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ABSTRACT – Fish collections were made in the lower Minnesota River in the vicinity of the Black Dog Generating Plant and at the intake structure of the plant from April, 1976, to April, 1977 as part of a section 316(b) demonstration study. Composition of the fish community of the area is reported along with notes on several species whose occurrence was considered unusual. New information on the occurrence of river carpsucker (*Carpiodes carpio* Rafinesque) and river darter *(Percina shumardi* Girard) to the Minnesota River is also presented.

The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), Section 316 (b), require that cooling water intake structures reflect the best technology available for minimizing adverse environmental impact. At water intakes, a large part of the adverse impact results from entrainment and impingement. Entrainment is the withdrawal of small organisms (primarily planktonic or drifting) into the cooling water system. Impingement occurs when larger organisms, primarily fish, become trapped against the intake screens by force of the current. The purpose of 316 (b) demonstrations is to provide the best possible estimate of what damage is or may be occurring. The Environmental Protection Agency (EPA, 1976) clearly recognizes that some level of damage can be acceptable.

Section 316 demonstrations are providing a good deal of biological information on areas which might not otherwise be studied. The large data base from such studies remains a virtually untapped resource, especially by the academic community. The data discussed herein were obtained from a 316 (b) demonstration concerning Northern States Power Company's Black Dog Generating Plant (BDGP) located at river mile 8.8 on the lower Minnesota River near Burnsville, Minnesota. The study was conducted by NUS Corporation and continued from April 14, 1976, through April 6, 1977.

The primary objective of this paper is to documant recent fish collections in the lower Minnesota River and the unusual occurrence of several fish species.

Study Area

The Minnesota River is shallow throughout most of its run and flows over a bottom of shifting sand. The reach from Savage downstream to confluence with the Mississippi River is maintained as a shipping channel. Average channel depth is 13 feet and the average width is 275 to 300 ft. The banks are steep, with only a narrow strip of shallows on each side. The bottom, composed of fine sand and silt, is scoured by frequent barge and towboat traffic. Because of impoundment of the Mississippi at lock and dam No. 2 near Hastings, the gradient of the Minnesota from Shakopee to this mouth is only 0.3 feet.

Average annual discharge of the Minnesota River at the USGS station at Jordan for 47 years of record (1930-1976) was 88 m^3/sec (3,120 cfs). Extreme fluctuations in flow are common to the lower Minnesota River. Flow during the 1976 - 1977 study was low, averaging 24.8 m^3/sec (876 cfs).

Water quality of the lower Minnesota River is affected by upstream agriculture and industry, large fluctuations in river flow, and barge traffic. EPA STORET data for river mile 7.0 indicate hard, turbid waters with large amounts of dissolved solids. The water temperature is typical of large temperate rivers, ranging from a high of 30.0 C in July to 0 C during the winter. Dissolved oxygen concentrations varied considerably during the summer of 1976, ranging from over 15 mg/l to less than 2 mg/l. A combination of high biological oxygen demand and phytoplankton blooms probably produced this variation. Winter dissolved oxygen concentrations remained above 4.5 mg/l during 1976 - 1977.

Sampling Methods

During the 1976 - 1977 NUS study, fish were collected from the river with trawls, electrofishing gear and plankton nets. Fish washed from the traveling screens at the Black Dog Plant intake also were collected. Methods are detailed in the 316 (B) demonstration for the Black Dog Plant (NUS, 1978).

Fish Community of the Area Studied

Sixty five species of fish representing 18 families have been found in the lower Minnesota River (Table 1). Trap net and electrofishing collections by the Minnesota Department of Natural Resources (DNR) in 1958 indicate that carp apparently dominated the fish community. Gizzard shad also were common. Game fish represented 7 percent of the catch by numbers and 4.5 percent by weight.

Electrofishing catches during 1976 - 1977 also were dominated by carp and gizzard shad (NUS, 1978). Trawling yielded substantial numbers of channel catfish, freshwater drum and carp. Electrofishing produced fish primarily age one-year and older, while trawling caught predominantly young-of-the-year and yearling fish.

Approximately 141,800 impinged fish were collected from the traveling screens at BDGP in 1976 - 1977, and approximately 96 percent of these were gizzard shad. The large catch of shad on the traveling screens indicates a high susceptibility to impingement and, apparently, high abundance

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in the Minnesota River. Emerald shiners, carp, white bass, freshwater drum, and channel catfish were respectively the next most numerically abundant fish caught on the screens.

