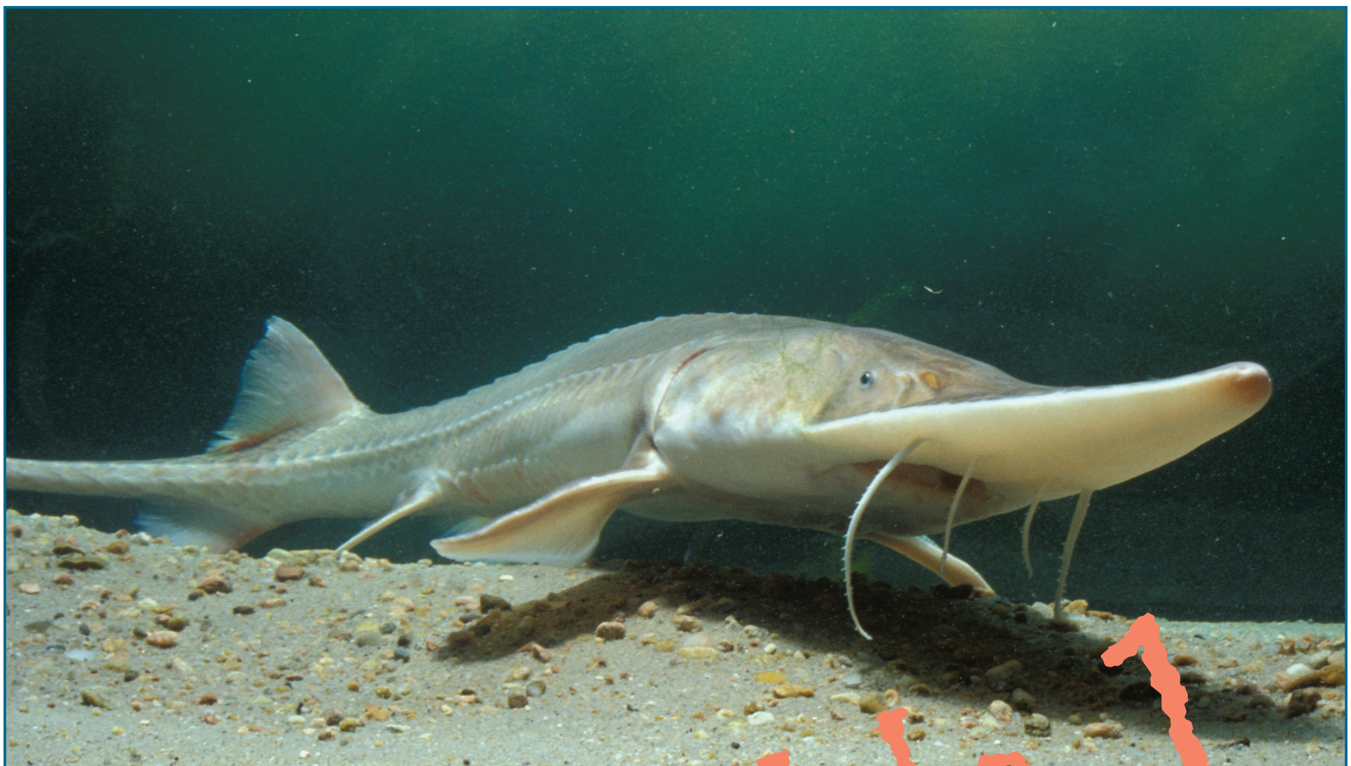
Ecology and Management of Sturgeon in the Lower Platte River, Nebraska



Draft No. 1

Ecology and Management of Sturgeon in the Lower Platte River, Nebraska

by

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and

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Nebraska Technical Series No. 18

Nebraska Game and Parks Commission
Lincoln, Nebraska

Draft 2007

A contribution of Federal Aid in Sport Fish Restoration,
Project F-141-R, Nebraska

ACKNOWLEDGEMENTS

We wish to thank the people and organizations that made this research possible. All projects require the involvement and dedication of many people and organizations to be successful and this one has involved more than most. First of all there are those who asked what was being done on pallid sturgeon in the Platte River and then asked how we could do more. The people who asked those questions were: Kirk Nelson, Larry Hutchinson, Gene Zuerlein, and Richard Holland of the Nebraska Game and Parks Commission, thank you for your foresight. Besides the people listed above, Mark Czaplewski, Mark Peyton and John Shadle provided extensive reviews of this report. Dianne Peters provided invaluable assistance in the editorial process and Steve O'Hare was responsible for the layout and design. Thank you all for your dedication.

The answers came through the involvement of the local and regional natural resources management, irrigation, public power districts along the Platte River and its tributaries. These groups are: the Upper Elkhorn NRD, the Lower Elkhorn NRD, the Lower Loup NRD, the Central Platte NRD, the Lower Platte North NRD, the Lower Platte South NRD, and the Papio-Missouri NRD, the Nebraska Public Power District, the Central Nebraska Public Power and Irrigation District, the Loup Public Power District, the Twin Loups Reclamation District, the North Loup and Middle Loup Public Power and Irrigation Districts, and the Farwell and Sargent Irrigation Districts, thank you for your support over the past five years. In addition, the US Fish and Wildlife Service, especially Steve Lydick, and the Nebraska Association of Resources Districts, especially Dean Edson, provided guidance and assistance.

On the ground (in the water) and in the labs, there were many people who carried out the work summarized in these pages. To the graduate students, Benjamin Swigle, Dane Shuman, and Stacey Kopf, thanks for your hard work and dedication. To the former full time employees, Jason Olnes, Cory Reade ,Vaughn Snook, Cara Ewell-Hodkin, Larry Vrtiska, Mike Kaminski, Ryan Ruskamp, Amy Erie, and Josh Gonsior, thank you for enduring the long hours, cold water and hot sun and even longer hours checking and re-checking the data. To the student workers who spent long hours in the lab picking samples, entering data, collecting larval fish or tracking fish for telemetry surveys; Tom van Denberg, Clayton Ridenour, Keller Kopf, Matt Neukirch, Lynne Klawer, Chris Thode, Dave Putensen, Kent Fricke, Doug Ekberg, Amanda Keep, and Justin Dawson, thanks so very much! And finally to the students in ichthyology and fisheries science classes over the past five years who participated in the weekend field trips to the Platte River, I hope that you gained some insights to what it takes to do science.

This research was supported by funding from the Federal Aid to Sport Fish Restoration (Project No. F-141-R), through the Nebraska Game and Parks Commission, the Pallid Sturgeon, Sturgeon Chub Task Force (with grants from the Nebraska Environmental Trust and State Wildlife Grant), and the U. S. Fish and Wildlife Service (Cooperative Agreement No. 1448-60181-99-J459). The University of Nebraska, Institute of Agriculture and Natural Resources, Agricultural Research Division and the School of Natural Resources provided administrative support, facilities, and salary for E. J. Peters.

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LIST OF EQUATIONS

LIST OF SCIENTIFIC NAMES USED IN THIS PUBLICATION

Family	Common name	*Scientific name*
Sturgeons	lake sturgeon	*Acipenser fulvescens*
	pallid sturgeon	*Scaphirhynchus albus*
	shovelnose sturgeon	*Scaphirhynchus platorynchus*
Paddlefish	paddlefish	*Polyodon spathula*
Gars	longnose gar	*Lepisosteus osseus*
	shortnose gar	*Lepisosteus platostomus*
Mooneyes	goldeye	*Hiodon alosoides*
Herrings	gizzard shad	*Dorosoma cepedianum*
Minnows	red shiner	*Cyprinella lutrensis*
	spotfin shiner	*Cyprinella spiloptera*
	western silvery minnow	*Hybognathus argyritis*
	brassy minnow	*Hybognathus hankinsoni*
	plains minnow	*Hybognathus placitus*
	shoal chub	*Macrhybopsis hyostoma*
	sturgeon chub	*Macrhybopsis gelida*
	sicklefin chub	*Macrhybopsis meeki*
	silver chub	*Macrhybopsis storeriana*
	emerald shiner	*Notropis atherinoides*
	river shiner	*Notropis blennius*
	bigmouth shiner	*Notropis dorsalis*
	sand shiner	*Notropis stramineus*
	suckermouth minnow	*Phenacobius mirabilis*
	fathead minnow	*Pimephales promelas*
	flathead chub	*Platygobio gracilis*
	western blacknose dace	*Rhinichthys obtusus*
	longnose dace	*Rhinichthys cataractae*
	creek chub	*Semotilus atromaculatus*
Asian carps	grass carp	*Ctenopharyngodon idella*
	common carp	*Cyprinus carpio*
	bighead carp	*Hypophthalmichthyes nobilis*

	silver carp	*Hypophthamichthyes molitrix*
Suckers	river carpsucker	*Carpiodes carpio*
	quillback	*Carpiodes cyprinus*
	longnose sucker	*Catostomus catostomus*
	white sucker	*Catostomus commersonii*
	blue sucker	*Cycleptus elongatus*
	smallmouth buffalo	*Ictiobus bubalus*
	bigmouth buffalo	*Ictiobus cyprinellus*
	shorthead redhorse	*Moxostoma macrolepidotum*
Catfishes	black bullhead	*Ameiurus melas*
	blue catfish	*Ictaluras furcatus*
	channel catfish	*Ictaluras punctatus*
	flathead catfish	*Pylodictus olivaris*
Silversides	brook silverside	*Labidesthes sicculus*
Killifishes	plains topminnow	*Fundulus sciadicus*
	northern plains killifish	*Fundulus kansae*
Livebearers	western mosquitofish	*Gambusia affinis*
Sticklebacks	brook stickleback	*Culaea inconstans*
Temperate basses	white perch	*Morone americana*
	white bass	*Morone chrysops*
Sunfishes	green sunfish	*Lepomis cyanellus*
	orangespotted sunfish	*Lepomis humilis*
	bluegill	*Lepomis macrochirus*
	largemouth bass	*Micropterus salmoides*
	white crappie	*Pomoxis annularis*
	black crappie	*Pomoxis nigromaculatus*
Perches	johnny darter	*Etheostoma nigrum*
	yellow perch	*Perca flavescens*
	sauger	*Sander canadensis*
	walleye	*Sander vitreus*
Drums	freshwater drum	*Aplodinotus grunniens*

CHAPTER 1
GENERAL INTRODUCTION

In 1999, the Nebraska Game and Parks Commission along with a consortium of Natural Resources Districts and Public Power and Irrigation districts developed a committee to investigate the possibilities of funding to supplement research on the Platte River dealing with pallid sturgeon. This developed into an organization known as the Pallid Sturgeon / Sturgeon Chub Task Force and on 18 May 2000, they approved the funding of a five-year study on pallid sturgeon, sturgeon chub and associated species in the lower Platte River. This funding dove-tailed with a Federal Aid to Sportfish Restoration project that focused on the ecological relationship of sturgeons with fish species typical of shifting sand-bed rivers. This report presents the results and conclusions of these integrated studies.

Goals and Objectives:

The goal of the Federal Aid to Sportfish Restoration study was to quantitatively describe the habitats used by sturgeons and the ecological relationships of sturgeons with fish species typical of shifting sand-bed rivers.

To accomplish these goals the study delineated five objectives.

Objective 1 was to document habitat use, relative habitat preference and species assemblages associated with adult and juvenile sturgeon in the lower Platte River.

Objective 2 was to document the phenology and relative abundance of larval recruitment for sturgeon and associated species in the lower Platte River.

Objective 3 was to determine how changes in river discharge influence habitat use by sturgeon life stages in the lower Platte River.

Objective 4 was to document the catch of sturgeon by anglers in the lower Platte River.

Objective 5 was to develop educational materials and management recommendations for the sturgeon fishery in the lower Platte River.

The goal of the Pallid Sturgeon / Sturgeon Chub Task Force (Task Force) study was to quantitatively describe habitat use by pallid sturgeon and sturgeon chub in the lower Platte River. The study also included an analysis of the ecological relationships among pallid sturgeon and sturgeon chub, and other fish species typical of shifting sand-bed rivers, exemplified by the Platte River.

To accomplish these goals, the Task Force study delineated five objectives.

Objective 1 was to document habitat use, relative habitat preference and species assemblages associated with adult and juvenile pallid sturgeon and sturgeon chub in the lower Platte River.

Objective 2 was to document the phenology and relative abundance of larvae for pallid sturgeon, sturgeon chub and associated species in the lower Platte River.

Objective 3 was to determine if changes in ambient river habitat conditions influence habitat use by pallid sturgeon and sturgeon chub life stages in the lower Platte River.

Objective 4 was to document the catch of sturgeon by anglers in the lower Platte River.

Objective 5 was to develop management recommendations and educational materials to facilitate appropriate recovery efforts for pallid sturgeon and sturgeon chub in the lower Platte River.

Study Area:

The Platte River has been a significant feature in the central Great Plains of North America since before the end of the last glacial advance. From its origin on the east slope of the Rocky Mountains in Colorado and extending east across Nebraska it drains over 230,000 km^2 (Galat et al. 2005a, NRC 2005). Flows in the Platte River system have been modified greatly by power generation facilities and municipal and irrigation diversions, which are facilitated by dams on the main stem as well as on major tributaries (Eschner et al.1983, Randle and Samad 2003). Even with the alterations in discharge that have accompanied the diversions from upstream sources, the lower Platte River has retained many of the braided channel characteristics of the historic river. In particular, the active channel of the lower Platte near Ashland, Nebraska was nearly 90 percent as wide with shallow, shifting sand bars in 1980 as it was in 1860 (Eschner et al.1983). This is in contrast to the narrowing of the active channel that has occurred at upstream sites. Eschner et al. (1983) found that in 1980 the active river channel near Duncan, NE was 50% of its 1860 width and near Cozad, NE the active channel was less than 10% of its 1860 width. This kind of habitat, now found in only a small proportion of the middle Missouri River and its tributaries, may have been preferred by pallid sturgeon and sturgeon chub. Channel stabilization activities of the Reclamation Act of 1904 and dam construction by the Pick-Sloan Plan of 1944 changed the middle Missouri River from a braided river with shifting sand bars to its present channelized form (Galat et al. 2005a). Other laws that contributed to the channelization and bank stabilization of the lower Missouri River included, in 1912 Public Law 62-241, in 1925 Public Law 68-585, in 1927 Public Law 70-560, and in 1945 Public Law 79-14.

The lower Platte River begins at the confluence of the Platte and Loup Rivers near the city of Columbus, Nebraska and extends downstream approximately 162 km to the Missouri River near Plattsmouth, Nebraska (Figure 1.1). In this reach, the Platte River is characterized by a wide, gently sloping channel of shifting sandbars. Riparian vegetation and stabilized sand bars are generally covered by a combination of cottonwood and eastern red cedar interspersed with areas of grasses and croplands (Peters et al. 1989, NDEQ 1990). Table 1.1 lists the major study locations and their river mile (RM) designations along the lower Platte River. These RM values were measured from a set of U.S. Army Corps of Engineers aerial photos (April 21, 1979).

In the lower Platte River, water temperatures of over 40 °C have been recorded in June, July, and August, but average monthly temperatures range from near 0 °C in January to about 25 °C in July (Peters et al. 1989). United States Geological Survey (USGS) records document typical pH values of 8.0, alkalinity of 153.5 mg $CaCO_3$/L, nitrate

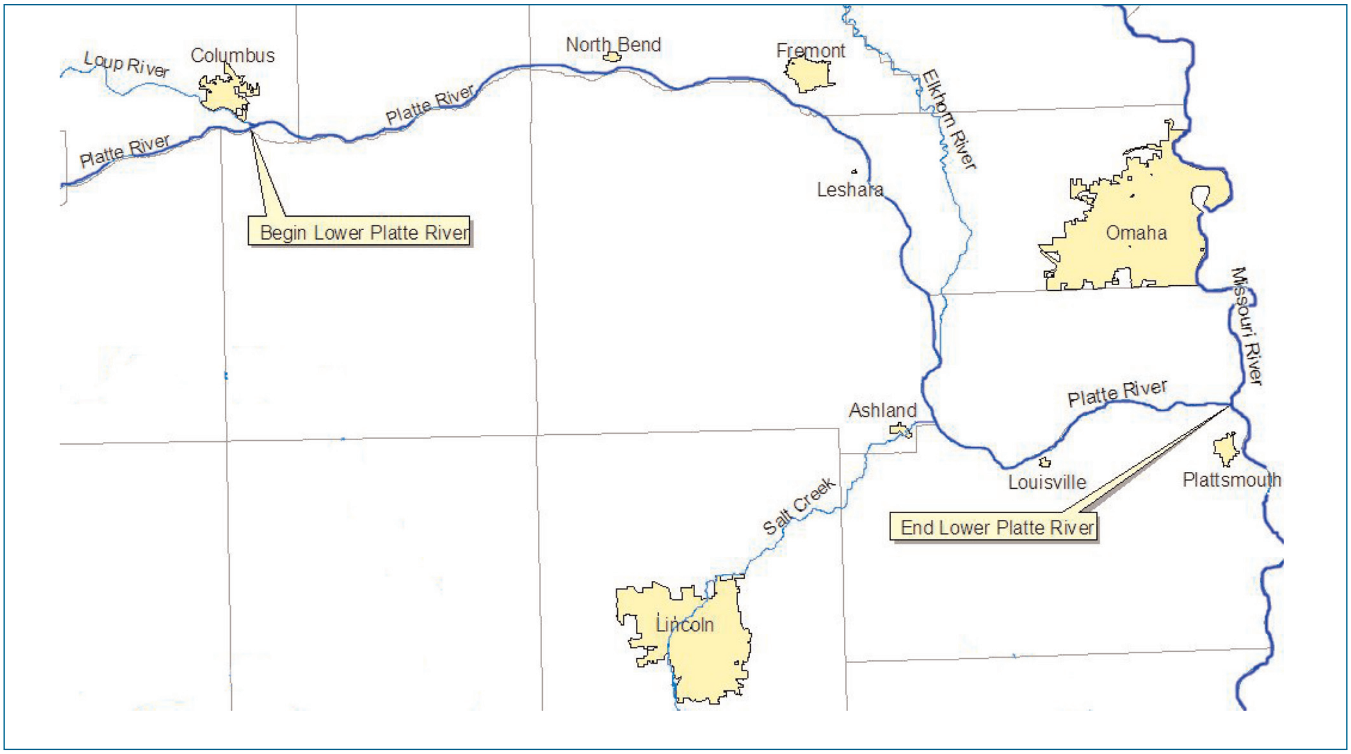

Figure 1.1 Map of the lower Platte River showing major tributaries and important landmarks used to reference study sites.

Table 1.1. Location of study sites and points of reference along the lower Platte River, Nebraska indicating river miles (RM) from the confluence of the Platte and Missouri Rivers (US Army Corps of Engineers aerial photography, April 21, 1979).

LOCATION	RM	TYPE OF SAMPLING or POINT OF REFERENCE
US Highway 81 bridge	106.1	Larval fish sampling
Confluence of Loup River with the Platte River	103	POINT OF REFERENCE
Confluence of the Loup Power Canal with the Platte River	101.5	POINT OF REFERENCE
Nebraska Highway 15 bridge	88.5	POINT OF REFERENCE
Nebraska Highway 79 bridge	72.4	Larval fish sampling Substrate sampling
US Highway 77 bridge	56. 8	POINT OF REFERENCE
Nebraska Highway 64 bridge	48.8	Substrate sampling Water chemistry sampling Access point for trawling
Nebraska Highway 92 bridge	41.5	POINT OF REFERENCE
Two Rivers State Recreation area	40.8	Larval fish sampling
Confluence of Elkhorn River with the Platte River	32.8	POINT OF REFERENCE
US Highway 6 bridge	27.8	Larval fish sampling site Substrate and water chemistry sampling site
Confluence of Salt Creek with the Platte River	25.9	POINT OF REFERENCE
Interstate Highway 80 bridge	25	POINT OF REFERENCE
Schramm Park	22	Upstream access point for creel survey
Louisville Lakes State Recreation Area	17-18	Access point for creel survey
Nebraska Highway 50 bridge	16.3	Access point for creel survey Substrate and water chemistry sampling site
Sand bar and deep run downstream from Louisville	15.5	Larval fish sampling site
Omaha Metropolitan Utilities District Cedar Island Well Field	5-7	POINT OF REFERENCE
US Highway 73,75 bridge	2.6	POINT OF REFERENCE
Schilling Wildlife Management Area	0 – 0.5	Downstream access point for creel survey Larval fish sampling site

nitrogen of 1.35 mg/L and phosphate phosphorous of 0.73 mg/L (Galat et al. 2005a). The Platte River basin, which originally was dominated by grasslands (Galat et al. 2005a, NRC 2005), has been highly modified for agricultural production which occupies approximately 90% of the land area. Irrigated agriculture in the central and lower sub-basins of the Platte River in Nebraska consumes 1,366,400 acre-feet of surface water each year (NRC 2005). The majority of this water is used to grow corn.

River Discharge (contributions of tributaries to the Platte River)

At its upstream end, the lower Platte River receives water from the Platte River and the Loup River. Mean monthly discharge records for the common time period of 1954 to 2004 were examined for all gages except the Platte River at Ashland, NE (USGS Gage: 6801000, 1954 – 1960 and 1989 – 1999). Table 1.2 (Mean monthly discharges) and Table 1.3 (Percentages of Louisville discharge) show that mean monthly discharge records from the Platte River near Duncan, NE (USGS Gage: 677400) average about 27% of the mean monthly discharge at the Louisville, NE gage (USGS Gage: 6805500). The highest monthly percentage of discharge, between Duncan and Louisville, occurs during January (34%), December (33%) and February (31%). The lowest percentage monthly discharge at Duncan occurs during August and is 18% of discharge at the Louisville gage.

During dry periods, especially during the summer, most or all of the flow in the Platte River comes from the Loup River system. The Loup River system drains approximately 15,230 square miles of sandy and loess soils in central

Nebraska. Most of the sandy soils support rangeland agriculture, while most of the loess soils are devoted to cultivated cropland agriculture (NDEQ 1990). Mean monthly discharge records from the Loup River near Genoa, NE (USGS gage: 679300) averages about 10 % of the Louisville gage and the Loup River Power Canal near Genoa, NE (USGS Gage: 6792500) over its period of record from 1937 to present averages 24 % of the Louisville Gage. The sum of these two gages, which would represent the total flow of the Loup River at the mouth of the Loup River, therefore averages, about 34 % of the discharge at the Louisville gage. The percentage that the Loup River contributes to the Platte River discharge at Louisville ranges from 25 % during June to 46 % during January.

Between the Loup River and the Elkhorn River the lower Platte receives small additions to its flow from the Shell Creek and Lost Creek drainages. However, on some occasions heavy rains in the Shell Creek Drainage can contribute large volumes of runoff to the lower Platte River. This runoff is typically silt-laden and has been noted to carry pesticides and nutrients at concentrations that are ranked "among the highest in the Nation" (Frenzel et al. 1998). This section of the lower Platte River also receives inflow from several drainage ditches that were dug to lower water tables on the north side of the river.

The Elkhorn River drains about 7,000 square miles from the eastern Sandhills, which produces considerable amounts of hay from grasses and alfalfa (NDEQ 1990). The eastern portion of the basin produces large quantities of corn and soybeans on loess soils in northeast Nebraska. Irrigation in most of the Elkhorn River drainage depends heavily on ground water withdrawals. Discharge from the Elkhorn River at Waterloo, NE (USGS Gage: 6800500) averages 21 % of the discharge for the Platte River at Louisville and ranges from 15 % during January to 27 % during June. This means that the Elkhorn River is an important contributor to summer flows in the lower Platte River.

Downstream from the Elkhorn River, Salt Creek, which includes the flows from the Wahoo Creek Drainage, enters the lower Platte River from the south side. Discharge from Salt Creek at Greenwood, NE (USGS Gage: 6803555) averages 5 % of the Platte River discharge at Louisville and ranges from 3 % during November through January to 8% during July and August. This is the only major tributary that drains land on the south side of the Platte River in Nebraska. Salt Creek receives flows from sewage treatment facilities in Lincoln, Nebraska and saline water from salt marshes in Lancaster County and therefore has water chemistry characteristics that are quite different from the other tributaries to the lower Platte River.

Overall, the inputs from these gaged sources account for an annual average of 88% of the discharge at Louisville and ranges from a low of 83% during May to July to a high of 99% during January. In contrast to these sources of water for the lower Platte River, the well fields for the cities of Lincoln and Omaha withdraw water from aquifers along and under the Platte River. The Lincoln well fields extend from just downstream of the confluence of the Platte River and the Elkhorn River (RM 32.8) to just upstream from the confluence of the Platte River and Salt Creek (RM 25.9). The operating Omaha well field is located in

Table 1.2. Mean monthly discharge (cfs) from 1954 to 2004 for selected gage stations associated with the lower Platte River, Nebraska. All gages have complete records except the Platte River at Ashland, NE where the period of record is 1954-1960 & 1989-1999.

				Discharge (cfs)				
Gage Location	USGS Gage Number	JAN	FEB	MAR	APR	MAY	JUN	JUL
Platte River near Duncan, NE	6774000	1633	2328	2923	2552	2601	2891	1432
Loup River near Genoa, NE	6793000	1043	1360	1661	732	612	727	293
Loup River Power Canal near Genoa, NE	6792500	1155	1604	1939	2191	2035	1960	1371
Platte River near North Bend, NE	6796000	3409	5164	7285	5992	5858	6562	3573
Elkhorn River near Waterloo, NE	6800500	713	1396	2421	2381	2321	2998	1616
Platte River near Ashland, NE	6801000	4047	6012	8610	8299	8298	9523	6186
Salt Creek near Greenwood, NE	6803555	159	262	496	393	608	716	508
Platte River near Louisville, NE	6805500	4742	7455	11013	9819	9823	11166	6278

				Discharge (cfs)			
Gage Location	USGS Gage Number	AUG	SEP	OCT	NOV	DEC	Yearly Mean
Platte River near Duncan, NE	6774000	729	1025	1487	1602	1596	1900
Loup River near Genoa, NE	6793000	241	258	148	470	1165	726
Loup River Power Canal near Genoa, NE	6792500	1262	1587	2024	1926	986	1670
Platte River near North Bend, NE	6796000	2452	3049	3837	4169	3606	4580
Elkhorn River near Waterloo, NE	6800500	989	789	827	871	770	1508
Platte River near Ashland, NE	6801000	3963	3652	4421	5076	4599	6057
Salt Creek near Greenwood, NE	6803555	314	261	258	180	149	359
Platte River near Louisville, NE	6805500	4105	4285	5164	5500	4894	7020

Table1.3. Percentage of discharge compared with Louisville discharge from 1954 to 2004 for selected gage stations associated with the lower Platte River, Nebraska. All gages have complete records except the Platte River at Ashland, NE where the period of record is 1954-1960 & 1989-1999.

				Discharge (%)				
Gage Location	USGS Gage Number	JAN	FEB	MAR	APR	MAY	JUN	JUL
Platte River near Duncan, NE	6774000	34%	31%	27%	26%	26%	26%	23%
Loup River near Genoa, NE	6793000	22%	18%	15%	7%	6%	7%	5%
Loup River Power Canal near Genoa, NE	6792500	24%	22%	18%	22%	21%	18%	22%
Platte River near North Bend, NE	6796000	72%	69%	66%	61%	60%	59%	57%
Elkhorn River near Waterloo, NE	6800500	15%	19%	22%	24%	24%	27%	26%
Platte River near Ashland, NE	6801000	85%	81%	78%	85%	84%	85%	99%
Salt Creek near Greenwood, NE	6803555	3%	4%	5%	4%	6%	6%	8%
Platte River near Louisville, NE	6805500	100%	100%	100%	100%	100%	100%	100%

				Discharge (%)			
Gage Location	USGS Gage Number	AUG	SEP	OCT	NOV	DEC	Yearly Mean
Platte River near Duncan, NE	6774000	18%	24%	29%	29%	33%	27%
Loup River near Genoa, NE	6793000	6%	6%	3%	9%	24%	10%
Loup River Power Canal near Genoa, NE	6792500	31%	37%	39%	35%	20%	24%
Platte River near North Bend, NE	6796000	60%	71%	74%	76%	74%	65%
Elkhorn River near Waterloo, NE	6800500	24%	18%	16%	16%	16%	21%
Platte River near Ashland, NE	6801000	97%	85%	86%	92%	94%	86%
Salt Creek near Greenwood, NE	6803555	8%	6%	5%	3%	3%	5%
Platte River near Louisville, NE	6805500	100%	100%	100%	100%	100%	100%

the area downstream from the Nebraska highway 50 bridge approximately from RM 7 downstream to RM 5. A new well field for the Omaha metropolitan area is being developed in the area upstream from the confluence of the Platte River and Elkhorn River between RM 33 and 38. Specific depletions of flows in the Platte River have not, to our knowledge, been measured, but water system officials from both Lincoln and Omaha have expressed concern when flows in the Platte River are low, especially during the summer.

Comparison of Historic Discharge Records to the 2000 to 2004 study period:

The period of 2000 to 2004 was one of very low precipitation in the Platte River drainage (US Drought Monitor: http://drought.unl.edu/dm). This resulted in depletions in the amount of water stored and released from reservoirs of the North and South Platte River system and resulted in periods of zero discharge in many sections of the Platte River from Columbus upstream to Elm Creek, Nebraska. An examination of the mean monthly discharge records at the Louisville gage as displayed in Table 1.4 (Comparison of mean monthly discharges) and Table 1.5 (Percentages) shows that discharge during the 2000 to 2004 period of study averaged 74% of pre-2000 flows and ranged from 53% of pre-2000 flows during June to 98% of pre-2000 flows during January. Discharge during the period of the study at the Duncan gage on the Platte River was proportionally the lowest, averaging 55% of pre-2000 flows while discharge during the period of the study at the Elkhorn River at Waterloo gage was proportionally the highest, averaging 102% of pre-2000 flows.

Mean daily discharge values from USGS gaging stations for the Platte River at Leshara, the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at Louisville for July 2001 through June 2004 on the dates those sites were sampled for water quality parameters are displayed on Figures 1.2, 1.3, 1.4 and 1.5, respectively (note that the scales on the Y-axes vary at each site).

HISTORICAL CONTEXT:

Over the years since the first European settlement of the Platte River basin, many conflicts have arisen over the use and allocation of its water resources. These conflicts have included the need for water to support the habitat of endangered and threatened species under the US Endangered Species Act. The US Fish and Wildlife Service has issued jeopardy opinions for activities that would affect the central Platte River, including one for the Narrows Project on the South Platte River in 1983, for water diversions on the Front Range in Colorado in 1994, and for relicensing the Kingsley hydroelectric project in 1997 (NRC 2005). In 1997, the states of Colorado, Wyoming, and Nebraska and the Department of the Interior entered into a Cooperative Agreement. As part of this agreement the parties have developed a program to reduce shortages to U.S. Fish and Wildlife Services target flows at Grand Island by 130,000 to 150,000 acre-feet per year and to protect or restore 10,000 acres of habitat in the central Platte region during the program's first 13 year increment (USDOI, Bureau of Reclamation, US Fish and Wildlife Service 2006).

Fish Species:

One hundred species of fish (76 native, 24 exotic) have

Table 1.4. Mean monthly discharge prior to and during study period for selected gage stations associated with the lower Platte River, Nebraska.

				Discharge (cfs)					
Gage Location	USGS Gage Number	Time Period	JAN	FEB	MAR	APR	MAY	JUN	JUL
Platte River, Duncan, NE	6774000	1929-1999	1506	2310	3019	2429	2560	2872	1259
		2000-2004	1587	1719	1918	1495	1324	592	337
Loup River, Genoa, NE	6793000	1944-1999	957	1377	1667	680	638	928	376
		2000-2004	1254	976	1634	887	501	129	139
Loup River Power Canal, Genoa, NE	6792500	1937-1999	1158	1513	1810	2107	1969	1921	1367
		2000-2004	835	1331	1621	2028	1898	1674	1266
Platte River, North Bend, NE	6796000	1950-1999	3466	5411	7510	6113	6020	6778	3778
		2000-2004	2828	3466	4912	4732	4462	3037	2075
Elkhorn River, Waterloo, NE	6800500	1929-1999	608	1198	2281	2061	2040	2857	1421
		2000-2004	922	1231	1838	1949	2847	2115	1841
Platte River, Ashland, NE	6801000	1928-1960 & 1989-1999	3732	5837	9007	7514	7675	9905	5385
		2000-2004	3255	5022	7354	6573	7997	5539	3743
Salt Creek, Greenwood, NE	6803555	1952-1999	159	269	518	423	595	725	537
		2000-2004	141	171	276	178	619	542	211
Platte River, Louisville, NE	6805500	1954-1999	4751	7610	11270	10071	9949	11706	6513
		2000-2004	4654	6030	8648	7498	8661	6193	4115

Table 1.4 (continued). Mean monthly discharge prior to and during study period for selected gage stations associated with the lower Platte River, Nebraska.

				Discharge (cfs)				
Gage Location	USGS Gage Number	Time Period	AUG	SEP	OCT	NOV	DEC	Yearly Mean
Platte River, Duncan, NE	6774000	1929-1999	563	903	1314	1479	1441	1140
		2000-2004	248	271	570	764	1022	575
Loup River, Genoa, NE	6793000	1944-1999	260	237	151	436	1072	431
		2000-2004	82	223	167	688	1342	500
Loup River Power Canal, Genoa, NE	6792500	1937-1999	1239	1546	1942	1853	992	1514
		2000-2004	1126	1530	1852	1713	970	1438
Platte River, North Bend, NE	6796000	1950-1999	2588	3129	3873	4219	3666	3495
		2000-2004	1464	2137	2897	3338	2664	2500
Elkhorn River, Waterloo, NE	6800500	1929-1999	964	735	730	752	655	767
		2000-2004	704	645	701	909	876	767
Platte River, Ashland, NE	6801000	1928-1960 & 1989-1999	3557	3428	3971	4529	3980	3893
		2000-2004	1908	2565	3406	4212	3851	3188
Salt Creek, Greenwood, NE	6803555	1952-1999	321	263	255	178	148	233
		2000-2004	203	171	191	163	124	170
Platte River, Louisville, NE	6805500	1954-1999	4298	4437	5287	5586	4947	4911
		2000-2004	2327	2887	3740	4507	4288	3550

been recorded from the Platte (Schainost and Koneya 1999, Peters and Schainost 2005). Of particular interest to this study are the pallid sturgeon, shovelnose sturgeon, and sturgeon chub, but all species encountered during this study have been evaluated in these results.

STRUCTURE OF THIS REPORT:

This report is divided into chapters each of which encompasses all or part of one of the major objectives.

Chapter 2 details the sampling effort for adult and juvenile fish and compares the efficacy of each method.

Chapter 3 details the study effort for water quality sampling.

Chapter 4 details the studies of habitat use, movement, and population characteristics for pallid sturgeon in the lower Platte River.

Chapter 5 details the studies of habitat use, movement, and population characteristics for shovelnose sturgeon in the lower Platte River.

Chapter 6 presents the information on shovelnose sturgeon food habits in the lower Platte River.

Chapter 7 details the habitat use and population characteristics for chubs in the lower Platte River.

Chapter 8 details the sampling effort for larval fish in the lower Platte River.

Chapter 9 details the creel survey in the lower Platte River.

Chapter 10 details the development of models of relationships between Platte River discharge and sturgeon and chub habitat and habitat connectivity in the lower Platte River.

Chapter 11 presents the conclusions drawn from the analyses of the data collected during this study.

Table 1.5. Percentage of discharge for study period (2000-2004) compared with discharge prior to study period for selected gage stations associated with the lower Platte River, Nebraska.

				% of pre-study flows				
Gage Location	USGS Gage Number	JAN	FEB	MAR	APR	MAY	JUN	
Platte River near Duncan, NE	6774000	105	74	64	62	52	21	
Loup River near Genoa, NE	6793000	131	71	98	131	79	14	
Loup River Power Canal near Genoa, NE	6792500	72	88	90	96	96	87	
Platte River near North Bend, NE	6796000	82	64	65	77	74	45	
Elkhorn River near Waterloo, NE	6800500	152	103	81	95	140	74	
Platte River near Ashland, NE	6801000	87	86	82	87	104	56	
Salt Creek near Greenwood, NE	6803555	89	63	53	42	104	75	
Platte River near Louisville, NE	6805500	98	79	77	74	87	53	

				% of pre-study flows				
Gage Location	USGS Gage Number	JUL	AUG	SEP	OCT	NOV	DEC	Yearly Mean
Platte River near Duncan, NE	6774000	27	44	30	43	52	71	55
Loup River near Genoa, NE	6793000	37	32	94	111	158	125	91
Loup River Power Canal near Genoa, NE	6792500	93	91	99	95	92	98	92
Platte River near North Bend, NE	6796000	55	57	68	75	79	73	67
Elkhorn River near Waterloo, NE	6800500	130	73	88	96	121	134	102
Platte River near Ashland, NE	6801000	70	54	75	86	93	97	81
Salt Creek near Greenwood, NE	6803555	39	63	65	75	91	84	68
Platte River near Louisville, NE	6805500	63	54	65	71	81	87	74

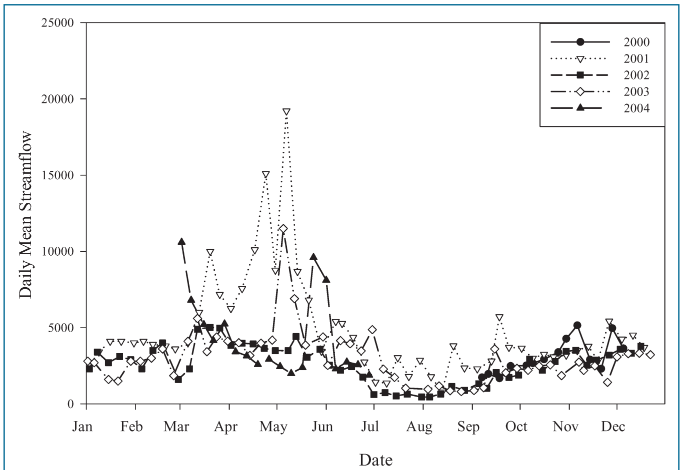

Figure 1.2. Daily mean streamflow (cfs) in the Platte River at Leshara, September 2000 to June 2004 (USGS data).

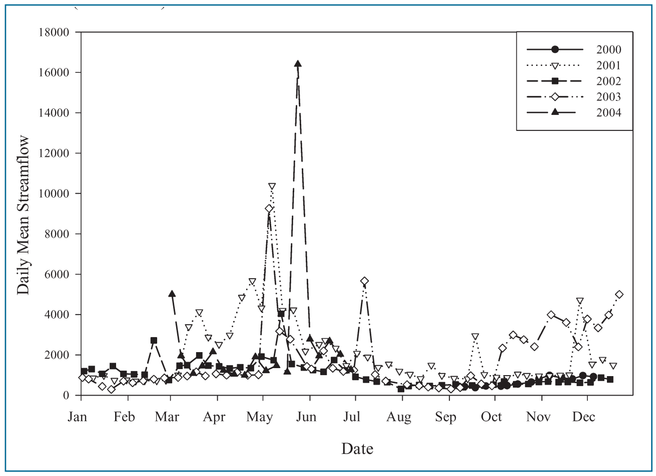

Figure 1.3. Daily mean streamflow (cfs) in the Elkhorn River at Waterloo, September 2000 to June 2004 (USGS data).

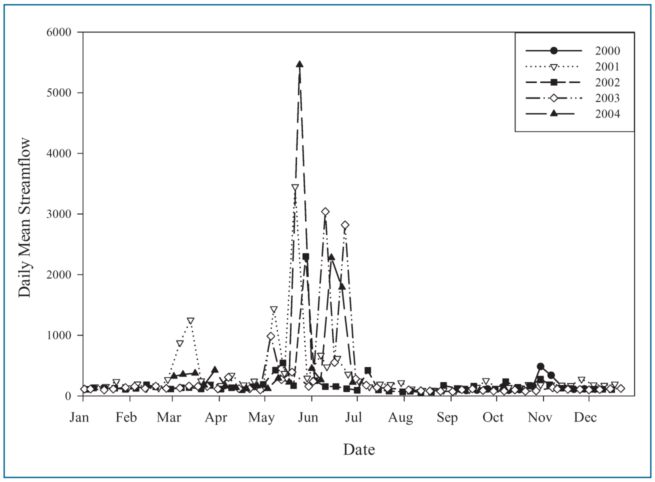

Figure 1.4. Daily mean streamflow (cfs) in Salt Creek at Greenwood, September 2000 to June 2004 (USGS data).

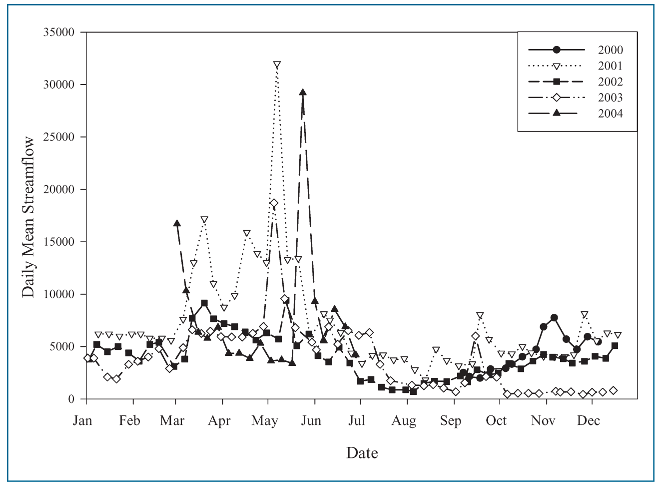

Figure 1.5. Daily mean streamflow (cfs) in the Platte River at Louisville, September 2000 to June 2004 (USGS data).

Releasing a juvenile pallid sturgon.

Pallid sturgon.

CHAPTER 2

OVERVIEW OF FIELD METHODS, CATCH AND A COMPARISON OF GEAR EFFORT

INTRODUCTION

To determine habitat use for pallid sturgeon, shovelnose sturgeon, sturgeon chubs, and associated species in the lower Platte River, we sampled for fish using a range of gear types. The gear types included drifted gill nets, drifted trammel nets, stationary gill nets, trotlines, trawls, seines, and minnow traps. Since pallid sturgeon, shovelnose sturgeon and sturgeon chub life stages are typically captured in different habitats and by different types of sampling gear, we used the gear to sample different Platte River habitats, but our efforts centered on those areas where previous research and literature suggested that pallid sturgeon, shovelnose sturgeon, and sturgeon chub would most likely be found. Previous studies (Peters et al. 1989, Peters and Holland 1994, Yu 1996) intensively sampled shallow water habitats and shoreline habitats in the lower Platte River between 1986 and 1995 and the results suggested that pallid sturgeon, shovelnose sturgeon or sturgeon chub do not use shallow water or shoreline habitats extensively. In addition, other studies on sturgeon and shovelnose pallid (Hofpar 1997, Snook et al. 2002) indicated that much of our sampling effort should be focused in the deepest and swiftest sections of the river.

Realizing that much of the sampling effort for this study was intentionally aimed at capturing the rare pallid sturgeon and sturgeon chub, it is important to understand that the sampling strategy was not a random or stratified random sampling design where samples were collected in proportion to their availability in the river. As stated earlier, previous studies had intensively sampled shallow water and shoreline habitats (Peters et al. 1989, Peters and Holland 1994, Yu 1996) and few sturgeon or sturgeon chubs were captured. Most of the different gears used were deployed near or in the deeper or swifter sections of the river. To understand the distribution of gear effort, we compared the distribution of samples to the habitat availability studies conducted by NGPC in the 1980s. These studies used a standardized transect data collection method to determine habitat availability over different discharge rates. While we have not directly tested to see if the transect data are still representative of the lower Platte River, in the view of the senior author (who was associated with the transect effort) the transect data are still a valid description of habitat availability in the river.

FIELD METHODS

Fish collection protocols:

Pallid sturgeon or shovelnose sturgeon that weighed at least 300 grams were deemed sufficiently large enough to hold a transmitter. Pallid sturgeon that were captured at times during the year when water temperatures were 16 °C or less were implanted with radio-telemetry transmitters and were tracked during the time they remained in the Platte River. This maximum temperature criterion for implanting transmitters in pallid sturgeon was stipulated by the federal endangered species permit from the U.S. Fish and Wildlife Service. There was no specific temperature restriction for implanting transmitters in shovelnose sturgeon, but most were implanted at temperatures below 25 °C. In general, all fish captured in any effort using the different gear types were identified, weighed, and measured using fork length for sturgeon and total length for other species. Habitat was characterized by recording information on habitat variables at several locations. Starting in 2000, all sturgeon collected were measured following Sheehan et al.(1999) to calculate the morphometric character index (mCI). In addition, a set of two digital photos was taken of each fish as a visual record for future analysis. These photos included a ruler for reference. Each fish was also PIT tagged and this number or alpha-numeric code was used to reference each individual. Starting in 2003, we added the measurements, new head length 1 and new head length 2 along with point to point in an attempt to improve our ability to distinguish pallid from shovelnose sturgeon (Figure 2.1).

All other larger fishes were identified to species, measured for total length, weighed to the nearest tenth of a kilogram, and released. Smaller fishes (less than approximately 6 inches) were identified to species, counted, and released. If identification was not possible in the field the specimens were fixed in a 10% formalin solution and returned to the laboratory for identification. Sturgeon chub and other similar species were fixed in 10% formalin for identification, measurement and other laboratory studies.

Fish Sampling Methods:

Drifted Gill Nets and Trammel Nets: Gill nets were constructed of monofilament nylon, 1.8 m (6 ft) deep by 30.5 m (100 ft) long, with four 7.6 m (25 ft) long alternating panels of 2.5 cm (1 in) and 5.1 cm (2 in) bar mesh. A pallid sturgeon or any other fish may be entangled in a gill net by wedging, caught by the gills or caught by their bony scutes (sharp bony scales) or other body projections. Trammel nets used in the Platte River measured 38.1 m (125 ft) long by 1.8 m (6 ft) deep. Trammel nets consist of three panels of netting suspended from a float line and a single or double lead line. The two outer panels are a larger mesh (15.0 cm) than the inner panel (2.5 cm). Fish are either gilled in the mesh or become bagged within the smaller mesh. Generally, trammel nets are less injurious to fish than gill nets and are also less size-selective (Hubert 1996). In addition, although they are more cumbersome to operate because of multiple, heavier mesh, they tend to be more efficient at catching and retaining fish located on or near the river bottom. The conversion of gear use from drifted gill nets to drifted trammel nets was dictated by the desire to comply with the standards that are currently being used by researchers on the Missouri River Pallid Sturgeon Recovery Team.

