00094 |

Table C-3:Continued.

| Sample Number | Site | Species | pp-DDD | pp-DDE | pp-DDT | PCBs | Toxaphene | t-Nonachlor | TPH |
|---|---|---|---|---|---|---|---|---|---|
| PI1CC1 | Poison Ivy 1 | Common carp | <0.00094 | <0.00094 | <0.00094 | <0.00471 | <0.00471 | <0.00094 | 377.0 |
| PI1CC2 | Poison Ivy 1 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00489 | <0.00489 | <0.00097 | 587.0 |
| PI1LMB1 | Poison Ivy 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | <0.00473 | <0.00473 | <0.00094 | 284.0 |
| PI1LMB2 | Poison Ivy 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00476 | <0.00476 | <0.00095 | 476.0 |
| PI1LMB3 | Poison Ivy 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.0049 | <0.0049 | <0.00098 | 588.0 |
| PI2CC1 | Poison Ivy 2 | Common carp | <0.00097 | <0.00097 | <0.00097 | <0.00485 | <0.00485 | <0.00097 | <1.0 |
| PI2CS1 | Poison Ivy 2 | Carpsucker | <0.00099 | <0.00099 | <0.00099 | <0.00495 | <0.00495 | <0.00099 | 495.0 |
| PI2CS2 | Poison Ivy 2 | Carpsucker | <0.00095 | <0.00095 | <0.00095 | <0.00479 | <0.00479 | <0.00095 | 766.0 |
| PI2LMB1 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00482 | <0.00482 | <0.00096 | 481.0 |
| PI2LMB2 | Poison Ivy 2 | Largemouth bass | <0.00096 | <0.00096 | <0.00096 | <0.00481 | <0.00481 | <0.00096 | <1.0 |
| PI2WC1 | Poison Ivy 2 | White crappie | <0.00096 | <0.00096 | <0.00096 | <0.0048 | <0.0048 | <0.00096 | 173.0 |
| SSP1LMB1 | Southside Pond 1 | Largemouth bass | <0.00098 | <0.00098 | <0.00098 | <0.00491 | <0.00491 | <0.00098 | 38.9 |
| SSP1LMB2 | Southside Pond 1 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | 0.0068 | <0.00474 | <0.00094 | 57.0 |
| SSP1LMB3 | Southside Pond 1 | Largemouth bass | <0.00097 | <0.00097 | <0.00097 | <0.00488 | <0.00488 | <0.00097 | <1.0 |
| SSP1LMB4 | Southside Pond 1 | Largemouth bass | <0.00095 | <0.00095 | <0.00095 | <0.00479 | <0.00479 | <0.00095 | <1.0 |
| SSP2LMB1 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | 0.0051 | <0.00473 | <0.00094 | 37.9 |
| SSP2LMB2 | Southside Pond 2 | Largemouth bass | <0.00099 | <0.00099 | <0.00099 | 0.0067 | <0.00495 | <0.00099 | 59.4 |
| SSP2LMB3 | Southside Pond 2 | Largemouth bass | <0.00090 | <0.00090 | <0.00090 | <0.0045 | <0.0045 | <0.00090 | 54.1 |
| SSP2LMB4 | Southside Pond 2 | Largemouth bass | <0.00094 | <0.00094 | <0.00094 | 0.0098 | <0.0047 | <0.00094 | 56.4 |

Table C-4: Chlorinated hydrocarbon data from the Marais des Cygnes River, Marais des Cygnes National Wildlife Refuge, 1998.

| Sample Number | Site | Species | aldrin | a-BHC | a-Chlordane | b-BHC | c-Nonachlor | d-BHC |
|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common carp | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| RIVRFHC1 | River | Flathead catfish | <0.00093 | <0.00093 | 0.00128 | <0.00093 | 0.00104 | <0.00093 |

Table C-4:Continued.

| Sample Number | Site | Species | Dieldrin | Endosulfan ii | Endrin | g-BHC | g-Chlordane | HCB |
|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common carp | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| RIVRFHC1 | River | Flathead catfish | 0.00262 | <0.00093 | <0.00093 | <0.00093 | 0.00114 | <0.00093 |

Table C-4:Continued.

| Sample Number | Site | Species | Heptachlor | Hept. | Mirex | op-DDD | op-DDE | op-DDT | Oxychlordane |
|---|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common carp | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 | <0.00096 |
| RIVRFHC1 | River | Flathead catfish | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 | <0.00093 |

Table C-4:Continued.

| Sample Number | Site | Species | pp-DDD | pp-DDE | pp-DDT | PCBs | Toxaphene | t-Nonachlor | TPH |
|---|---|---|---|---|---|---|---|---|---|
| RIVRCC1 | River | Common carp | <0.00096 | 0.00119 | <0.00096 | 0.0069 | <0.00483 | 0.00096 | 38.6 |
| RIVRFHC1 | River | Flathead catfish | <0.00093 | 0.00376 | <0.00093 | 0.0177 | <0.00468 | 0.0024 | 204.0 |