Low Numbers, Low Diversity of Game Fish

Both the DNR 1958 survey and the NUS 1976 -1977 study demonstrate that the fish community of the lower Minnesota River has a relatively low diversity and is apparently dominated by rough fish. Game fish represented only a small percentage.

The predominance of rough fish probably results from a multiplicity of natural and man-induced stresses. The bottom of unstable sand, silt and organic debris, churned by towboats during the ice-free season, contributes to the naturally high turbidity. Maintenance dredging has limited the available types of habitat and, consequently, the diversity of the macroinvertebrate community. High turbidity, an unstable substrate, and limited shallow areas also preclude the growth of aquatic macrophytes. Similarly, preferred spawning habitat is severely limited.

The most abundant fish of the lower Minnesota River have reproductive strategies that allow successful reproduction in the main stem of the river. Gizzard shad, carp, and freshwater drum release their eggs in the water column or broadcast them over the substrate. These species provide no parental care, do not build nests, and are characterized by high fecundities and low egg and larvae survival rates. Temporarily flooded backwaters or sloughs are preferred spawning areas of northern pike, carpsuckers and buffalo, but such habitat is limited along the lower Minnesota River.

Nesting fishes, such as bass, sunfish and crappies, require protected shallows with a moderately hard substrate. Cover of stones, aquatic macrophytes, or fallen trees may be important, depending on the species. Species with these spawning requirements are forced to spawn in marginally suitable areas and are not abundant in the lower Minnesota River.

Redhorse, suckers, walleye, sauger and most darters found in the lower Minnesota River prefer to spawn in flowing streams on sand, gravel or rock and probably use the tributary streams with higher water quality for spawning.

Fish populations of the lower Minnesota River are probably supported to a great extent by contribution of young fish from upstream areas with more suitable spawning habitat, to an unknown extent by young fish from Black Dog Lake, and, to a limited extent, by migration of adults from other parts of the river system.

Unusual Species Noted

The occurrences of several species were considered unusual and are discussed here:

SHOVELNOSE STURGEON *(Scaphirhynchus platorynchus,* Rafinesque)

Eddy and Underhill (1974) reported that in Minnesota the shovelnose sturgeon is restricted to the Mississippi River below St. Anthony Falls, the St. Croix River below Taylors Fall and the Minnesota River below Granite Falls. This species is no longer considered abundant in the state (Eddy and Underhill 1974). Despite extensive collecting in recent years with a variety of gear, the Minnesota DNR has not reported shovelnose sturgeon in Lake St. Croix or in the Mississippi River near Red Wing, Minnesota. According to Eddy and Underhill (1974) there have been no recent reports of this species in the Minnesota River, but Ecology consultants, Inc. (1974) in a survey of the Minnesota River upstream near Henderson in 1973 - 1974, caught a single specimen (688 mm TL; 453 g).