Both gill and trammel nets were drifted with the current, with the net extended perpendicular to the flow of the current for distances up to about 200-400 m, depending on where

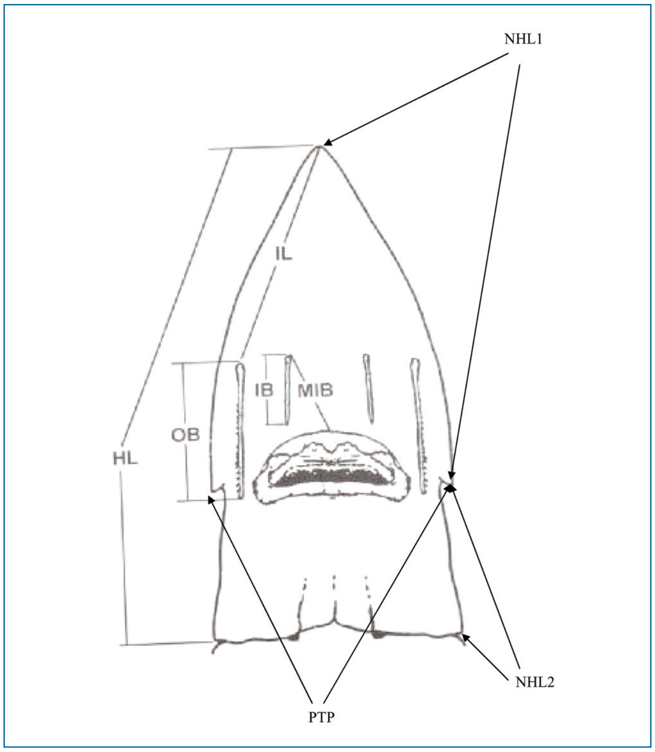

Figure 2.1. Diagram of the underside of a pallid sturgeon head showing measurements used to calculate the morphometric character index (Sheehan et al. 1999). OB = outer barbel length, IB = inner barbel length, MIB = mouth to inner barbel length, IL = interrostrum length, HL = head length, PTP = point to point length, NHL1 = new head length 1, NHL2 = new head length 2 (Total head length = NHL1+NHL2).

landing sites were available. Locations for drifting a net were determined on site to best sample the available habitat. Areas that contained high concentrations of sunken snags were typically avoided when using entanglement gear. A crew of three or more workers deployed the net at the upstream end of the area to be sampled and walked or floated with the net to keep it spread and to release it if it became snagged on underwater obstructions. Sampling locations were selected at areas along and downstream from sandbars where water currents converge, or areas of sunken sandbars (underwater areas of shifting sand dunes typically 30-200 cm under the water surface) that were identified by Snook (2001) to be important habitats for pallid sturgeon. These areas typically had a 0.5-2 m deep shelf located on the downstream end. The average width of the net fished throughout the run and total length of the run was measured with a laser range finder. The length and width measurement was then multiplied to estimate the area sampled. The location of each run was determined at the start and the end of each run using a handheld global positioning system (GPS) unit.

Measurements used to describe the habitat sampled by the drifted nets were as follows. Water depth, mean column velocity, bottom velocity, and substrate were recorded at the estimated center of the net width at the start, mid point and end of the drift. Additionally, a single measurement of water temperature, dissolved oxygen, and specific conductivity was recorded for each run. A water sample was collected to determine total suspended solids and water turbidity in the laboratory, and pictures of the area sampled were taken. The distance to the shore in each direction was measured with a laser rangefinder to provide a method to approximate channel position of the run.

Stationary Gill Nets: Stationary gill nets sets were used to attempt to capture sturgeon in the Platte River after they were recommended by researchers working in the Missouri and Mississippi Rivers. The nets were set parallel with the current in deep, slack water areas. The gill nets used were the same as the drifted gill nets, measuring 1.8 m (6 ft) deep by 30.5 m (100 ft) long, with four 7.6 m (25 ft) long alternating panels of 2.5 cm (1 in) and 5.1 cm (2 in) bar mesh and constructed of monofilament nylon. Nets were set overnight and fish were removed, identified and counted the following morning.

Trotlines: Trotlines were used to sample for sturgeon in the cold water times of the year. They were recommended by researchers working in the lower Mississippi River (Killgore; personal communication). Our trotlines were 30 m long with 24 circle hooks alternating in size (10/0 and 12/0) attached to the main line by 0.5 m drop lines at 1.0 m intervals. Hooks were baited with night crawlers. Trotlines were set in the late afternoon, allowed to fish all night and retrieved in the morning. The trotlines were fished for approximately 18 hours and all fish caught were removed, identified, measured and released. Trotlines were typically set in deep pools and runs, and near sunken sandbars. Habitat variables were recorded at the upstream and downstream ends of the trotline after the line was set and then the next day prior to removing the trotline from the water. The location of each trotline set was determined by a GPS unit.

Trawls: Benthic fish trawls were used to sample deeper run and pool habitats for pallid sturgeon, sturgeon chub and associated species. The trawl design was a modified otter trawl and it was used primarily in water over 1.0 m deep. The majority of samples were taken from channel habitat and areas of swift velocity where chubs have been found in previous research (Peters et al. 1989, Schainost and Koneya 1999). Sampling started in May and concluded in September. Sampling was timed to include the time chub spawning takes place to allow various age classes to be collected.

Habitat measurements recorded for each sample included: depth, mean column velocity, bottom velocity, dissolved oxygen, temperature, specific conductivity, total suspended solids, and GPS coordinates. Sand/gravel substrate combinations were recorded by percent of composition. Large fish were counted, measured, and released in the field and small fish were preserved in 10% formalin and brought back to the lab for further analysis.

Seines and minnow traps: Smaller fishes were also sampled using several other gears. Seines were used to sample shallow water habitats near sandbars. The seines used in this study included 1/16th in, 1/8th in, and 3/8th in mesh seines from 15 to 25 ft long. Some seines were modified by attaching a chain to the lead line to attempt to capture fish near the bottom of the river.

In addition to general seine hauls, during 2002 and 2003, we collected small-fish at the US Highway 6 Bridge using minnow traps. Rectangular minnow traps made of 6.35 mm (1/4 in) wire mesh were deployed at dusk, left undisturbed over night, and retrieved at dawn. Traps were placed in "clusters" of three traps each in four different macro habitats. Typical habitats sampled included: deeper swift channels, shallow riffle areas, snag eddies (pools), and stabilized bank runs. Each trap was held in place with a 1.8 m (6 ft) length of rebar rod. Minnow traps were typically set in a side by side by side configuration in broader habitat types (such as deep or shallow runs) or in line with one another in narrower habitats (such as along a bank or behind a snag). At sunrise, traps were removed and the fish were either identified and measured in the field or preserved in 10% formalin and processed in the laboratory.

Telemetry: Sturgeon captured using drifted gill or trammel nets and trotlines were evaluated to determine whether they could receive a radio transmitter. These fish were identified using Sheehan et al. (1999), and measured for fork length and weight. Only those sturgeon whose body weight exceeded 300 g were considered to be large enough to receive a transmitter. This corresponds to the recommendation that all transmitters weigh less than 2.0% of each individual's body weight (Winter 1996). Small transmitters weighed 15 g, measured 42 x 15 mm, and had a life expectancy of approximately 400 days. Large transmitters weighed 20 g, measured 51 x 15 mm, and had a battery life of approximately 625 days.

To insert a radio tag into a sturgeon, the fish was held belly side up over a plastic tub (65 x 42 x 25 cm) while the gills were irrigated with river water. A small mid-ventral incision was made in the peritoneal cavity to allow for insertion of the transmitter. The radio transmitter was inserted and a 30 cm radio antenna protruded from the fish's belly through a separate incision made with a large gauge hypodermic needle. Finally, the incision was closed with three or four individually tied sutures. Radio tagged fish were searched for or monitored throughout the year, from shore, boat, and aircraft to determine their locations in the Platte River. A permanent telemetry station was set up at the Schilling WMA located at the confluence with the Missouri River to monitor when radio tagged fish entered or left the Platte River.

Radio telemetry information used to evaluate habitat use was obtained exclusively from airboat surveys, while movement data came from all three contact methods (shore, boat and aircraft). Sturgeons were located by triangulating the radio signal using a directional loop antenna. Final locations were typically accomplished by removing the antenna from the receiver to find the strongest signal.

To describe the area used by a telemetry tagged sturgeon, measurements of the habitat, including water depth, mean column velocity, bottom velocity, substrate, and cover, were made at the focal point of the radio signal location and then, 2 m upstream, 2 m downstream, 2 m to the left, and 2 m to the right of the focal location (Hofpar 1997, Snook 2001, Swigle 2003). This combination of measurements was used to provide a more detailed description of the habitat conditions in the immediate vicinity of sturgeon. This set of measurement locations also encompassed the estimated range of error associated with location of radio signals determined from previous studies of sturgeon and catfish (Bunnell 1988, Chapman 1995, Hofpar 1997, Snook 2001, Swigle 2003). In addition, single measurements of dissolved oxygen, water temperature, conductivity, and suspended solids were made at each location. This protocol was consistent with those used by similar studies in Montana (Bramblett 1996, Bramblett and White 2001) and Illinois (Hurley 1998). The presence of underwater sand dunes and the proximity of radio-tagged fish to shallow sunken sandbar ledges were also recorded. Underwater sand dunes are waves in the sandy riverbed and sandbar ledges are areas with a rapid increase in water depth downstream from or lateral to shallow submerged sandbars.

Gear Comparisons:

To compare the habitat sampled by the different gear types, we compared the habitat both graphically and statistically. Gear types compared included; drifted gill nets, drifted trammel nets, trawls, trotlines, and seines. Additionally, the habitat attributes for the locations of radio-tagged shovelnose sturgeon were included to provide a comparison of the gear deployment with the observed sturgeon habitat. To estimate the available habitat in the river, we used transect data gathered by the NGPC during a previous Instream Flow Incremental Methodology (IFIM) study (NGPC 1993a, b). These data included measurements of depth and mean column velocity measured at points along several transect lines from three different localities under differing discharge conditions. Habitat sampled for each gear type was described in several ways. First the median and 25% and 75% values were reported for each habitat variable collected at the sampling time. Next, depth and mean column velocities collected during gear sampling were compared with samples of habitat availability collected by NGPC. Depth and mean column velocity was analyzed using a bivariate table with four categories of depth and four categories of mean column velocity. First, the distribution of the habitats sampled was determined by tabulating the number of samples for each cell in the table, and then calculating the percent frequency of each cell in the table. Gear selection of the depth and velocity combinations was determined by dividing the percent frequency of occurrence in each cell with the percent frequency of the habitat availability for that cell. The gear selection was normalized by dividing each cell value by the sum of all cell values. These values were standardized to a scale of 0 to 1 by dividing each cell value by the largest cell value (Bovee and Milhous 1978, Peters et al. 1989). In cases where undefined numbers would result in division by zero, the value was replaced with a zero. To provide a graphic representation of the data, scatterplots of depth and mean column velocity are also presented. To compare the habitats that each gear sampled in comparison to other gears, box plots of each habitat variable are presented.

For statistical comparisons, the distributions of the individual measurement for habitat variables were tested for normality, and if they were found to fit a normal distribution and have equal variances, then an ANOVA with pairwise comparisons with Holm-Sidak corrections were used to test for differences among group means. In most cases, the distributions were not normally distributed, so the data were rank transformed and means were compared using Kruskal-Wallis One Way Analysis of Variance on Ranks with Dunn's method of pairwise comparisons.

RESULTS AND DISCUSSION

As noted in the methods section, the sampling effort on the lower Platte River was designed to attempt to capture the rare pallid sturgeon. As a result, the sampling effort was not evenly distributed throughout the lower Platte River. Most of the effort was focused on the reach of river below the confluence with the Elkhorn River. In this area, two smaller areas, one around Louisville, NE and the other near the mouth of the Platte River received extra effort as we captured pallid sturgeon in these areas. Stationary gill nets and minnow traps are not shown or further discussed as neither method was effective at catching pallid sturgeon or sturgeon chubs and their use was discontinued after a preliminary testing period.

The types of sampling gear used also changed throughout the year. Trotlines were used during the cold water periods and then the actively deployed nets and trawls were used primarily in the warmer water periods of the year. In addition to being used in cold water, trotlines were most effective at sampling the deepest and swiftest waters in the river and captured mostly shovelnose and pallid sturgeon. As the water warmed and discharge decreased as the year progressed, trammel nets proved effective at catching a wide range of species, including many shovelnose sturgeon and a few pallid sturgeon. Trawls proved most effective for capturing sturgeon chub, although neither seines nor trawls caught many.

Drifted gill and trammel nets: Fish were captured by drifting gill nets during 2000, 2001, 2002 and 2004. Figures 2.2 a,b,c and 2.3 a,b,c show the distribution of sampling effort from drifted gill and trammel nets. Trammel nets were first used experimentally in the same fashion as drifted gill nets during 2002, and subsequently used primarily instead of drifted gill nets in 2003 and 2004. The number and timing of runs of drifted gill nets (Table 2.1) and drifted trammel nets (Table 2.2) varied among months and years.

Overall, the drifted nets sampled water approximately 0.7 m deep with 0.56 m/s mean column velocities and 0.35 m/s bottom velocities over a sand substrate. Monthly averages for the mean, minimum, and maximum of each of these physical habitat variables changed based on the overall river discharge and tended to be located in deeper and swifter waters in the spring when compared to summer samples (Table 2.3).

The mean, minimum, and maximum water quality measurements also varied throughout the year (Table 2.4). Water temperatures were generally in the low 20s °C as this sampling gear started after trotlines were suspended at 16 °C. Dissolved oxygen appears to be high for most of the samples with a low reading of 5.18 mg/L in June of 2000. Specific conductivity varied with discharge and location with the majority of the readings in the 500 – 600 µS/cm range. The highest reading of 1,566 also occurred in June of 2000. Total suspended solids readings averaged 374.7 mg/L, but showed wide fluctuations from 70 mg/L to 2,848 mg/L.

The number and type of fish caught in the drifted nets varied among months and generally reflected the changes in effort between March and October (Table 2.5), yet some species were caught either randomly throughout the sampling season (paddlefish, smallmouth buffalo, flathead catfish) or mostly in one part of the sampling season (blue suckers in spring). Average number of fish captured per run was highest in the early spring, was lowest in May, and then increased and generally stayed around 6 fish per run throughout the summer and early fall.

When viewing the fish capture data by year (Table 2.6), we see a general increase in capture after the conversion from gill nets to trammel nets in 2003 and most species' yearly capture roughly follows overall effort. Exceptions to this pattern included blue suckers which were captured in much higher numbers in 2004 than any other year, and gizzard shad were captured with declining frequency over time.

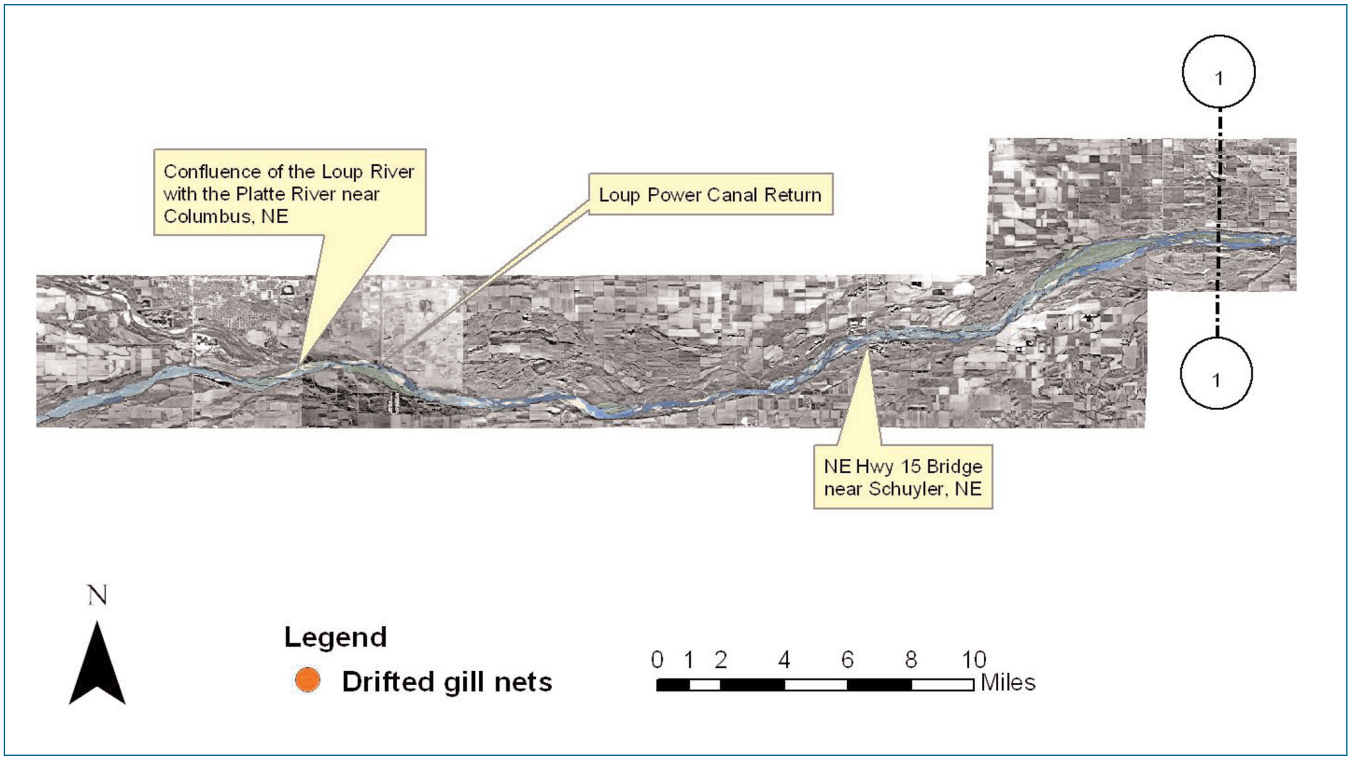

Figure 2.2a. Map of the locations of drifted gill net runs attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

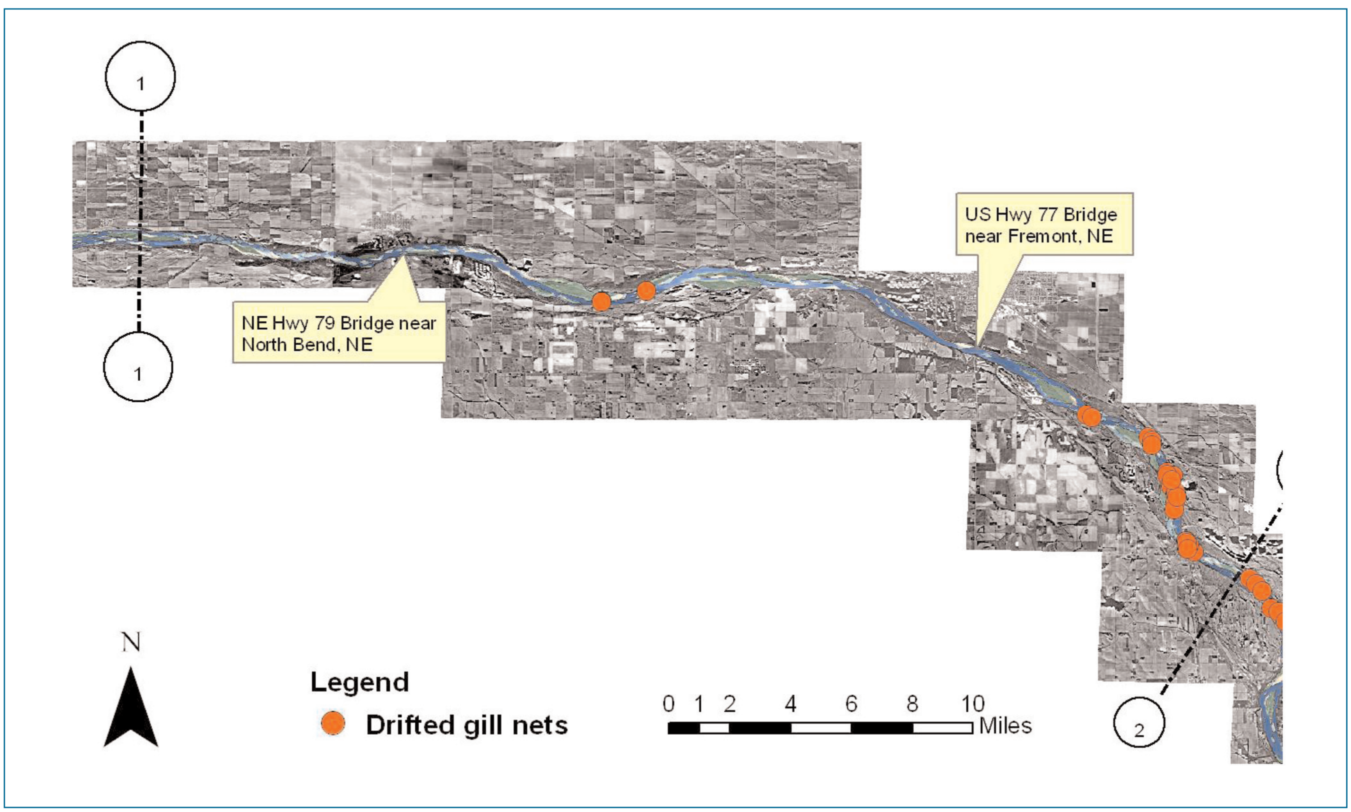

Figure 2.2b. Map of the locations of drifted gill net runs attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

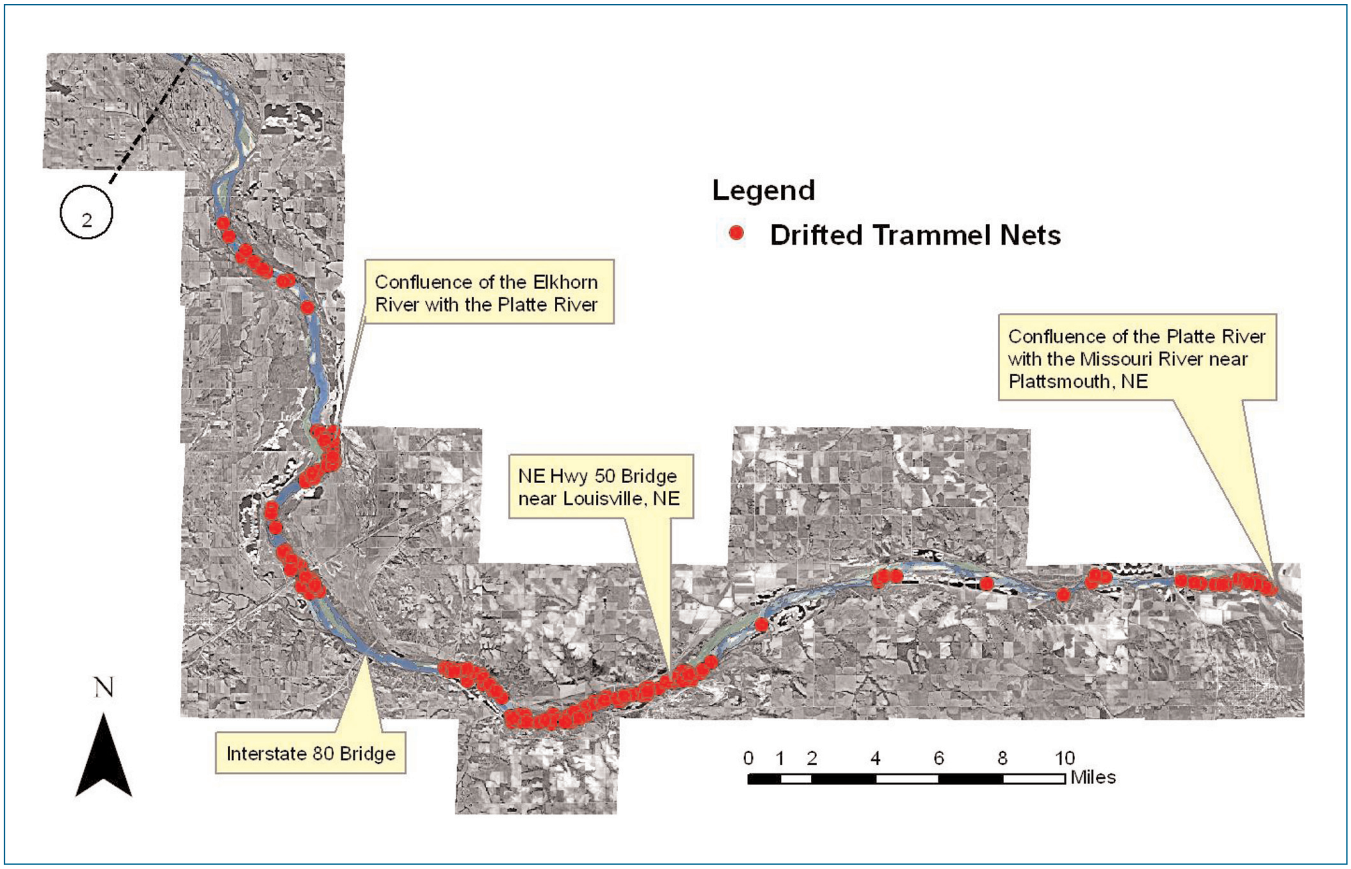

Figure 2.2c. Map of the locations of drifted gill net runs attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

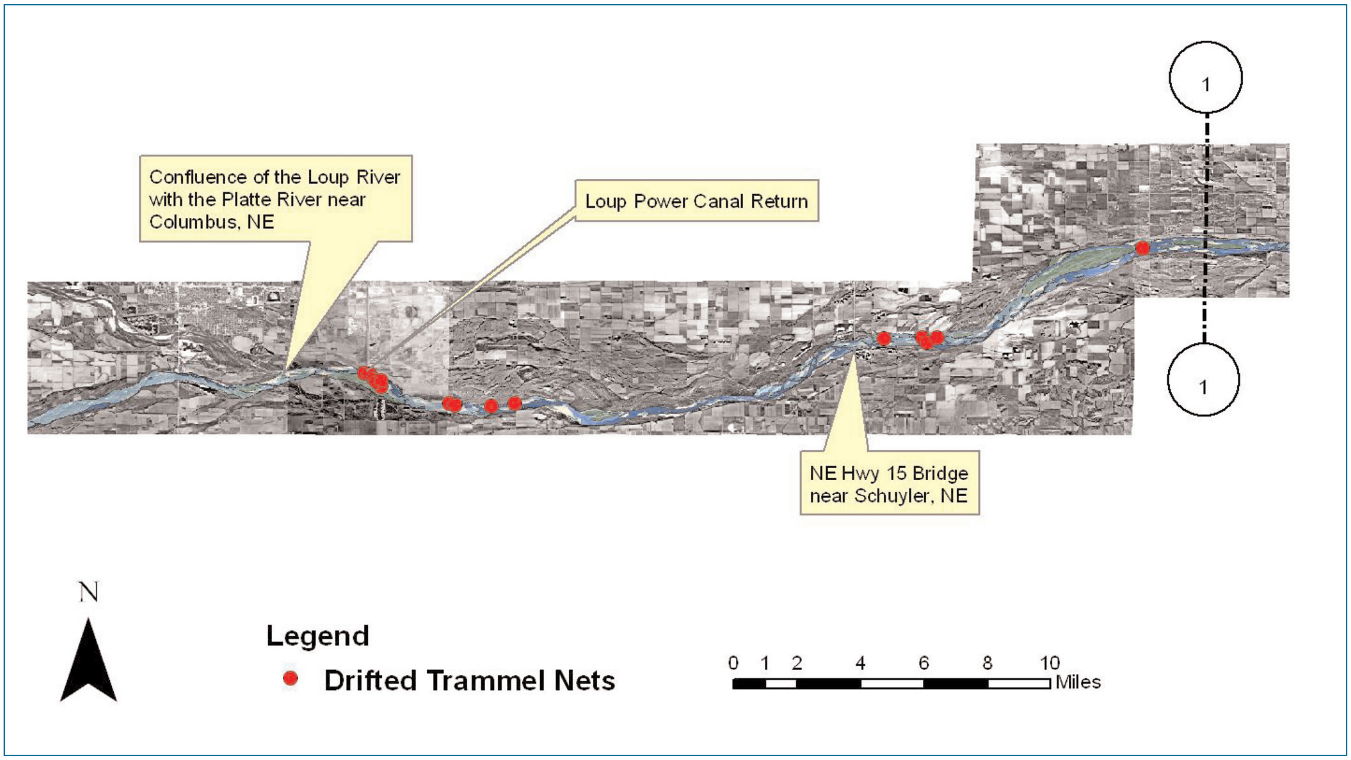

Figure 2.3a. Map of the locations of drifted trammel net runs attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

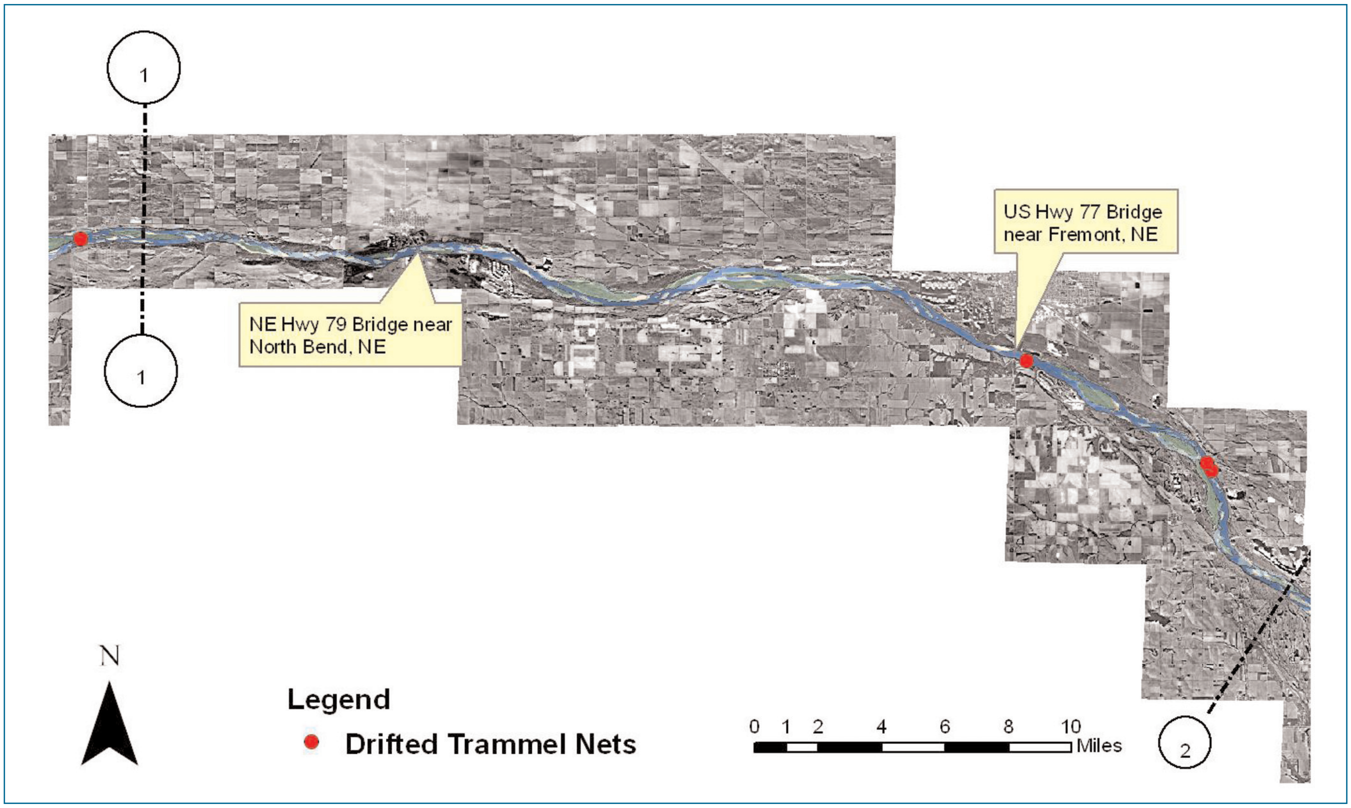

Figure 2.3b. Map of the locations of drifted trammel net runs attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

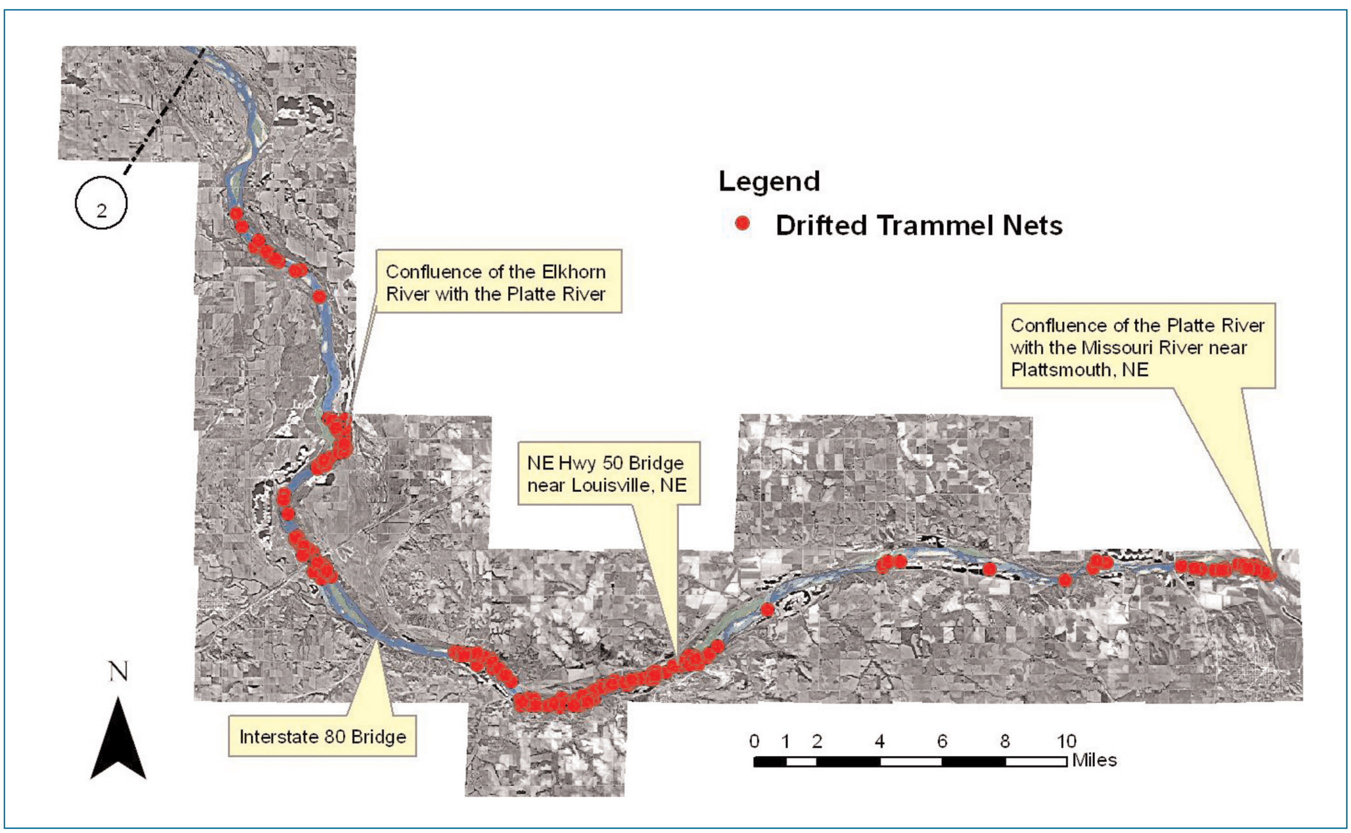

Figure 2.3c. Map of the locations of drifted trammel net runs attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

Table 2.1. Average monthly habitat variables associated with drifted gill nets.

Date By Month	Average Depth (m)	Average Mean Velocity (m/s)	Average Bottom Velocity (m/s)	Number of Runs
04/2004	1.13	0.77	0.40	2
05/2000	0.70	0.64	0.29	8
05/2001	0.85	0.68	0.40	6
05/2002	0.56	0.52	0.32	63
06/2000	0.81	0.65	0.37	17
06/2001	0.86	0.61	0.38	35
06/2002	0.56	0.50	0.31	54
07/2000	0.52	0.52	0.34	26
07/2001	0.70	0.59	0.37	28
07/2002	0.54	0.47	0.34	14
08/2000	0.70	0.60	0.39	12
08/2001	0.66	0.54	0.35	22
08/2002	0.51	0.49	0.34	16
09/2001	0.67	0.54	0.35	9
09/2002	0.59	0.59	0.40	7
10/2001	0.70	0.50	0.32	2

Table 2.2. Average monthly water quality measurements associated with drifted gill nets.

Date By Month	Average Water Temp (°C)	Average Dissolved Oxygen (mg/L)	Average Specific Conductivity (µS/cm)	Average Total Suspended Solids (mg/L)	Average Turbidity (NTU)	Number of net runs
04/ 2004	17.0	11.2	619.5	91.5	41.8	2
05/ 2000	21.1	9.3	548.9	521.3		8
05/ 2001	20.9	8.9	595.0	400.6		6
05/ 2002	22.2	10.0	547.4			63
06/ 2000	24.5	8.3	658.4	448.8		17
06/ 2001	24.3	10.6	582.3	211.3		35
06/ 2002	25.6	8.6	440.3			54
07/ 2000	28.0	9.5	606.3	375.8		26
07/ 2001	26.4	8.9	626.7	337.3		28
07/ 2002	27.0	10.6	428.5			14
08/ 2000	26.1	9.0	669.0	154.9		12
08/ 2001	26.3	10.0	641.7			22
08/ 2002	24.1	9.8	536.7			16
09/ 2001	20.5	10.7	724.4			9
09/ 2002	17.7	9.9	513.0			7
10/ 2001	14.9	10.3	672.5			2

Table 2.3. Average monthly habitat variables associated with drifted trammel nets.

Date By Month	Average Depth (m)	Average Mean Velocity (m/s)	Average Bottom Velocity (m/s)	Number of Runs
03/2004	0.90	0.45	0.21	4
04/2004	1.19	0.65	0.27	23
05/2003	0.58	0.60	0.40	25
05/2004	1.21	0.66	0.34	19
06/2003	0.57	0.50	0.31	53
06/2004	0.61	0.49	0.31	15
07/2003	0.63	0.47	0.25	38
07/2004	0.84	0.66	0.50	12
09/2003	0.45	0.51	0.26	3
09/2004	0.36	0.52	0.40	2
10/2003	0.52	0.50	0.44	3

Table 2.4. Average monthly water quality measurements associated with drifted trammel nets.

Date By Month	Average Water Temp (°C)	Average Dissolved Oxygen (mg/L)	Average Specific Conductivity (µS/cm)	Average Total Suspended Solids (mg/L)	Average Turbidity (NTU)	Number of net runs
03/ 2004	17.2	10.7	698.3	126.0	63.5	4
04/ 2004	16.2	12.4	630.8	124.7	58.1	23
05/ 2003	20.8	10.5	533.1	389.5	391.7	25
05/ 2004	16.5	13.7	671.9	166.7	117.5	19
06/ 2003	24.0	10.1	463.5	468.4	412.2	53
06/ 2004	22.3	9.4	399.5	1251.3	1767.0	15
07/ 2003	29.1	8.5	476.9	532.5	568.8	38
07/ 2004	27.6	12.0	417.1			12
09/ 2002	19.3	9.1	430.4			4
09/ 2003	17.7	12.4	445.7	102.3	91.4	3
09/ 2004	20.8	10.1	678.0		1040.0	2
10/ 2003	16.6	12.7	754.0			3

Table 2.5. Number of fish caught in drifted gill net runs and drifted trammel net runs by month from 2000 to 2004.

Common Name	March	April	May	June	July	August	September	October	Total Number Of Fish
Pallid Sturgeon	0	0	3	0	1	0	1	0	5
Shovelnose Sturgeon	1	100	158	345	284	132	84	29	1133
Paddlefish	0	2	3	2	1	0	1	0	9
Longnose Gar	2	6	13	16	26	4	4	0	71
Shortnose Gar	3	19	29	57	53	44	14	7	226
Goldeye	5	39	45	125	126	37	17	32	386
Gizzard Shad	1	1	5	18	7	17	1	9	59
Grass Carp	0	2	2	4	4	0	2	0	14
Common Carp	0	6	11	22	17	4	2	2	64
Bighead Carp	0	1	1	21	8	0	0	0	31
River Carpsucker	2	10	34	41	42	9	10	7	155
Quillback	8	6	38	126	146	11	10	11	356
Blue Sucker	2	29	61	9	6	0	0	0	107
Smallmouth Buffalo	0	6	5	8	5	2	0	0	26
Bigmouth Buffalo	0	0	0	6	9	2	0	1	18
Shorthead Redhorse	1	0	1	6	3	1	2	0	14
Blue Catfish	0	0	0	1	0	0	0	0	1
Channel Catfish	11	7	17	21	29	1	1	4	91
Flathead Catfish	1	2	2	0	2	0	0	1	8
White Bass	0	0	0	2	0	0	0	0	2
Striped Bass Hybrid	0	0	0	0	1	0	1	0	2
White Crappie	0	2	0	0	0	0	1	0	3
Black Crappie	0	0	1	1	0	0	0	0	2
Sauger	0	2	7	11	5	0	0	0	25
Saugeye	0	0	2	1	1	0	0	0	4
Walleye	0	0	1	4	6	0	1	0	12
Freshwater Drum	1	1	6	4	9	0	0	5	26
Totals	38	241	445	851	791	264	152	108	2890
Drifted Gill Nets	0	2	77	106	68	50	16	4	323
Trammel Nets	4	23	44	68	50	0	9	15	213
Total # of Runs	4	25	121	174	118	50	25	19	536
Average # of fish per run	9.5	9.6	3.7	4.9	6.7	5.3	6.1	5.7	5.4

Table 2.6. Number of fish caught in drifted gill net runs and trammel net runs by year from 2000 to 2004.

Common Name	2000	2001	2002	2003	2004	Total Number Of Fish
Pallid Sturgeon	0	0	1	0	4	5
Shovelnose Sturgeon	100	185	223	357	268	1133
Paddlefish	1	1	3	2	2	9
Longnose Gar	3	16	28	12	12	71
Shortnose Gar	37	34	44	77	34	226
Goldeye	38	80	110	133	65	426
Gizzard Shad	31	2	15	9	2	59
Grass Carp	0	1	1	7	5	14
Common Carp	10	9	5	25	15	64
Bighead Carp	0	1	1	25	4	31
River Carpsucker	13	9	24	76	33	155
Quillback	5	17	61	206	67	356
Blue Sucker	5	3	6	9	84	107
Smallmouth Buffalo	2	1	5	8	10	26
Bigmouth Buffalo	1	4	3	10	0	18
Shorthead Redhorse	0	1	5	7	1	14
Blue Catfish	0	0	0	1	0	1
Channel Catfish	7	8	15	29	32	91
Flathead Catfish	1	0	1	1	5	8
White Bass	0	0	2	0	0	2
Striped Bass Hybrid	1	0	1	0	0	2
White Crappie	0	0	0	1	2	3
Black Crappie	0	0	1	1	0	2
Sauger	2	0	4	14	5	25
Saugeye	0	0	1	1	2	4
Walleye	0	1	3	7	1	12
Freshwater Drum	6	0	6	9	5	26
Totals	263	373	569	1027	658	2890
Drifted Gill Net	63	102	156	0	2	323
Trammel Net	0	0	16	122	75	213
Total # of run	63	102	172	122	77	536
Average # of fish per run	4.2	3.7	3.3	8.4	8.5	5.4

Trotlines: A total of 223 trotlines was set in the lower Platte River between 2001 and 2004. Figure 2.4 a,b,c show the distribution of sampling effort for trotlines. Trotlines were used when the water temperature was below 16 °C and were most commonly used in the spring of the year (Table 2.7). Trotlines proved to be effective at catching sturgeon with 364 of the 371 fish captured either a shovelnose sturgeon (n = 354) or pallid sturgeon (n = 10) and the trotlines averaged a little less than two fish per trotline set (Table 2.8).

Trotlines were generally set in water greater than 1 m in depth and in depths greater than 1.7 m on average in 2004. Mean velocities were generally greater than 0.5 m/s and bottom velocities greater than 0.3 m/s (Table 2.9). Trotlines were most commonly set on sand substrate and were located in the deepest, swiftest channel habitats or in deep holes adjacent to sand bars.

As a result of setting the trotlines primarily in the spring of the year, water chemistry variables approximate typical spring time conditions (Table 2.10). The water temperature averaged between 5.9 °C and 19.8 °C and dissolved oxygen was generally high (> 9 mg/L). Specific conductivity of the water was usually between 500 and 700 µS/cm with peak readings over 1,000 µS/cm. Total suspended solids readings were usually between 170 and 300 mg/L with maximum readings over 1,400 mg/L.

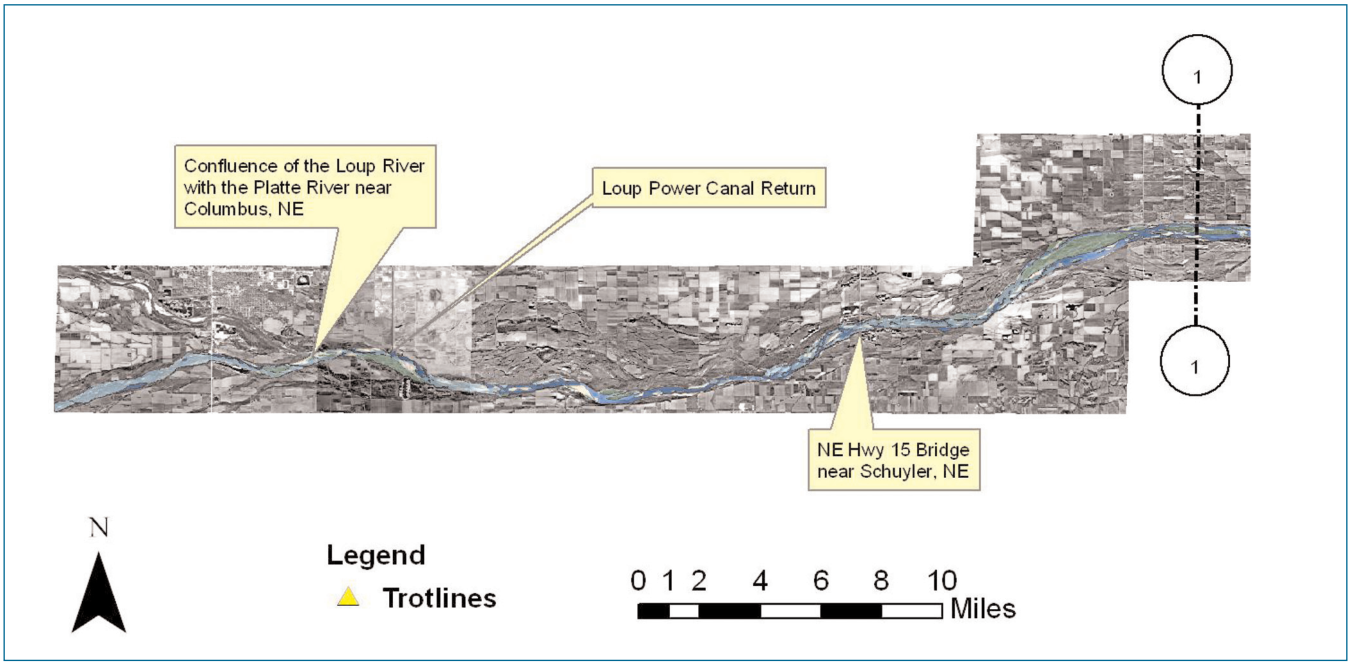

Figure 2.4a. Map of the locations of trotline sets attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

Trotline sampling.

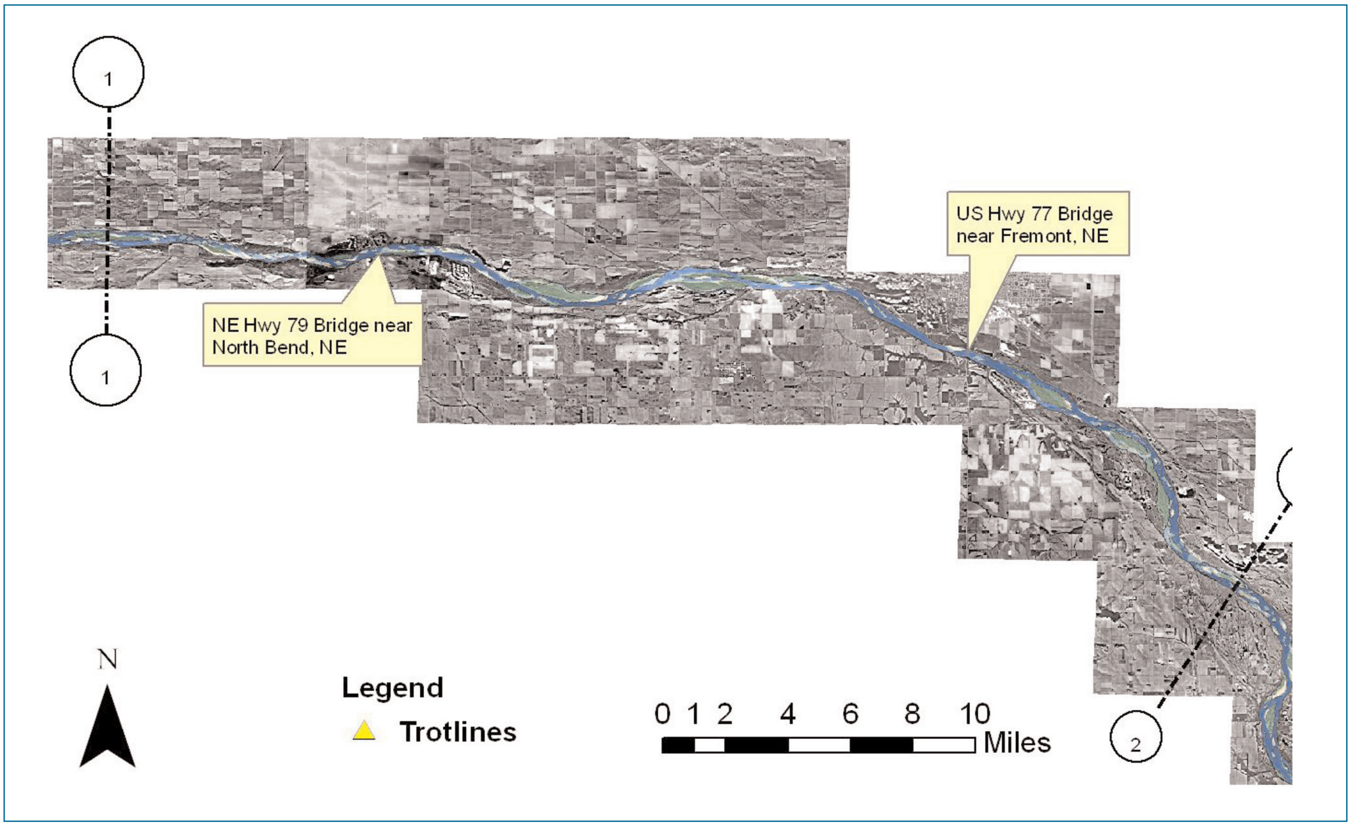

Figure 2.4b. Map of the locations of trotline sets attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

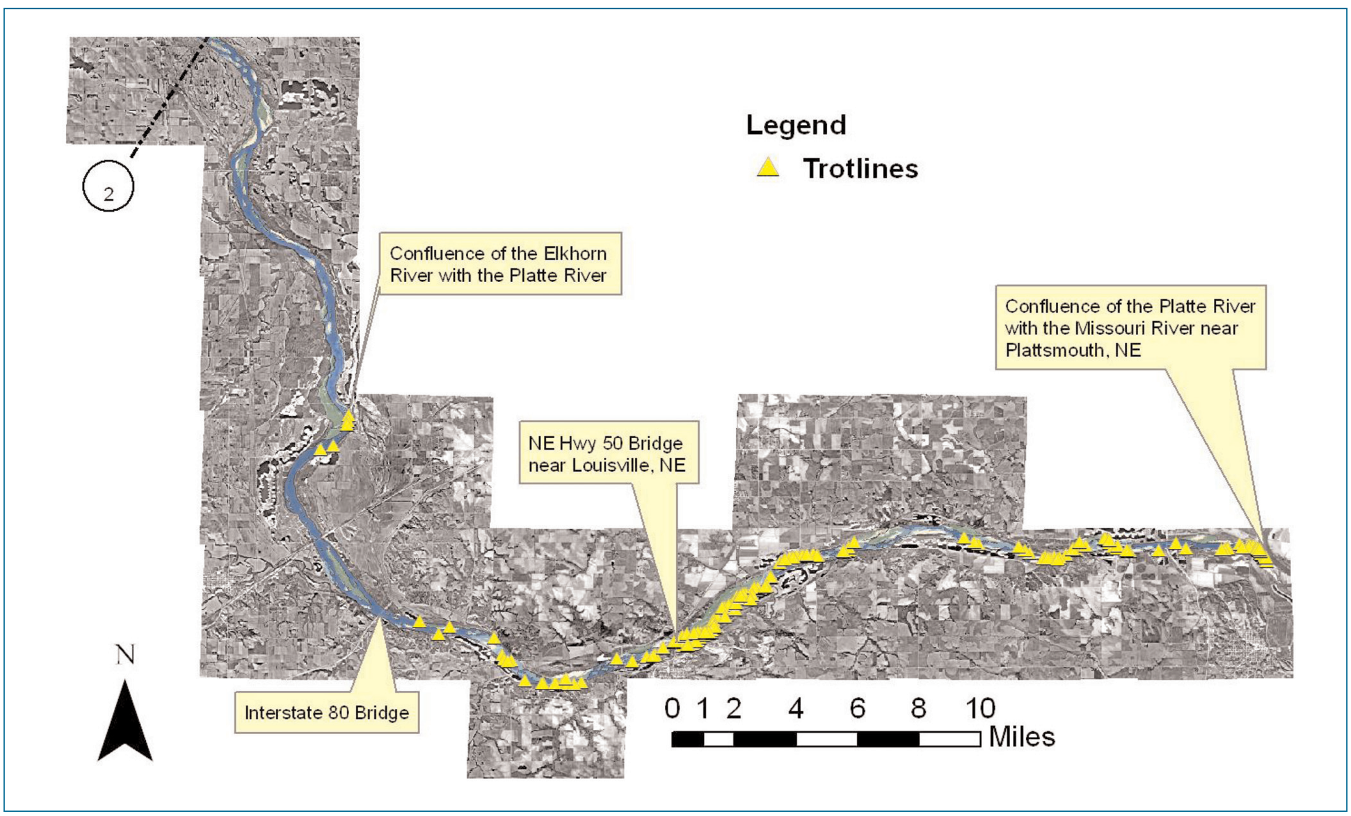

Figure 2.4c. Map of the locations of trotline sets attempting to capture sturgeon and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

Table 2.7. Number of trotline sets per month and year.

Year	MAR	APR	MAY	JUN	SEPT	OCT	NOV	Total Number Of Trotlines Set
2001	5	7	12	5	3	3	10	45
2002	3	11	7	-	-	8	5	34
2003	15	57	1	-	-	-	-	73
2004	28	43	-	-	-	-	-	71
Total	51	118	20	5	3	11	15	223

Table 2.8. Number of fish caught during trotline sets by month.

Common Name	MAR	APR	MAY	JUNE	SEPT	OCT	NOV	Total Number Of Fish Caught
Pallid Sturgeon	0	9	1	0	0	0	0	10
Shovelnose Sturgeon	93	195	36	9	0	8	13	354
Common Carp	1	1	1	0	0	0	0	3
Channel Catfish	1	1	0	0	2	0	0	4
Total	95	206	38	9	2	8	13	371
Number of Trotlines Set	51	117	20	5	3	12	15	223
Average Catch per Trotline	1.9	1.8	1.9	1.8	0.7	0.7	0.9	1.7

Table 2.9. Average monthly habitat variables associated with trotline sets.

Date By Month	Average Depth (m)	Average Mean Velocity (m/s)	Average Bottom Velocity (m/s)	Number of Runs
03/2001	1.16	0.51	0.30	5
03/2002	1.03	0.56	0.31	3
03/2003	1.12	0.74	0.39	15
03/2004	1.70	0.83	0.37	28
04/2001	0.89	0.58	0.37	7
04/2002	1.11	0.66	0.37	11
04/2003	1.36	0.69	0.35	57
04/2004	1.86	0.88	0.31	43
05/2001	1.23	0.74	0.37	13
05/2002	1.45	0.60	0.38	7
06/2001	1.15	0.65	0.56	5
09/2001	0.97	0.70	0.46	4
10/2001	0.89	0.47	0.31	3
10/2002	1.28	0.65	0.37	8
11/2001	1.30	0.71	0.40	10
11/2002	0.66	0.44	0.28	5

Table 2.10. Average monthly water quality measurements associated with trotline sets.

Date By Month	Average Water Temp (°C)	Average Dissolved Oxygen (mg/L)	Average Specific Conductivity (µS/cm)	Average Total Suspended Solids (mg/L)	Average Turbidity (NTU)	Number of net runs
03/2001	7.7	11.0	616.2		176.0	5
03/2002	6.7	12.3	845.0	55.7	117.8	3
03/2003	10.9	10.6	619.9	87.6	170.9	15
03/2004	10.0	10.9	601.1	143.3	191.6	28
04/2001	12.5	10.0	618.1		465.8	7
04/2002	14.4	12.1	725.4	63.5	125.5	11
04/2003	15.6	11.3	592.2	83.3	188.4	57
04/2004	13.7	12.1	620.6	70.6	115.7	43
05/2001	19.8	8.8	703.5		286.7	13
05/2002	16.0	9.6	654.2	426.7	533.6	7
06/2001	18.2	10.4	530.4		180.5	5
09/2001	18.6	10.3	493.5			4
10/2001	12.8	10.1	741.2	40.6	86.3	3
10/2002	10.6	11.5	602.1			8
11/2001	12.9	11.4	678.0	40.9	79.9	10
11/2002	5.9	13.9	588.7			5

Trawls: A total of 164 trawl runs was completed between 2001 and 2004 in the lower Platte River. Figure 2.5 a,b,c shows the distribution of sampling effort with trawls. The majority of these were in the 2002 sampling season (n = 93) and the 2004 sampling season (n = 51) (Table 2.11).

Trawling was principally in deeper runs of the river due to the constraints in deploying the gear and the physical habitat reflects these conditions (Table 2.12). The mean of the depths recorded for each run averaged between 1.1 and 1.6 m with a maximum depth of 4.1 m over the four sampling years. The mean column velocities averaged near 0.6 m/s and the bottom velocity ranged from 0.28 to 0.47 m/s.

The water conditions trawled reflected late spring to summer conditions in the Platte River (Table 2.13). The average temperatures were usually around 24 °C with a range from 15.1 to 30.6 °C. Dissolved oxygen was generally over 9 mg/L, and specific conductivity ranged on average from 392 to 871 µS/cm in the different sampling years. Total suspended solids varied greatly from 52 to 2,892 mg/L.

The trawls proved to be effective at catching a wide range of species from the Platte River. A total of 29 different species was collected with the most common species being sand shiner (n = 2,845), shoal chub (n = 2,021), emerald shiner (n = 1,214), and channel catfish (n = 1,170) (Table 2.14). Catch rate per trawl run varied greatly throughout the sampling season, ranging from a low of 4.1 fish per run in May to a high of 339.1 fish per run in August (Table 2.15).

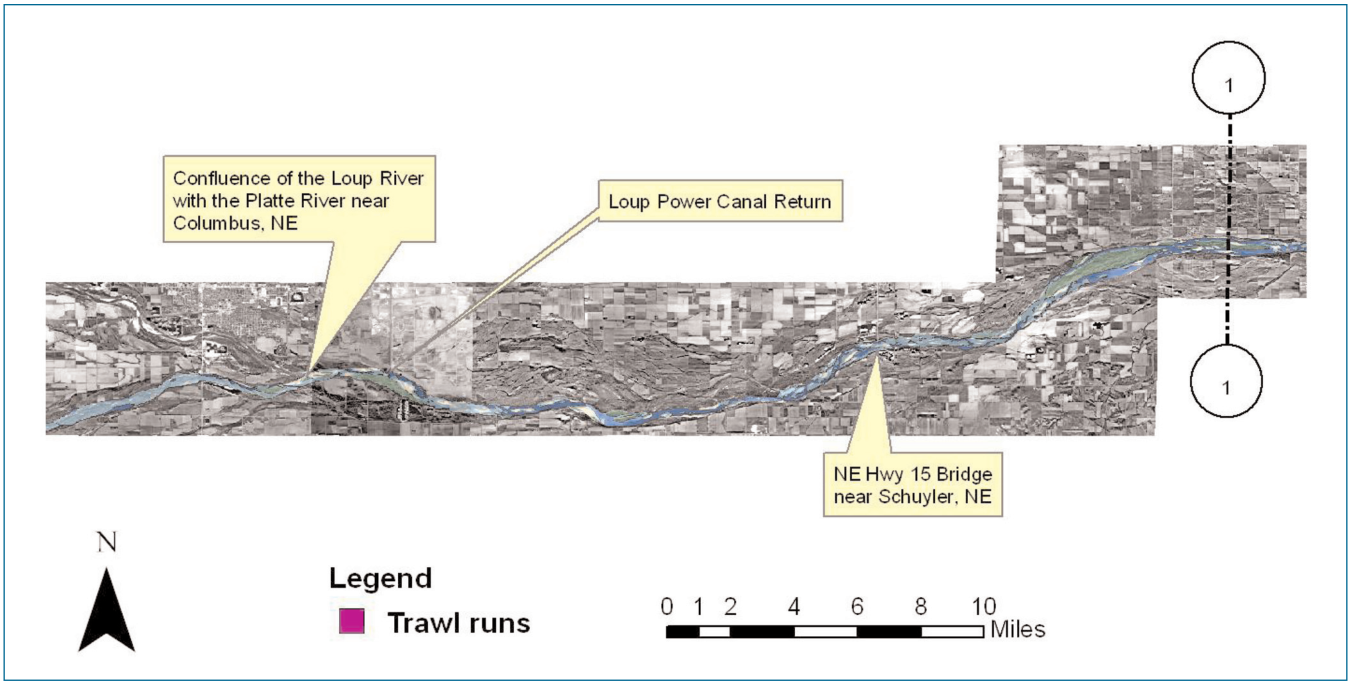

Figure 2.5a. Map of the locations of trawl runs attempting to capture sturgeon and sturgeon chub and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

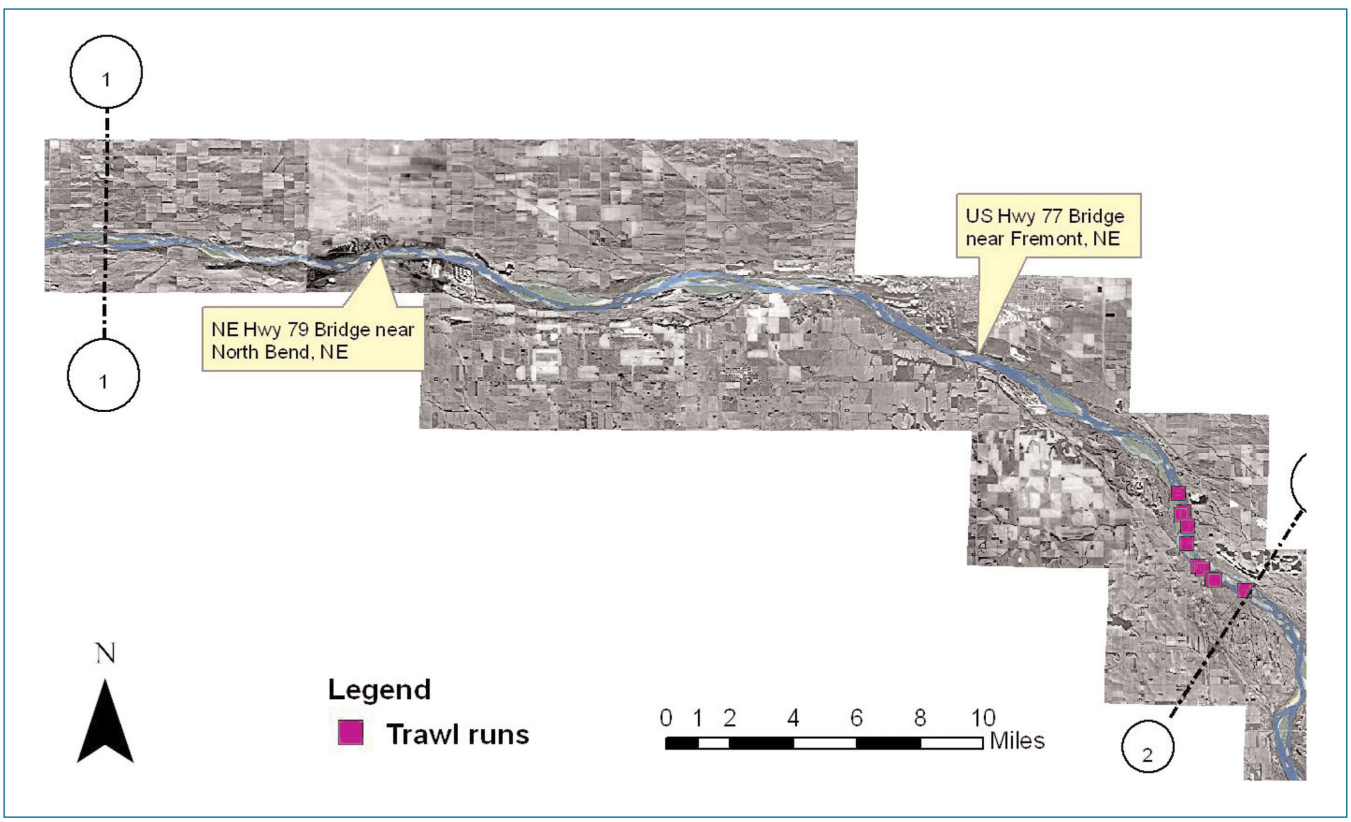

Figure 2.5b. Map of the locations of trawl runs attempting to capture sturgeon and sturgeon chub and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

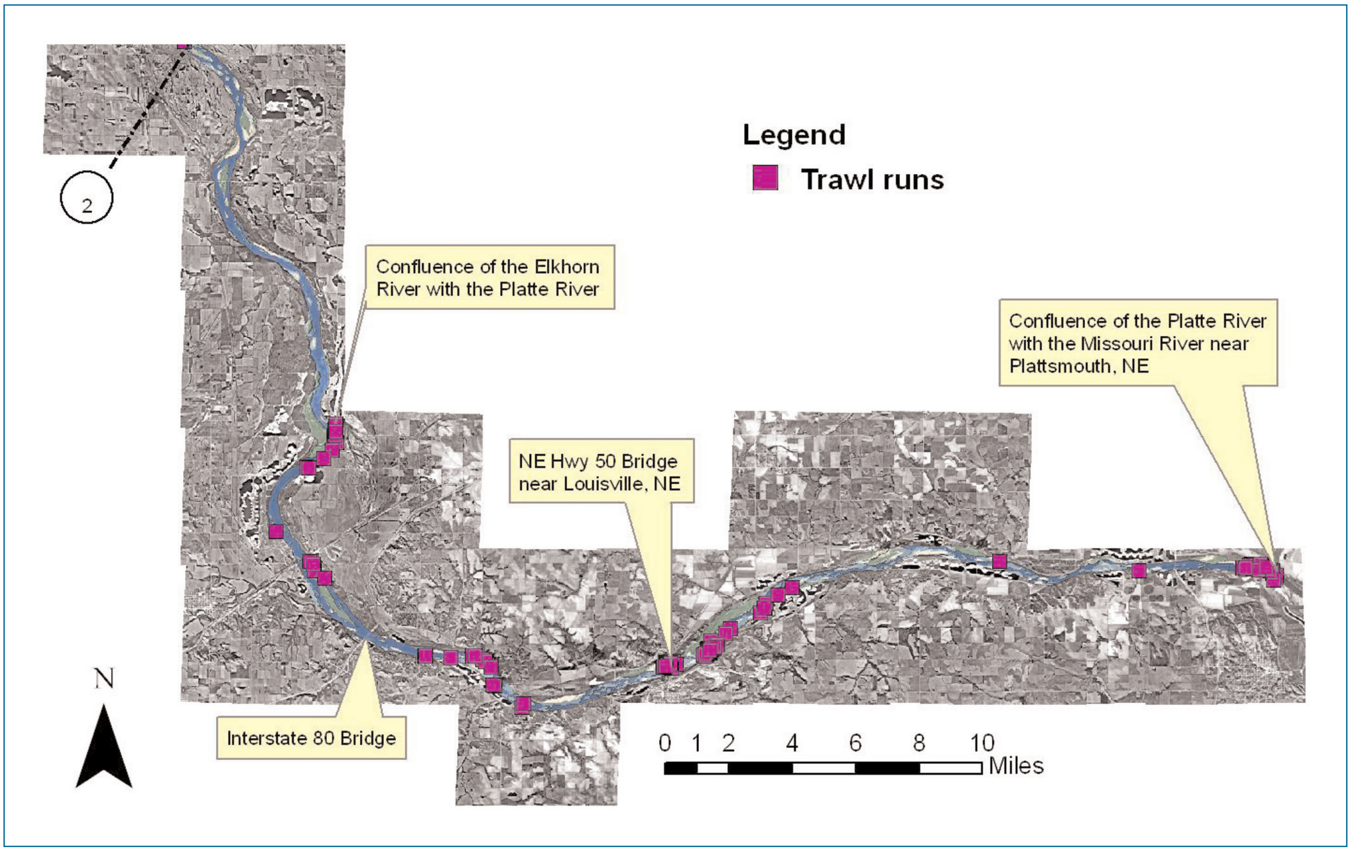

Figure 2.5c. Map of the locations of trawl runs attempting to capture sturgeon and sturgeon chub and associated species in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

Table 2.11. Number of trawl runs from 2001 to 2004.

Year	April	May	June	July	August	September	Total Number of Runs
2001	-	-	3	4	-	2	9
2002	-	20	31	17	10	15	93
2003	-	11	-	-	-	-	11
2004	1	4	42	4	-	-	51
Total	1	35	76	25	10	17	164

Table 2.12. Average monthly habitat variables associated with trawl runs.

Date By Month	Average Depth (m)	Average Mean Velocity (m/s)	Average Bottom Velocity (m/s)	Number of Runs
04/2004	1.1	0.5	0.2	3
05/2002	1.4	0.7	0.3	40
05/2003	1.4	0.5	0.4	4
05/2004	1.6	0.7	0.3	7
06/2001	1.9	0.7	0.0	6
06/2002	1.3	0.7	0.4	61
06/2004	1.7	0.8	0.5	110
07/2001	0.9	0.7	0.4	8
07/2002	0.8	0.6	0.3	34
07/2004	1.1	1.0	0.6	12
08/2002	0.7	0.5	0.2	20
09/2001	0.2	0.4	0.2	4
09/2002	0.8	0.6	0.3	30

Table 2.13. Average monthly water quality measurements associated with trawl runs.

Date By Month	Average Water Temp (°C)	Average Dissolved Oxygen (mg/L)	Average Specific Conductivity (µS/cm)	Average Total Suspended Solids (mg/L)	Average Turbidity (NTU)	Number of net runs
04/2004	13.6	11.6	696.0			3
05/2002	22.4	9.0	621.4	660.9	741.3	40
05/2003	17.5	9.0	392.9			4
05/2004	25.7	9.4	526.3			7
06/2001	27.6	8.2	647.3			6
06/2002	23.4	8.5	619.5	604.0	657.7	61
06/2004	23.1	9.4	547.5	1558.3	1973.6	110
07/2001	29.0	8.5	725.0			8
07/2002	26.0	10.5	1124.6	95.8	53.1	34
07/2004	27.6	12.0	417.1			12
08/2002	26.3	8.8	1343.7	80.7	44.1	20
09/2001	17.7	11.6	427.3			4
09/2002	23.0	10.2	1006.2	117.2	56.9	30

Trawling in the Platte.

Table 2.14. Number of fish caught in trawl runs by year.

Common Name	Gear Type	2001	2002	2003	2004	Total
Shovelnose Sturgeon	Trawl	1	60	0	17	78
Chub	Trawl	3	1,909	2	107	2,021
Sturgeon Chub	Trawl	0	2	0	0	2
Silver Chub	Trawl	0	109	0	27	136
Flathead Chub	Trawl	1	6	0	0	7
Red Shiner	Trawl	129	89	2	5	225
Emerald Shiner	Trawl	1	8	0	2	11
River Shiner	Trawl	9	1,192	8	5	1,214
Bigmouth Shiner	Trawl	0	2	0	0	2
Sand Shiner	Trawl	0	2,822	10	13	2,845
Western Silvery Minnow	Trawl	0	1	0	0	1
Brassy Minnow	Trawl	0	1	0	0	1
Plains Minnow	Trawl	0	47	0	0	47
Suckermouth Minnow	Trawl	0	6	0	0	6
Fathead Minnow	Trawl	0	2	0	0	2
Grass Carp	Trawl	0	0	0	1	1
Common Carp	Trawl	0	0	0	2	2
River Carpsucker	Trawl	0	46	0	1	47
Quillback	Trawl	0	5	0	0	5
Blue Sucker	Trawl	0	3	0	1	4
Blue Catfish	Trawl	0	3	0	0	3
Channel Catfish	Trawl	1	1,122	11	36	1,170
Flathead Catfish	Trawl	0	3	0	1	4
White Perch	Trawl	0	2	0	0	2
Green Sunfish	Trawl	0	1	0	0	1
Bluegill	Trawl	1	1	0	1	3
Johnny Darter	Trawl	0	2	0	0	2
Sauger	Trawl	0	2	0	0	2
Freshwater Drum	Trawl	0	40	0	0	40
	Totals	146	7,486	33	219	7,884
	Total # of Trawls	9	93	11	51	164
	Average catch per Trawl	16.22	80.49	3	4.294	48.07

Table 2.15. Number of fish caught in trawl runs by month.

Common Name	Gear Type	April	May	June	July	August	September	Total
Shovelnose Sturgeon	Trawl	1	35	18	7	7	10	78
Speckled Chub	Trawl	0	40	211	730	840	200	2,021
Sturgeon Chub	Trawl	0	1	1	0	0	0	2
Silver Chub	Trawl	6	1	28	38	40	23	136
Flathead Chub	Trawl	0	1	5	0	0	1	7
Red Shiner	Trawl	0	5	64	17	2	137	225
Emerald Shiner	Trawl	0	2	4	0	0	5	11
River Shiner	Trawl	1	8	43	297	740	125	1,214
Bigmouth Shiner	Trawl	0	0	0	1	0	1	2
Sand Shiner	Trawl	0	19	38	845	1,487	456	2,845
Western Silvery Minnow	Trawl	0	0	0	1	0	0	1
Brassy Minnow	Trawl	0	0	0	0	1	0	1
Plains Minnow	Trawl	0	0	0	46	1	0	47
Suckermouth Minnow	Trawl	0	0	0	6	0	0	6
Fathead Minnow	Trawl	0	0	0	2	0	0	2
Grass Carp	Trawl	0	0	1	0	0	0	1
Common Carp	Trawl	0	0	2	0	0	0	2
River Carpsucker	Trawl	0	3	1	6	22	15	47
Quillback	Trawl	0	0	0	2	2	1	5
Blue Sucker	Trawl	0	1	1	0	2	0	4
Blue Catfish	Trawl	0	0	0	0	1	2	3
Channel Catfish	Trawl	2	46	259	479	222	162	1,170
Flathead Catfish	Trawl	0	0	1	1	1	1	4
White Perch	Trawl	0	0	0	0	2	0	2
Green Sunfish	Trawl	0	0	0	1	0	0	1
Bluegill	Trawl	0	0	1	1	0	1	3
Johnny Darter	Trawl	0	0	0	2	0	0	2
Sauger	Trawl	0	0	0	1	1	0	2
Freshwater Drum	Trawl	0	0	0	20	20	0	40
	Totals	10	162	678	2,503	3,391	1,140	7,884
	Total # of Trawls	1	35	76	25	10	17	164
	Average catch per Trawl	10	5	9	100	339	67	48

Seines: Seines were used in a variety of ways to try to catch smaller fish associated with sturgeon or to capture sturgeon chubs. Several different size mesh seines were used, including 1/8th, 1/16th, and 3/8th inch mesh. In addition to the use of different size mesh seines, different seining tactics were used for different purposes. Some seines were used to collect fish near radio-tagged sturgeon, others were used to sample near drifted entanglement gear, others were used randomly, and some were used to sample near minnow traps. As a result of this non-systematic data collection, the data analysis will be a generalized description of the catch for specific collection techniques. Although seines caught a large number of fish, seines did not prove to be an effective method to capture either sturgeon or sturgeon chubs.

A total of 252 different seine hauls were performed in the lower Platte River during this project with the majority of these samples coming from June, July, and August (Table 2.16). Figure 2.6 a,b,c show the distribution of sampling effort with seines.

The physical habitat sampled by the seines was usually less than 0.5 m deep and less than 0.3 m/s mean column velocity (Table 2.17). Compared to other gears, the substrate in which seines were used tended to be much higher in silt than typically found in the river . Given the depth, velocity, and substrate characteristics of the seine samples, the seines tended to be run in pool habitats with minimal water current. These habitats appear not to be suitable habitats for sturgeon or chubs given their low catches for the effort. Water chemistry readings associated with seine hauls show a typical pattern for water conditions found in the Platte River (Table 2.18).

A total of 33 different species was caught in the seines with red shiners (n = 26,889) by far the most common species, followed by river shiners (n = 2,527), sand shiners (n = 1,321), and emerald shiners (n = 1,026) (Table 2.19). Only 7 shovelnose sturgeon were caught in all of the seine hauls. The 1/16th inch seines accounted for most of the fish captured (n = 31,929) as a result of the large number of small red shiners captured by this small mesh net (Table 2.20). The 1/8th mesh seine also caught red shiners and Table 2.21 shows the breakdown for fish catches with this seine. The 3/8th in mesh seine was probably the best for capturing species of interest. Of the fish caught in seines, all of the sturgeon and many of the chubs were captured in the 3/8th in mesh seine (Table 2.22). This seine had a chain attached to the lead line to keep it down in deeper water and this seemed to help catch more and different species. Red shiners were still the numerically dominant fish captured, but many other species were caught in relatively higher numbers than in other seines.

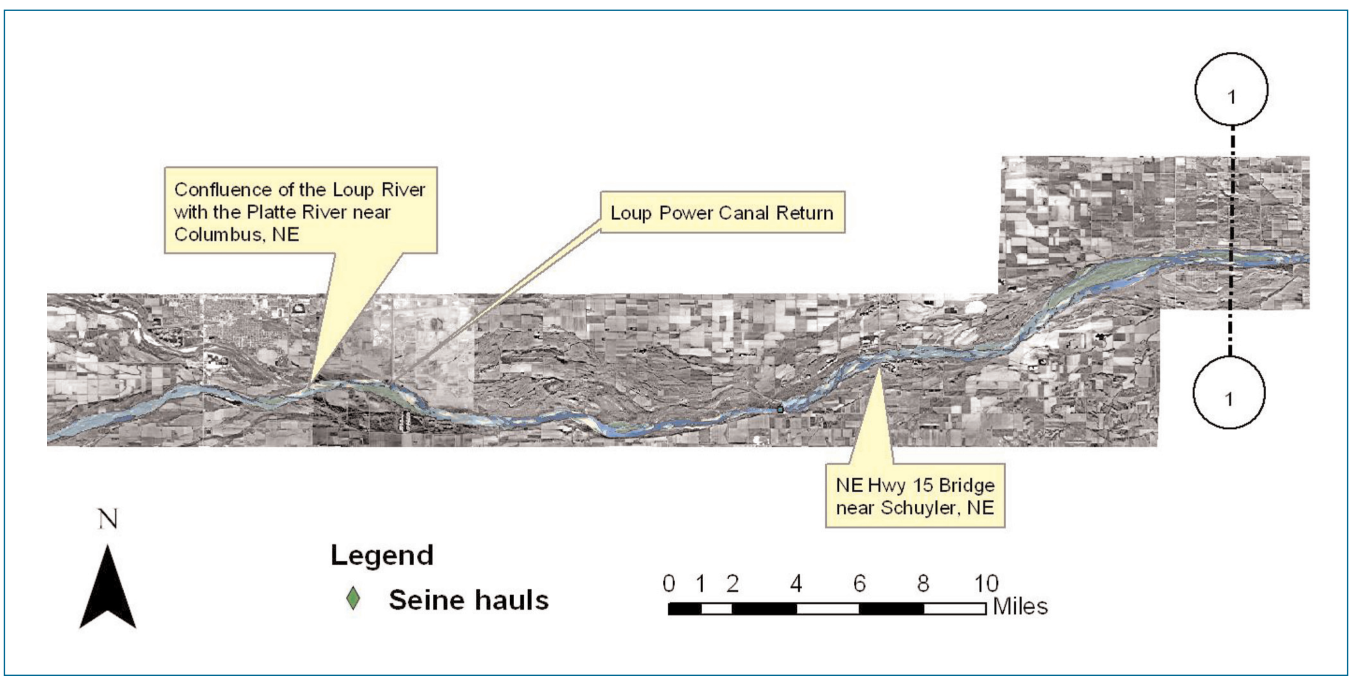

Figure 2.6a. Map of the locations of seine hauls attempting to capture pallid sturgeon and sturgeon chub in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

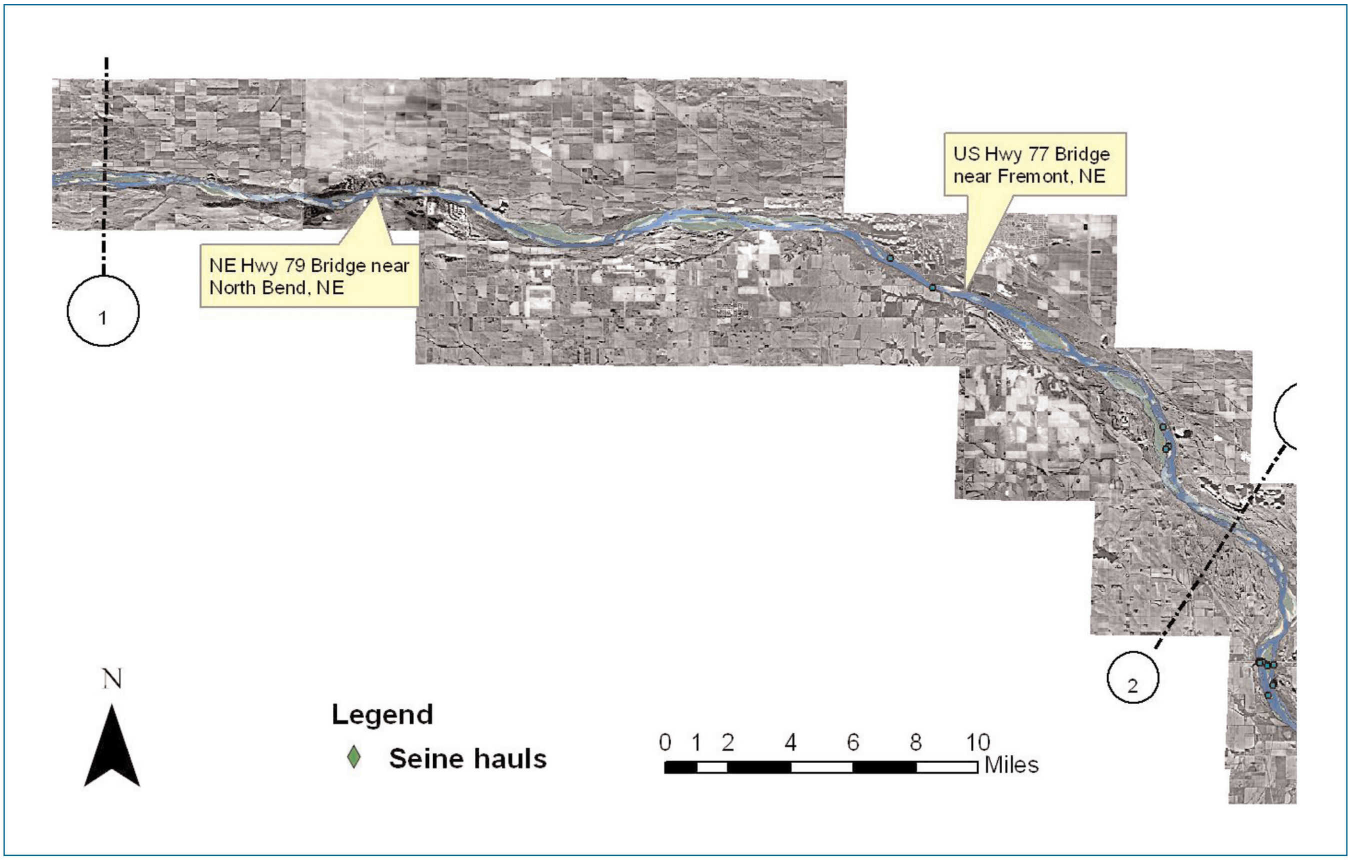

Figure 2.6b. Map of the locations of seine hauls attempting to capture pallid sturgeon and sturgeon chub in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

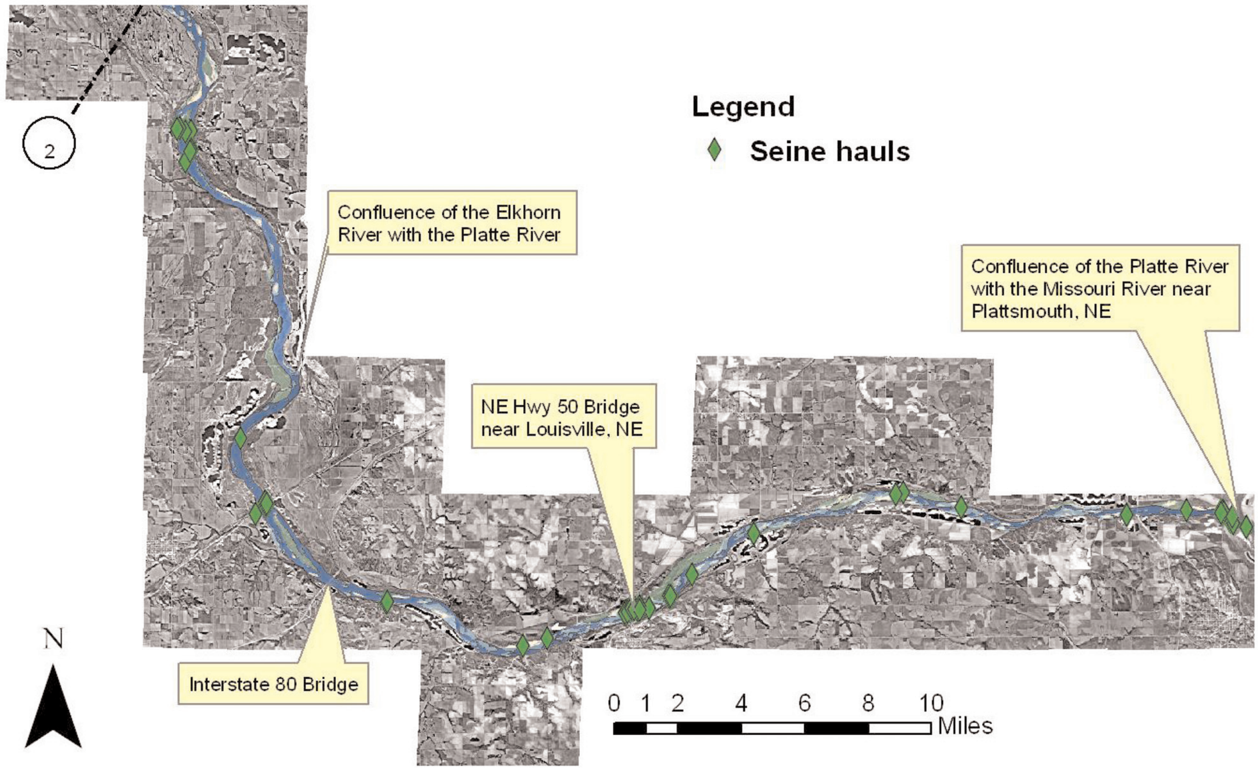

Figure 2.6c. Map of the locations of seine hauls attempting to capture pallid sturgeon and sturgeon chub in the lower Platte River. Match lines with other map sections of the lower Platte River are denoted by number and dashed lines.

Table 2.16. Number of seine hauls by mesh size and month and year.

Seine Mesh	Year	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1/16th inch	2000	0	7	8	3	3	0	0	0	0	21
1/16th inch	2001	0	1	2	10	27	0	0	0	0	40
3/8th inch	2001	0	0	14	11	0	6	0	0	0	31
1/8th inch	2002	0	7	13	15	3	6	3	6	3	56
1/16th inch	2002	0	3	3	14	8	0	0	0	0	28
3/8th inch	2002	1	4	0	8	5	0	0	0	0	18
1/8th inch	2003	6	9	3	9	6	6	6	0	0	45
1/16th inch	2003	0	1	0	0	0	0	0	0	0	1
3/8th inch	2003	0	2	0	8	2	0	0	0	0	12
Total		7	34	43	78	54	18	9	6	3	252

Table 2.17. Average monthly habitat variables associated with seine hauls.

Method	Date By Month	Average Depth (m)	Average Mean Velocity (m/s)	Average Bottom Velocity (m/s)	Number of Runs
1/8" seine	04/2003	0.8	0.2	0.1	12
1/8" seine	05/2002	0.4	0.2	0.1	18
1/8" seine	05/2003	0.7	0.3	0.2	10
1/8" seine	06/2002	0.6	0.1	0.0	20
1/8" seine	06/2003	0.6			4
1/8" seine	07/2002	0.5	0.2	0.1	58
1/8" seine	07/2003	0.6	0.1	0.1	25
1/8" seine	08/2002	0.7	0.5	0.2	6
1/8" seine	08/2003	0.7	0.1	0.1	14
1/8" seine	09/2002	0.4	0.3	0.2	18
1/8" seine	09/2003	0.6	0.2	0.1	10
1/8" seine	10/2002	0.7	0.5	0.1	3
1/8" seine	10/2003	0.4	0.2	0.1	13
1/8" seine	11/2002	0.5	0.3	0.2	8
1/8" seine	12/2002	0.6	0.2	0.1	7
1/16" seine	05/1998	0.4	0.2		32
1/16" seine	05/2000	0.2	0.3		26
1/16" seine	05/2001	0.6			7
1/16" seine	05/2002	0.2	0.2		8
1/16" seine	05/2003	0.3	0.1		6
1/16" seine	06/1998	0.3	0.2		36
1/16" seine	06/1999	0.4	0.2		13
1/16" seine	06/2000	0.3	0.3		30
1/16" seine	06/2001	0.6	0.0		22
1/16" seine	06/2002	0.4			10
1/16" seine	07/1998	0.5	0.2		19
1/16" seine	07/1999	0.4	0.0		8
1/16" seine	07/2000	0.6	0.3		15
1/16" seine	07/2001	0.2	0.1		85
1/16" seine	07/2002	0.4	0.1		89
1/16" seine	08/1999	0.1	0.2		8
1/16" seine	08/2000	0.3	0.2		22
1/16" seine	08/2001	0.4			176
1/16" seine	08/2002	0.5	0.1		51
3/8" seine	04/2002	0.6	0.6	0.5	2
3/8" seine	05/2002	0.5	0.4	0.3	28
3/8" seine	05/2003	0.6	0.9		11
3/8" seine	06/2001	0.6	0.2	0.2	35
3/8" seine	07/2001	0.4	0.3	0.2	41
3/8" seine	07/2002	0.4	0.3	0.2	50
3/8" seine	07/2003	0.5	0.4		31
3/8" seine	08/2002	0.3	0.3	0.2	23
3/8" seine	08/2003	0.7	0.6		9
3/8" seine	09/2001	0.3	0.4	0.4	14

Table 2.18. Average monthly water quality measurements associated with seine hauls.

Method	Date By Month	Water Temp (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Average Turbidity (NTU)	Number of net runs
1/8" seine	04/2003	14.6	10.1	462.5	335.5		6
1/8" seine	05/2002	18.9	9.4	637.0	179.0		7
1/8" seine	05/2003	18.4	9.7	518.8	338.3		9
1/8" seine	06/2002	23.6	7.1	554.6	190.2		13
1/8" seine	06/2003	23.3	6.2	512.0			3
1/8" seine	07/2002	27.3	9.4	428.0	100.5		15
1/8" seine	07/2003	26.0	5.9	513.8	166.0		9
1/8" seine	08/2002	21.7	6.6	451.3			3
1/8" seine	08/2003	24.1	7.7	448.6	123.0		6
1/8" seine	09/2002	21.1	6.6	388.1			6
1/8" seine	09/2003	13.4	8.7	493.6	98.0		6
1/8" seine	10/2002	14.8	8.3	505.0			3
1/8" seine	10/2003	15.8	8.9	491.6	53.0		6
1/8" seine	11/2002	4.8	12.3	344.8			6
1/8" seine	12/2002	0.0	13.5				3
1/16" seine	05/1998	21.7	10.4	681.6	257.6		9
1/16" seine	05/2000	24.1	9.2	572.6	504.7		7
1/16" seine	05/2001	14.9	3.9		237.0		1
1/16" seine	05/2002	19.5	9.1	488.5	194.3		3
1/16" seine	05/2003	23.1	11.4	558.0	133.0		1
1/16" seine	06/1998	26.0	5.9	628.0	207.0		6
1/16" seine	06/1999	26.5	9.6	633.0	507.0		2
1/16" seine	06/2000	24.8	8.9	493.5	261.9		8
1/16" seine	06/2001	22.4	11.3	513.5	157.5		2
1/16" seine	06/2002	26.7	6.6	687.7	240.0		3
1/16" seine	07/1998	32.5	10.5	541.0	386.0		4
1/16" seine	07/1999	25.6	6.7	607.5	291.0		2
1/16" seine	07/2000	26.1	7.8	495.3	648.0		3
1/16" seine	07/2001	24.4	8.0	611.6	89.0		10
1/16" seine	07/2002	27.2	8.7	449.9	83.8		14
1/16" seine	08/1999	21.9	8.2	530.0	142.0		1
1/16" seine	08/2000	29.5	9.4	425.2	119.7		3
1/16" seine	08/2001						27
1/16" seine	08/2002	25.7	7.3	436.0			8
3/8" seine	04/2002	20.6	17.1	630.0			1
3/8" seine	05/2002	17.2	9.3	495.5	203.7	84.5	4
3/8" seine	05/2003						2
3/8" seine	06/2001	24.5	10.4	593.8			14
3/8" seine	07/2001	28.6	7.4	579.5	718.0		11
3/8" seine	07/2002	29.6	12.4	1665.9	95.4	52.5	8
3/8" seine	07/2003	29.8	8.7	351.9			8
3/8" seine	08/2002	27.6	11.3	715.0			5
3/8" seine	08/2003	28.3	13.8	752.5			2
3/8" seine	09/2001	17.7	11.6	426.0			6

Table 2.19. Species caught in all seines.