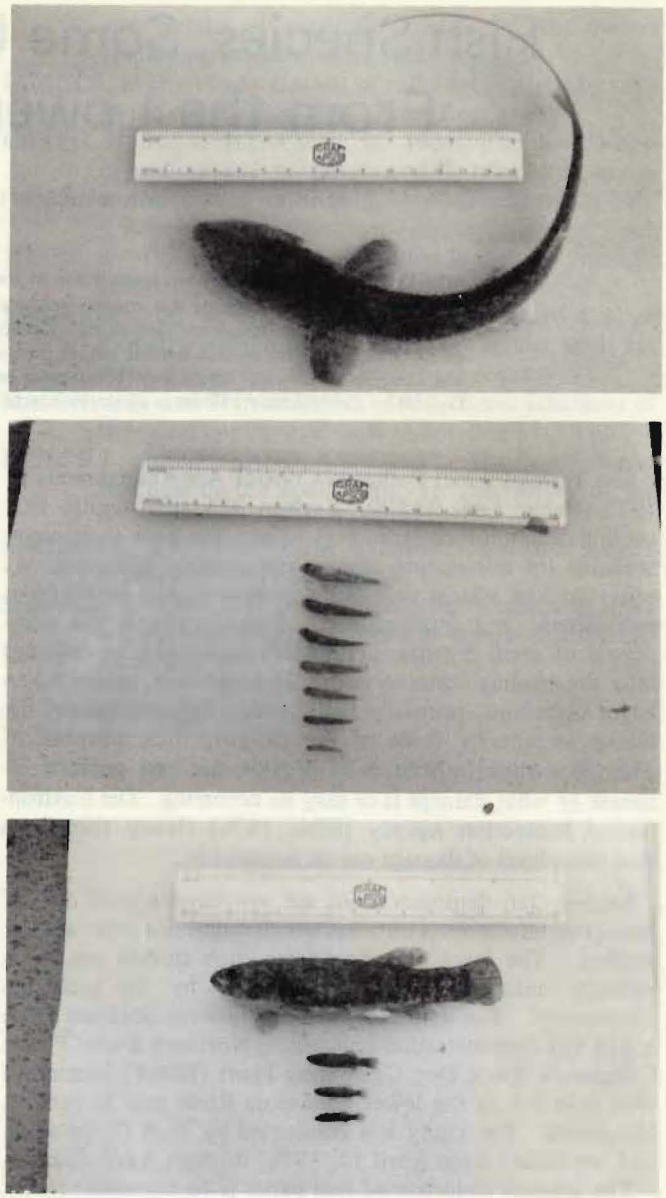

Figure I.
a. Central mudminnow, *Umbra limi;* **b. River darter,** *Percina shumardi;* **c. Shovelnose sturgeon,** *Scaphirynchus platoryncus.*

In the 1976 - 1977 NUS study, two live shovelnose sturgeon were collected on the traveling screens at the BDGP in October. These fish measured 323 mm and 335 mm TL and weighted 35 g and 41 g, respectively. Based on data in Carlander (1969) for Lake Oahe, S.D., these fish were estimated to be about three years old. We believe these specimens to be the most recent records of shovelnose sturgeon in Minnesota.

CENTRAL MUDMINNOW *(Umbra limi,* Kirtland).

This species is widely distributed in Minnesota. It is found in the Red River and Lake Superior sub-drainage basins and is very common in the bog country of north-central Minnesota (Eddy and Underhill 1974). Mudminnows prefer bogs, ditches and streams with muddy bottoms and abundant aquatic vegetation (Eddy and Underhill 1974). This species is extremely hardy; it has been known to survive dissolved oxygen concentrations of less than 1 ppm (Eddy and Underhill 1974). This tolerance of nearly anoxic conditions results from the respiratory capability of this swim bladder (Black 1945).

Sixteen specimens were collected in 1976 - 1977. Ten mudminnows ranging in size from 72 to 115 mm TL were collected from the traveling screens in late March and early April, 1977. All were at least one year old, based on data of Peckham (1955) and Westman (1941). Several specimens were females in spawning condition, and it would appear that spawning in Minnesota occurs during April and May. Six additional specimens between 20 and 30 mm TL were collected in plankton nets in June 1976. All of these were young-of-the year.

The occurrence of the central mudminnow at the time of peak flow in the Minnesota River suggests that they may have originated in tributaries upstream of BDGP. Eddy and Underhill (1974) suggest that the mudminnow is not a regular inhabitant of large rivers in Minnesota. The low number collected would indicate that this species is not abundant in the main stem of the lower Minnesota River. Inability to conduct an extensive seining program to sample shallower nearshore waters, however, precludes any definite conclusion.

SPECKLED CHUB *(Hybopsis aestivalis,* Girard)

The existence of the speckled chub in Minnesota was doubted before 1960. Since then, as a result of increased sampling effort in fastwater areas with shifting sand bottoms (Eddy and Underhill 1974), it has been reported from a number of localitites in the southern half of the state, including the Minnesota River above Mankato and corresponding tributaries. The authors are not aware of any records of this species in the lower Minnesota River. Although this segment of the river, particularly the area near BDGP, does not resemble the preferred habitat described by Eddy and Underhill (1974), both young and adults of this species were collected frequently near BDGP in 1976. Specimens collected during April, May, and June ranged from 26 to 48 mm TL and were considered to be about one year old, based on information reported by Starrett (1951). Those captured from late June through September ranged from 6 to 38 mm TL and appeared to be young-of-the-year. Starrett (1951) reports that speckled chub in the Des Moines River, Iowa, mature at age 1 and spawn in July and August of their second summer of life. Bottrell et al. (1964) report that the large (2.5 mm diameter) semibouyant eggs of the speckled chub were present in the Cimarron River, Oklahoma, from mid-May to late August, indicating an extended spawning season. Young speckled chub grew to between 17 and 19 mm in 3 to 4 weeks in the Cimarron River (Bottrell et al. 1964). Based on the above information and the presence of young speckled chub between 16 and 19 mm from late June through late August, it would appear that these fish spawn in the lower Minnesota River from early June through most of August.