Common Name	2000	2001	2002	2003	Total
Shovelnose Sturgeon	0	1	6	0	7
Longnose Gar	0	1	1	0	2
Goldeye	0	0	1	1	2
Gizzard Shad	0	12	50	53	115
Speckled Chub	5	47	153	14	219
Silver Chub	0	86	90	26	202
Flathead Chub	0	10	1	0	11
Creek Chub	0	0	1	0	1
Red Shiner	1,401	15,030	8,756	1,702	26,889
Emerald Shiner	16	532	417	61	1,026
River Shiner	189	1,347	938	53	2,527
Sand Shiner	42	448	697	134	1,321
Western Silvery Minnow	0	4	0	0	4
Brassy Minnow	0	0	15	0	15
Plains Minnow	70	100	3	19	192
Fathead Minnow	4	15	13	1	33
Common Carp	0	60	1	2	63
Bighead Carp	0	1	0	0	1
River Carpsucker	14	15	140	16	185
Quillback	3	3	10	14	30
Bigmouth Buffalo	0	2	0	0	2
Shorthead Redhorse	0	1	0	0	1
Channel Catfish	17	30	306	13	366
Western Mosquitofish	0	18	52	0	70
Brook Silverside	10	51	8	8	77
White Bass	0	9	1	0	10
Green Sunfish	0	21	0	0	21
Bluegill	0	16	5	0	21
Largemouth Bass	0	2	1	1	4
White Crappie	0	13	1	0	14
Johnny Darter	0	0	4	0	4
Freshwater Drum	0	31	25	0	56
Unknown species	358	3,149	610	8	4,125
Total	2,129	21,055	12,306	2,126	37,616

Table 2.20. Fish species caught in 1/16 inch mesh seines by month.

Common Name	Seine Mesh	May	June	July	August	Total
Gizzard Shad	1/16th inch	0	6	34	1	41
Speckled Chub	1/16th inch	2	1	22	7	32
Silver Chub	1/16th inch	0	18	29	8	55
Flathead Chub	1/16th inch	0	4	0	0	4
Creek Chub	1/16th inch	0	0	1	0	1
Red Shiner	1/16th inch	1,064	712	10,762	10,994	23,532
Emerald Shiner	1/16th inch	16	5	189	695	905
River Shiner	1/16th inch	21	108	812	1,072	2,013
Sand Shiner	1/16th inch	8	69	313	326	716
Western Silvery Minnow	1/16th inch	0	0	0	4	4
Plains Minnow	1/16th inch	6	7	42	102	157
Fathead Minnow	1/16th inch	0	3	12	14	29
Common Carp	1/16th inch	0	1	4	0	5
River Carpsucker	1/16th inch	2	3	26	86	117
Quillback	1/16th inch	0	0	2	7	9
Channel Catfish	1/16th inch	20	0	23	27	70
Western Mosquitofish	1/16th inch	1	7	21	39	68
Brook Silverside	1/16th inch	0	0	28	40	68
White Bass	1/16th inch	0	0	4	6	10
Green Sunfish	1/16th inch	0	0	11	10	21
Bluegill	1/16th inch	0	0	1	20	21
Largemouth Bass	1/16th inch	0	0	1	2	3
White Crappie	1/16th inch	0	4	0	10	14
Johnny Darter	1/16th inch	0	0	4	0	4
Freshwater Drum	1/16th inch	0	7	11	13	31
Unknown species	1/16th inch	55	889	2,467	588	3,999
	Totals	1,195	1,844	14,819	14,071	31,929

Table 2.21. Fish species caught in 1/8th inch mesh seines by month.

CommonName	Seine Mesh	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Longnose Gar	1/8th inch	0	0	0	1	0	0	0	0	0	1
Goldeye	1/8th inch	0	0	0	1	1	0	0	0	0	2
Gizzard Shad	1/8th inch	0	0	0	19	0	0	0	0	0	19
Speckled Chub	1/8th inch	0	5	1	9	5	0	1	3	0	24
Silver Chub	1/8th inch	0	0	0	23	0	1	0	0	0	24
Red Shiner	1/8th inch	81	370	484	961	396	176	230	1	13	2,712
Emerald Shiner	1/8th inch	1	4	0	5	40	5	2	0	1	58
River Shiner	1/8th inch	7	28	2	50	5	37	0	5	11	145
Sand Shiner	1/8th inch	2	19	5	58	6	37	27	0	5	159
Plains Minnow	1/8th inch	0	0	0	3	0	0	0	0	0	3
Fathead Minnow	1/8th inch	0	0	0	1	0	0	0	0	0	1
River Carpsucker	1/8th inch	0	0	1	1	3	0	1	0	0	6
Channel Catfish	1/8th inch	0	9	23	21	2	0	0	0	1	56
Western Mosquitofish	1/8th inch	0	0	1	1	0	0	0	0	0	2
Brook Silverside	1/8th inch	0	0	0	3	6	0	0	0	0	9
Largemouth Bass	1/8th inch	0	0	1	0	0	0	0	0	0	1
Freshwater Drum	1/8th inch	0	0	0	9	0	0	0	0	0	9
Unknown species	1/8th inch	0	0	0	9	0	0	0	0	0	9
Total		91	435	518	1,175	464	256	261	9	31	3,240

Table 2.22. Fish species caught in 3/8th inch mesh seines by month.

Common Name	Seine Mesh	April	May	June	July	August	Sept.	Total
Shovelnose Sturgeon	3/8th inch	0	0	1	6	0	0	7
Longnose Gar	3/8th inch	0	0	1	0	0	0	1
Gizzard Shad	3/8th inch	0	0	5	50	0	0	55
Speckled Chub	3/8th inch	0	52	0	50	61	0	163
Silver Chub	3/8th inch	2	9	1	78	32	1	123
Flathead Chub	3/8th inch	0	0	0	5	0	2	7
Red Shiner	3/8th inch	0	87	100	392	10	56	645
Emerald Shiner	3/8th inch	1	16	17	8	20	1	63
River Shiner	3/8th inch	0	23	12	286	31	17	369
Sand Shiner	3/8th inch	0	46	11	287	101	1	446
Brassy Minnow	3/8th inch	0	15	0	0	0	0	15
Plains Minnow	3/8th inch	0	1	0	17	14	0	32
Fathead Minnow	3/8th inch	0	1	0	2	0	0	3
Common Carp	3/8th inch	0	0	6	51	1	0	58
Bighead Carp	3/8th inch	0	0	1	0	0	0	1
River Carpsucker	3/8th inch	0	1	2	56	3	0	62
Quillback	3/8th inch	0	6	1	14	0	0	21
Bigmouth Buffalo	3/8th inch	0	0	0	2	0	0	2
Shorthead Redhorse	3/8th inch	0	0	0	1	0	0	1
Channel Catfish	3/8th inch	0	23	0	167	44	6	240
Freshwater Drum	3/8th inch	0	0	0	16	0	0	16
Unknown species	3/8th inch	0	0	66	50	0	1	117
Total		3	280	224	1,538	317	85	2,447

Gear comparisons:

To better understand the apparent conflicts in the descriptions of some species habitat use found for different gear types, we compared the habitat sampled by the different gear types. Depth and mean column velocity are two of the more important habitat variables for describing fish habitat in the Platte River. The bivariate analysis of depth and mean column velocity along with the scatterplots with depth and mean velocity for the sampling effort show the distribution of available habitat based on IFIM habitat transect data collected by NGPC, and related to the samples for drifted gill nets, drifted trammel nets, trotlines, trawls, and seines (Tables 2.23 – 2.45 and Figures 2.7 – 2.12, respectively). Habitat availability is based on the IFIM transect data collected by NGPC at three sites (Cedar Creek, Louisville, and North Bend) at various discharges.

As planned in our original sampling strategy, all of our gear types sampled deeper and swifter water than randomly available in the river. For the variable depth (Figure 2.13), pairwise comparisons showed most gears sampled different depths on average, with the exception of trotlines and trawls, trammel nets and shovelnose sturgeon tracking, and trammel nets and gill nets. From shallowest to deepest, the average depths sampled were the IFIM transects (median = 0.31 m), seines (median = 0.40 m), drifted gill nets (median = 0.61 m), drifted trammel nets (median = 0.63 m), shovelnose sturgeon tracking (median = 0.77 m), trawls (median = 1.17 m), and trotlines (median = 1.33 m).

For the variable mean column velocity (Figure 2.14), pairwise comparisons showed most gears sampled different velocities on average, with the exception of trotlines and trawls, shovelnose sturgeon tracking and trawls, and drifted trammel nets and drifted gill nets. In order from slowest to fastest mean water column velocities, the median velocities sampled were seines (0.18 m/s), IFIM transects (0.48 m/s), drifted trammel nets (0.53 m/s), drifted gill nets (0.55 m/s), shovelnose sturgeon tracking (0.58 m/s), trawls (0.67 m/s), trotlines (0.72 m/s). For bottom velocities (Figure 2.15), seines were different from all other gear types and trammel nets were different from trotlines and shovelnose sturgeon tracking. In order from slowest to fastest, the median bottom velocities sampled were seines (0.18 m/s), drifted trammel nets (0.30 m/s), drifted gill nets (0.34 m/s), trawls (0.34 m/s), trotlines (0.35 m/s), and shovelnose sturgeon tracking (0.36 m/s).

For temperature (Figure 2.16), most of the gear types were different with the exception of drifted gill nets, seines, and trawls were not different, and drifted trammel nets were not different from trawls and shovelnose sturgeon tracking.

In order from coldest to warmest, the median temperatures sampled were trotlines (14.1 °C), shovelnose sturgeon tracking (21.1 °C), drifted trammel nets (22 °C), trawls (24.4 °C), seines (24.7 °C), and drifted gill nets (25.2 °C).

For dissolved oxygen (Figure 2.17) and specific conductivity (Figure 2.18), most gear types were different with the exception of drifted gill nets, drifted trammel nets, and seines, and trotlines and trawls. In order from lowest to highest, the median specific conductivity sampled was drifted trammel nets (504 µS/cm), seines (518 µS/cm), drifted gill nets (522 µS/cm), shovelnose sturgeon tracking (560 µS/cm), trawls (598 µS/cm), and trotlines (598 µS/cm).

For total suspended solids (Figure 2.19), drifted trammel nets and drifted gill nets were different from shovelnose sturgeon tracking, trotlines, and seines. Trawls were different than trotlines and shovelnose sturgeon tracking. In order from lowest to highest total suspended solids, the median total suspended solids sampled were shovelnose sturgeon tracking (143 mg/L), seines (150 mg/L), trotlines (157 mg/L), trawls (187 mg/L), drifted gill nets (217 mg/L), drifted trammel nets (311 mg/L).

For discharge (Figure 2.20), trotlines were sampled at different discharge levels than all other gear, and trawls and shovelnose sturgeon tracking also differed. In order from lowest to highest, the median total discharge rate at sampling times were shovelnose sturgeon tracking (3,835 cfs), drifted gill nets (4,170 cfs), drifted trammel nets (4,410 cfs), trawls (4,920 cfs), and trotlines (6,130 cfs).

Table 2.23. Descriptive statistics for the IFIM habitat availability data.

Parameter	Units	Number	Missing	Median	25%	75%
Depth	m	2200	0	0.31	0.15	0.61
Mean column velocity	m/s	2200	41	0.48	0.31	0.62

Table 2.24. Number of observations for the categories of depth and velocity for the IFIM habitat availability data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	434	560	36	0	1030
	0.30-0.60	42	310	205	3	560
	0.60-0.90	17	142	202	9	370
	>0.90	6	26	136	31	199
	Total	499	1038	579	43	2159

Table 2.25. Percent of observations for the categories of depth and velocity for the IFIM habitat availability data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	20.1	25.9	1.7	0.0	47.7
	0.30-0.60	1.9	14.4	9.5	0.1	25.9
	0.60-0.90	0.8	6.6	9.4	0.4	17.1
	>0.90	0.3	1.2	6.3	1.4	9.2
	Total	23.1	48.1	26.8	2.0	100.0

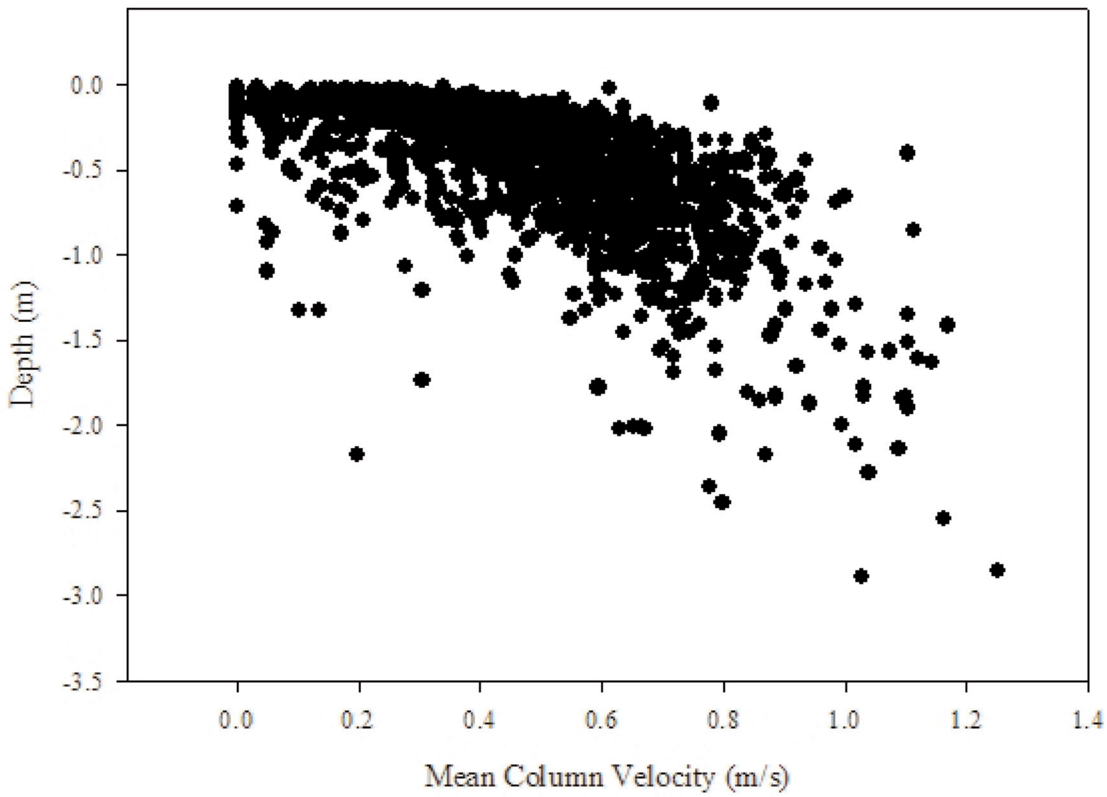

Figure 2.7. Scatter plot of depth versus mean column velocity for data measured along transects from the Instream Flow Incremental Methodology study in the lower Platte River, Nebraska (NGPC data files)

Table 2.26. Descriptive statistics for the drifted gillnet sampling data.

Parameter	Units	Number	Missing	Median	25%	75%
Depth	m	323	60	0.61	0.50	0.77
Mean column velocity	m/s	323	62	0.55	0.47	0.63
Bottom velocity	m/s	323	65	0.34	0.27	0.43
Temperature	°C	323	22	25.2	22.0	27.1
Dissolved oxygen	mg/L	323	26	9.4	8.2	10.6
Specific conductivity	µS/cm	323	31	522	439	646
Total suspended solids	mg/L	323	210	217	163	359

Table 2.27. Number of observations for the categories of depth and velocity for the drifted gillnet sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	1	4	0	0	5
	0.30-0.60	6	95	24	0	125
	0.60-0.90	1	48	50	1	100
	>0.90	1	7	23	0	31
	Total	9	154	97	1	261

Table 2.28. Percent of observations for the categories of depth and velocity for the drifted gillnet sampling data.

Depth (m)	mean column velocity (m/s) <0.30	0.30-0.60	0.60-0.90	>0.90	Total
<0.30	0.4	1.5	0.0	0.0	1.9
0.30-0.60	2.3	36.4	9.2	0.0	47.9
0.60-0.90	0.4	18.4	19.2	0.4	38.3
>0.90	0.4	2.7	8.8	0.0	11.9
Total	3.4	59.0	37.2	0.4	100.0

Table 2.29. Normalized sampling effort for the categories of depth and velocity for the drifted gillnet sampling data.

Depth (m)	mean column velocity (m/s) <0.30	0.30-0.60	0.60-0.90	>0.90
<0.30	0.01	0.02	0.00	0.00
0.30-0.60	0.42	0.91	0.35	0.00
0.60-0.90	0.17	1.00	0.73	0.33
>0.90	0.49	0.80	0.50	0.00

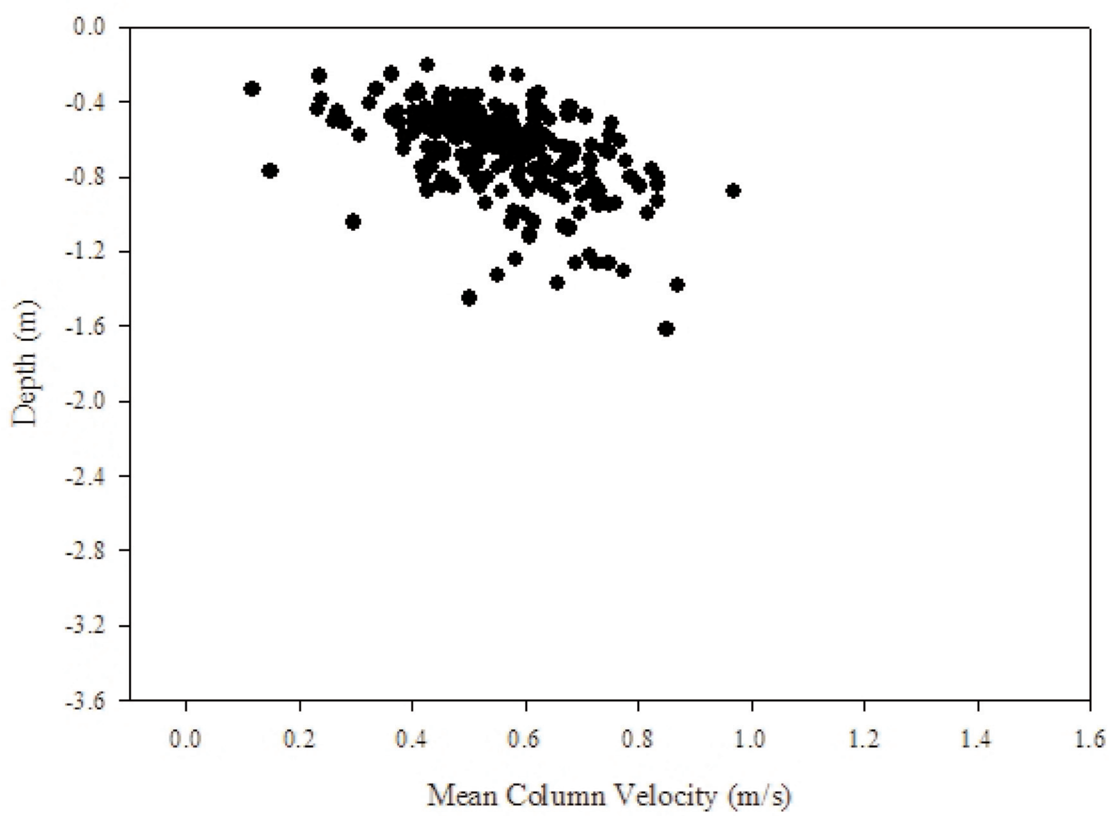

Figure 2.8. Scatter plot of depth versus mean column velocity for data measured at the location of gill net drifts in the lower Platte River, Nebraska.

Table 2.30. Descriptive statistics for the drifted trammel net sampling data.

Parameter	Units	Number	Missing	Median	25%	75%
Depth	m	213	32	0.63	0.498	0.904
Mean column velocity	m/s	213	32	0.54	0.45	0.623
Bottom velocity	m/s	213	32	0.297	0.229	0.388
Temperature	°C	213	29	21.95	17.5	26.9
Dissolved oxygen	mg/L	213	32	10.08	8.942	11.918
Specific conductivity	µS/cm	213	35	504	405	634
Total suspended solids	mg/L	213	73	310.5	150	494
Turbidity	NTU	213	71	206	75	396

Table 2.31. Number of observations for the categories of depth and velocity for the drifted trammel net sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	6	0	0	6
	0.30-0.60	5	59	14	0	78
	0.60-0.90	0	36	15	0	51
	>0.90	0	15	28	3	41
	Total	5	116	57	3	181

Table 2.32. Percent of observations for the categories of depth and velocity for the drifted trammel net sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	3.3	0.0	0.0	3.3
	0.30-0.60	2.8	32.6	7.7	0.0	43.1
	0.60-0.90	0.0	19.9	8.3	0.0	28.2
	>0.90	0.0	8.3	15.5	1.7	25.4
	Total	2.8	64.1	31.5	1.7	100.0

Table 2.33. Normalized sampling effort for the categories of depth and velocity for the drifted trammel net sampling data.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.02	0.00	0.00
	0.30-0.60	0.21	0.33	0.12	0.00
	0.60-0.90	0.00	0.44	0.13	0.00
	>0.90	0.00	1.00	0.36	0.17

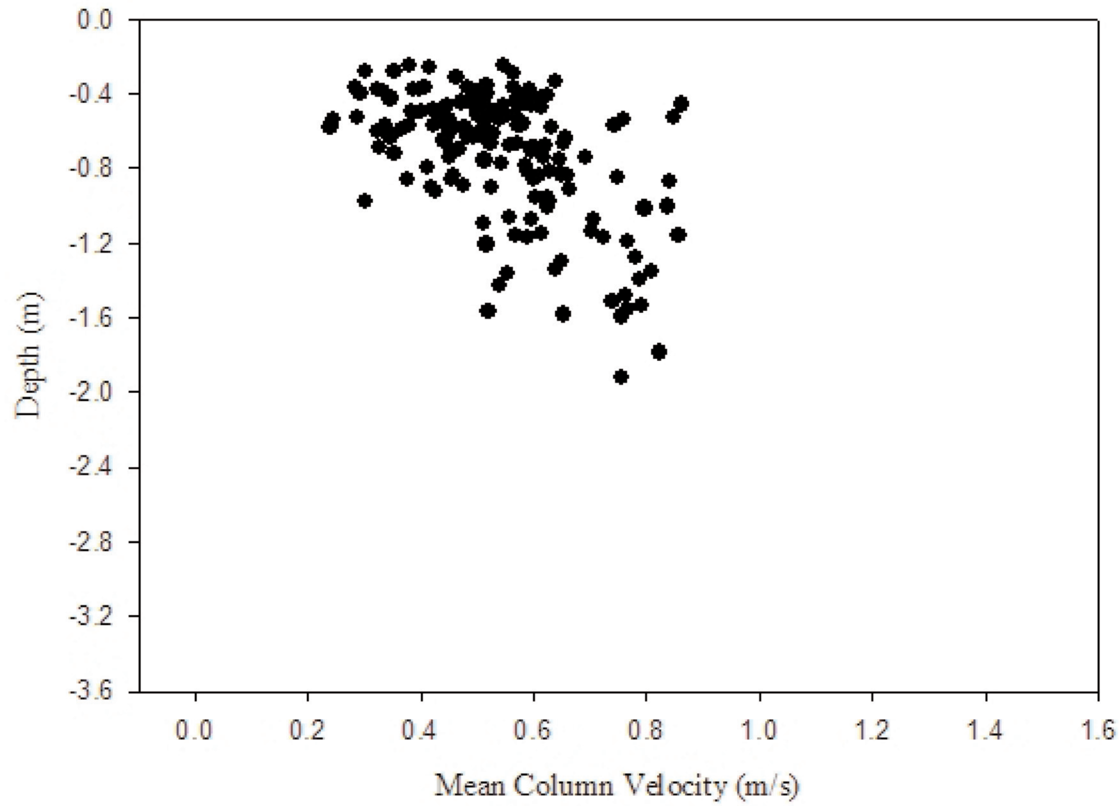

Figure 2.9. Scatter plot of depth versus mean column velocity for data measured at the location of trammel net drifts in the lower Platte River, Nebraska.

Table 2.34. Descriptive statistics for the trotline sampling data.

Parameter	Units	Number	Missing	Median	25%	75%
Depth	m	224	33	1.33	1.07	1.71
Mean column velocity	m/s	224	35	0.72	0.60	0.84
Bottom velocity	m/s	222	66	0.35	0.26	0.46
Temperature	°C	224	9	14.1	9.7	16.3
Dissolved oxygen	mg/L	224	17	11.2	10.5	12.0
Specific conductivity	μS/cm	224	14	598	537	695
Total suspended solids	mg/L	224	64	157	118	204

Table 2.35. Number of observations for the categories of depth and velocity for the trotline sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	0	0	0	0
	0.30-0.60	1	1	0	0	2
	0.60-0.90	0	14	11	1	26
	>0.90	3	26	98	33	160
	Total	4	41	109	34	188

Table 2.36. *Percent of observations for the categories of depth and velocity for the trotline sampling data.*

Depth (m)	mean column velocity (m/s) <0.30	0.30-0.60	0.60-0.90	>0.90	Total
<0.30	0.0	0.0	0.0	0.0	0.0
0.30-0.60	0.5	0.5	0.0	0.0	1.1
0.60-0.90	0.0	7.4	5.9	0.5	13.8
>0.90	1.6	13.8	52.1	17.6	85.1
Total	2.1	21.8	58.0	18.1	100.0

Table 2.37. Normalized sampling effort for the categories of depth and velocity for the trotline sampling data.

Depth (m)	mean column velocity (m/s) <0.30	0.30-0.60	0.60-0.90	>0.90
<0.30	0.00	0.00	0.00	0.00
0.30-0.60	0.02	0.00	0.00	0.00
0.60-0.90	0.00	0.09	0.05	0.10
>0.90	0.47	0.94	0.68	1.00

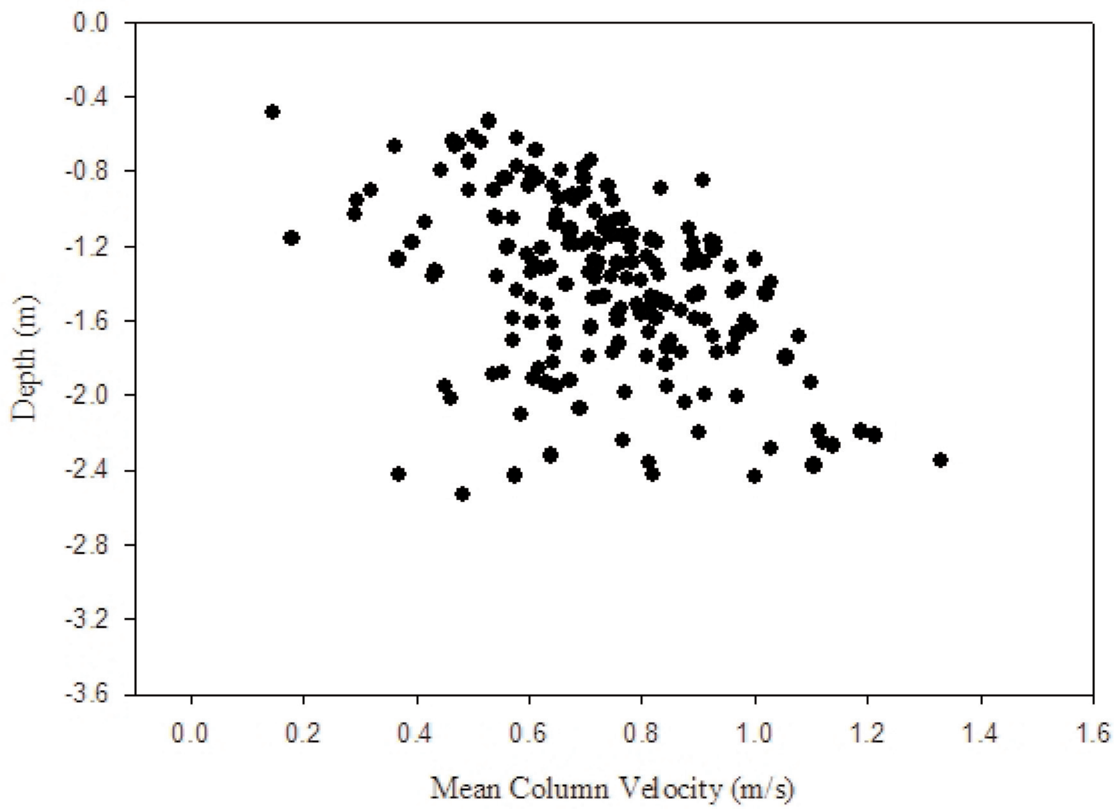

Figure 2.10. Scatter plot of depth versus mean column velocity for data measured at the location of trotline sets in the lower Platte River, Nebraska.

Table 2.38. Descriptive statistics for the trawl sampling data.

Parameter	Units	Number	Missing	Median	25%	75%
Depth	m	157	2	1.17	0.81	1.62
Mean column velocity	m/s	157	19	0.67	0.53	0.84
Bottom velocity	m/s	157	22	0.34	0.22	0.48
Temperature	°C	157	10	24.4	21.3	26.2
Dissolved oxygen	mg/L	157	10	9.3	8.3	10.4
Specific conductivity	µS/cm	157	10	598	515	871
Total suspended solids	mg/L	157	52	187	107	1224

Table 2.39. Number of observations for the categories of depth and velocity for the trawl sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	1	2	0	0	3
	0.30-0.60	1	10	0	0	11
	0.60-0.90	0	18	15	1	34
	>0.90	2	15	52	21	90
	Total	4	45	67	22	138

Table 2.40. Percent of observations for the categories of depth and velocity for the trawl sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.7	1.4	0.0	0.0	2.2
	0.30-0.60	0.7	7.2	0.0	0.0	8.0
	0.60-0.90	0.0	13.0	10.9	0.7	24.6
	>0.90	1.4	10.9	37.7	15.2	65.2
	Total	2.9	32.6	48.6	15.9	100.0

Table 2.41. Normalized sampling effort for the categories of depth and velocity for the trawl sampling data.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.01	0.00	0.00
	0.30-0.60	0.04	0.05	0.00	0.00
	0.60-0.90	0.00	0.19	0.11	0.16
	>0.90	0.49	0.85	0.56	1.00

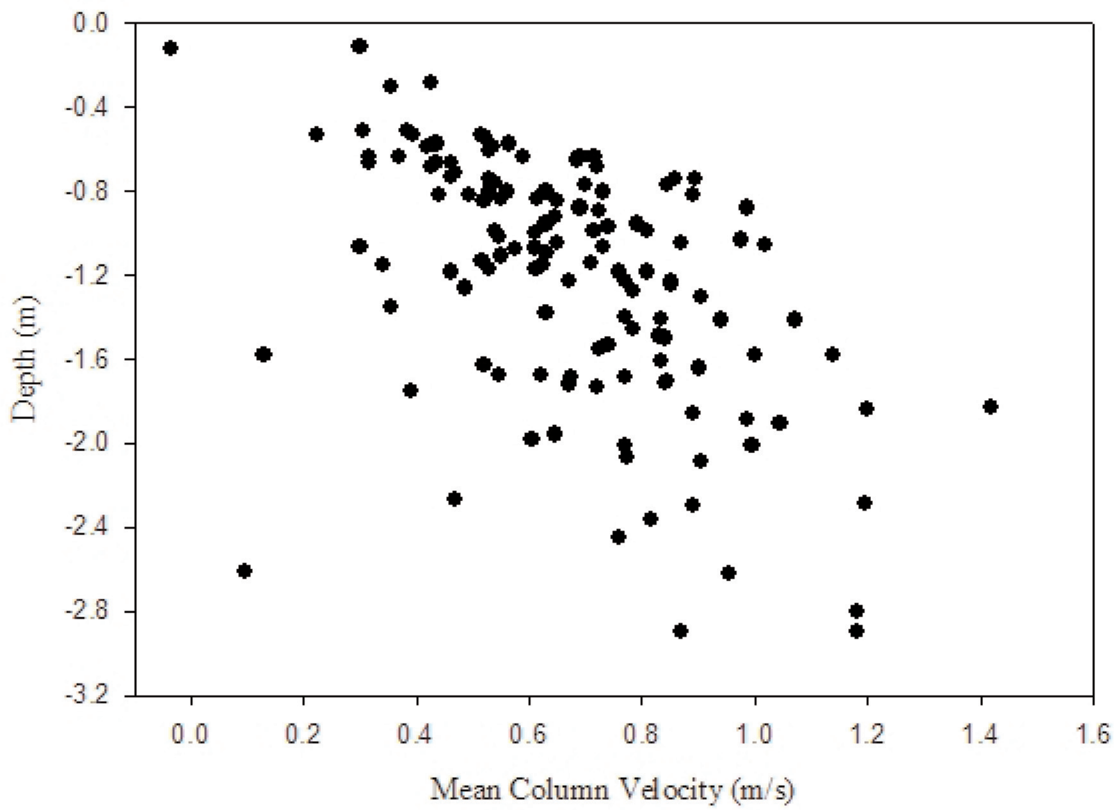

Figure 2.11. Scatter plot of depth versus mean column velocity for data measured at the location of trawl runs in the lower Platte River, Nebraska.

Table 2.42. Descriptive statistics for the seine sampling data.

Parameter	Units	Number	Missing	Median	25%	75%
Depth	m	252	40	0.46	0.30	0.66
Mean column velocity	m/s	252	61	0.27	0.12	0.44
Bottom velocity	m/s	252	116	0.18	0.07	0.30
Temperature	°C	252	57	23.7	18.2	26.4
Dissolved oxygen	mg/L	252	57	8.7	7.3	10.9
Specific conductivity	µS/cm	252	62	505	440	584
Total suspended solids	mg/L	252	147	150	111	266

Table 2.43. Number of observations for the categories of depth and velocity for the seine sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	35	14	0	0	49
	0.30-0.60	39	38	4	0	81
	0.60-0.90	31	18	1	0	50
	>0.90	3	5	3	0	11
	Total	108	75	8	0	191

Table 2.44. Percent of observations for the categories of depth and velocity for the seine sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	18.3	7.3	0.0	0.0	25.7
	0.30-0.60	20.4	19.9	2.1	0.0	42.4
	0.60-0.90	16.2	9.4	0.5	0.0	26.2
	>0.90	1.6	2.6	1.6	0.0	5.8
	Total	56.5	39.3	4.2	0.0	100.0

Table 2.45. Normalized sampling effort for the categories of depth and velocity for the seine sampling data.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.04	0.01	0.00	0.00
	0.30-0.60	0.51	0.07	0.01	0.00
	0.60-0.90	1.00	0.07	0.00	0.00
	>0.90	0.27	0.11	0.01	0.00

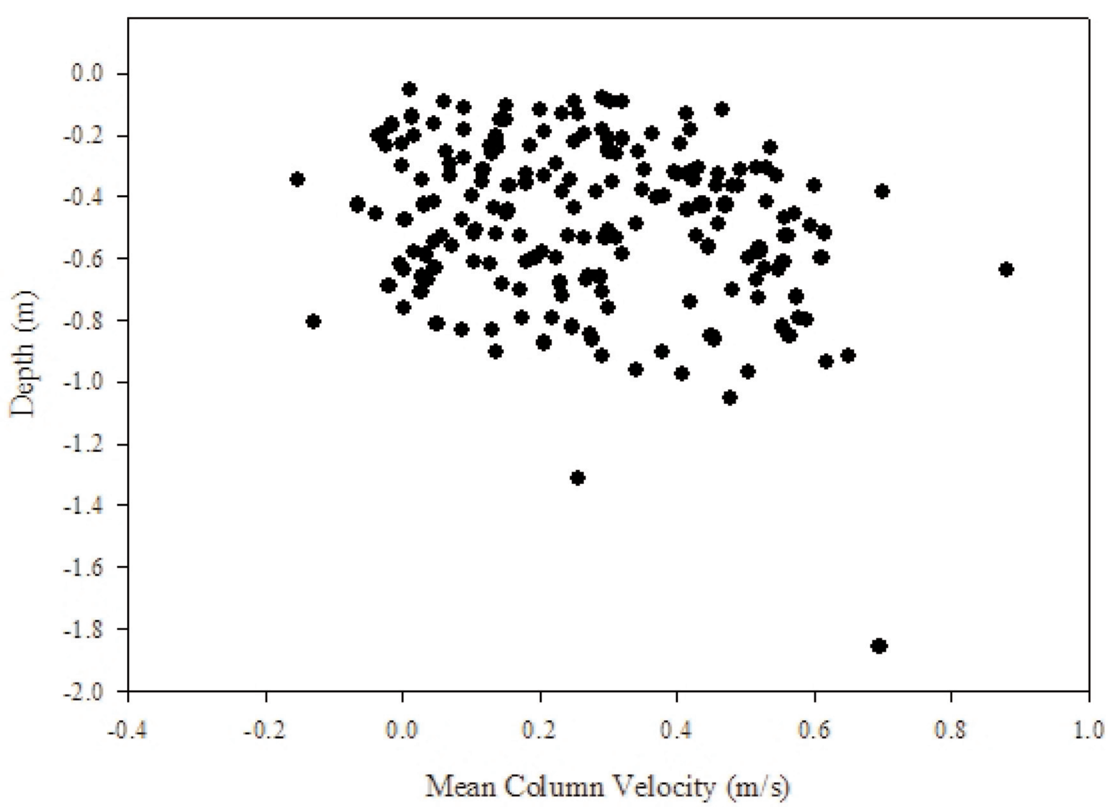

Figure 2.12. Scatter plot of depth versus mean column velocity for data measured at the location of seine runs in the lower Platte River, Nebraska.

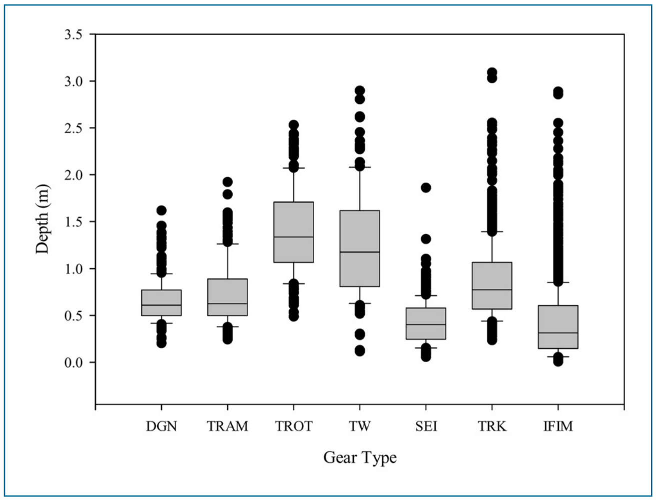

Figure 2.13. Box plots of average depth for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), telemetry (TRK), and IFIM measurements (IFIM). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

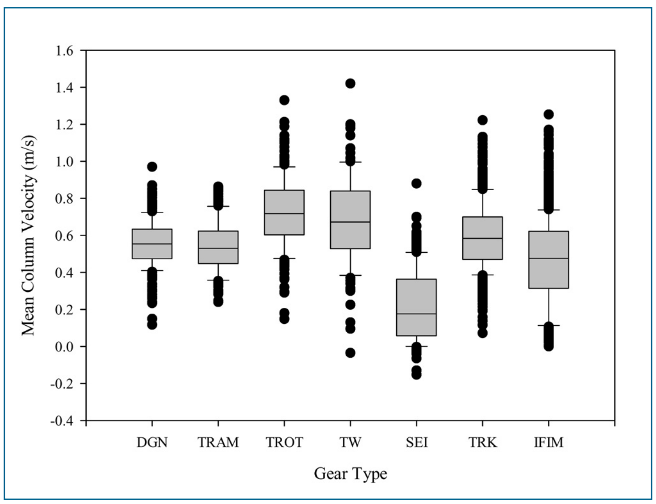

Figure 2.14. Box plots of average mean column velocity for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), telemetry (TRK), and IFIM measurements (IFIM). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

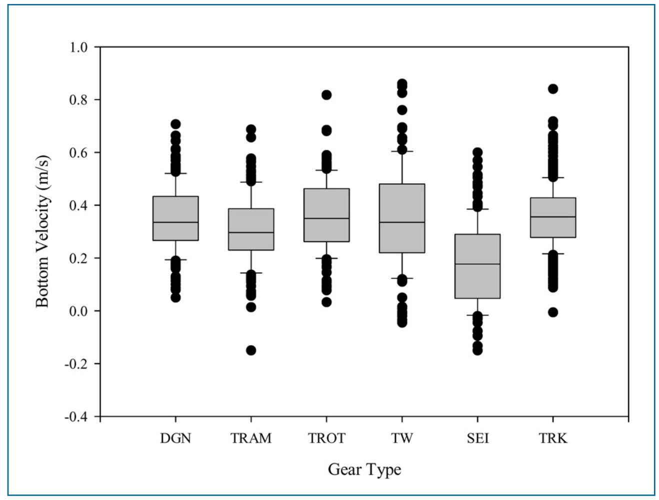

Figure 2.15. Box plots of average bottom velocity for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), and telemetry (TRK). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

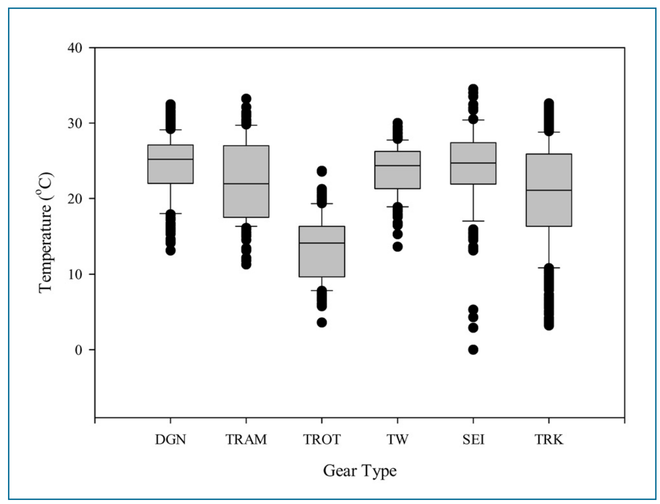

Figure 2.16. Box plots of average temperature for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), and telemetry (TRK). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

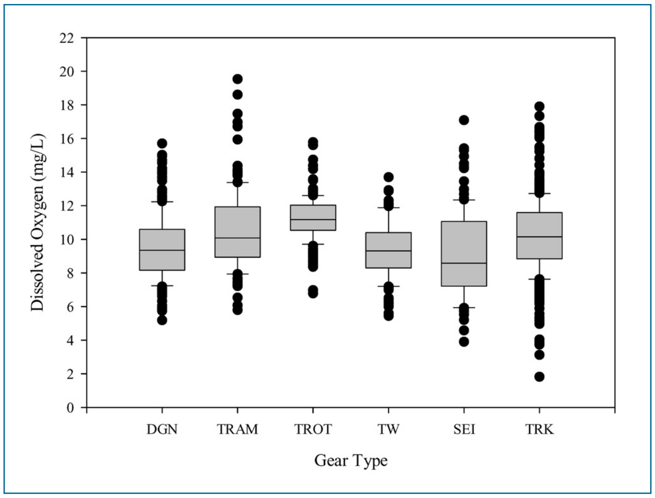

Figure 2.17. Box plots of average dissolved oxygen for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), and telemetry (TRK). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

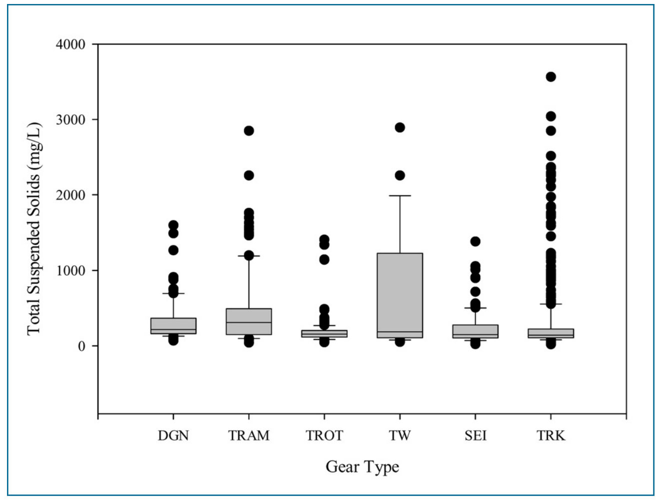

Figure 2.19. Box plots of average suspended solids for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), and telemetry (TRK). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

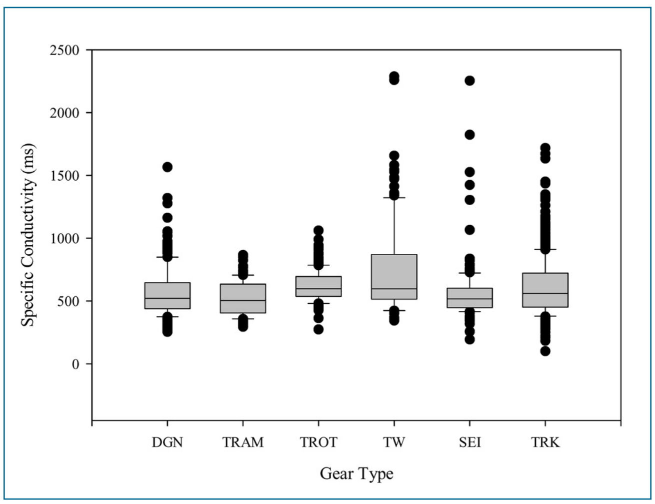

Figure 2.18. Box plots of average specific conductivity for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), and telemetry (TRK). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

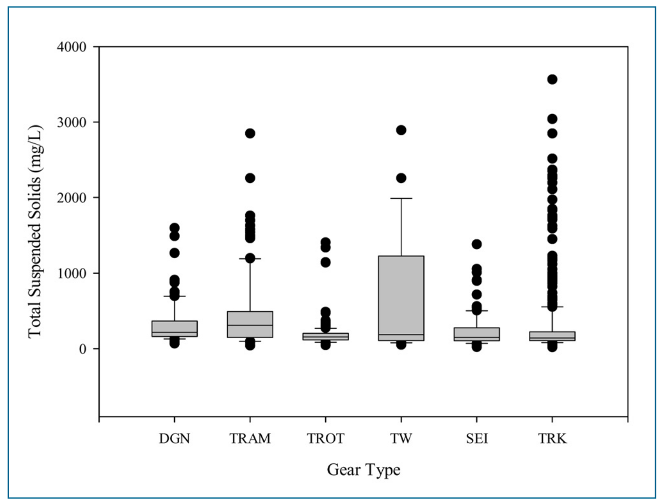

Figure 2.20. Box plots of average discharge for drifted gill nets (DGN), drifted trammel nets (TRAM), trotlines (TROT), trawls (TW), seines (SEI), and telemetry (TRK). The box boundaries indicate the 25th and 75th percentiles, the line within the box denotes the median, whiskers (error bars) indicate the 10th and 90th percentiles and the dots indicate values out to the limits of the observations

CHAPTER 3

AMBIENT RIVER HABITAT CONDITIONS IN THE LOWER PLATTE RIVER NEBRASKA

INTRODUCTION

Habitat conditions are important to the existence and viability of fish populations. In association with the study of pallid sturgeon, shovelnose sturgeon and sturgeon chub populations in the Platte River and with the support of a grant from the US Fish and Wildlife Service a monitoring program was initiated to measure several water quality parameters in the lower Platte River basin beginning in September 2000. The parameters measured corresponded directly to the water quality measurements which were made in association with radio-telemetry locations of radio tagged pallid sturgeon and shovelnose sturgeon and with collections of fish during the sturgeon and chub studies.