RIVER CARPSUCKER *(Carpiodes carpio,* Rafinesque)

According to Eddy and Underhill (1974), this species is a problem in Minnesota. Cox (1897), Surber (1920), and Eddy and Surber (1947) report that the river carpsucker was rather common in the state, but Phillips and Underhill (1971) were unable to find any in their field collections from Minnesota waters or in the Bell Museum of Natural History collection. Phillips and Underhill also checked with the Minnesota DNR field crews and commercial fisherman with the same results, although the DNR reported collecting river carpsucker between 1966 and 1971 in the St. Croix River. The apparent discrepencies between earlier records of abundance and the absence of recent occurrences may be due to confusion of the river carpsucker with the quillback (*Carpiodes cyprunus* LeSeur) by earlier investigators (Eddy and Underhill 1974). Although Phillips River (Krosch 1972). The apparent discrepencies between earlier records of abundance and the absence of recent occurrences may be due to confusion of the river carpsucker with the quillback (*Carpiodes cyprinus* LeSeur) by earlier investigators (Eddy and Underhill 1974). Although Phillips and Underhill (1971) and Eddy and Underhill (1974) feel that the river carpsucker is present in the Mississippi River in southeastern Minnesota, the presence of this species had yet to be definitely established in Minnesota before this study's collection of 12 specimens between May 1976 and January 1977. Most specimens were collected from the traveling screens at BDGP. Total lengths for the specimens ranged from 127 mm to 335 mm. These specimens will be deposited in the fish collection of the Bell Museum of Natural History.

STONECAT *(Noturus flavus,* Rafinesque)

Eddy and Underhill (1974) reported that this species is common in the St. Croix River and its tributaries as well as tributaries of the Minnesota River and Mississippi River below St. Anthony Falls. They also note that stonecats prefer swift water and seem to disappear from streams subject to heavy enrichment and siltation. The occurrence of four specimens in this collection (three in late June and early July and one in September) in the lower Minnesota River is considered noteworthy because this portion of the river is so different from the preferred habitat described by Eddy and Underhill (1974). These specimens probably were strays from the main stem or tributaries upstream.

BROOK STICKLEBACK *(Culaea inconstans,* Kirtland)

The brook stickleback is reported by Eddy and Underhill (1974) to be common in Minnesota. It inhabits the clear, cool densely vegetated waters of ponds, pools and spring-fed brooks (Eddy and Underhill, 1974). The poor water quality, warm water and absence of aquatic vegetation would seem to preclude the occurrence of this species in the lower Minnesota River; however, 16 specimens were collected by trawl and plankton net and on the traveling screens at BDGP between mid-May and early August 1976. The specimens ranged from 14.6 to 23 mm TL and all appeared to be young-of-the-year, based on age and growth data reported in Carlander (1969).

The brook stickleback spawns in Minnesota from late April to mid-June (Jacobs, 1945). It constructs a nest in aquatic vegetation in shallow water using dead vegetation or green algae. Spawning by this species in the lower Minnesota River is unlikely because of the absence of suitable habitat. The young collected in 1976 probably originated in other waters and probably should be considered transient in the main stem of the lower Minnesota River.

FANTAIL DARTER *(Etheostoma flabellare,* Rafinesque)

Eddy and Underhill (1974) list the fantail darter as common in the tributaries of the Minnesota River and the Mississippi south of the Twin Cities. A single specimen (48 mm TL) was collected from the traveling screens at BDGP in April 1976. Since this species usually inhabits small, swiftly-flowing streams with rock bottoms, the fantail darter is not considered a permanent member of the ichthyofauna of the main stem of the lower Minnesota River. Individuals probably are strays from local tributaries.