The objective of this portion of the study was to sample the water quality parameters; temperature, dissolved oxygen, water conductivity (including specific conductivity and salinity), and suspended solids at four locations in the lower Platte River basin. Substrate composition was an additional habitat component of the Platte River habitat that was measured within the study area.

METHODS

Starting in September 2000, we measured water temperature (°C), dissolved oxygen (mg/L), specific conductivity (µS/cm), salinity (ppt), and total suspended solids (mg/L) at four sites in the lower Platte River basin. Starting in July 2001, turbidity was added to the list of parameters measured. Two sampling sites, near Leshara, NE (Nebraska Highway 64 Bidge) and Louisville, NE (Nebraska Highway 50 Bridge), were on the Platte River, while two other sites, near Greenwood, NE and Waterloo, NE were located on Salt Creek and the Elkhorn River, respectively. Salt Creek and the Elkhorn River are the two main tributaries of the lower Platte River and examination of past water quality records indicated that their inflows have important impacts on the chemistry of the Platte River (Hitch et al. 2003). Temperature, dissolved oxygen, specific conductivity and salinity were measured using a YSI model 85 meter. Suspended solids were determined by filtering a measured portion of a water sample following the APHA (1987) standard method. Turbidity was measured from a water sample using a Hach model 2100P turbidimeter.

All sites were sampled weekly through the year, except when ice conditions made water sampling dangerous. A sample at a location consisted of two readings at the Elkhorn River and Salt Creek sites, four readings at the Leshara site and five readings at the Louisville site. The number of samples varied with respect to the width of the river at the sampling location. Five temperature-recording units were placed at the Louisville site to monitor temperature on a continuous basis.

In the summer of 2003 (July/August), substrate samples were collected from the four water quality study sites and from sites at the US Highway 6 Bridge near Ashland, NE and the Nebraska State Highway 79 Bridge near North Bend, NE. Subsequent substrate samples were collected during October 2003 and March 2004. Samples were collected along transects across the channel using a hand-held corer that penetrated the substrate to a depth of approximately 30 cm. A random number determined the distance of each initial core location from the shore. Ten core samples were collected at an even distance for narrow sites (Salt Creek and the Elkhorn River) and 20 for Platte River sites. Water depth and mean column velocity were also measured at each core location. Cores were placed in individually labeled gallon plastic jars with any accompanying water in the corer. In the lab, samples were allowed to evaporate and then placed in pans for drying in an oven at 105 °C. Samples were then dry sieved through nested screens to separate, silt (passed through 230 sieve), fine sand (retained by 230 sieve), sand (retained by 60 sieve), coarse sand (retained by 18 sieve), and gravel (retained by 10 sieve). Each textural component was then weighed and expressed as a percentage of the total weight of the core sample.

RESULTS AND DISCUSSION

Temperature:

Average weekly temperature values for the Platte River at Leshara, the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at Louisville for the time period September 2000 through June 2004 are displayed on Figures 3.1, 3.2, 3.3 and 3.4, respectively. Water temperatures at all four sites followed basically the same pattern from year to year, peaking in July at the two Platte River sites and the Elkhorn River site at temperatures >30 °C. The Salt Creek site tended to warm faster and remain above 30 °C from June to August. In the Platte River, the highest water temperatures occurred in 2002 (Figures 3.1 and 3.4) and this coincides with the periods of lowest discharge (Figures 1.2 and 1.5). Salt Creek contrasted with the other three sites during winter, since it seldom had temperatures down to 0 °C.

Figures 3.5 to 3.9 display data from the temperature recorders installed at the Louisville site during 2000, 2001, 2002, 2003 and 2004, respectively. Note that the scales on the axes vary from one figure to the other. Unfortunately, there are gaps in the data due to lost or destroyed recorders and the data presented is the record of only one recorder. Fortunately, the times of critically high temperatures during the period of the study have been recorded. These extreme temperatures occurred during July and August 2001, 2002 and 2003. The other major value of these records is the amount of temperature fluctuation that is recorded within a day and from day to day in the lower Platte River. Diel temperature fluctuations of 10 °C are not uncommon and have been previously reported by Fessel (1996) and Yu (1996).

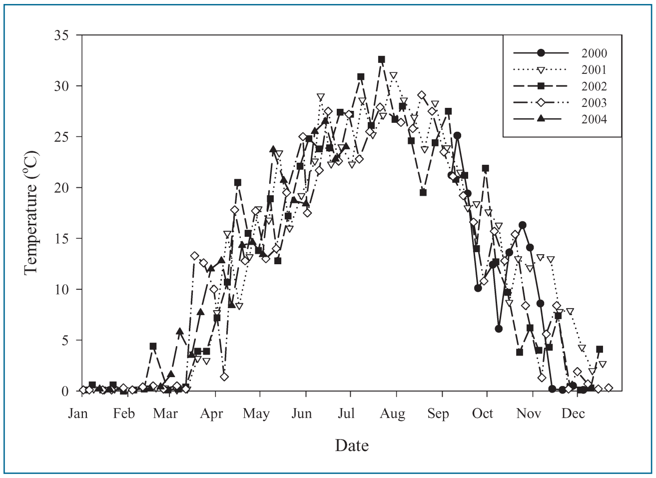

Figure 3.1. Platte River at Leshara average water temperature, September 2000 to June 2004.

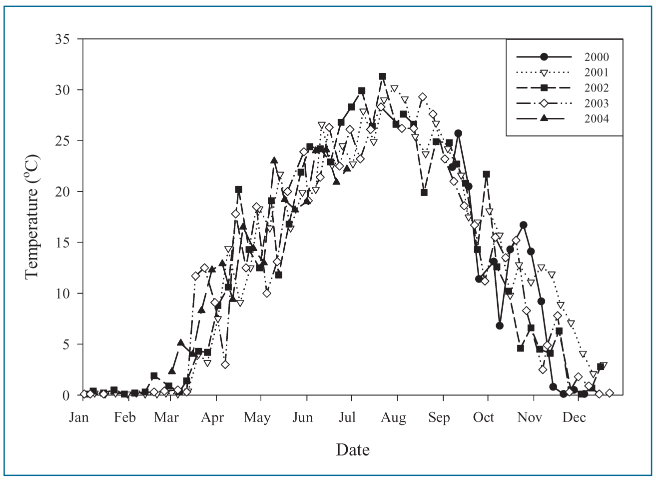

Figure 3.2. Elkhorn River at Waterloo average water temperature, September 2000 to June 2004.

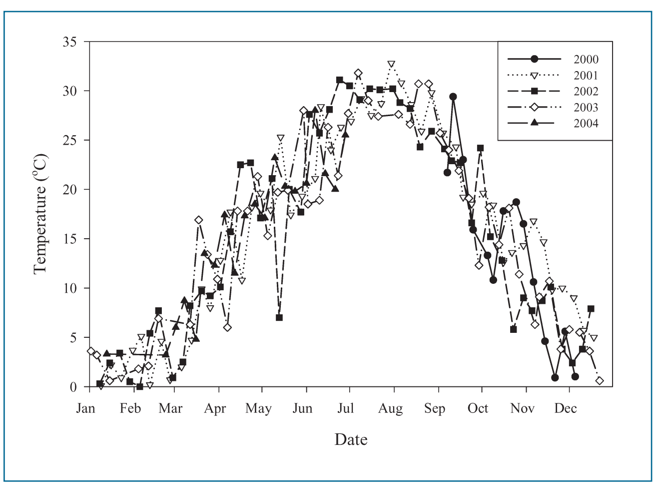

Figure 3.3. Salt Creek at Greenwood average water temperature, September 2000 to June 2004.

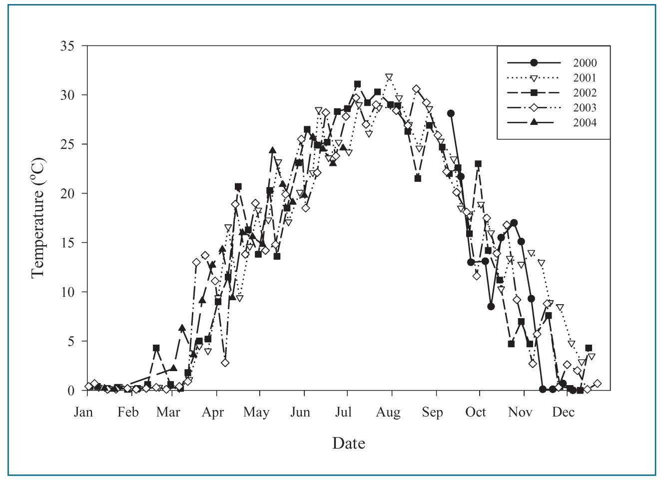

Figure 3.4. Platte River at Louisville average water temperature, September 2000 to June 2004.

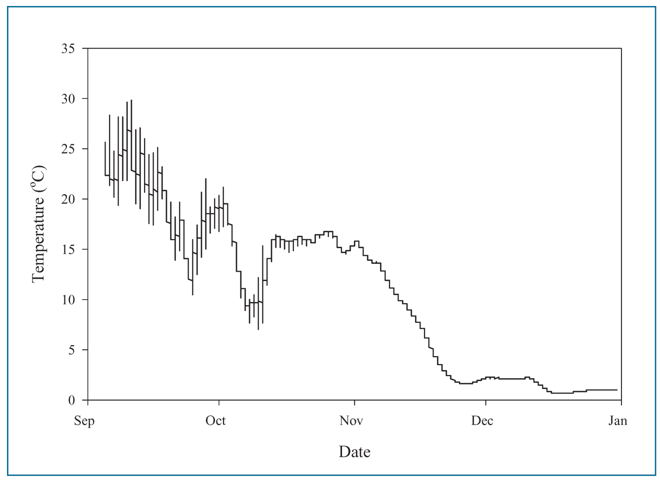

Figure 3.5. Platte River temperature probe data from September 5, 2000 to December 31, 2000 at Louisville, Nebraska.

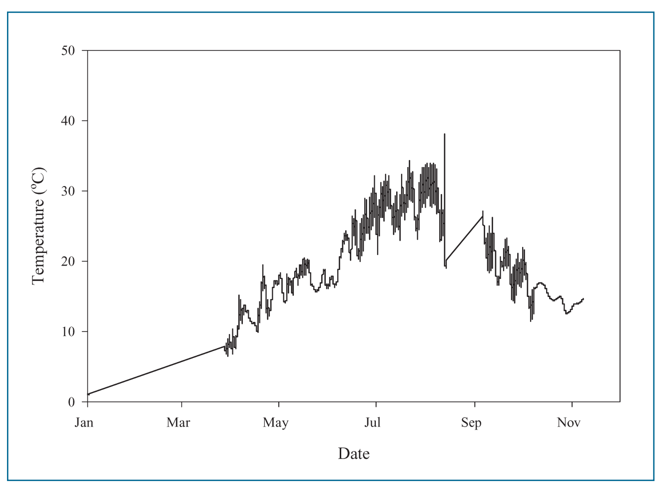

Figure 3.6. Platte River temperature probe data from January1, 2001 to November 8, 2001 at Louisville, Nebraska.

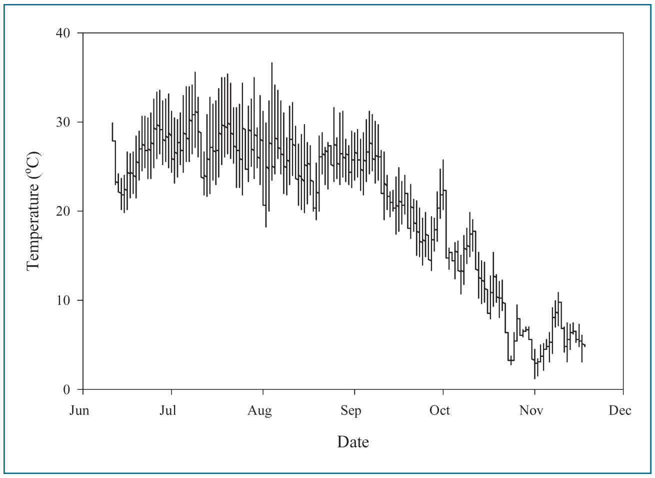

Figure 3.7. Platte River temperature probe data from June 11, 2002 to November 18, 2002 at Louisville, Nebraska.

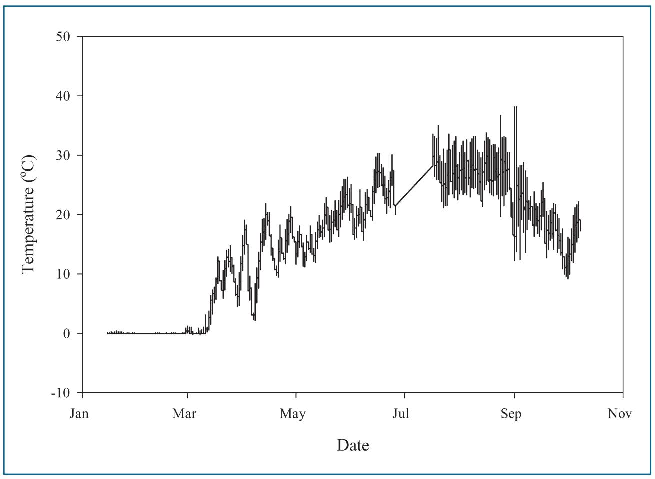

Figure 3.8. Platte River temperature probe data from January 15, 2003 to October 8, 2003 at Louisville, Nebraska.

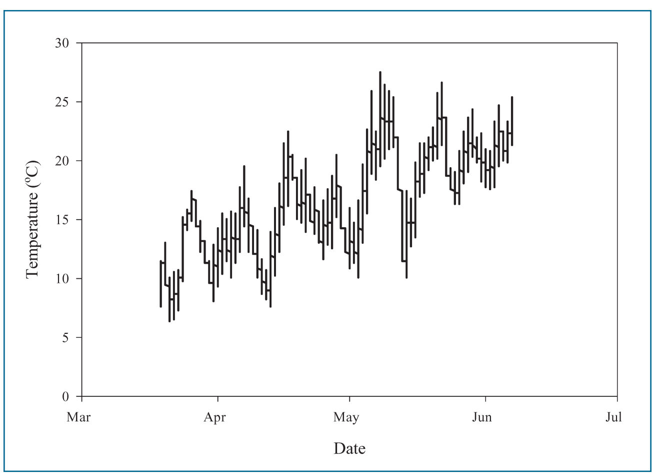

Figure 3.9. Platte River temperature probe data from March 19, 2004 to June 7, 2004 at Louisville, Nebraska.

Dissolved Oxygen:

Average weekly dissolved oxygen values for the Platte River at Leshara, the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at Louisville for the time period September 2000 through June 2004 are displayed on Figures 3.10, 3.11, 3.12 and 3.13, respectively. Dissolved oxygen concentrations do not appear to be a limiting factor in the Platte River proper, since no concentrations below 5 mg/L were measured and this is the generally recognized lower limit for aquatic life (Boyd 1979). However, the Elkhorn site had concentrations below 5 mg/L during May and July 2003 and May 2004. The Salt Creek site had the most severe dissolved oxygen conditions with concentrations below 5 mg/L in November 2000, July and August 2002, June 2003 and May 2004.

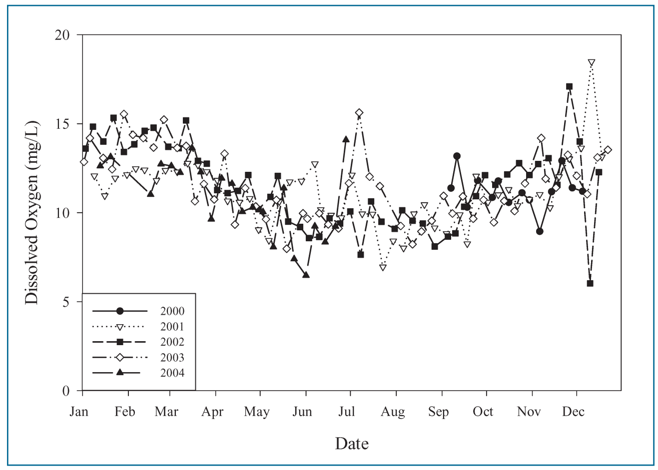

Figure 3.10. Platte River at Leshara average dissolved oxygen, September 2000 to June 2004.

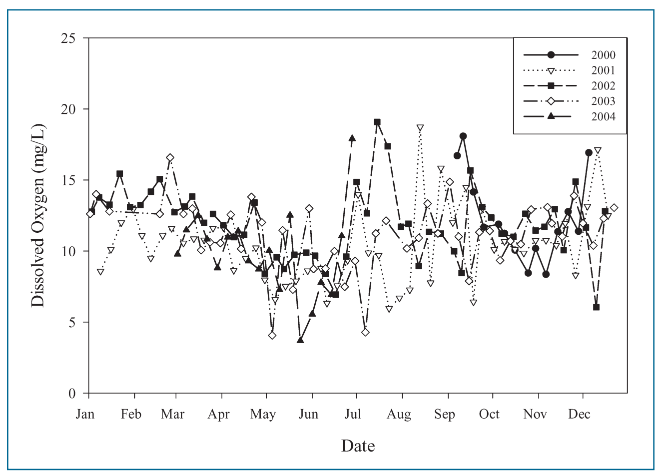

Figure 3.11. Elkhorn River at Waterloo average dissolved oxygen, September 2000 to June 2004.

Specific Conductivity:

Average weekly specific conductivity values for the Platte River at Leshara, the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at Louisville for September 2000 through June 2004 are displayed on Figures

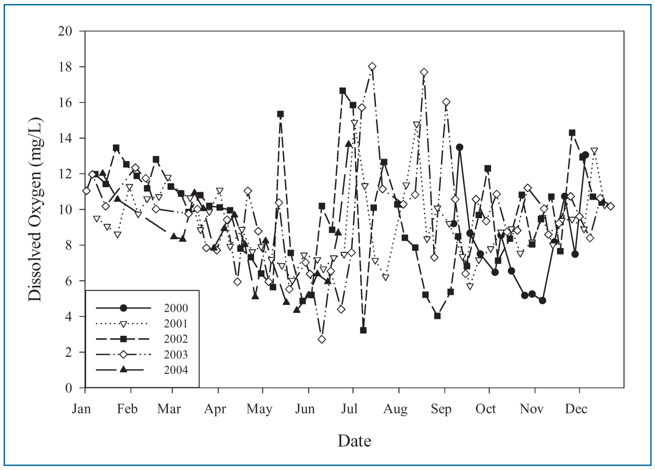

Figure 3.12. Salt Creek at Greenwood average dissolved oxygen, September 2000 to June 2004.

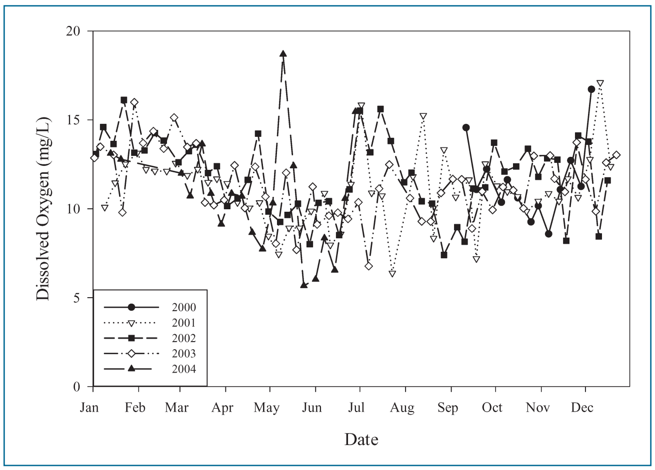

Figure 3.13. Platte River at Louisville average dissolved oxygen, September 2000 to June 2004.

3.14, 3.15, 3.16 and 3.17, respectively (note that the scales on the Y-axes vary at each site). Conductivity values rarely exceeded 600µS/cm at the Leshara site on the Platte River and 700µS/cm at the Elkhorn River site. In contrast, the Salt Creek site seldom had conductivity values less than 1,000 µS/cm. Since the Louisville site is downstream from the confluence of the Platte River with Salt Creek, conductivity values there reflect the mixing of the lower conductivity and higher conductivity water sources. The conductivity readings at the Leshara site (Fig. 3.14) averaged the lowest of all the sites monitored and were least influenced by changes in discharge. At the Elkhorn site (Fig. 3.15) the lowest conductivity readings coincided with high discharge events during the months of May through August (Fig. 1.3). The lowest conductivity readings at the Greenwood site on Salt Creek (Fig. 3.16) coincided with high discharge events during the period from May through June (Fig. 1.4), but other changes in conductivity seemed unrelated to discharge. Conductivity readings at the Louisville site (Fig. 3.17) were highest during the July through September period when discharge was lowest (Fig 1.5).

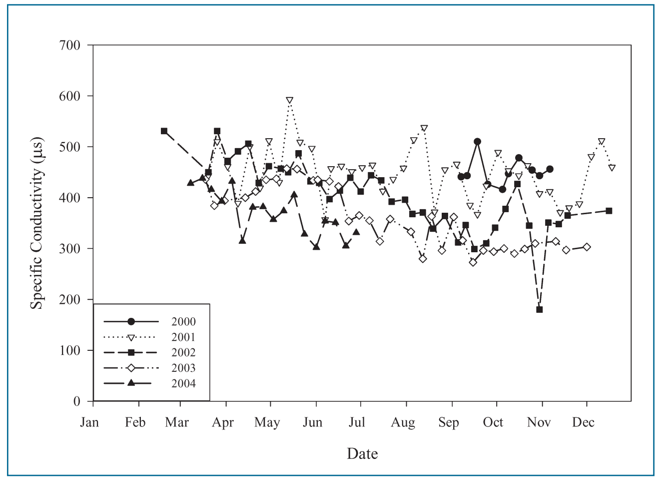

Figure 3.14. Platte River at Leshara average specific conductivity, September 2000 to June 2004.

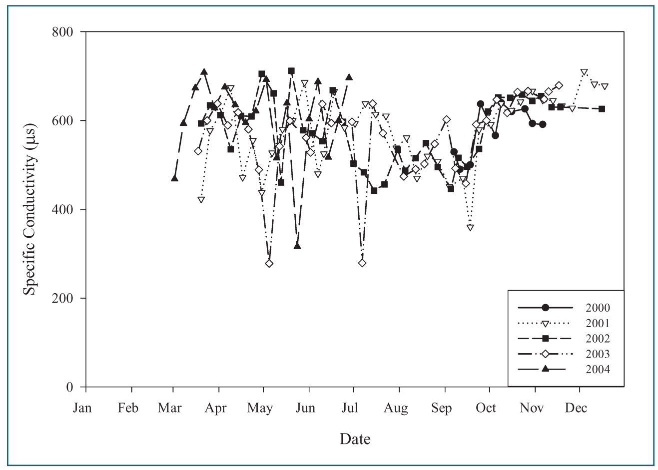

Figure 3.15. Elkhorn River at Waterloo average specific conductivity, September 2000 to June 2004.

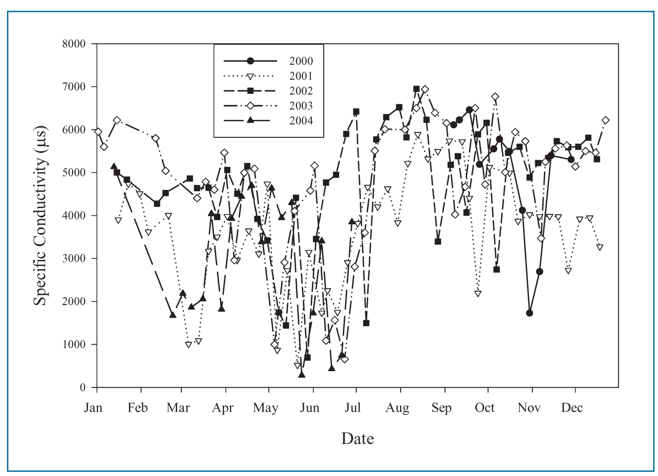

Figure 3.16. Salt Creek at Greenwood average specific conductivity, September 2000 to June 2004.

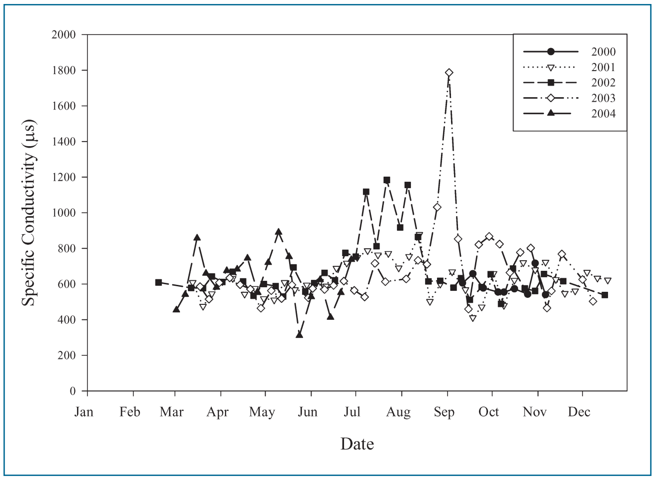

Figure 3.17. Platte River at Louisville average specific conductivity, September 2000 to June 2004.

Salinity:

Average weekly salinity values for the Platte River at Leshara, the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at Louisville for September 2000 through June 2004 are displayed on Figures 3.18, 3.19, 3.20 and 3.21, respectively (note that the scales on the Y-axes vary at each site). As expected, salinity values for the Leshara site on the Platte River were the lowest, ranging from 0.1 ppt up to 0.3 ppt with the majority of values at 0.2 ppt. The Elkhorn River site salinity ranged from 0.1 ppt to 0.4 ppt with most values at 0.3 ppt. Salinities in Salt Creek were the highest and most variable with most values above 2.0 ppt and some up to nearly 4.00 ppt. The influence of Salt Creek can be seen at the Louisville site on the Platte River where most salinity values ranged from 0.2 to 0.4 ppt, with some spikes at or above 0.6 ppt. The range in salinity readings at all sites, except the Greenwood site did not provide much insight to habitat conditions. The lowest salinity values at the Greenwood site (Fig. 3.20) coincided with highest discharges during the months of May through July (Fig. 1.4). However, the highest salinity reading at the Louisville site (Fig. 3.21) during September 2003 coincided with very low discharge (Fig. 1.5).

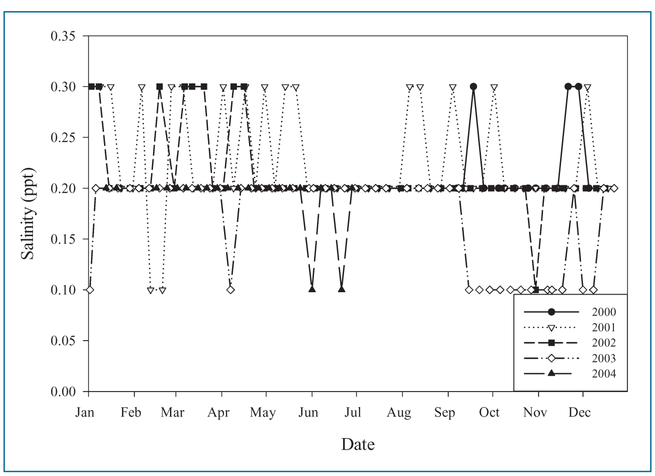

Figure 3.18. Platte River at Leshara average weekly salinity, September 2000 to June 2004.

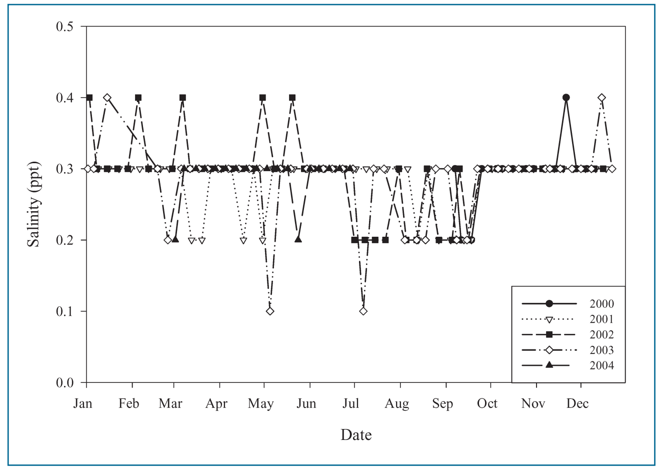

Figure 3.19. Elkhorn River at Waterloo average weekly salinity, September 2000 to June 2004.

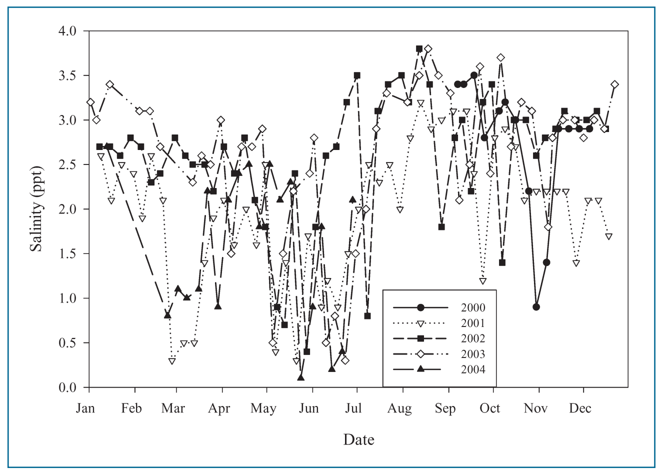

Figure 3.20. Salt Creek at Greenwood average weekly salinity, September 2000 to June 2004.

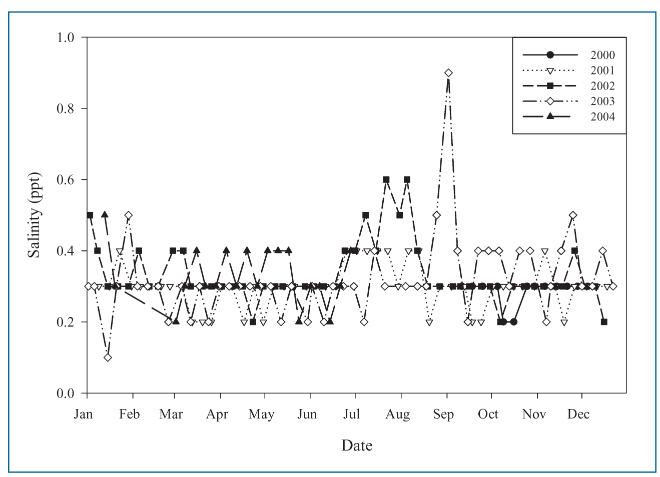

Figure 3.21. Platte River at Louisville average weekly salinity, September 2000 to June 2004.

Suspended solids:

Average weekly suspended solids values for the Platte River at Leshara, the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at Louisville for September 2000 through June 2004 are displayed on Figures 3.22, 3.23, 3.24 and 3.25, respectively (note that the scales on the Y-axes vary at each site). Suspended solids loads are related to runoff events upstream from the site at which they are measured because peaks are often related to erosion silt being transported into the river channel. Peaks in suspended solids at the Louisville site (Fig. 3.25) correspond with high discharge events (Fig. 1.5) and reflect the inputs of materials from the three other sampling sites (Figures 3.22 – 3.24), even though all three may not be contributing solids at the same rate. The peak in suspended solids during late June 2004 corresponds to the peak in suspended solids measured at the Leshara site at the same time (Fig. 3.22) combined with inputs from the Elkhorn River (Fig. 3.23) and Salt Creek (Fig. 3.24) at the same time. These readings appear to be consistent with high discharge from all three upstream sites (Figures 1.2, 1.3, 1.4).

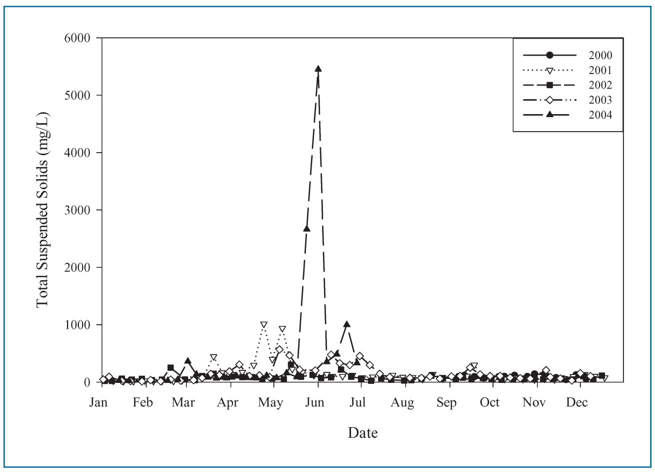

Figure 3.22. Platte River at Leshara average weekly total suspended solids, September 2000 to June 2004.

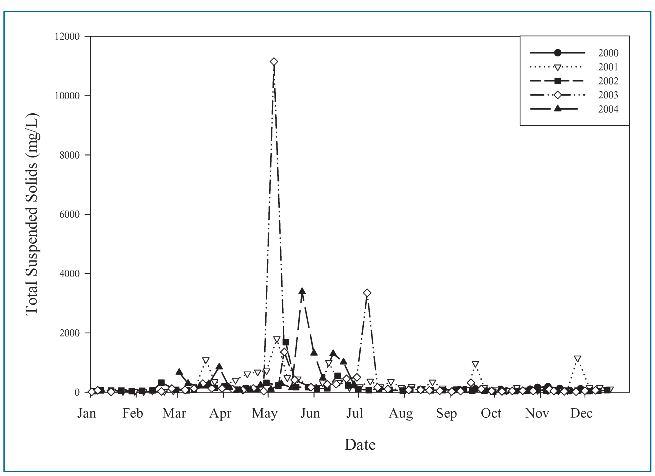

Figure 3.23. Elkhorn River at Waterloo average weekly total suspended solids, September 2000 to June 2004.

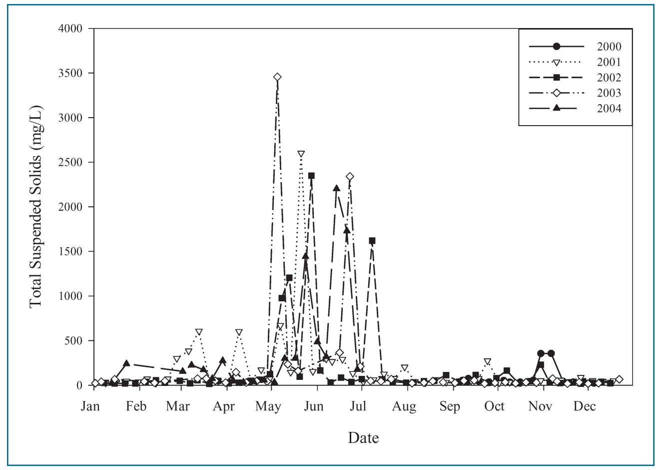

Figure 3.24. Salt Creek at Greenwood average weekly total suspended solids, September 2000 to June 2004.

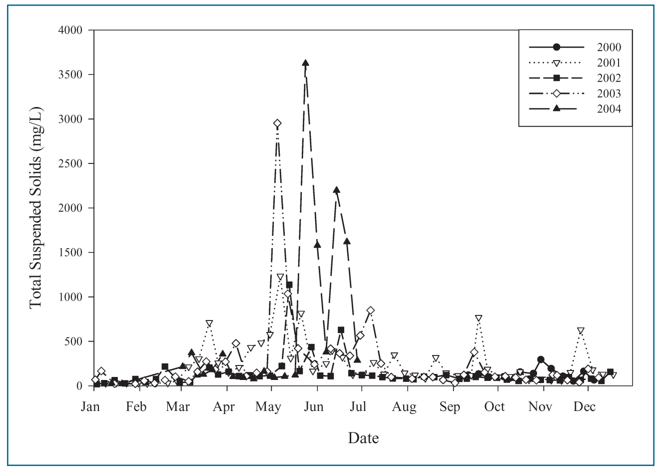

Figure 3.25. Platte River at Louisville average weekly total suspended solids, September 2000 to June 2004.

Turbidity:

Average weekly turbidity values (NTU) for the Platte River at Leshara, the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at Louisville for July 2001 through June 2004 are displayed on Figures 3.26, 3.27, 3.28 and 3.29, respectively (note that the scales on the Y-axes vary at each site). Turbidity values follow the suspended solids loads measured at each of the sites. Similarly, the peaks in turbidity coincide with peaks in discharge as discussed in the suspended solids section.

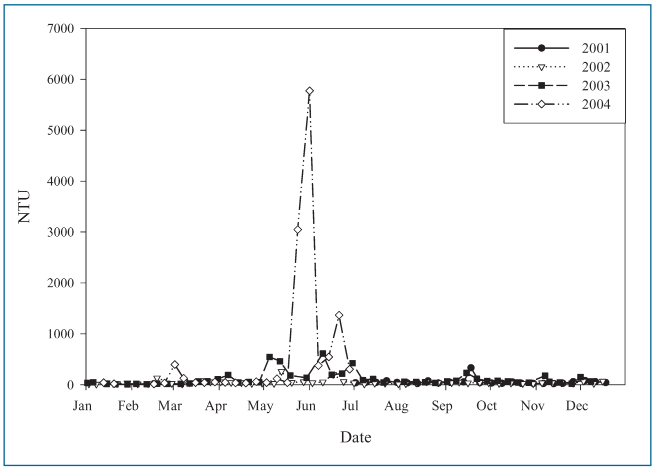

Figure 3.26. Platte River at Leshara average weekly NTU, September 2000 to June 2004.

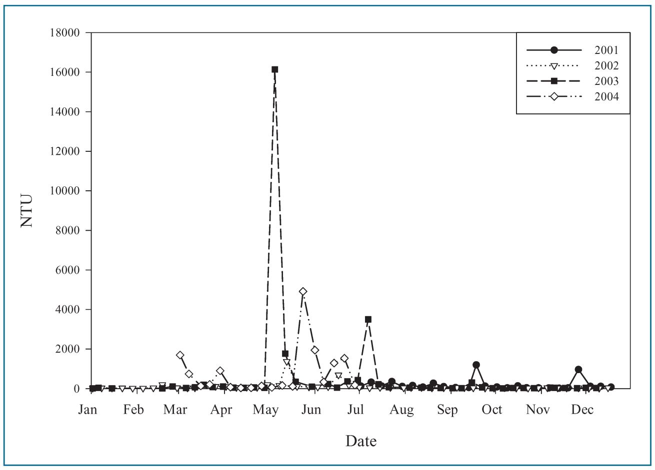

Figure 3.27. Elkhorn River at Waterloo average weekly NTU, September 2000 to June 2004.

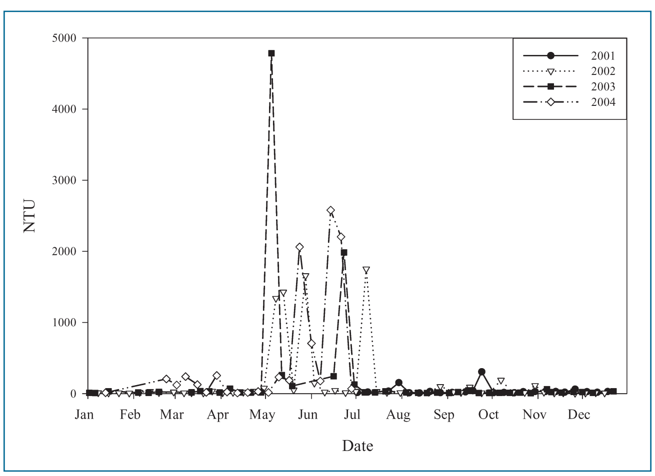

Figure 3.28. Salt Creek at Greenwood average weekly NTU, September 2000 to June 2004.

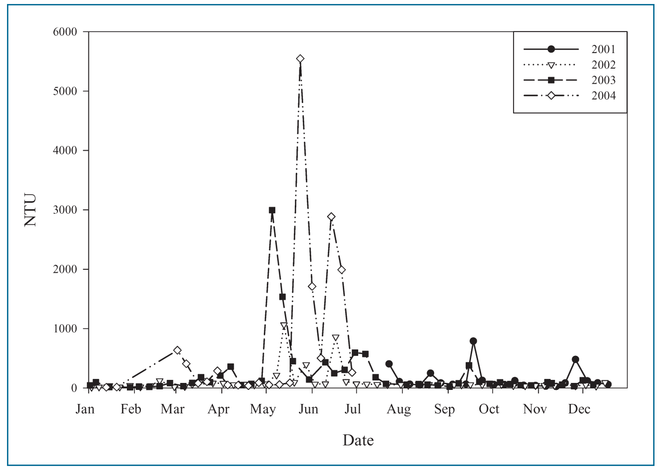

Figure 3.29. Platte River at Louisville average weekly NTU, September 2000 to June 2004.

Substrate:

Table 32 summarizes the substrate composition for all sites. Substrate composition expressed as percent of total sample weight for silt (<230), fine sand (230), sand (60), coarse sand (18) and gravel (10) along transects across the channels for the Platte River near North Bend (Nebraska highway 79), the Platte River at Leshara (Nebraska highway 64), the Elkhorn River at Waterloo, the Platte River near Ashland (US highway 6), Salt Creek at Greenwood, and the Platte River at Louisville (Nebraska highway 50) for July /August 2003, October 2003 and March 2004, are displayed as Figures 3.30 through 3.47, respectively.

The majority of Platte River substrate is sand and fine sand. The general trend at all sites was that core samples from locations with greater mean column velocities tended to have higher percentages of gravel and coarse sand. Conversely, sample locations with lower mean column velocities tended to have higher percentages of silt and fine sand.

NORTH BEND SITE ON THE PLATTE RIVER: The North Bend site (Figures 3.30, 3.31, 3.32) is the upstream most site sampled for substrate in this study and is located near the Nebraska State Highway 79 bridge. Here the river ranged from 403 to 447 m wide with depths up to 1.6 m, and was dissected by three or more bars up to 70 m wide. The substrate was dominated by sand and fine sands. Coarse sand and gravel were generally present but, in combination seldom exceeded 40% by weight in any one sample. Silt was most frequently present in shallow or exposed bar samples.

The pairwise multiple comparison procedure showed that the North Bend site had significantly higher percentages of coarse sand than the Elkhorn River site ($p<0.001$) and significantly lower percentages of sand than the Salt Creek site ($p<0.001$). Percentages of fine sand at North Bend were significantly lower than those at the Elkhorn River site ($p=0.002$) and significantly higher than those at the Salt Creek site ($p<0.001$). The North Bend site showed no significant differences in substrate composition with any of the other Platte River sites sampled.

LESHARA SITE ON THE PLATTE RIVER: The Leshara site is located near the Nebraska State Highway 64 Bridge. The river channel ranged from 503 to 580 m wide and up to 2 m deep at this site (Figures 3.33, 3.34, 3.35). The channel was dissected by one or more exposed bars up to 100 m in width. Sand and fine sand dominated most of the sample locations but, exposed bars were primarily fine sand and silt.

The pairwise multiple comparison procedure showed that substrate samples from the Leshara site on the Platte River had significantly higher percentages of coarse sand than the Elkhorn River site (p=0.004). The Leshara site also had significantly lower percentages of sand (p<0.001) and significantly higher percentages of fine sand (p<0.001) than the Salt Creek site. The only significant differences between the substrate composition at the Leshara site and other Platte River sites were that the percent coarse sand was lower (p=0.004) and the percent fine sand was higher (p<0.001) at the Louisville site.

ELKHORN RIVER SITE: The Elkhorn River site is located near the Nebraska State Highway 64 Bridge in the town of Waterloo, Nebraska. The river at this site ranged from 58 to 66 m wide and was up to 1.5 m deep (Figures 3.36, 3.37, 3.38). No exposed bars were found at this site. Fine sand and sand size materials dominated the substrate in the July 2003 samples and the composition shifted to sand during the October 2003 and March 2004 samples. On these dates fine sand and silt was found in higher percentage in samples from shoreline locations.

The pairwise comparison procedure showed that the Elkhorn River site had significantly lower percentages of coarse sand than the Salt Creek site (p=0.001) and indeed all of the sites along the Platte River as detailed below. The percentage of fine sand at the Elkhorn River site was significantly higher than that at the Salt Creek site (p<0.001) and all the Platte River sites, except the one at Leshara as detailed above. The percentage of sand at the Elkhorn River site was significantly lower than that at the Salt Creek site (p<0.001).

ASHLAND SITE ON THE PLATTE RIVER: The Ashland site is located near the US Highway 6 bridge over the Platte River. The channel ranged from 390 to 420 m wide and up to 1 m deep. In contrast to the other sites on the Platte River, there were no exposed bars that divided the river into smaller channels. However, there were exposed bars on the bank-line areas up to about 100 m wide (Figures 3.39, 3.40, 3.41). Silt was confined to exposed bar locations. Coarse sand and gravel were most abundant in the deeper, faster sections of the channel.

The pairwise comparison procedure showed that the site at the US Highway 6 Bridge on the Platte River had significantly higher percentages of coarse sand than the Elkhorn River site (p<0.001). This site also had significantly lower percentages of sand than the Salt Creek site (p<0.001). The percentage of fine sand was significantly lower than those found in the Elkhorn River site (p=0.001) and significantly higher than those found at the Salt Creek site (p<0.001). The Ashand site showed no signifiant differences in substrate composition with any of the other Platte River sites sampled.

SALT CREEK SITE: The Salt Creek site is located just north of Greenwood, Nebraska. This site ranged from 39 to 41 m wide and up to 0.7 m deep (Figures 3.42, 3.43, 3.44). The channel was divided by an exposed bar with the July and October 2003 samples. Although sand was by far the largest component of the substrate, silt commonly occurred in the samples more frequently than the other sites.

LOUISVILLE SITE ON THE PLATTE RIVER: The Louisville site is located near the Nebraska State Highway 50 bridge on the Platte River. It was the most downstream location in the Platte River that was sampled for substrate composition during this study. The channel at this site ranged from 407 to 516 m wide and up to 1.1 m deep (Figures 3.45, 3.46, 3.47). The channel at this site was divided by several small bars during the July 2003 sample but, no exposed bars were found during October 2003 or March 2004. From July 2003 to March 2004, there appeared to be a shift toward a finer substrate composition.

The pairwise comparison procedure showed that the substrate at the Louisville site on the Platte River had significantly higher percentages of gravel than the Elkhorn River site (p<0.001) and the Salt Creek site (p=0.004). Percentages of coarse sand at Louisville were significantly higher than those found at the Elkhorn River site (p=0.001) and at the Leshara site on the Platte River (p=0.004). The percentage of sand at the Louisville site was significantly lower than at the Salt Creek site (p=0.001). The percentage of fine sand at the Louisville site was significantly lower than the percentages at the Elkhorn River site (p<0.001) and the Leshara site on the Platte River (p<0.001) and significantly higher than at the Salt Creek site (p=0.005). Percentages of silt, sand and gravel at the Louisville site were not significantly different from any other site sampled on the Platte River.