TABLE I – Fish From the Lower Minnesota River

	Collection by NUS Corporation 1976 - 1977		Minn. DNR study, 1958; Ecology Consultants, 1974		
	Electrofishing	Trawling	Ichthyoplankton	Impinged	Previous studies
Lepisosteus platostomus					X
Scaphichynchus platorynchus				X	X
Amia calva					X
Dorosoma cepedianum	X	X	X	X	X
Hiodon tergisus				X	X
Umbra limi			X	X	X
Esox lucius	X			X	X
Campostoma anomalum					X
Cyprinus carpio	X	X	X	X	X
Hybognathus hankinsoni					X
Hybopsis aestivalis		X	X		
Hybopsis storeriana				X	
Notemigonus chrysoleucas			X	X	
Notropis atherinoides	X	X	X	X	X
Notropis blennius			X		
Notropis cornutus					X
Notropis dorsalis					X
Notropis lutrensis					X
Notropis spilopterus	X		X	X	X
Notropis stramineus			X		X
Notropis volucellus			X		X
Pimephales notatus			X		X
Pimephales promelas		X	X	X	X
Rhinichthys atratulus					X
Semotilus atromaculatus					X
Ictiobus bubalus	X			X	X
Ictiobus cyprinellus		X		X	X
Carpiodes carpio	X			X	X
Carpiodes cyprinus	X	X		X	X
Carpiodes velifer	X				X
Hypentelium nigricans				X	X
Moxostoma anisurum					X
Moxostoma erythrurum				X	X
Moxostoma macrolepidotum	X	X		X	X
Catostomus commersoni		X	X	X	X
Ictalurus melas		X		X	X
Ictalurus natalis			X		
Ictalurus nebulosus				X	
Ictalurus punctatus	X	X	X	X	X
Noturus flavus		X	X	X	
Noturus gyrinus				X	
Pylodictus olivaris			X	X	X
Anguilla rostrata					X
Percopsis omiscomaycus				X	
Lota lota				X	
Culaea inconstans		X	X	X	X
Morone chrysops	X	X	X	X	X
Lepomis cyanellus	X		X	X	X
Lepomis gibbosus				X	
Lepomis humilis	X	X		X	
Lepomis macrochirus				X	X
Micropterus dolomieui					X
Micropterus salmoides					X

TABLE I – Fish From the Lower Minnesota River (Continued)

	Electrofishing	Trawling	Ichthyoplankton	Impinged	Previous studies
Ambloplites rupestris					X
Pomoxis annularis		X		X	X
Pomoxis nigromaculatus		X		X	X
Etheostoma flabellare				X	
Etheostoma nigrum					X
Perca flavescens			X	X	
Percina maculata					X
Percina phoxocephala					X
Percina shumardi		X	X	X	
Stizostideon canadense		X		X	X
Sitzostideon vitreum vitreum				X	X
Aplodinotus grunniens	X	X	X	X	X

RIVER DARTER *(Percina shumardi,* Girard)

The river darter occurs in large rivers and lakes in Minnesota; however, no specimens had been collected in the Minnesota River or tributaries prior to 1976 (Nordlie, Underhill and Eddy, 1961; Underhill, 1957; Eddy and Underhill, 1974). Between early June 1976 and April 1977, the authors collected 17 specimens with trawls, plankton nets and from the traveling screens at BDGP. Most specimens were considered to be Age 1 or older although several young-of-the-year were collected in June, 1976. In addition, low densities (less than 1/100 m^3) of larvae thought to be of the genus *Percina* were collected throughout April, May, and June. Since the river darter was the only member of this genus collected during the study, it is likely that these larvae also were river darter. However, positive identification cannot be made at present because of a lack of taxonomic information on the early phases of the other members of this genus (*P. capriodes, p. maculata* and *P. phoxocephala)* that reportedly occur in the Minnesota River.

Figure II. - Boat with gear for towing plankton nets.

Observations on Future Approaches

Recently much interest has been shown by government agencies in utilizing the Minnesota River for recreation. Upstream portions of the Minnesota River (river mile 191 to 206) have been classified under the Wild and Scenic Rivers Program, while studies of the river between Le Seur and Shakopee are currently being planned by the Minnesota DNR. However, the portion of the river from Shakopee to the mouth, including that portion covered in this study, is presently receiving little attention, although because of its proximity to the Twin Cities metropolitan area has the potential for considerable recreational use. It is hoped that this study might renew biological interest in the lower Minnesota River.

A much greater amount of information collected during this study is available in the BDGP Section 316(b) demonstration (NUS 1978) and may be utilized by other investigators.

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