AMBIENT RIVER HABITAT DISCUSSION:

Other sources of information on the chemical constituents in the water of the Platte River include the annual publications of the USGS (Water Resources Data – Nebraska such as Hitch et al. (2003)). Of particular note to this study are the surface-water stations on the Platte River (Table 1.2) at North Bend (06796000), the Platte River near Leshara (06796500), the Elkhorn River at Waterloo (06800500), the Platte River near Ashland (06801000), Salt Creek at Greenwood (06803555) and the Platte River at Louisville (06805500). The stations on the Platte River near Leshara and Salt Creek at Greenwood only measure discharge. The stations on the Elkhorn River at Waterloo and the Platte River at Louisville measure discharge and, in the 2002 water year, both sites also sampled chemistry, temperature and suspended solids as part of their regular operations on a monthly basis from October through March and twice monthly April through September.

The Louisville station sampled specific conductance, water temperature and suspended sediment concentrations

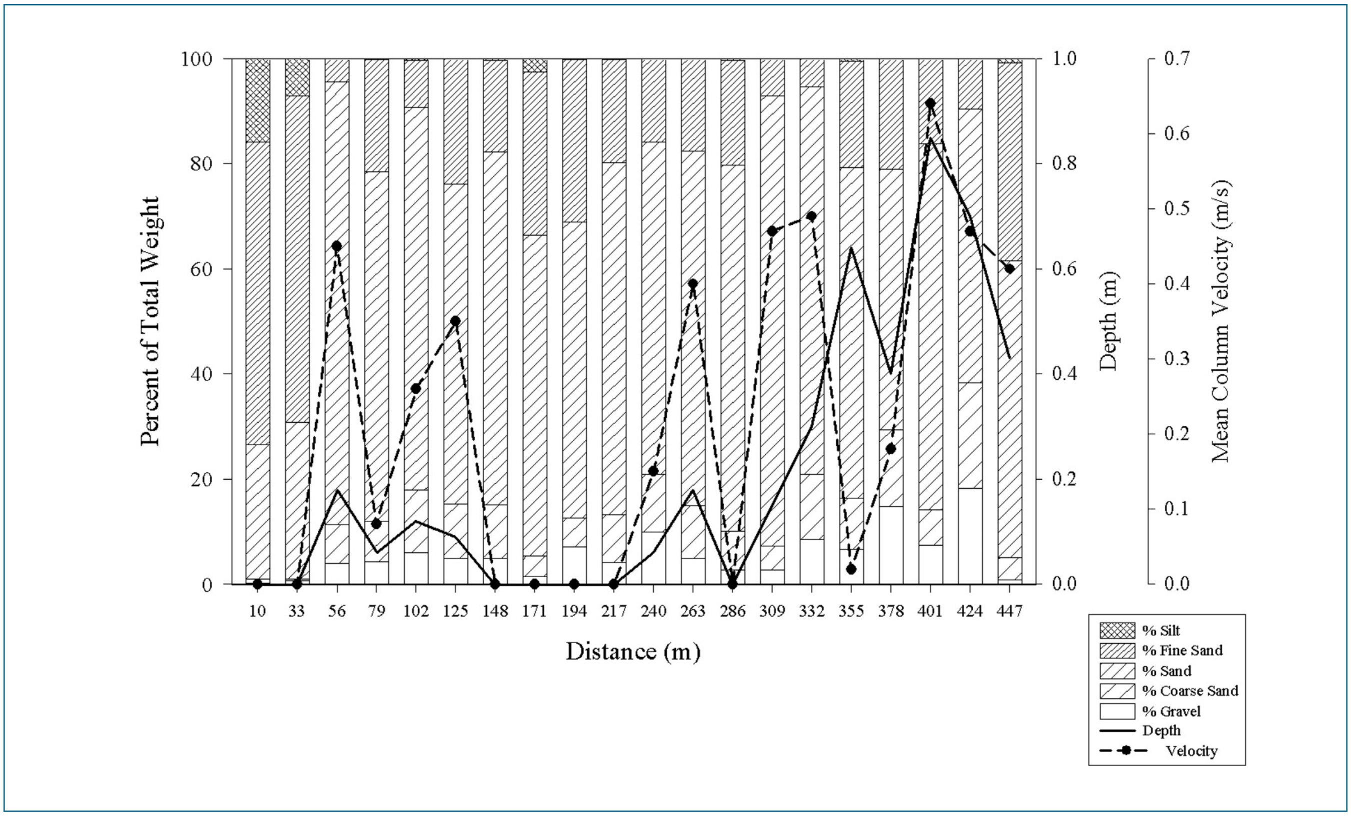

Figure 3.30. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 79 Bridge August 5, 2003.

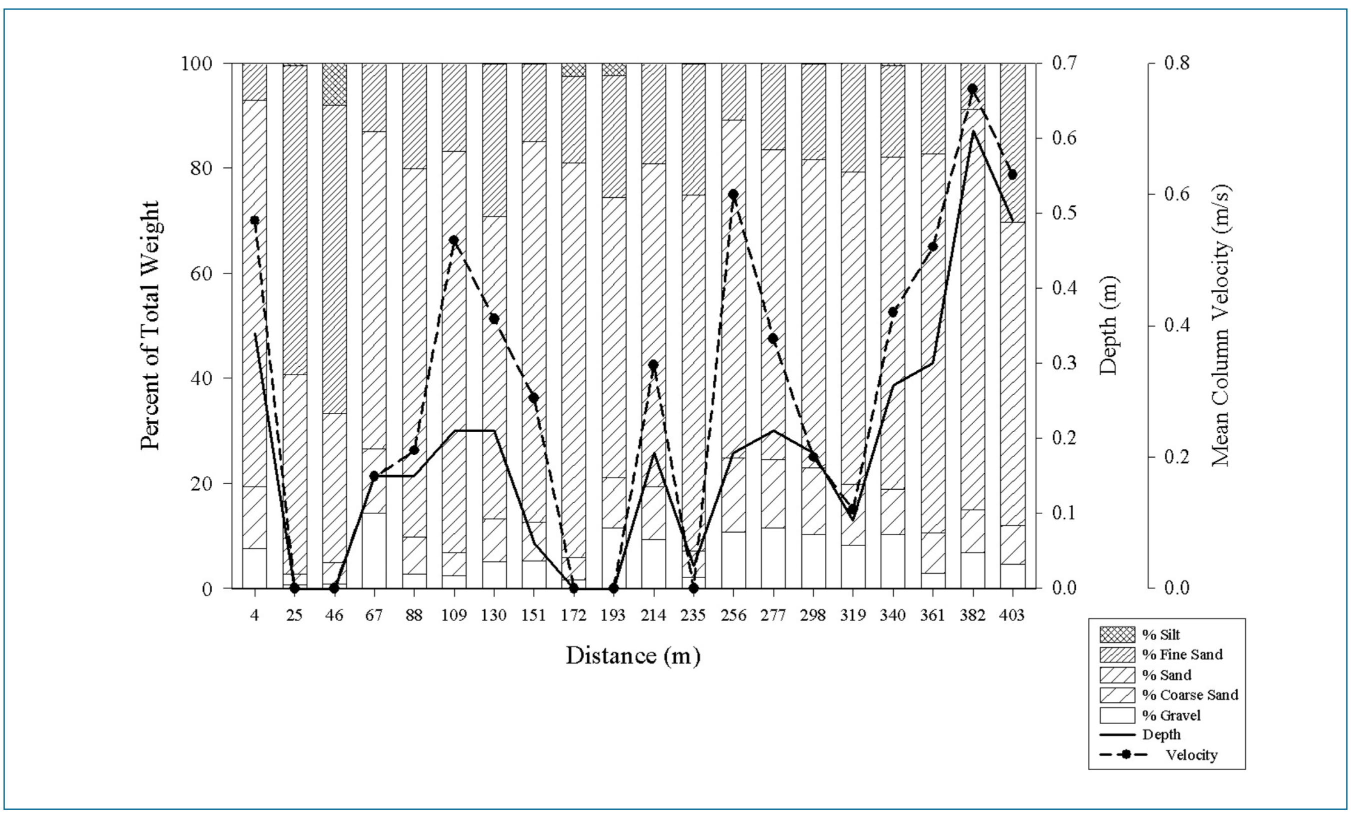

Figure 3.31. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 79 Bridge October 24, 2003.

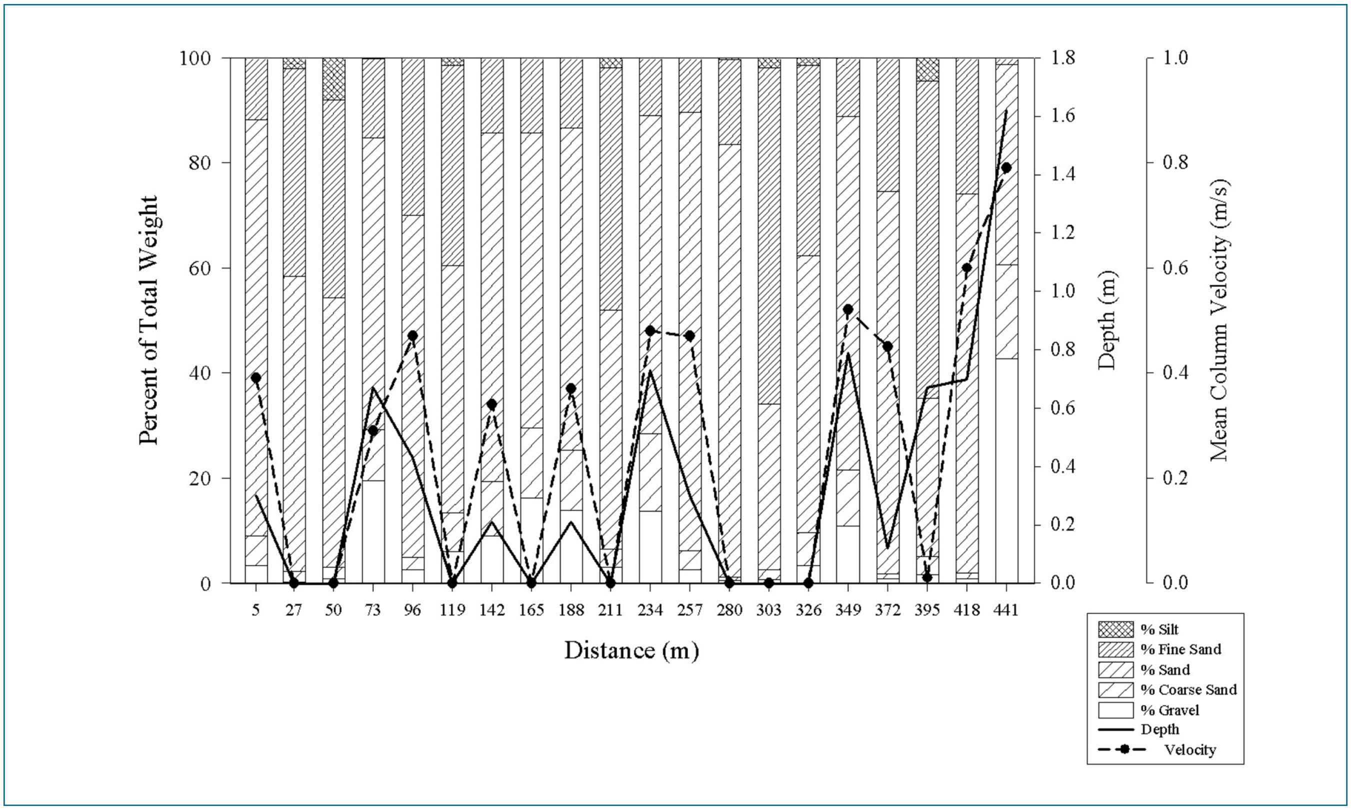

Figure 3.32. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 79 Bridge March 12, 2004.

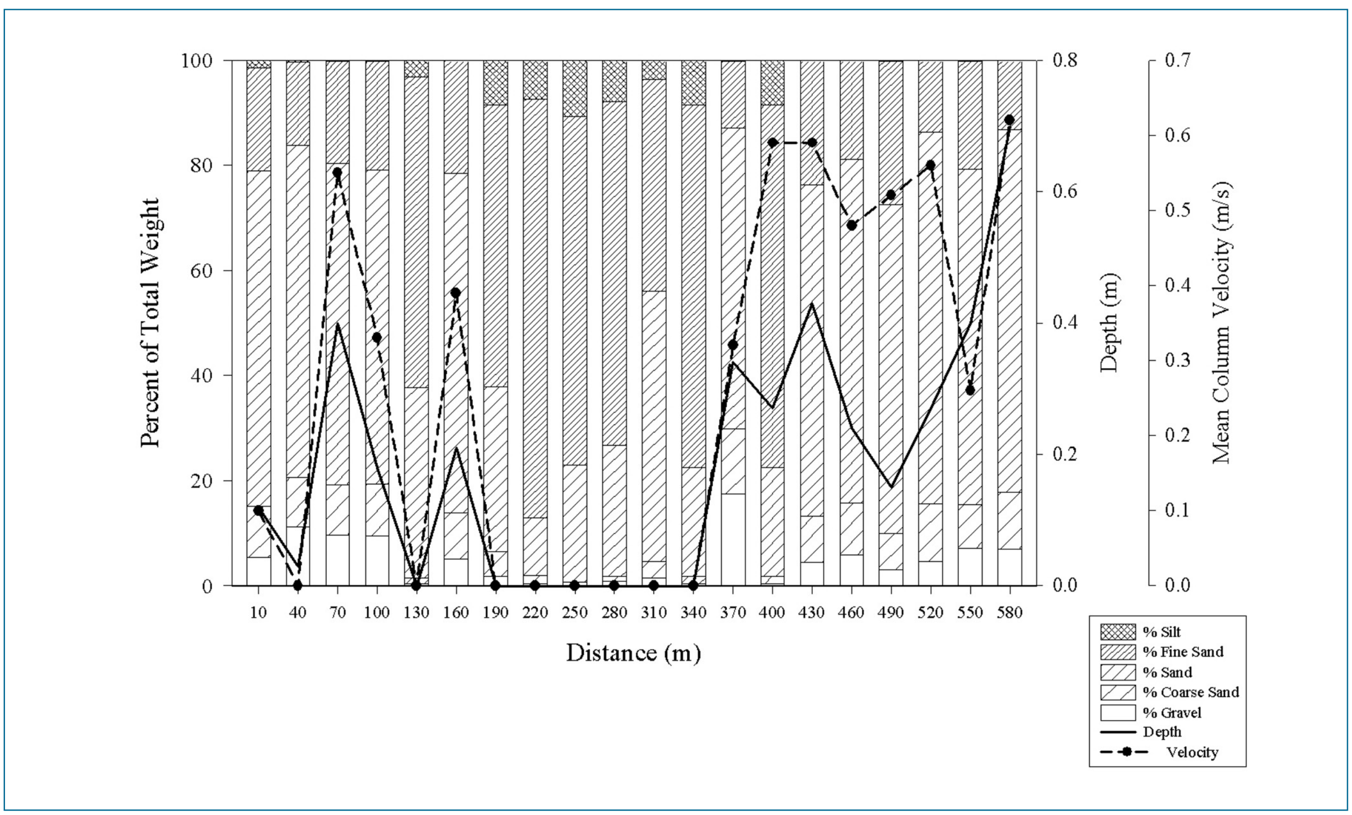

Figure 3.33. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 64 Bridge August 15, 2003.

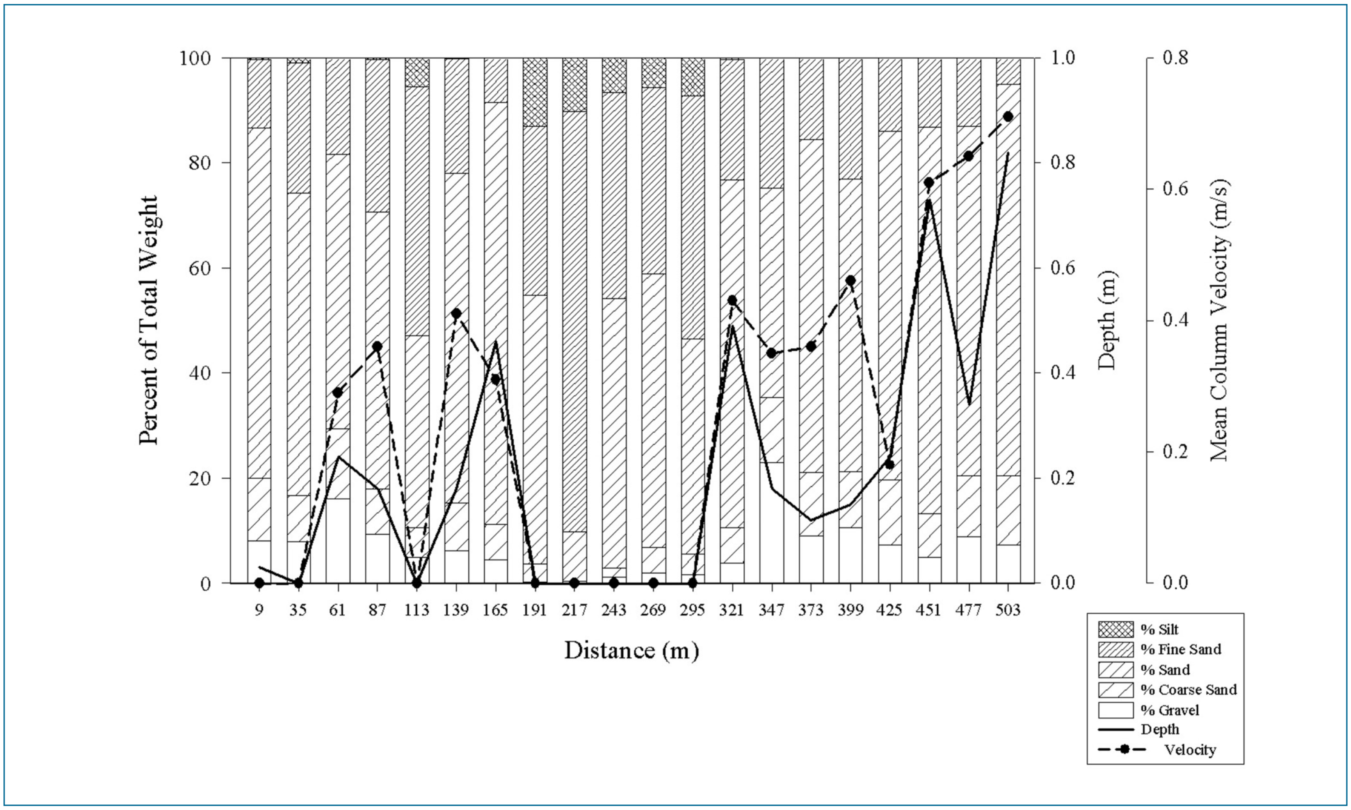

Figure 3.34. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 64 Bridge October 24, 2003.

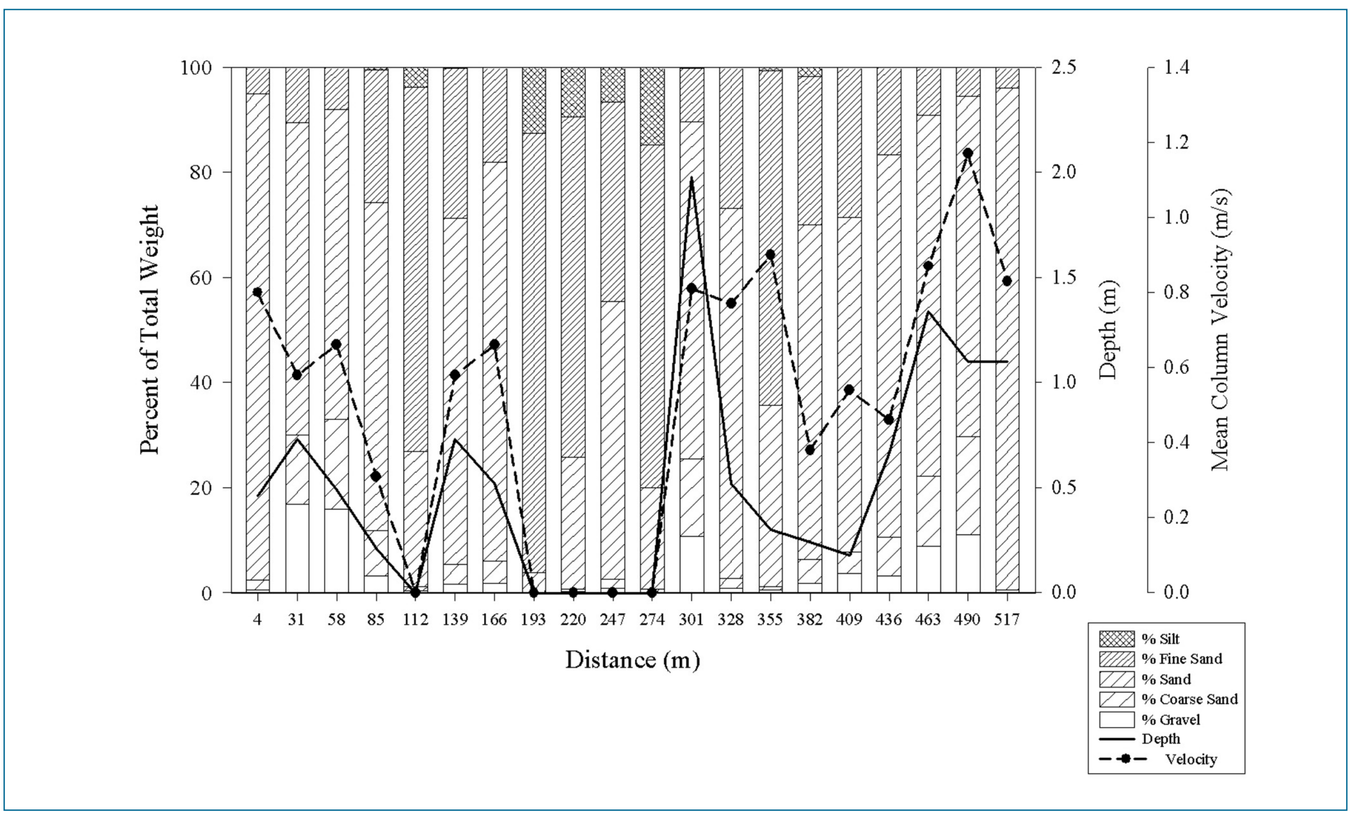

Figure 3.35. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 64 Bridge March 30, 2004.

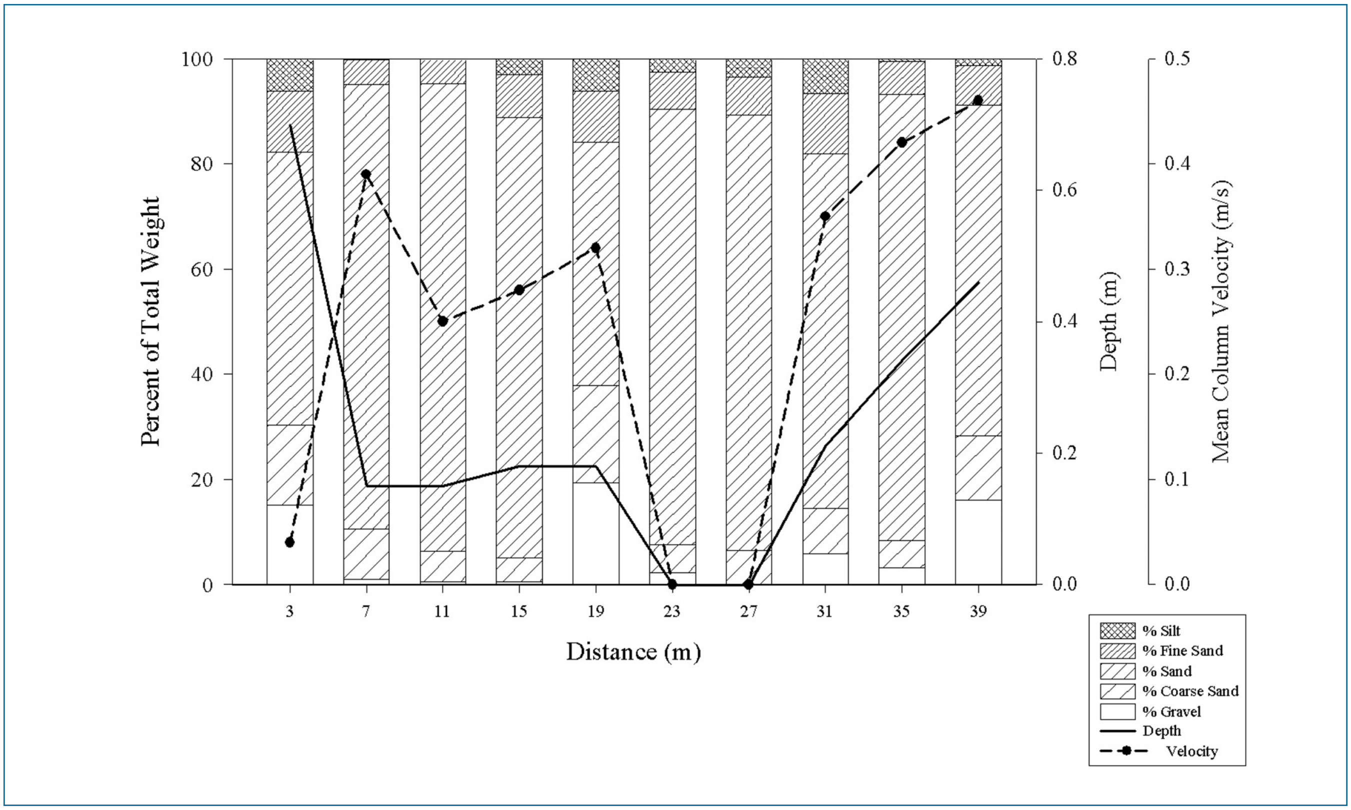

Figure 3.36. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Elkhorn River near Nebraska State Highway 64 Bridge July 23, 2003

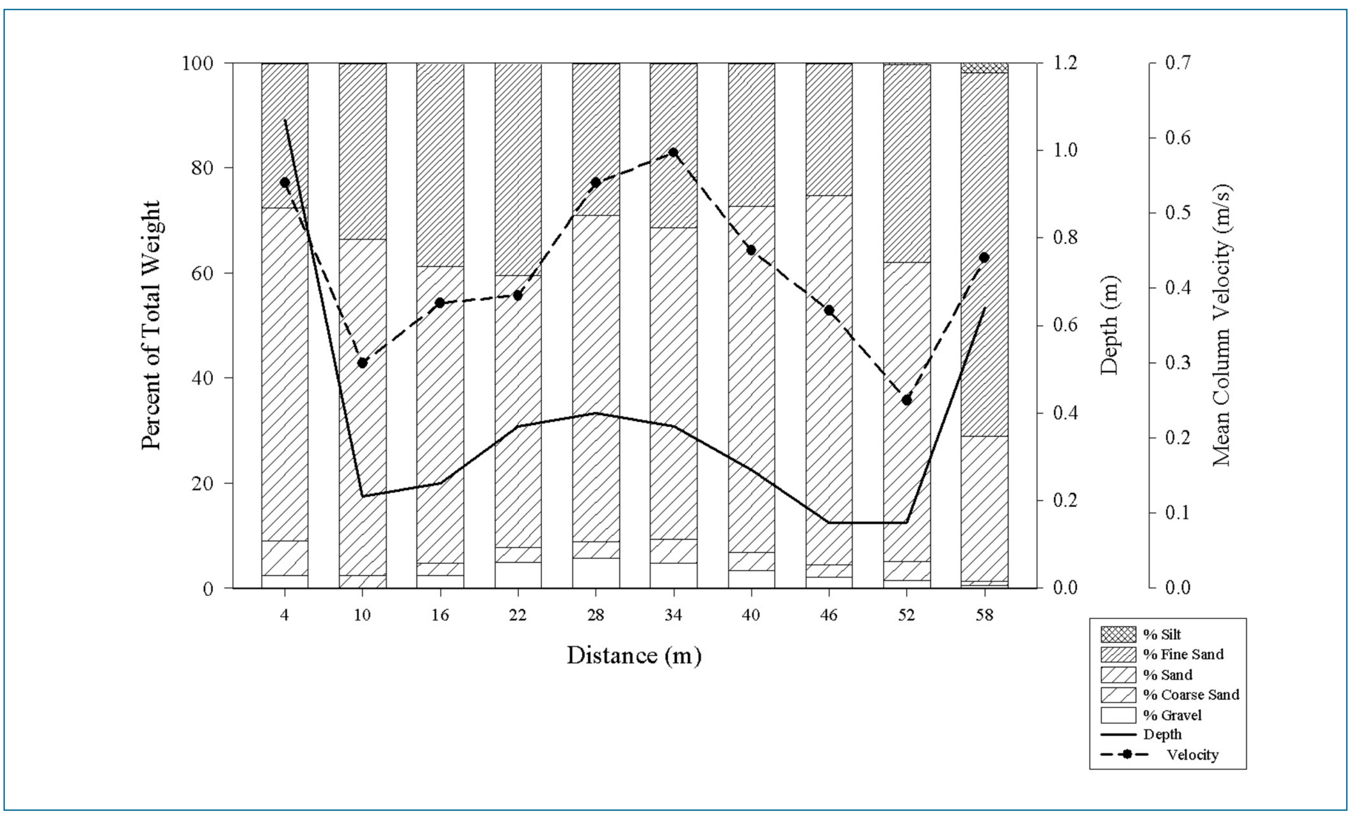

Figure 3.37. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Elkhorn River near Nebraska State Highway 64 Bridge October 8, 2003.

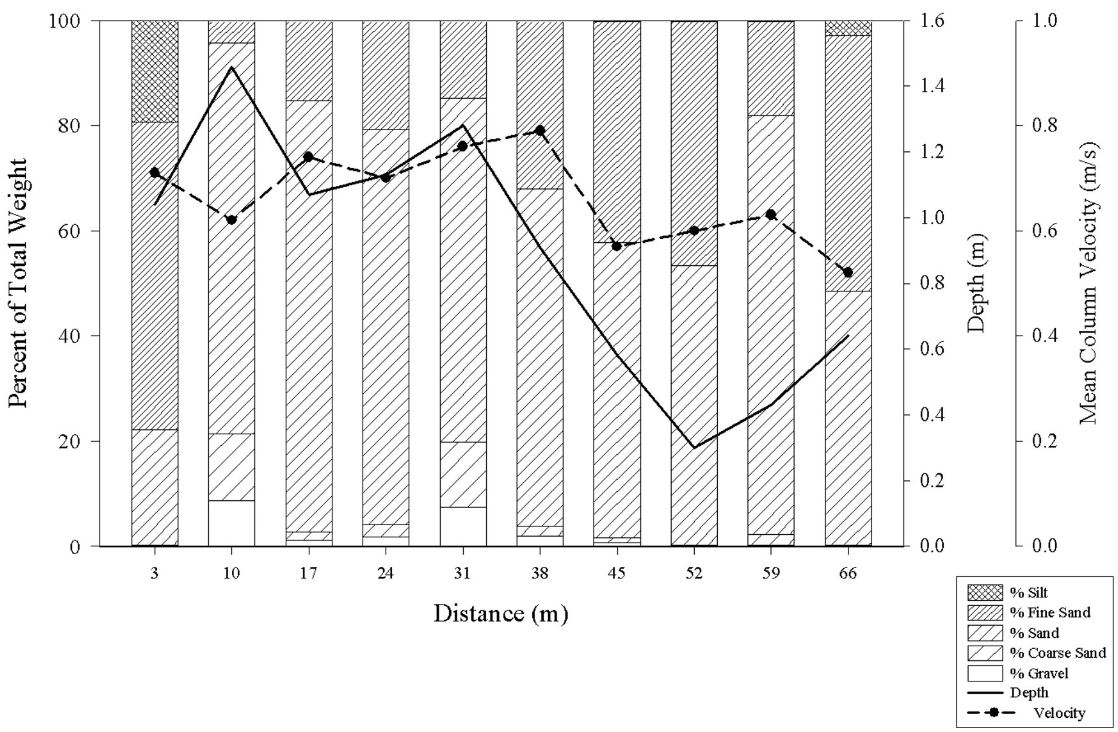

Figure 3.38. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Elkhorn River near Nebraska State Highway 64 Bridge March 31, 2004.

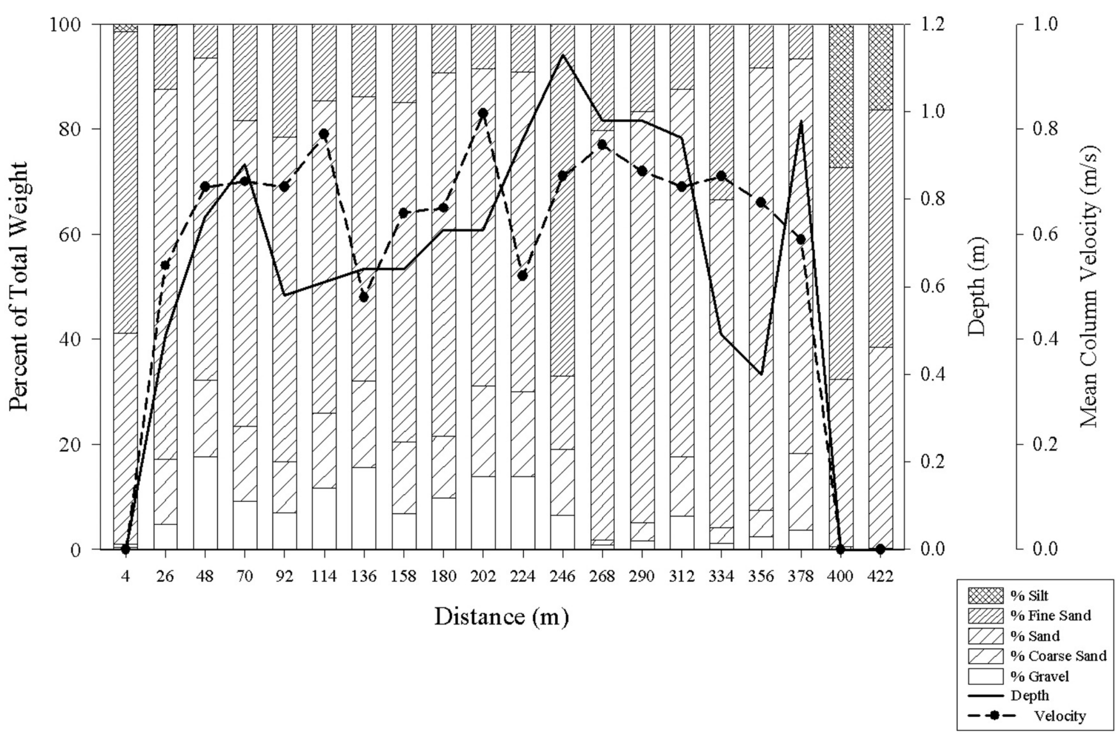

Figure 3.39. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near US Highway 6 Bridge July 31, 2003.

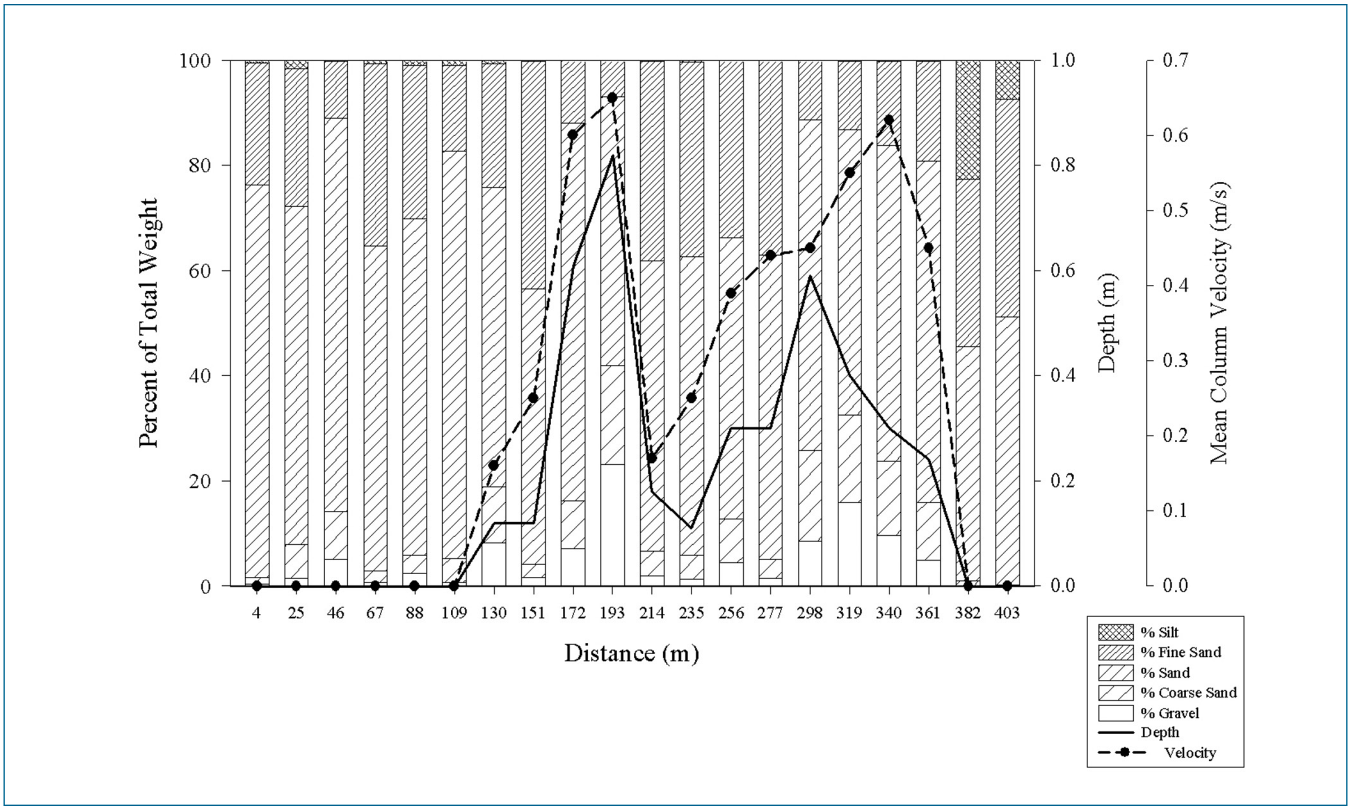

Figure 3.40. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near US Highway 6 Bridge October 10, 2003.

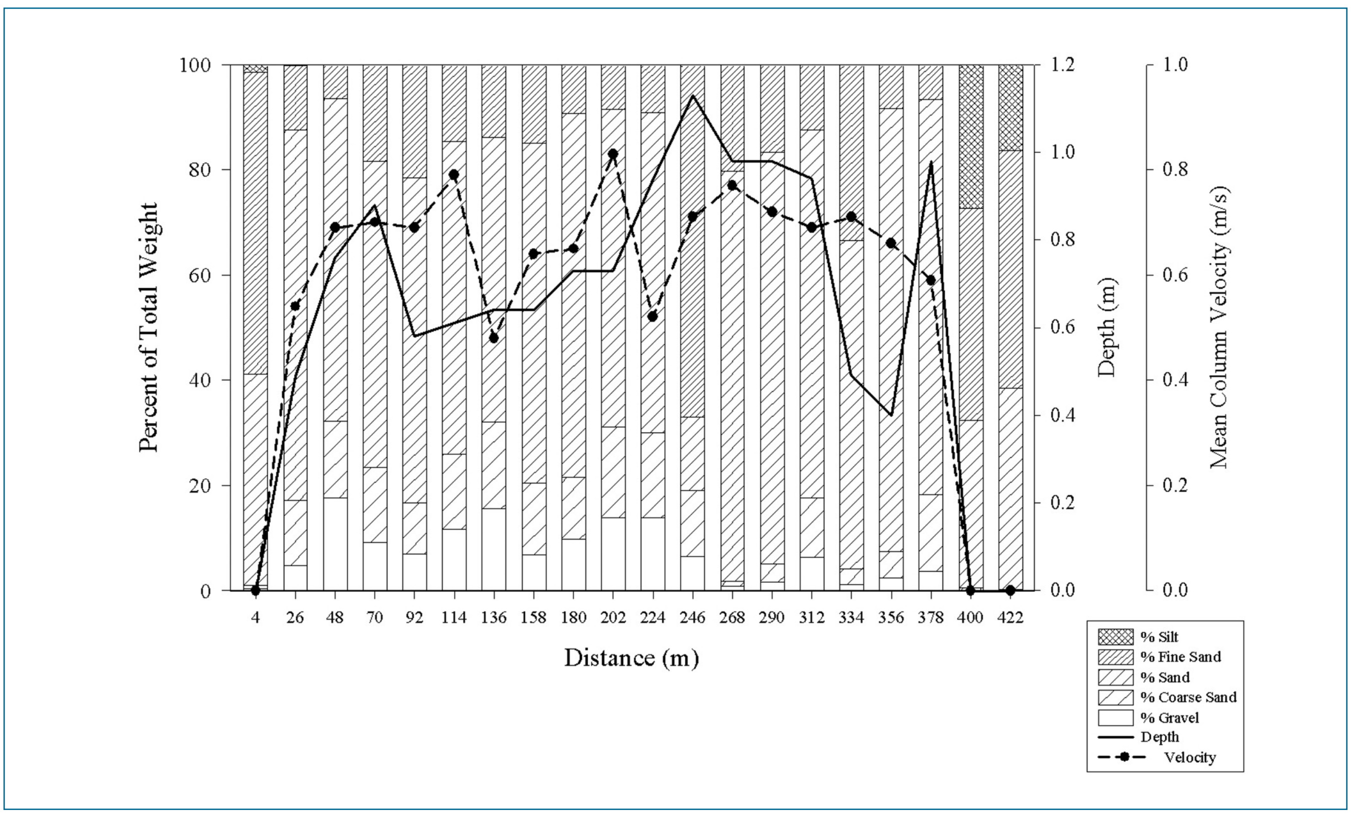

Figure 3.41. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near US Highway 6 Bridge March 19, 2004

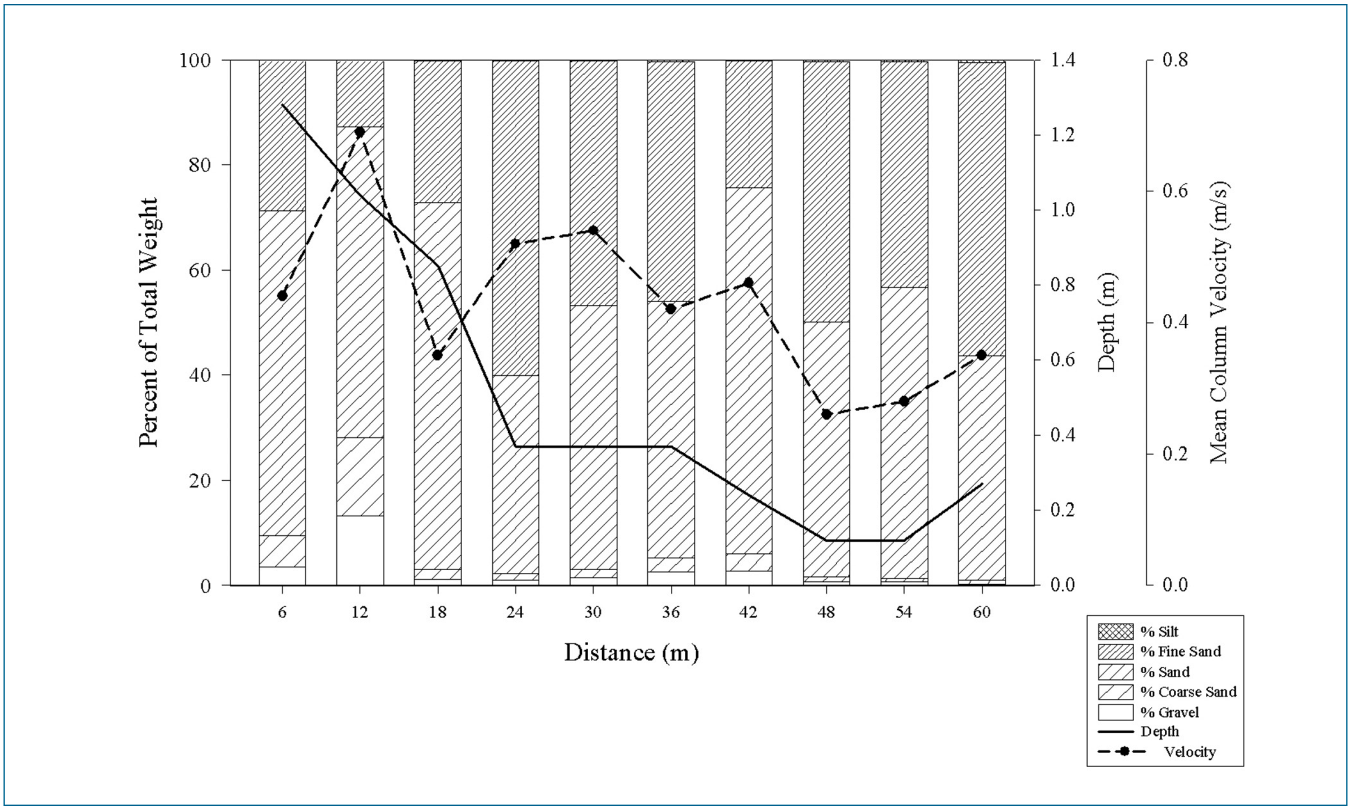

Figure 3.42. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across Salt Creek near Greenwood July 30, 2003.

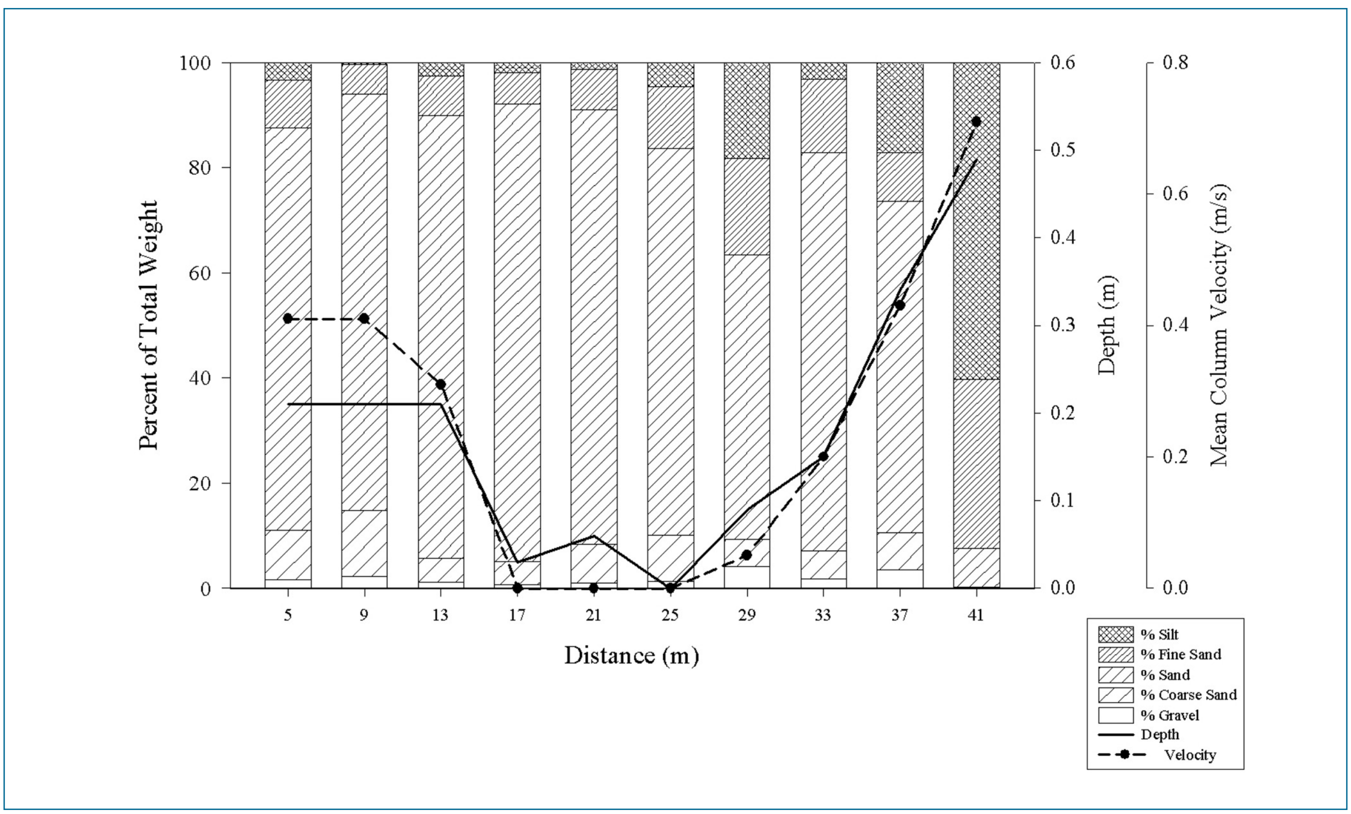

Figure 3.43. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across Salt Creek near Greenwood October 8, 2003.

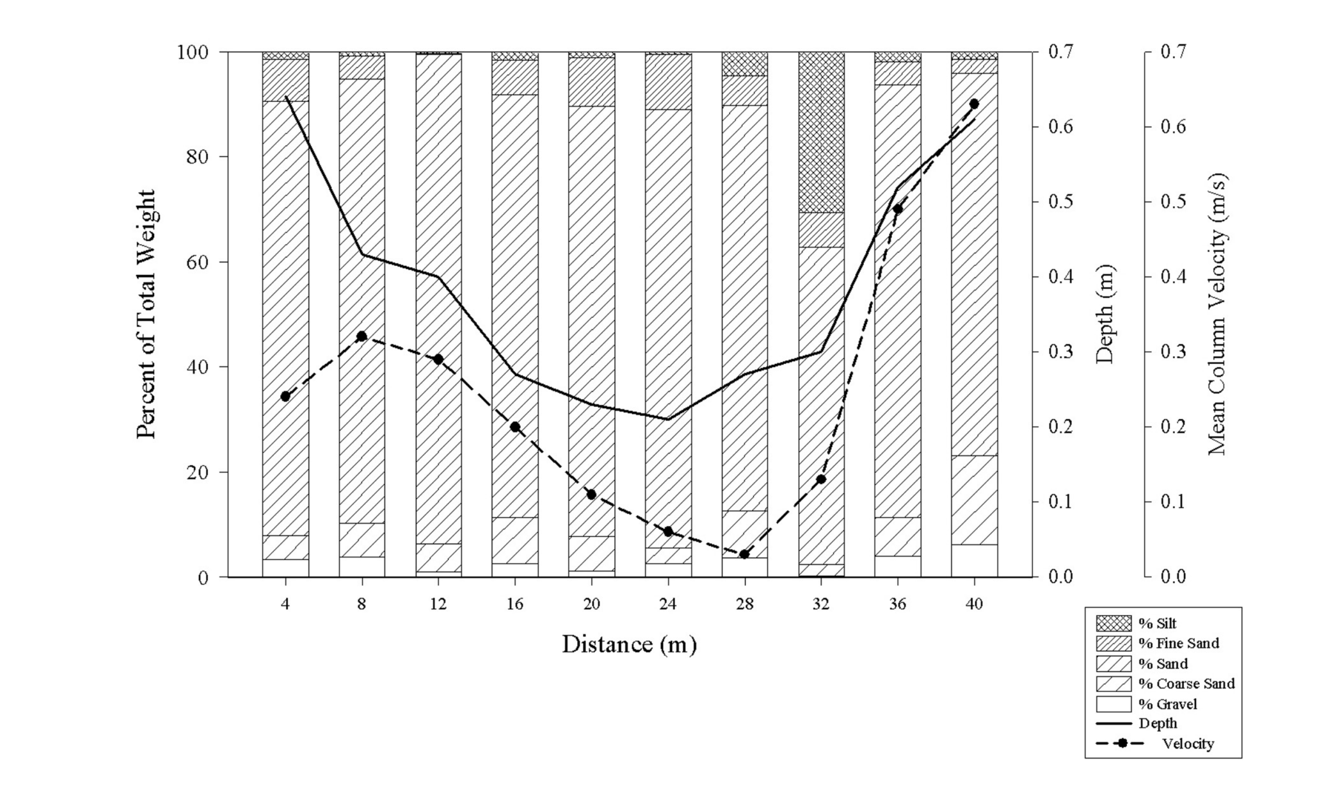

Figure 3.44. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across Salt Creek near Greenwood March 11, 2004.

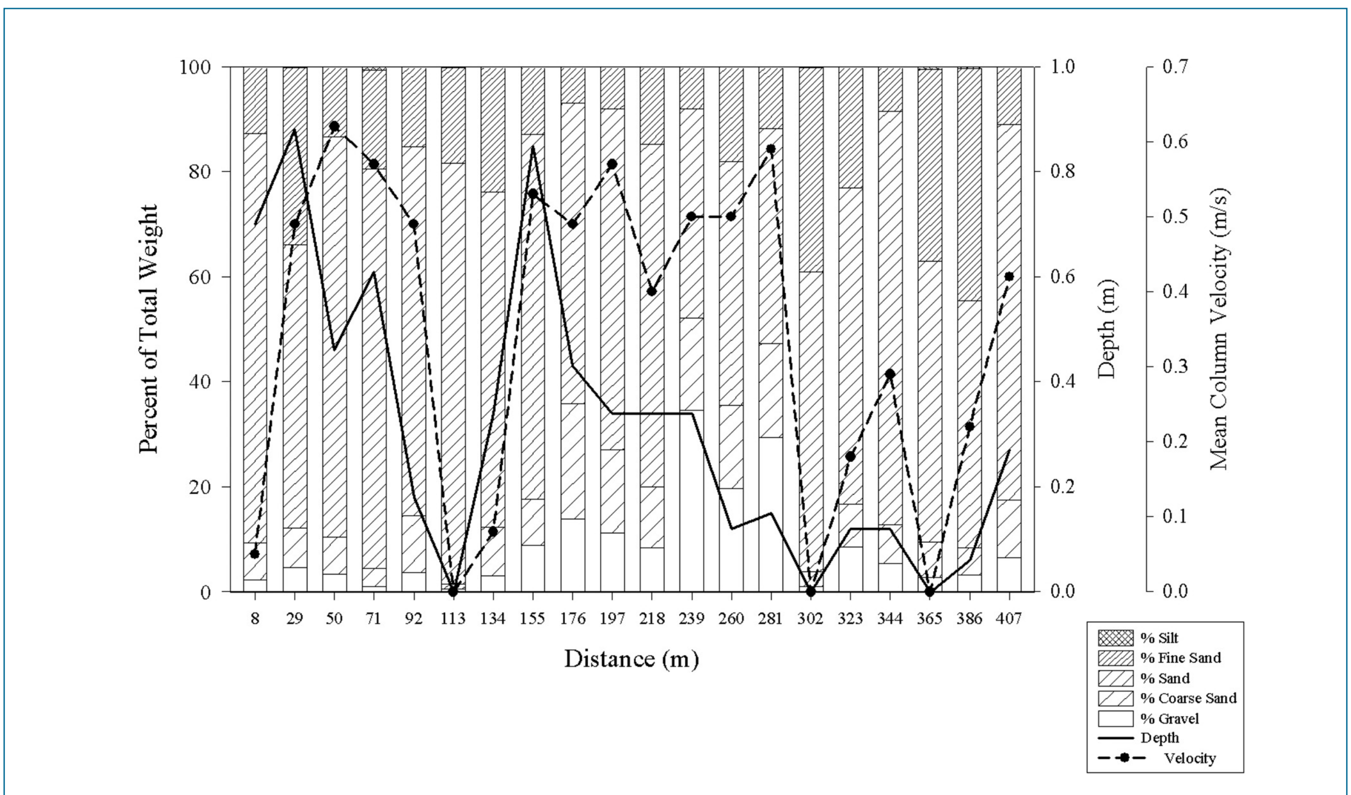

Figure 3.45. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 50 Bridge July 23, 2003.

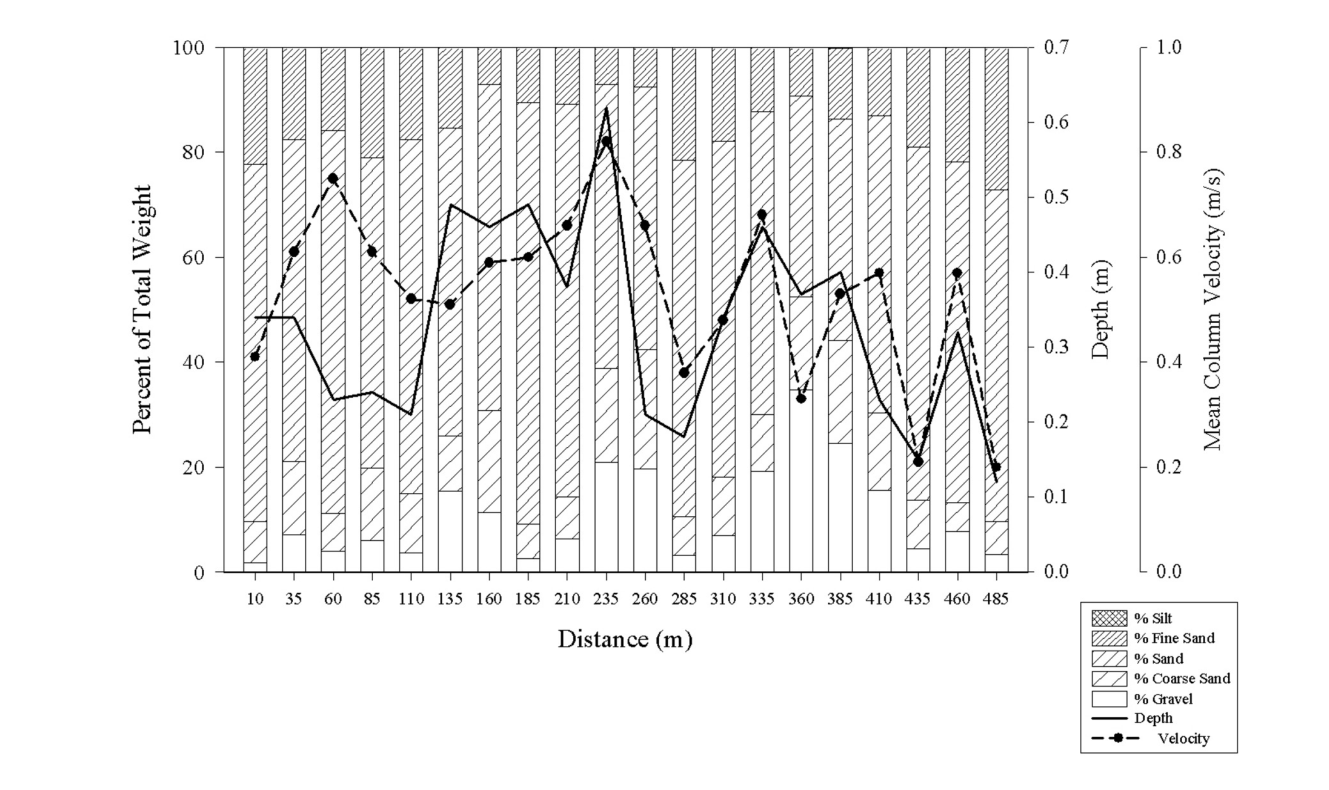

Figure 3.46. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 50 Bridge October 10, 2003.

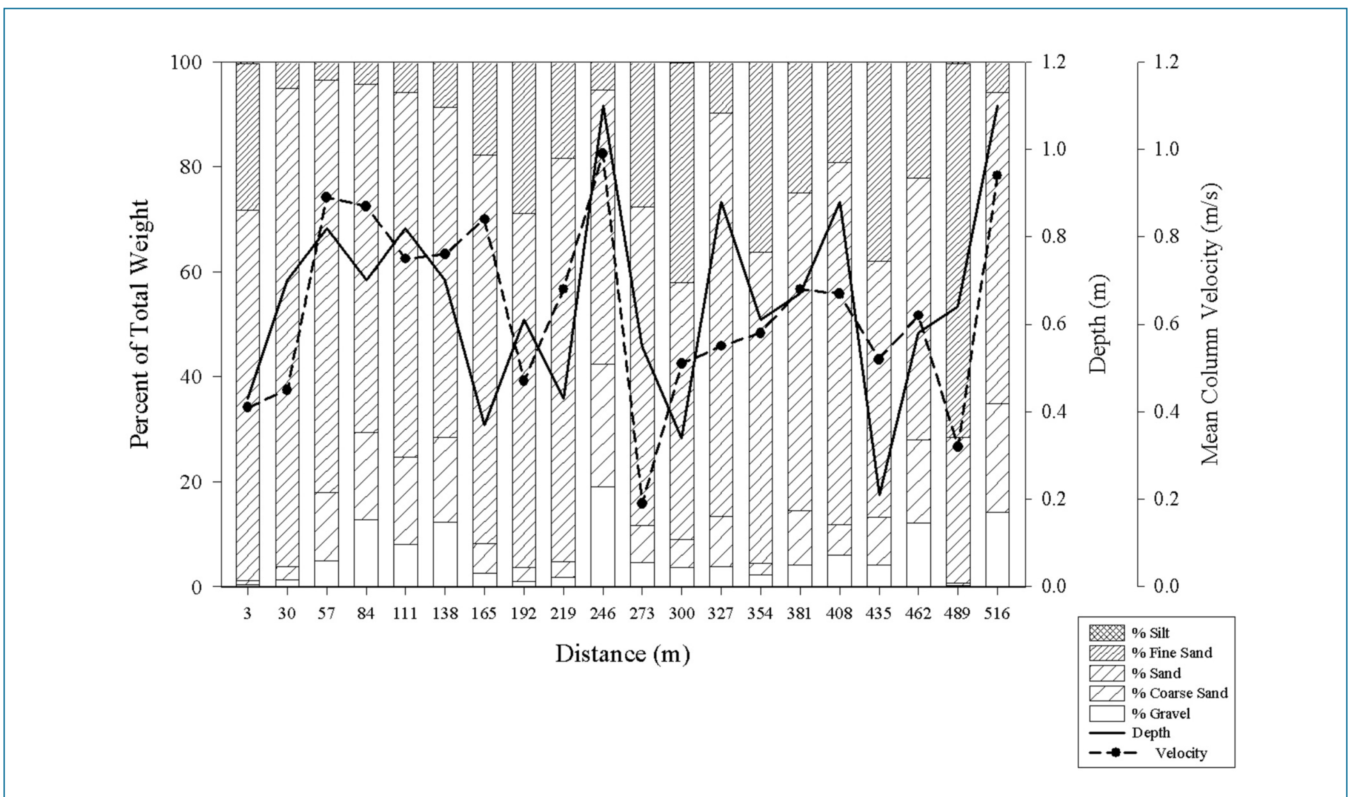

Figure 3.47. Percent substrate composition (silt, fine sand, sand, coarse sand, gravel) from core samples, depth and mean column velocities measured along a transect across the Platte River near Nebraska State Highway 50 Bridge March 17, 2004.

on a daily basis from November 1974 to September 1981. During this time period specific conductance readings varied from a low of 254µS/cm to a high of 3,450µS/cm. Our records at Louisville were well within this range. The high temperature recorded by USGS at Louisville was 36°C on 24 July 1977 (Hitch et al. 2003). Our daily temperature records are 38°C on 31 August and 1 September 2003. Suspended solids concentrations measured by USGS at Louisville ranged from 60 mg/L to 11,600 mg/L. Our highest suspended solids measurement was less than 3,800 mg/L during June 2004.

During the 2002 water year, USGS measured turbidity at the Louisville station ranging from 24 to 2,200 NTU, while our values for the same time period ranged from <50 to just over 1,000 NTU. Dissolved oxygen measurements by USGS ranged from 5.5 to 14.0 mg/L while ours ranged from 7.0 to 17.0 mg/L. The highest temperature reading recorded by USGS at Louisville during 2002 was 27.0°C on 27 July and our high was 31°C on 10 July. Specific conductance values measured by USGS at Louisville ranged from 410 to 1,990 µS/cm, while our values ranged from 400 to 1,200 µS/cm. Suspended solids concentrations measured by USGS ranged from 31 to 1,940 mg/L, while our measurements ranged from 17 to about 1,372 mg/L.

The Elkhorn River at Waterloo was sampled for a similar suite of water quality parameters during the 2002 water year. The highest water temperature measured by USGS at this station was 28°C on 10 July and our highest for this time period was 32°C on 20 July. Dissolved oxygen concentrations measured by USGS at Waterloo ranged from 1.5 to 14.3 mg/L, while our measurements ranged from 6.8 to 19.0 mg/L. Specific conductance measurements by USGS ranged from 286 to 668µS/cm, while ours ranged from 420 to 720µS/cm. Suspended solids measured by USGS ranged from 45 to 6,910 mg/L, while our measurements ranged from 16 to 1,808 mg/L for the same time period. Turbidity measurements by USGS ranged from 20 to 3,500 NTU, while our measurements ranged from 16.2 to 1,412 NTU.

Other accounts of water quality in the lower Platte River include Peters et al. (1989) who measured water temperature, dissolved oxygen, specific conductance and suspended solids while collecting data on fish and invertebrate habitat use in the reach of the lower Platte from Rogers to Fremont, Nebraska in 1986 and 1987. They measured water temperatures up to 32 °C during both years. Dissolved oxygen concentrations that they measured ranged from 2 to 14 mg/L. Specific conductance values in this reach of the Platte River ranged from 200 to 890µS/cm. However, in a related study Holland and Peters (1989) found a gradient in conductivity values from north to south across the Platte River. Typical conductivity values on the north were 315µS/cm and 550µS/cm on the south. They concluded that low conductivity water from the Loup River and Loup Power Canal were the source of low conductivity (283µS/cm) water that did not mix evenly with the higher conductivity water from the Platte River (922µS/cm) for up to 32 km downstream. A similar gradient may be established downstream from the confluence of Salt Creek with the Platte River near Ashland, but the volume of Salt Creek is considerably smaller than the Loup River. Monthly mean suspended solids concentrations were less than 500mg/L in the Rogers to Fremont reach, but reached 5,563 mg/L on 1 July 1986. Maximum concentrations exceeded 3,000mg/L in June 1986 and in May 1987.

Fessell (1996) found that only three of 19 fish species that he tested from the Platte River had mean critical thermal maxima that exceeded 38ºC. These were the plains topminnow, the plains killifish and the western mosquitofish . Species most closely related to sturgeon chub had mean critical thermal maxima of 35.2ºC for flathead chub, 35.5ºC for speckled chub, and 37.4ºC for silver chub. Recording temperature probe data indicate that maxima for flathead chub and shoal (speckled) chub may have been exceeded during July and August 2001, July and August 2002 and August and early September 2003 (Figures 3.6, 3.7, 3.8).

Yu (1996) evaluated the relationships between several chemical and physical parameters and habitat use by fishes in the lower Platte River. His analysis encompassed sites in the lower Platte River at Columbus, Rogers, North Bend, and Louisville during 1992 and 1993. In addition, he summarized habitat conditions for sampling done in the vicinity of North Bend from 1987 to 1993. Although most of the measurements for this data set are from sites upstream from the areas sampled in our 2001-2004 study, the values for maximum temperature, specific conductance, total suspended solids and dissolved oxygen fit within the ranges we found at the Platte River site near Leshara.

The substrate composition among the sites along the lower Platte River from North Bend to Louisville is quite consistent. The only significant differences indicated through the pairwise comparisons were between the Louisville site and the Leshara site for the coarse sand and fine sand fractions. However, substrate composition at the Elkhorn River site and the Salt Creek site differed significantly from the four Platte River sites on at least one substrate fraction.

The lower Platte River is a diverse complex of habitats that support species adapted to living in variable environments and several studies (Pflieger and Grace 1987, Cross and Moss 1987) have noted changes in species composition away from native species associated with stabilization of discharge and reductions in turbidity. To survive and prosper here they must be able to accommodate wide changes in temperature while they feed and reproduce in turbid conditions with fluctuating water levels. By many standards it is a harsh environment, but most of the native species have evolved under these conditions and they are apparently disadvantaged when changes in water management results in cooler, clearer water and stable discharge that favors non-native species.

Table 3.1. Average percent by weight for fractions of core samples retained by number 10, 18, 60, and 230 sieves, and the fraction passing through the number 230 sieve (<230) collected from the Elkhorn River at Waterloo, Salt Creek at Greenwood, and the Platte River at North Bend, Leshara, the US Highway 6 Bridge, and Louisville, Nebraska during the summer and fall of 2003 and the spring of 2004.

Location and screen mesh size	Summer 2003	Fall 2003	Spring 2004	Mean
Elkhorn River at Waterloo, NE				
10 mesh	2.754	2.795	2.239	2.596
18 mesh	2.366	3.196	3.425	3.329
60 mesh	54.359	57.768	62.018	58.048
230 mesh	39.310	35.897	30.024	35.077
<230 mesh	0.211	0.345	2.292	0.949
Salt Creek at Greenwood, NE				
10 mesh	6.408	1.748	2.851	3.669
18 mesh	9.127	6.485	7.006	7.539
60 mesh	76.633	68.338	79.901	74.957
230 mesh	7.815	12.132	5.833	8.593
<230 mesh	3.015	11.301	4.410	6.242
Platte River at North Bend, NE				
10 mesh	5.761	6.450	7.633	6.615
18 mesh	8.345	8.447	6.439	7.744
60 mesh	62.106	62.254	58.755	61.038
230 mesh	22.355	22.105	26.070	23.510
<230 mesh	1.431	0.744	1.103	1.093
Platte River at Leshara, NE				
10 mesh	4.813	6.835	4.127	5.258
18 mesh	6.492	8.310	5.885	6.896
60 mesh	49.180	55.974	56.988	54.047
230 mesh	36.464	26.347	30.454	31.088
<230 mesh	3.050	2.532	2.544	2.709
Platte River at US Highway 6				
10 mesh	5.177	4.963	6.665	5.602
18 mesh	6.932	7.466	9.603	8.000
60 mesh	63.772	60.515	59.649	61.312
230 mesh	22.430	25.209	21.797	23.145
<230 mesh	1.689	1.848	2.287	1.941
Platte River at Louisville, NE				
10 mesh	8.598	10.929	5.943	8.490
18 mesh	9.846	12.093	9.347	10.429
60 mesh	62.533	61.533	63.578	62.548
230 mesh	18.892	15.407	21.067	18.455
<230 mesh	0.131	0.036	0.065	0.077

Platte River Aerial

CHAPTER 4

HABITAT USE, MOVEMENT AND POPULATION CHARACTERISTICS OF PALLID STURGEON IN THE LOWER PLATTE RIVER

INTRODUCTION

Pallid sturgeon are typically grey colored hunch-backed fishes with five rows of bony scutes that have been found in the lower Mississippi River and Missouri River upstream to the Great Falls in Montana. Extensive sampling in the tributaries of the Missouri River basin has found populations of pallid sturgeon only in the Yellowstone, Kansas and Platte Rivers (USFWS 1993) and Cross and Collins (1995) state that it only enters the Kansas River during floods. However, tributary mouths have been characterized as an important habitat feature by several studies (Hurley1998, Sheehan et al. 1998). The earliest records of pallid sturgeon in Nebraska were from the Missouri River during the 1950's and the earliest record from the Platte River was from Sarpy County in 1979 (Darrell Feit; personal communication) but as Keenlyne (1989) pointed out, many fishery reports failed to distinguish between pallid and shovelnose sturgeon until the 1970's. Starting in January 2000, the NGPC began compiling pallid sturgeon catches in Nebraska (Darrell Feit; personal communication) including records from 1979, 1990, 1993, 1995 and 1997. This listing includes documented Heritage Data base reports from anglers and each report was subjectively evaluated for accuracy. Figures 4.1 and 4.2 indicate the locations of pallid sturgeon captured by anglers that were confirmed by Darrell Feit from the NGPC from the Platte River and the Elkhorn River prior to and during this study.

Historically, pallid sturgeon were more abundant in the main stem and major tributaries of the Missouri and Mississippi Rivers than they are currently. Forbes and Richardson (1905) estimated that pallid sturgeon comprised 1 in 5 river sturgeon collected in the lower Missouri River. Keenlyne (1989) reported that "correspondence and notes of researchers suggest that pallid sturgeon were still fairly common in many parts of the Mississippi and Missouri river systems as late as 1967". In 1990 the pallid sturgeon was listed as an endangered species by the US Fish and Wildlife Service (Federal Register 55 [September 6, 1990]: 36641-36647). Overfishing and modification of rivers for navigation, power production and agricultural water use are hypothesized to be responsible for the decline of pallid sturgeon (Kallemeyn 1983, USFWS 1993).

Since 1997 pallid sturgeon have been stocked in the Missouri River and Platte River to attempt to augment their recovery from endangered status (Krentz et al. 2005). In 1997, 401 pallid sturgeon were stocked into the Platte River at the Nebraska highway 50 Bridge. These fish were hatched in 1997 at the Blind Pony Fish Hatchery in Missouri and were tagged with external Floy tags at the base of their pectoral fins. In 1998, 84 age 6 pallid sturgeon, spawned at the Blind Pony Fish Hatchery in Missouri in 1992 were tagged with passive integrated transponder (PIT) tags and coded wire tags and released into the Platte River at Two Rivers State Recreation Area (RM 40). Ten of these fish were also implanted with radio transmitters. In 1999, 15 age 7 pallid sturgeon were PIT tagged, coded wire tagged and implanted with radio transmitters and released into the Platte River at Two Rivers State Recreation Area. These fish were monitored for movement and habitat use from April 1998 to May 2000 (Snook 2001), but none of these fish were collected during this study. From 1994 through 2004, 68,815 pallid sturgeon have been stocked into the section of the Missouri River which comprises Recovery Priority Management Area 4 that extends from Gavins Point Dam downstream to the mouth of the Missouri River. Of these, 20,622 were stocked in the Missouri River between Bellevue, NE (RM 601.4) and St. Helena, NE (RM 799) during the years 2002-2004 (Krentz et al. 2005).

The objective for this study was to study the juvenile and adult pallid sturgeon population in the lower Platte River, Nebraska. Efforts focused on three main areas of investigation.

- **First,** determine the habitat conditions that pallid sturgeon use and document the species which are associated with them in these habitats.
- **Second,** determine the movement patterns of pallid sturgeon into, within and out of the Platte River.
- **Third,** determine the characteristics of the pallid sturgeon population in the Platte River. This included an analysis of their age and growth, length weight relationship and morphometrics.

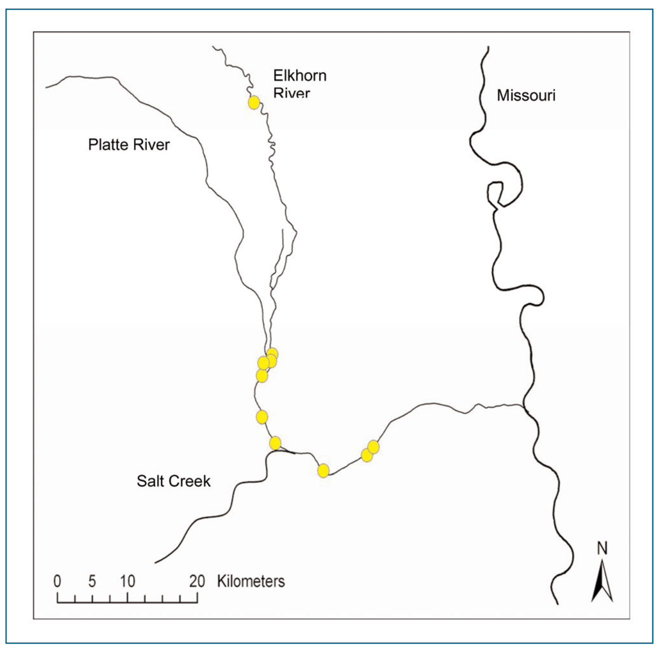

Figure 4.1. Locations of confirmed pallid sturgeon captures within the Platte River basin by anglers prior to this study (1979 – 2000).

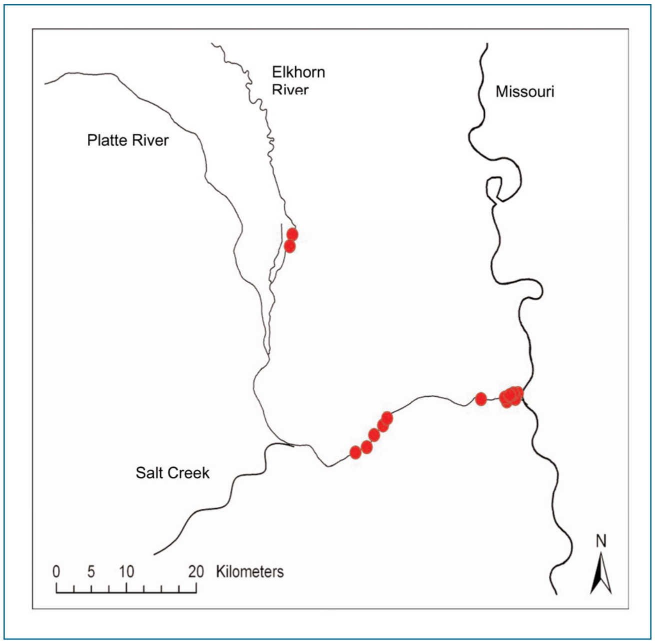

Figure 4.2. Locations of confirmed pallid sturgeon captures within the Platte River basin during this study (2001 – 2004).

METHODS

Sampling efforts for juvenile and adult pallid sturgeon used a variety of gears to sample as wide a range of habitats as possible in the lower Platte River. The gears used for pallid sturgeon were primarily, drifted gill nets, drifted trammel nets, trotlines, and trawls, but stationary gill nets, seines and minnow traps were also used. Detailed descriptions of the deployment and use of these gears is described in chapter 2 of this report.

When a Pallid sturgeon was captured, it was weighed, measured (fork length) and measured for morphometric analysis (Sheehan et al. 1999). All pallid sturgeon were tagged with a PIT tag if scanning showed that they did not already have one. Individuals that were large enough (>300 g) were implanted with a uniquely tuned radio transmitter tag, released in the vicinity of their capture and monitored from surface boats and aircraft on a regular basis. These methods are detailed in Chapter 2 of this report.

RESULTS AND DISCUSSION

A total of 15 pallid sturgeon were captured, 13 during this study and two fish, captured by the University of Nebraska Statewide stream fisheries inventory crew during their sampling of the lower Platte River. One specimen, captured on a trotline on 2 April 2004 was identified as a pallid sturgeon, but then it was lost before it could be measured. Habitat data were collected on the 13 fish from this study. The same habitat data were not collected on the 590 mm pallid sturgeon captured on 23 July 2004 by the Statewide inventory crew because they used different measurement methodologies. This fish was not scanned for a PIT tag. However, the 363 mm, 150 gram pallid sturgeon caught on September 25, 2004 was scanned for a PIT tag and the habitat where it was caught was measured according to the pallid sturgeon study protocol. This fish was tagged with PIT tag number 4311506852 and released. Pallid sturgeon were caught in drifted gill nets (1), drifted trammel nets (4), and with trotlines (10). Most of the captures occurred in the spring of the year with the most fish being captured in April (9) and May (4). Table 4.1 provides the time and capture locations of all pallid sturgeon captured during this study and includes two pallid sturgeon captured by the statewide stream fisheries inventory project on 23 July 2004 and 25 September 2004. The specimens identified as “wild” showed no evidence of any type of tag, but it is possible that a PIT tag may have been lost.

Radio implanted pallid sturgeon:

Pallid sturgeon 621, a female (880 mm, 2.45 kg), was captured on a trot line, implanted, tagged with PIT tag 115551734A, and released near Louisville, Nebraska at RM 16.2 on May 3, 2001 (Figure 4.3). Three days later (May 6, 2001) this fish was located 0.95 km downstream of the release site. Some local movement was observed, however the pallid remained within 0.25 km of this location from 6 May through 24 May. Between 3 May and 29 May, this fish moved at an average rate of 150 m/d, while from 29 May to June 9, 2001 it moved at an average downstream rate of 1,940 m/d. This pallid sturgeon resided in the Platte River a minimum of 37 days, entering the Missouri River on 9 June 2001. This fish was considered to be a wild fish as it showed no identification tags or markings upon capture.

Pallid sturgeon 721 (1,030 mm, 4.1 kg. sex unknown), was captured on 23 May 2002 in a drifted gill net 800 m upstream from the capture site of pallid sturgeon 621 (Figure 4.4). This fish was implanted, tagged with PIT tag 422D7E243F, and released at Louisville at RM 16.2 and located 14.8 km downstream of the release site five days later. This pallid sturgeon resided in the Platte River at least 8 days, entering the Missouri River on 30 May 2002. This fish moved downstream at an average rate of 3,250 m/d. This fish was likely a wild fish as it showed no identification tags or markings upon capture. General inspection during surgical implantation was unable to determine the sex of this fish. Because of the rapid downstream movement, it may have already spawned, but we were unable to confirm this.

Pallid sturgeon 542 (788 mm, 1.8 kg, sex unknown), was captured on a trotline, implanted, tagged with PIT tag 43114E287B, and released 3 April 2003 upstream of the mouth of the Platte River at RM 3.70 (Figure 4.5). This fish remained within 1 km of the release site until 23 April; however, by 27 April the fish had entered the Missouri River. In comparison with pallid sturgeon tracked during 2001 and 2002, fish 542 entered the Missouri River considerably earlier in the year. Early movement out of the Platte River was possibly influenced by increased spring 2003 water temperatures. During the second week in April of 2003 river temperatures exceeded 20°C. Temperatures in the Platte River during 2001 and 2002 did not exceed 20°C until the second week of May. This fish was likely a wild fish as it had no identification tags or markings upon capture.

Pallid sturgeon 291 (891 mm, 2.7 kg, sex unknown) was captured on April 8, 2004 on a trotline approximately 0.6 RM

Table 4.1. Capture information for pallid sturgeon caught by this study and by the Nebraska stream fisheries inventory (*) in the Platte River between 3 May 2001 and 25 September 2004.

Date Captured	Location	North GPS	West GPS	Method	Pit Tag #	Status
5/3/2001	0.5 miles downstream from Hwy 50	41.01268	96.15036	Trotline	115551734A	Wild
5/23/2002	0.5 mi upstream from Hwy 50	41.01027	96.1677	Gill net	422D7E243F	Wild
4/3/2003	1 mile upstream from Hwy 75	41.06188	95.95645	Trotline	43114E287B	Wild
4/2/2004	4 miles upstream from Hwy 75	41.0527	95.98572	Trotline	unknown	unknown
4/7/2004	near Schilling WMA	41.05292	95.88122	Trotline	444411282B	Stocked
4/8/2004	near Schilling WMA	41.05778	95.88575	Trotline	4262274C51	Stocked
4/8/2004	near Schilling WMA	41.0568	95.88419	Trotline	4311594D2B	Wild
4/13/2004	near Schilling WMA	41.05703	95.88486	Trotline	424E754E2A	Stocked
4/14/2004	near Schilling WMA	41.05743	95.89998	Trotline	431156624B	Wild
4/15/2004	1.25 miles downstream from Hwy 75	41.05693	95.90102	Trotline	4442685D64	Stocked
4/15/2004	1.25 miles downstream from Hwy 75	41.05693	95.90102	Trotline	43115B1A46	Wild
5/13/2004	near Cedar Creek, NE	41.05377	96.1018	Trammel net	44435F0919	Stocked
5/13/2004	near Cedar Creek, NE	41.05168	96.1082	Trammel net	44233E4D32	Stocked
7/23/2004*	2 miles upstream from Hwy 50	40.99528	96.2121	Trammel net	unknown	unknown
9/25/2004*	4 miles upstream from Hwy 75	41.05972	95.96324	Trammel net	4311506852	Wild

upstream from the mouth of the Platte River. It was implanted, tagged with PIT tag 4311594D2B, and released at that location (Figure 4.6). This fish was tracked on four different occasions before it entered the Missouri River. This fish was likely a wild fish as it showed no identification tags or markings upon capture.

Pallid sturgeon 910 (494 mm, 408g, sex unknown) was captured on 8 April 2004 on a trotline 0.6 RM upstream of the mouth of the Platte River and released at the site where it was captured. This pallid sturgeon (PIT tag number: 4262274C51) was hatched at Garrison National Fish Hatchery on 26 June 2001 and stocked at Boonville, MO (RM 195.1) on 3 April 2002. It was 200mm long when it was tagged. When we caught this fish on a trotline on 8 April 2004 near the mouth of the Platte River it had been at large for 736 days and had traveled a minimum of 399.9 miles. During that time it had grown 294mm in length. Since this fish was age 5 when it was captured its sex could not be determined. This fish was not located again after it was released.

Pallid sturgeon 260 (695 mm, 1.0 kg, sex unknown) was captured on 13 April 2004 on a trotline 0.72 RM upstream of the mouth of the Platte River and was released at this point (Figure 4.7). This pallid sturgeon was a recapture (PIT tag number: 424E754E2A) that had been stocked in the Missouri River at Boonville, Missouri (RM 195.1) on 25 April 2002. This fish had been at large for 719 days and had traveled a minimum of 400 miles before we caught it. It had been hatched on June 14, 1999 at the Gavins Point Fish Hatchery and it was 580mm long and weighed 860 grams when it was tagged. During its time at large this fish had grown 115mm in length and gained about 140 grams in weight. Since this fish was age 5 when captured it was an immature fish and its sex could not be determined. This fish was tracked one time before it entered the Missouri River two days after it was released.

Pallid sturgeon 931 (497 mm, 0.4 kg, sex unknown) was captured on 14 April 2004 on a trotline 0.8 RM upstream from the mouth of the Platte River, implanted, tagged with PIT tag 431156624B, and released at this point. This fish was not located after it was released. This fish had no PIT tags or other markings upon capture and was considered to be a wild fish.

Pallid sturgeon 231 (913 mm, 2.8 kg, sex unknown) was captured on 15 April 2004 on a trotline 0.9 RM upstream from the mouth of the Platte River (Figure 4.8). It was implanted, tagged with PIT tag 43115B1A46, and released at this point. This fish was located once and followed to the Missouri River on the same day that it was released. This fish had no PIT tags or other markings upon capture and was considered to be a wild fish.

All the pallid sturgeon implanted during April 2004 apparently moved out of the Platte River by 15 April 2004 during the time when a back-flushing operation at the Metropolitan Utilities District (MUD) water treatment plant released a white material into the river.

Recaptures of PIT tagged fish:

The pallid sturgeon recovery effort within RPMA 4 includes the stocking of hatchery reared individuals into the Missouri River and Platte River. During this study six PIT tagged pallid sturgeon were captured and their tag numbers were traced to specific hatchery sources, stocking locations and dates using the US Fish and Wildlife Service database. Two of these individuals were large enough to implant with radio transmitters and they are described in the previous section, but four were too small to implant with radio transmitters. These "recaptures" are described individually here.

The pallid sturgeon with PIT tag number 444411282B was hatched at Gavins Point National Fish Hatchery on 22 June 2002 and stocked at Bellevue, NE (RM 601.4) on 4 September 2003. It was 304 mm in length and weighed 118 grams when it was tagged. When this fish was caught on 7 April 2004 on a trotline at the mouth of the Platte River it was 333mm long and weighed 112g. This fish had been at large for 216 days and was caught about 7 miles from its point of stocking. During that time it had grown 29mm in length and lost 6g in weight.

The pallid sturgeon with PIT tag number: 4442685D64 was hatched at Gavins Point National Fish Hatchery on 22 June 2002 and stocked at Bellevue, NE (RM 601.4) on 4 September 2003. It was 251mm long and weighed 63g when it was tagged. When this fish was caught on 15 April 2004 on a trotline in the Platte River (RM 1.3) it was 284mm long and weighed 100g. This fish had been at large for 224 days and had traveled a minimum of 8.2 miles from where it was stocked before it was caught During that time it had grown 33mm in length and gained 37g in weight.

The pallid sturgeon with PIT tag number 44233E4D32 was hatched at Gavins Point National Fish National Hatchery on 22 June 2002 and stocked at Bellevue, NE (RM 601.4) on 4 September 2003. It was 287mm long and weighed 101g when it was tagged. When this fish was caught on 13 May 2004 in a trammel net run in the Platte River near Cedar Creek (RM 12.5) it was 329mm long and weighed 120grams. This fish had been at large for 252 days and had traveled a minimum of 19.4 miles before it was caught. During that time it had grown 42mm in length and gained 19g in weight.

The pallid sturgeon with PIT tag number 44435F0919 was hatched at Gavins Point National Fish Hatchery on 22 June 2002 and stocked at Bellevue, NE (RM 601.4) on 4 September 2003. It was 299mm long and weighed 105g when it was tagged. When this fish was caught on 13 May 2004 in a trammel net run in the Platte River near Cedar Creek (RM 12) it was 334mm long and weighed 119grams. This fish had been at large for 252 days and had traveled a minimum of 19.4 miles before it was caught. During that time it had grown 35mm in length and gained 15g in weight.

Habitat at capture locations:

In general, pallid sturgeon were most frequently captured in the deepest and swiftest runs of the river (Table 4.2). The depth averaged almost 1.6 m and the mean column current velocities approached 0.8 m/s. Within these areas of swift, deep water, pallid sturgeon were using bottom velocities similar to those found throughout the river. These values were above the average depths and velocities sampled by any gear type which suggests that shallow, slow moving water is not commonly selected habitat for pallid sturgeon in the lower Platte River. While these depths are not considered deep for the Missouri River, over 90% of the lower Platte River is less that 60 cm deep with an average depth of 26 cm (Peters et al. 1989). While pallid sturgeon captures were not observed in as close proximity to sandbar ledges or underwater dunes as shovelnose sturgeon, the deep runs where we captured most of the pallid sturgeon typically had a wide range of instream habitats (shallow and exposed sandbars) within 50 to 100 m of the capture locations. The overall catch rate improved substantially in 2004 (12 of the 15 fish captured) when the deepest, swiftest flow areas were targeted during sampling.

Our capture of pallid sturgeon began after the water temperature reached approximately 10 °C and stopped after it reached 17 °C (Table 4.3). Pallid sturgeon were captured in water with relatively high dissolved oxygen, high conductivity readings and a range of turbidities. These water quality variables may reflect the spring time water conditions when pallid sturgeon are moving in the Platte River or may be actively selected by the fish. At this time it is not possible to differentiate from the data gathered.

Habitat Analysis (DRIFTED GILL NETS AND TRAMMEL NETS):

Pallid sturgeon were captured in 5 of the 536 nets. Drifted gill nets and trammel nets captured pallid sturgeon at an average depth of 1.04 m, an average mean column velocity of 0.63 m/s, and an average bottom velocity of 0.37 m/s over a substrate composed primarily of sand (Table 4.2). Water temperature averaged 17.8ºC, dissolved oxygen averaged 10.1 mg/L, specific conductivity averaged 589 uS/cm and suspended solids averaged 235.5 mg/L (Table 4.3).

For statistical comparisons of pallid sturgeon habitat use, the distribution of the data within the habitat variables was not normal for any of the variables measured so the data were rank transformed. Differences between the mean habitat for

Table 4.3. Water quality data measured in association with pallid sturgeon captures (*) denotes specimens caught by the Nebraska Stream Fishery Inventory study.

Collection Method	PIT tag number	Date captured	Average Depth (m)	Average Mean Velocity (m/s)	Average Bottom Velocity (m/s)
Trotline	115551734A	5/3/2001	1.46	1.02	0.54
Trotline	43114E287B	4/3/2003	1.52	0.63	0.21
Trotline	unknown	4/2/2004	1.74	0.85	0.38
Trotline	444411282B	4/7/2004	1.63	0.99	0.37
Trotline	4262274C51	4/8/2004	2.22	1.21	0.38
Trotline	4311594D2B	4/8/2004	1.68	1.08	0.17
Trotline	424E754E2A	4/13/2004	2.42	0.37	0.29
Trotline	431156624B	4/14/2004	1.79	0.71	0.35
Trotline	4442685D64	4/15/2004	1.71	0.85	0.34
Trotline	43115B1A46	4/15/2004	1.71	0.85	0.34
Gill net	422D7E243F	5/23/2002	0.39	0.50	0.23
Trammel net	44435F0919	5/13/2004	1.51	0.74	0.46
Trammel net	44233E4D32	5/13/2004	1.92	0.76	0.17
Trammel net	unknown	7/23/2004*			
Trammel net	4311506852	9/25/2004*	0.36	0.52	0.40
		Average	1.58	0.79	0.33

nets catching pallid sturgeon and in nets not containing pallid sturgeon using Mann-Whitney t-test on ranks were not observed for the variables of depth ($p = 0.98$), mean column velocity ($p = 0.56$), bottom velocity ($p = 0.90$), dissolved oxygen ($p = 0.44$), specific conductivity ($p = 0.74$), total suspended solids ($p = 0.94$) or daily mean discharge ($p = 0.95$). The only variable to show a difference in use was temperature ($p = 0.02$). The pairwise comparisons showed that nets where fish were caught had lower median temperatures (median = 13.4 °C) than either all nets (median = 24.6 °C) or nets without pallid sturgeon (median = 24.6 °C). There was no statistical difference between depths measured in all nets and nets without pallid sturgeon. The results of these analyses must be interpreted cautiously due to the low sample size for pallid sturgeon.

Habitat Analysis (TROTLINES):

Trotlines proved to be our most effective gear for catching pallid sturgeon with 10 of the 15 fish captured coming from trotline sets. The majority of the pallid sturgeon caught on trotlines were captured in the lower 10 km of the river, early in the year, on trotlines set in deep swift waters. The trotlines captured all sizes of both wild and stocked pallid sturgeon. In the spring of 2004, we specifically targeted the deepest and swiftest waters in the mouth of the Platte River and captured 9 pallid sturgeon as a result.

Pallid sturgeon were captured in 9 of the 223 trotlines set in the Platte River. Trotlines captured pallid sturgeon at an average depth of 1.8 m, an average mean column velocity of 0.86 m/s and an average bottom velocity of 0.34 m/s over a substrate composed primarily of sand (Table 4.2). Water temperature averaged 14.6ºC, dissolved oxygen averaged 11.9 mg/l, specific conductivity averaged 496.8 uS/cm and suspended solids averaged 145.7 mg/L (Table 4.3). The data for the habitat variables for depth, temperature, dissolved oxygen, specific conductivity, total suspended solids, and discharge were not normally distributed, so the data were rank transformed for statistical comparisons of pallid sturgeon habitat use. Mean column and bottom velocity data were normally distributed, and therefore, not transformed. Differences between the mean habitat for trotlines which caught pallid sturgeons and trotlines not containing pallid sturgeons using Mann-Whitney t-test on ranks (or t-test on non-transformed data) were observed for depth ($p = 0.02$), but not for the other variables (mean column velocity $p = 0.12$, bottom velocity $p = 0.84$, temperature $p = 0.66$, dissolved oxygen $p = 0.35$, specific conductivity $p = 0.85$, total suspended solids $p = 0.82$ or daily mean discharge $p = 0.26$). The pairwise comparisons for depth showed that trotlines where fish were caught were deeper (median = 1.7 m) than either all nets (median = 1.3 m) or nets without pallid sturgeon (median = 1.3 m). The results of this analysis must be interpreted cautiously due to the low sample size for pallid sturgeon.

Water depth seems to be the most widely measured variable recorded for catches of pallid sturgeon in published reports. Clancey (1990) caught pallid sturgeon from the tail race of Fort Peck reservoir on the Missouri river at depths ranging from 1.2 to 3.7m. Watson and Stewart (1991) caught them from the Missouri and Yellowstone Rivers at depths between 0.6 and 14.5m, while Constant et al. (1997) caught them at an average depth of 15.2m from a constructed channel of the Atchafalaya River in Louisiana. In the lower Mississippi River pallid sturgeon are typically caught on trotlines in water 50 to 75 feet deep. By comparison, pallid sturgeon in the Platte River are captured in water depths at the lower end of those measured by other studies.

Velocity measurements associated with pallid sturgeon captures are relatively uncommon. Clancey(1990) measured mean column velocities ranging from 0.46 to 0.96m/s where pallid sturgeon were caught in the Fort Peck reservoir tail race. This range matches well with velocities where pallid sturgeon were caught in the Platte River. Other studies use descriptors ranging from swift to slow to describe the habitats of capture. This may be due to the difficulty of getting accurate measurements of velocity in areas that are deep and often swift.

Specific assessments of other habitat variables at the times when pallid sturgeon were collected are sparse and are generally expressed in descriptive terms. Sandy substrates and turbid water are the two most frequently mentioned characteristics. The values measured in association with Platte River collections agree with these conditions. Based on our experience catching pallid sturgeon, we think that water velocity is a primary factor in determining what habitat that they use once sufficient water depth and turbidity are factored into the matrix of conditions. The pallid sturgeon's selection for sandy substrates is probably related to their turbidity selection. Chemical and physical requirements for pallid sturgeon have not been sufficiently elucidated to assess where the conditions we encountered in the Platte River fit into a quality environment for this species.

Habitat use (Radio Telemetry):

The data gathered from random daily measurements around radio tagged pallid sturgeon provide a picture similar to the capture data (Tables 4.4 to 4.7). The fish were found in deep, swift water although the average depth observed was slightly shallower than that where the pallid sturgeon were captured(1.27 m as compared to 1.6 m). The habitats used by

Table 4.4. Habitat variables measured in association with pallid sturgeon during random daily telemetry contacts.

Fish	Date	Average depth (m)	Average mean velocity (m/s)	Average bottom velocity (m/s)	Average % Silt	Average % sand	Average % gravel	Presence of ledges	Presence of dunes	Daily mean discharge (CFS)
621	5/4/2001	1.83	1.14	0.59	0	100	0			16000
621	5/6/2001	1.49	0.76	0.54	0	100	0			31500
621	5/9/2001	1.24	0.62	0.35	0	100	0			23700
621	5/14/2001	1.40	0.76	0.54	0	100	0			13300
621	5/15/2001	0.90	0.84	0.52	26	74	0			11700
621	5/22/2001	1.00	0.75	0.57	0	100	0			12500
621	5/24/2001	1.81	0.96	0.61	0	100	0			8460
621	6/1/2001	0.96	0.78	0.59	0	100	0			11600
621	6/5/2001	0.98	0.88	0.68	0	100	0			8100
621	6/7/2001	0.73	0.76	0.46	0	100	0			8129
721	5/29/2002	1.19	0.82	0.51	0	100	0	No	Yes	7480
542	4/4/2003	1.35	0.78	0.44	0	100	0	Yes	No	7200
542	4/5/2003	1.18								7520
542	4/7/2003	0.78	0.70	0.57	0	100	0	No	No	6020
542	4/8/2003	1.20	0.99	0.48	0	100	0	No	No	5810
542	4/9/2003	1.07	0.77	0.46	0	100	0	No	Yes	6810
542	4/10/2003	0.89	0.79	0.45	0	100	0	No	Yes	6720
542	4/13/2003	0.91	0.65	0.22	0	100	0	No	Yes	7220
542	4/14/2003	1.96	1.11		0	100	0		Yes	7600
542	4/15/2003	0.62	0.40	0.26	0	100	0	Yes	Yes	9300
542	4/17/2003	1.18	0.71	0.41				No	Yes	7230
542	4/21/2003	0.62	0.58	0.30				No	Yes	6600
542	4/22/2003	1.11	0.75	0.06				Yes	Yes	6610
542	4/23/2003	0.79	0.65	0.14	0	100	0	No	Yes	6340
542	4/24/2003	1.35	1.02	0.53	0	100	0	No	No	6190
542	4/25/2003	0.84	0.71	0.42	0	100	0	No	Yes	5960
542	4/26/2003	1.51	0.86	0.48	0	100	0	No	Yes	5810

Table 4.4 (continued)

Fish	Date	Average depth (m)	Average mean velocity (m/s)	Average bottom velocity (m/s)	Average % Silt	Average % sand	Average % gravel	Presence of ledges	Presence of dunes	Daily mean discharge (CFS)
291	4/12/2004	1.11	0.61	0.40	0	100	0	No	Yes	4360
291	4/13/2004	1.47	0.78	0.30	0	100	0	No	Yes	4460
260	4/14/2004	1.13	0.52	0.21	0	100	0	No	No	4890
291	4/14/2004	1.16	0.95	0.53	0	100	0	No	No	4890
231	4/15/2004	1.74	0.73	0.44	0	100	0	No	Yes	4620

Table 4.5. Individual and combined average habitat variables measured in association with pallid sturgeon during daily random telemetry contacts.

Fish	Average depth (m)	Average mean velocity (m/s)	Average bottom velocity (m/s)	Average % Silt	Average % sand	Average % gravel	Daily mean discharge (CFS)
231	1.74	0.73	0.44	0	100	0	4620
260	1.13	0.52	0.21	0	100	0	4890
291	1.25	0.78	0.41	0	100	0	4570
542	1.08	0.76	0.37	0	100	0	6809
621	1.23	0.82	0.55	2.6	97.4	0	14499
721	1.19	0.82	0.51	0	100	0	7480
Average	1.27	0.74	0.41	0.4	99.6	0	7145

pallid sturgeon fit in the deep water, swift current velocity spatial niche (Hardy and Associates 1992). Pallid sturgeon were generally found over sand substrate and were observed within 10m of a sandbar ledge 15% of the time and among underwater dunes 76% of the time.

Pallid sturgeon are fish of large turbid rivers (Cross and Collins 1995, Bailey and Allum 1962, Lee et al.1980). Bramblett and White (2001) found them most regularly in river reaches with frequent islands and sand bars. This fits well with our observations. Hurley (1998) found them at the mouths of tributaries and Snook et al. (2002) found them at the downstream end of sand bars where currents converge. Depth of water used by telemetry located pallid sturgeon range from less than 1 m (Bramblett and White 2001, Snook et al. 2002) to 12 m (Hurley 1998). Depth use in the Platte River is undoubtedly truncated by availability of deeper water, but we found that pallid sturgeon used deeper water at rates higher than expected by chance. Bottom velocity use ranged from 0 to 0.97m/s (Bramblett and White 2001 and Snook et al. 2002). Our observations of bottom velocity fit comfortably with these previous observations.

Pallid sturgeon tolerate temperatures from 0 to 33ºC, but no specific thermal tolerances have been published. Our permits required us to limit our sampling for pallid sturgeon to times when water temperatures were below 17ºC, but water temperatures of up to 24.9ºC were measured when a specimen was caught on 23 July 2004 and also during a telemetry survey on 15 May 2001. Bailey and Cross (1954) and Erickson (1992) state that pallid sturgeon avoid areas that are not turbid. Average total suspended solids during our study ranged from 86 to 1,172 mg/L which agrees with these general statements. Very little is known about pallid sturgeon tolerances for most water chemistry parameters, but the Missouri River and its western tributaries are generally high in dissolved solids and maintain acceptable dissolved oxygen concentrations (Galat et al. 2005a). The Platte River where pallid sturgeon were found seems to fit those standards. However, as noted local water quality problems may arise when back flushing of water treatment facilities occurs.

ASSOCIATED SPECIES:

Six species of fish were captured in the same gear along with pallid sturgeon during this study. Shovelnose sturgeon were captured on 12 of the 14 occasions when pallid sturgeon were captured. Shovelnose sturgeon were captured on 8 of the 9 trotline sets, in 1 of the 1gill nets and in 3 of the 4 trammel nets which captured pallid sturgeon. Only trammel nets caught additional fish species with pallid sturgeon. Goldeye and blue sucker were caught in 2 of 4 nets that also caught pallid sturgeon. Shortnose gar, grass carp and river carpsucker were caught in 1 of 4 nets that also caught pallid sturgeon.

MOVEMENT:

Of the 15 pallid sturgeon, only eight were large enough to be implanted with a radio transmitter. Two of these fish that we radio tagged were previously PIT tagged, indicating to us that they were hatchery reared fish. Radio tagged pallid sturgeon were located seven times from the air and 42 times from the airboat (Table 4.8). Figures 4.3-4.8 summarize the movements of the pallid sturgeon which we were able to locate via telemetry after they were implanted with transmitters and released. The female (Fish 621) was carrying eggs when it was captured on 3 May 2001 (Figure 4.4). Since this fish remained near Louisville (RM 15.5) for nearly a month before rapidly moving downstream it is tempting to assume that it was in the Platte River to spawn.

Table 4.6. Water quality variables measured in association with pallid sturgeon during random daily telemetry contacts.

Fish	Date	Water Temp (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	Total Suspended Solids (mg/L)
621	5/4/2001	14.8	8.74	510	876
621	5/6/2001	18.2	7.54	444	1208
621	5/9/2001	19.1	8.12	504	1228
621	5/14/2001	24.0	8.41	534	466
621	5/15/2001	24.9	8.75	549	432
621	5/17/2001	24.7	8.19	610	838
621	5/22/2001	15.8	12.22	528	574
621	5/24/2001	13.2	9.65	670	270
621	6/1/2001	16.1	8.80	514	503
621	6/5/2001	16.8	9.82	675	198
621	6/7/2001	18.5	7.80	621	445
721	5/29/2002	22.0	6.71	523	1172
542	4/4/2003	9.1	9.85	641	231
542	4/5/2003	7.9	10.34	582	236
542	4/7/2003	3.5	12.20	655	213
542	4/8/2003	6.5	11.46	510	305
542	4/9/2003	7.7	11.58	500	244
542	4/10/2003	9.8	10.70	559	236
542	4/13/2003	17.6	10.50	616	
542	4/14/2003	20.9	14.51	552	167
542	4/15/2003	20.2	10.67	548	156
542	4/16/2003	19.1	15.90	565	152
542	4/17/2003	13.2	11.54	701	168
542	4/21/2003	14.2	10.93	644	238
542	4/22/2003	15.1	12.28	474	226
542	4/23/2003	15.0	11.07	573	159
542	4/24/2003	12.7	11.81	712	192
542	4/25/2003	12.9	10.32	620	76
542	4/26/2003	16.1	11.05	645	74
291	4/12/2004	10.1	18.41	640	
291	4/13/2004	9.4	12.21	589	101
260	4/14/2004	14.3	12.48	655	114
291	4/14/2004	14.3	12.48	655	114
231	4/15/2004	15.0	12.47	584	86

Table 4.7. Individual and combined average water quality variables measured in association with pallid sturgeon during daily random telemetry contacts.

Fish	Water Temp (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	Total Suspended Solids (mg/L)
231	15.0	12.47	584	86
260	14.3	12.48	655	114
291	11.3	14.37	628	108
542	13.0	11.57	594	192
621	18.7	8.91	560	640
721	22.0	6.71	523	1172
Average	15.7	11.09	591	385

Table 4.8. Number of pallid sturgeon locations in the Platte River, Nebraska by survey method and year from 2000 to 2004.

Common Name	Survey Method	2000	2001	2002	2003	2004	Total Number of Locations
Pallid Sturgeon	Boat	2	11	7	17	5	42
Pallid Sturgeon	Plane	-	3	1	2	1	7
	Total	2	14	8	19	6	49

Unfortunately, we have no direct confirmation of spawning by this fish. However, larval sturgeon were captured in samples collected on 23 May 2001 at RM 27.9. This was just prior to the time when fish 621 started moving downstream. Fish 721 (Figure 4.5) may have been a spent female, because no eggs were detected when it was implanted with the transmitter at RM 15.5 on 23 May 2002. This fish moved downstream between each telemetry location and exited the Platte River on 30 May 2002. It is also tempting to interpret this fish's movements as post-spawning because a larval sturgeon was captured at RM 27.9 on 21 May 2002. Again there is no direct confirmation of this hypothesis. Fish 542 (Figure 4.6) was the only other pallid sturgeon which was detected in the Platte River for more than a couple of days. It was captured on 3 April 2003 and was last detected in the Platte River on 27 April 2003. During most of that time it remained near the location it was captured at about RM 3.0 before moving to the mouth of the Platte River. No sturgeon larvae were captured during the time when this fish was detected in the Platte River.

Of the seven pallid sturgeon that were not implanted with radio transmitters, four already carried either PIT tags, one escaped before it could be handled, one was captured by a crew that did not have authorization to implant a telemetry tag, and one showed no evidence of being tagged, but was too small to implant. The pallid sturgeon captured by the Nebraska stream inventory crew in a trammel net at River Mile 20 on 23 July 2004 was not scanned for tags. This fish was 590mm in length and was released at the same location as it was caught. The final small pallid sturgeon that was caught on 25 September 2004 carried no tags when it was caught in a trammel net at RM 4.5, and was presumed to be a wild fish. This fish was 363mm in length and weighed 150g. It was PIT tagged (4311506852) and released at the same location as it was caught.

PALLID STURGEON MOVEMENT DISCUSSION:

Pallid sturgeon that use the Platte River appear to be mobile animals. Up to the year 2004 evidence pointed toward a conclusion that they may only be using the Platte River during the spring and early summer. This would agree with observations by Bramblett and White (2001) who found that pallid sturgeon moved upstream into the Yellowstone River from the Missouri River in the spring and downstream again later in the year. However, in 2004 one juvenile size pallid sturgeon was captured in the Platte River in July and another during September. Snook (2001) noted that two of the pallid sturgeon he was tracking during 1999 moved upstream during late September. Hofpar (1997) recorded similar movements in shovelnose sturgeon in the Platte River during the fall of 1996. Our small sample size limits our

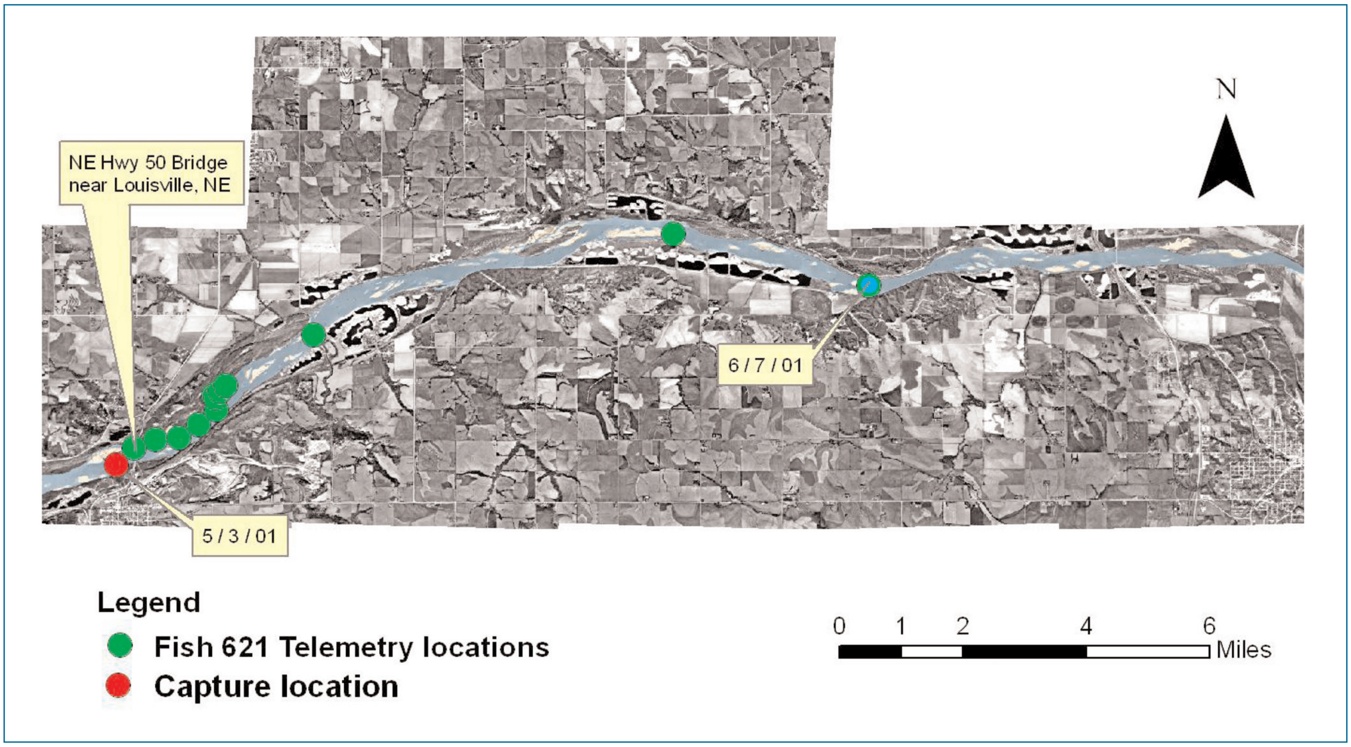

Figure 4.3. Capture and telemetry locations of pallid sturgeon #621 during May and June of 2001.

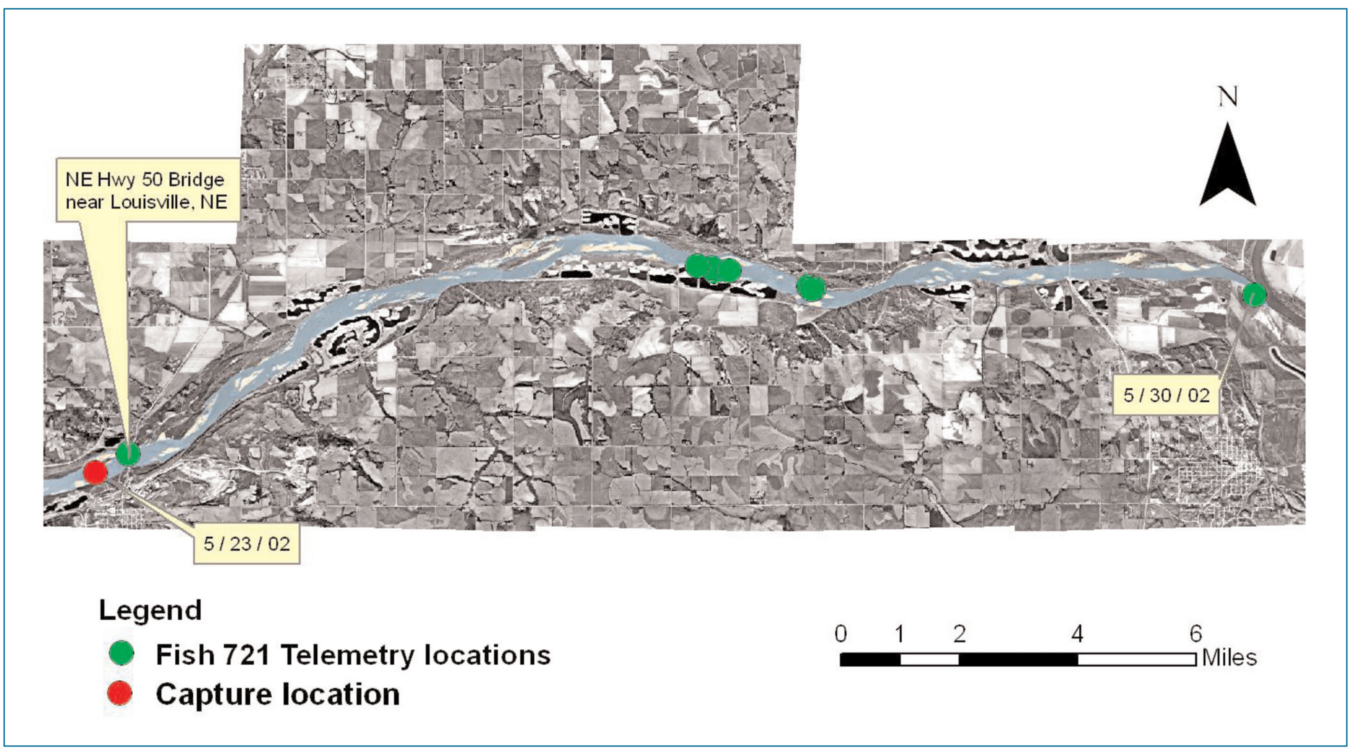

Figure 4.4. Capture and telemetry locations of pallid sturgeon #721 during May of 2002.

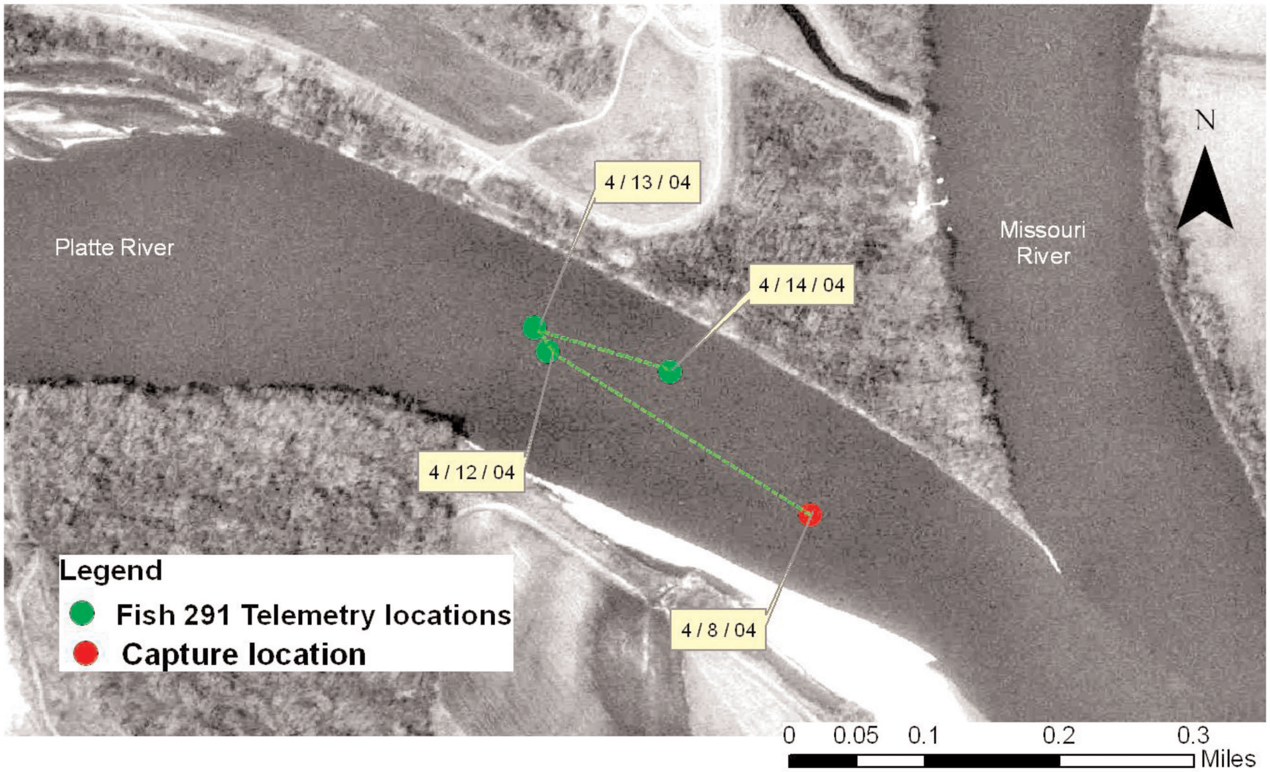

Figure 4.6. Capture and telemetry locations of pallid sturgeon #291 during April of 2004.

ability to make definitive statements about the number of pallid sturgeon that use the Platte River, but the fact that we caught pallid sturgeon during spring, summer and fall months of the year indicates to us that the lower Platte River is an important part of RPMA 4 (USFWS 1993), which includes all of the Missouri River downstream from Gavins Point Dam to its confluence with the Mississippi River (approximately 800 river miles).

The pallid sturgeon that carried PIT tags gave us some insights to the distances that this species travels. Four of the tagged fish had only traveled a short distance from Bellevue, NE (7-20 miles) but two of the fish we captured had traveled over 400 miles upstream from Boonville, MO to reach the Platte River. The distances moved and survival duration for pallid sturgeon provides support for two conclusions. First, pallid sturgeon stocked into the Missouri River are surviving and growing and that they do travel up tributary rivers. Second, the capture of six pallid sturgeon that were stocked into the Missouri River suggests that conditions in the Platte River are attractive to stocked pallid sturgeon. We captured 6 hatchery reared pallid sturgeon during 2004 while Krentz et al. (2005) recorded a total of 91 recaptures from all of RPMA 4. That works out to 1 recapture / 2.1 miles of river in the Platte River and 1 recapture / 8.8 miles of river in the Missouri River.

Bramblett and White (2001) reported that movement rates in the Yellowstone and Missouri rivers were highest in the spring (March 20–June 20) and lowest during the winter (21 December–19 March) for both shovelnose and pallid sturgeon. In addition, they speculated that long-range spring and summer movements by both species were associated with spawning activities. Although the pallid sturgeon in the Platte River were not tracked outside of spring months, our data support this theory. Following synchronized long-distance upstream movements by shovelnose tracked in 2001 and 2002, these radio-tagged fish were relatively sedentary between 18 May and 13 June 2001 and 14- 28 May 2002. Collection of day-old larval Scaphirhynchus at RM 27.8 on 23 May 2001 and 21 May 2002 coincided with these dates. Water temperatures during sedentary periods ranged from 17.2 to 21.6°C (2001) and from 15.2 to 25.1ºC (2002); encompassing reported temperatures for Scaphirhynchus reproduction (Moos 1978). Given this combination of evidence, reproduction by Scaphirhynchus sturgeon in the Platte River likely takes place between mid-May and early June.

Pallid sturgeon activity in the Platte River may also be attributable to reproduction. During spring months pallid sturgeon moved downstream in coordinated patterns, exhibited spring sedentary phases similar to shovelnose sturgeon, and one pallid sturgeon (fish 621) carried late-stage eggs. Although pallid sturgeon reproduction in the Platte River cannot be confirmed, additional efforts should continue to substantiate this speculation.

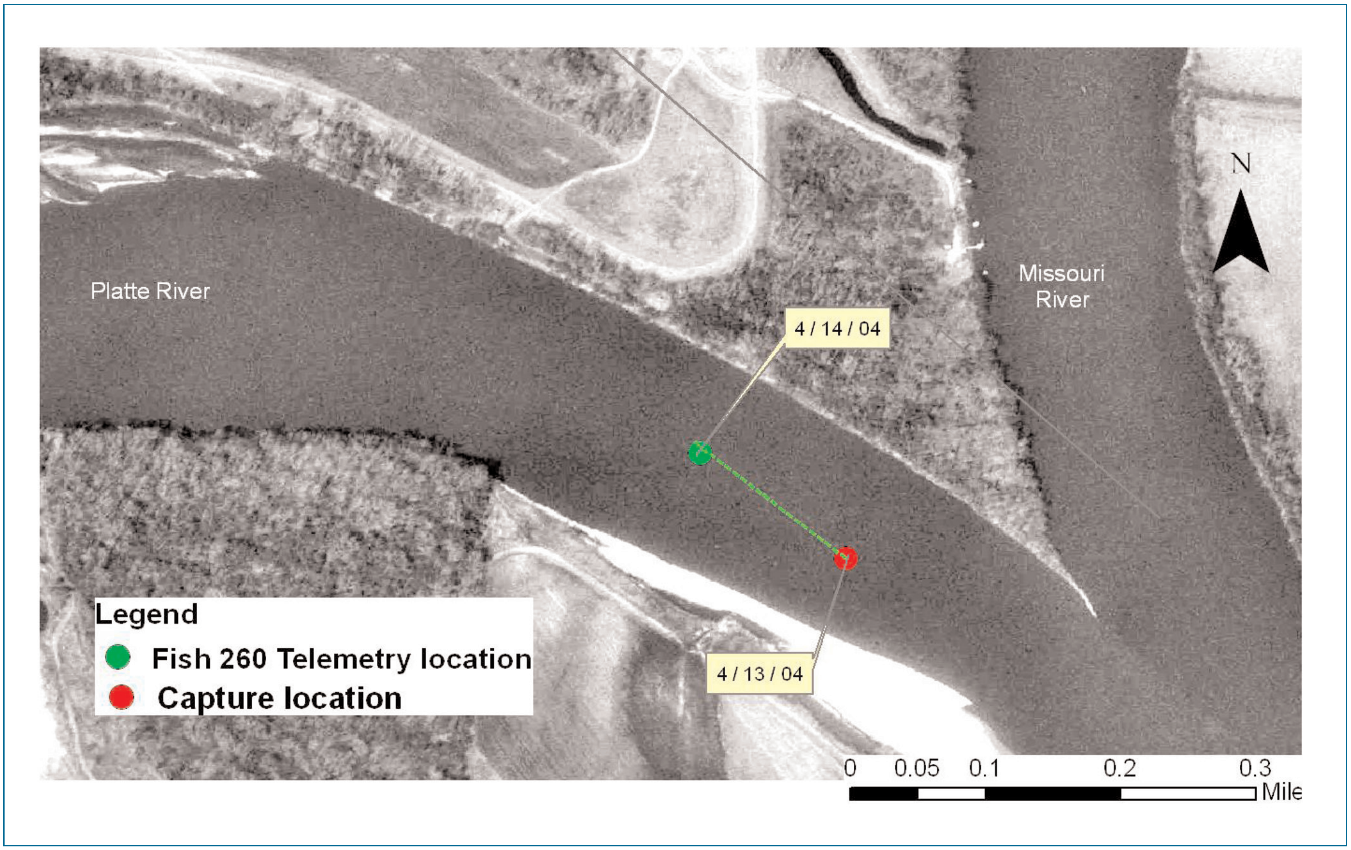

Figure 4.7. Capture and telemetry locations of pallid sturgeon #260 during April of 2004.

None of the implanted pallid sturgeon was detected moving out of the Platte River in one year and then returning into the Platte River the next year. However, this is not unexpected if they had spawned during the year when we caught them we would not expect them to return for as long as10 years to reproduce again (Keenlyne and Jenkins 1993). During the 5-year study no confirmed pallid sturgeon eggs or larval fish were sampled in the Platte River. However, as noted above Scaphirhynchus larvae were sampled.

AGE AND GROWTH:

We were not able to determine the age of pallid sturgeon captured during this study because our Endangered Species permit did not allow that. However, there were six PIT tagged pallid sturgeon caught during this study for which we have information about their age and the size at which they were released (Table 4.9). From this information we can reconstruct some growth histories and make some inferences about the growth of pallid sturgeon in the lower Platte River and adjoining portions of the Missouri River. The four fish that were at large only from age 1 to age 2 were really in the wild for about seven months through the autumn, winter and early spring and their average growth of 34.75mm reflects this short interval. Fish 910 was at large for two years, from age 1 to age 3 and grew 294mm in length. Fish 260 was released at age 3 and recaptured at age 5 during which time it grew 115mm. Fogle (1963) found that pallid sturgeon growth was rapid at first, but slowed to about 70 mm per year by age 5. This pattern seems to be holding for the PIT tagged fish we captured in the Platte River.

Although we have no specific documentation of age for the fish in which we found no PIT tags, if we use the value of 70mm/year (Fogle 1963) as an upper limit we can predict their ages. Based on these assumptions, fish 621 would be approximately age 7 or 8, fish 721 age 10 or 11, fish 542 age 6 or 7, fish 291 age 7 or 8, fish 231 age 8 or 9. The smaller untagged fish captured on 25 September 2004 is estimated to be age 2 and the 590mm fish caught on 23 July 2004 is estimated to be age 3.

Pallid sturgeon are long lived fishes. As a result of this and the fact that most of their skeletons are cartilaginous, determination of growth rates has been challenging (Morrow et al. 1998). Helms (1973), working in the Mississippi River and Fogle (1963) working in the Missouri River, found large variations in length at age for shovelnose sturgeon. Determining the age of pallid sturgeon has been limited by endangered species regulations designed to protect the species from undue stress. Hurley (1998) used hatchery reared pallid sturgeon to document the age determination by use of pectoral fin rays and found that most readings were 3 years off.

LENGTH / WEIGHT:

During the 5 years of sampling we weighed and measured 14 pallid sturgeon. The mean condition factor (K(FL)) for

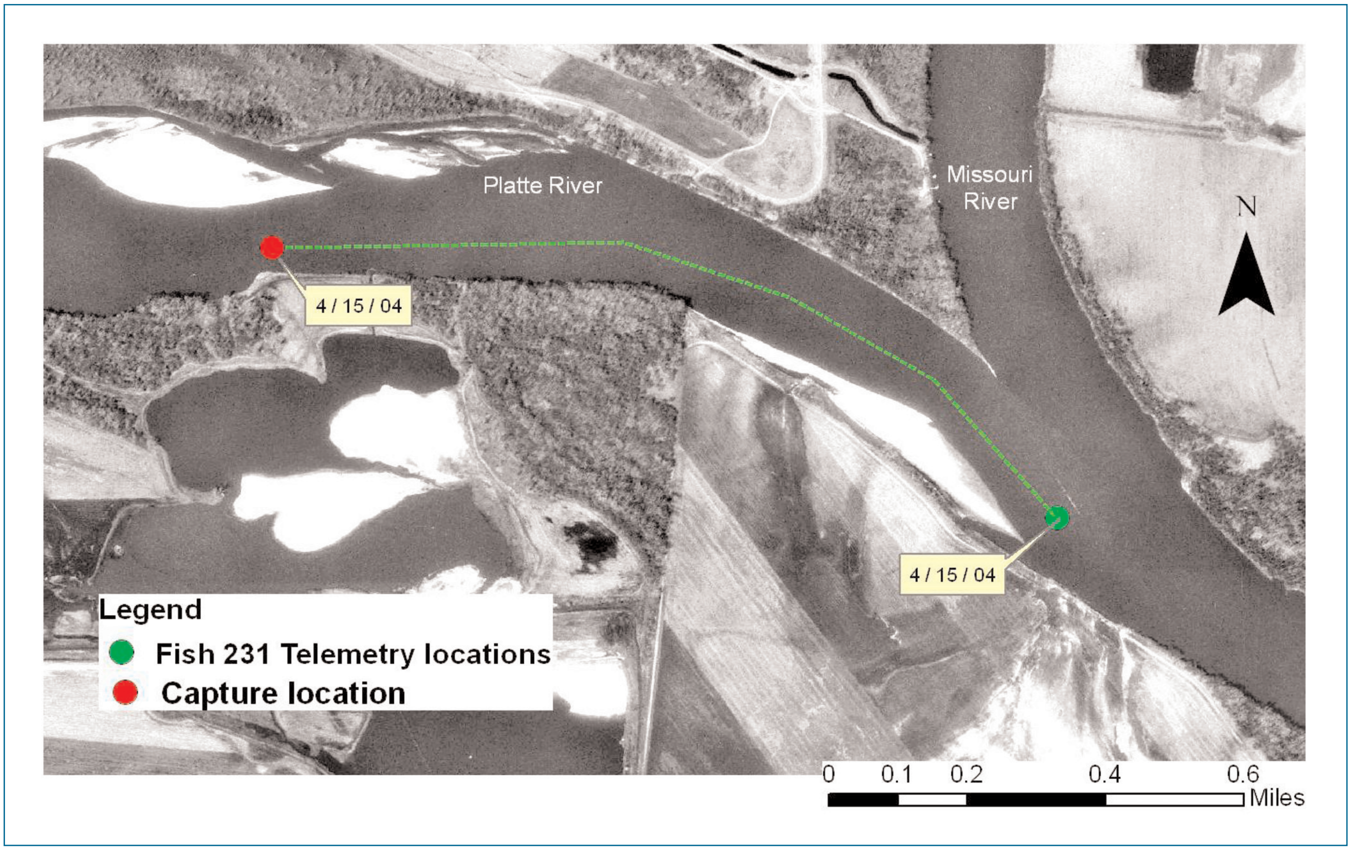

Figure 4.8. Capture and telemetry locations of pallid sturgeon #231 during April of 2004.

these sturgeon was 0.349 and the fish ranged from 284 mm to 1,030 mm fork length. The relationship between length and K(FL) exhibited a non-significant relationship ($t = 1.020$; $p = 0.328$) with a positive slope. However, the power of this test was low. The only other set of data available on lengths and weights of pallid sturgeon was for 74 hatchery reared pallid sturgeon from the Gavins Point National Fish Hatchery in Yankton, South Dakota. These fish ranged in size from 423 to 734 mm and had a mean K(FL) of 0.410. The relationship of K(FL) to fork length showed a significant, positive linear relationship ($t = 4.932$; $p < 0.001$). As expected, the condition factor of fish in the wild was lower than those from a hatchery, but because of the small sample size no statistical comparisons were made.

Indexes of condition for fish fall into two main types, the Fulton condition factors (K) and relative weight (Wr) (Anderson and Neumann 1996). The value of K is computed by multiplying the weight of a fish in grams (W) by 100,000 and dividing this product by the length of the fish in millimeters cubed (L^3). Relative weight values compare the weight of an individual fish of a given length to a standard weight for fish of that same length as calculated from a regression equation developed for that species. Carlander (1969) summarized K values for many species including pallid sturgeon. However, the values he listed were calculated using total lengths (K(TL)) rather than the fork length measurements we typically use to measure pallid sturgeon today. More recently, Quist et al. (1999) developed standard weight equations for shovelnose sturgeon that has allowed use of this method of assessing condition to be used for the management and evaluation of shovelnose sturgeon population health. However, at this time, there are no published standard weight equations for evaluation of pallid sturgeon condition. Shuman et al. (2006) developed proportional stock density and relative stock density criteria for pallid sturgeon, but did not develop standard weight equations. So, as yet there are no standard criteria by which the well-being of pallid sturgeon captured in the Platte River can be judged.

MORPHOMETRICS:

Of the 15 pallid sturgeon caught between 3 May 2001 and 25 September 2004, 13 were measured for calculation of the mCI (see Chapter 2). One specimen not measured was the pallid sturgeon that escaped before it could be measured and the other was captured by the statewide stream inventory crew on 23 July 2004. In general, the mCI did a reasonable job distinguishing the 13 pallid sturgeon that were measured from shovelnose, but there was some overlap. No fish identified in the field as a pallid sturgeon exhibited mCI values over -0.19 (Figure 4.9), but some fish that were identified as being shovelnose sturgeon exhibited mCI values as low as -0.73. All of the fish that exhibited a mCI higher than a value of -1.0 were less than 334 mm fork length and four of these were hatchery reared fish with either elastomere or PIT tags. On the other hand, the fish we classified as shovelnose sturgeon that exhibited mCI values between -0.2 and -0.73 included a mixture of sizes, but many were over 500 mm fork length. It is possible that some of these fish may be hybrids, but we have not received confirmation of any hybrids from tissue samples submitted for analysis.

Difficulties in distinguishing between pallid sturgeon and shovelnose sturgeon have led several studies to propose morphological and meristic tools as field aids. Compounding the difficulties in accurate species identification is the suspicion that the two species are hybridizing. Hybridization has led to a number of intergrades with individuals lacking definite characteristics of one species or the other. Carlson et al. (1985) and Sheehan et al. (1999), have proposed indexes that have been the basis for many field identifications. Unfortunately, several studies, including Kuhajda et al. (2005) have found inconsistencies in identification of specimens because of the difficulties in consistently performing certain field measurements such as barbel lengths. On the other hand, Murphy et al. (2005) found that in the lower Mississippi River basin, using morphometric ratios may be useful in areas where hybridization rates are low. Based on the information that we have, we do not think that any of the pallid sturgeon we caught were hybrids.

Table 4.9. Age and length of PIT tagged pallid sturgeon at time of release and capture during the study in the Platte River, Nebraska, 2000-2004.

PIT tag number (telemetry tag number)	Age		Length	
	Release	Capture	Release	Capture
444411282B	1	2	304	333
4442685D64	1	2	251	284
44233E4D32	1	2	287	329
44435F0919	1	2	299	334
4262274C51 (910)	1	3	200	494
424E754E2A (260)	3	5	580	695

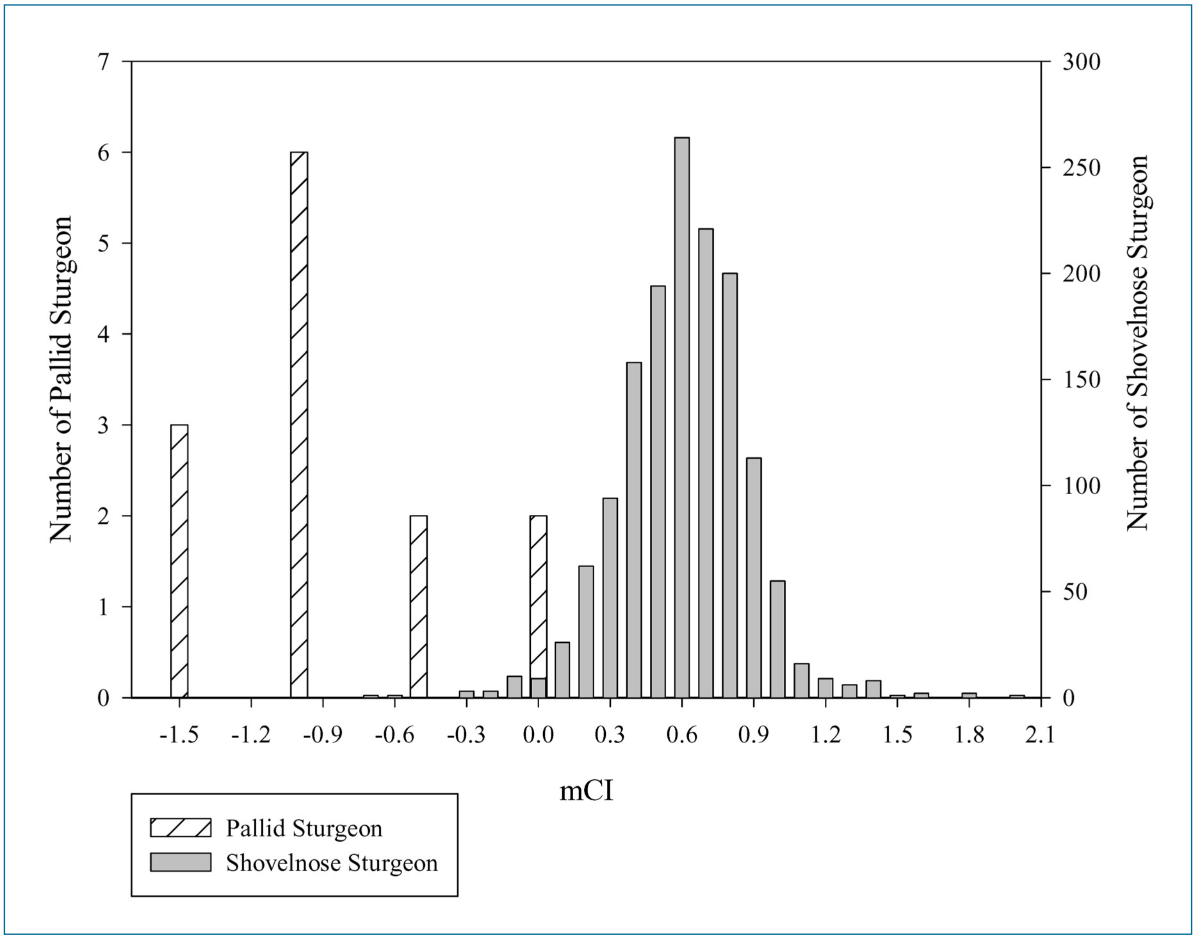

Figure 4.9. Comparison of mCI values calculated from measurements on pallid and shovelnose sturgeon from the Platte River.

Morphometrics of pallid sturgeon

CHAPTER 5

HABITAT USE, MOVEMENT AND POPULATION CHARACTERISTICS OF SHOVELNOSE STURGEON IN THE LOWER PLATTE RIVER

INTRODUCTION

Shovelnose sturgeon are tan, elongate, somewhat hunchback fish with five rows of bony plates extending the length of their bodies. Their mouth is ventral and both the upper and lower lips have four lobes. They have four barbels on the lower side of their snout (Lee et al. 1980). Shovelnose sturgeon are bottom dwelling fish of turbid rivers and are found throughout the Mississippi and Missouri River systems. Shovelnose sturgeon are more common and widespread in the Platte River than pallid sturgeon. While we do not consider shovelnose sturgeon to be surrogates for pallid sturgeon, shovelnose sturgeon are the nearest relative to pallid sturgeon and share many traits. This makes an understanding of shovelnose sturgeon habitat use, movement and population characteristics helpful to the overall management of the Platte River for both species.

Hofpar (1997) and Swigle (2003) studied habitat use and movement by shovelnose sturgeon and Shuman (2003) studied their population characteristics. The theses by Swigle (2003), Shuman (2003) and the publication by Shuman et al. (2007) comprise a major portion of the analysis presented in this chapter.

The objective is to present current information on the juvenile and adult shovelnose sturgeon population in the lower Platte River, NE. These efforts focused on three main areas of investigation.

- **First,** to determine the habitat conditions that shovelnose sturgeon use and document the species which are associated with them in these habitats.
- **Second,** to determine the movement patterns of shovelnose sturgeon into, within and out of the Platte River.
- **Third,** to determine the characteristics of the shovelnose sturgeon population in the Platte River. This included an analysis of their age and growth, length weight relationships, morphometric characteristics and population density.

METHODS

Sampling efforts for juvenile and adult shovelnose sturgeon used a variety of gears to sample a range of habitats in the lower Platte River. The gears used for shovelnose sturgeon were primarily, drifted gill nets, drifted trammel nets, trotlines and trawls, but stationary gill nets, seines and minnow traps were also used. Details on deployment and use of these gears are described in Chapter 2 of this report.

Distribution:

GPS locations were recorded for each sample collected. These locations were used to describe the distribution of shovelnose sturgeon within the lower Platte River. The number and catch per unit area of shovelnose sturgeon captured in the drifted nets was tabulated to examine local distributional patterns.

Habitat Use:

Habitat use for each species was described by comparing samples with shovelnose sturgeon to samples without shovelnose sturgeon for each sampling gear. Where normality and equality of variance of the data existed, the means were compared with a t-test. Where normality and equality of variance did not exist, data were rank transformed and compared with a Mann-Whitney Rank Sum Test. For telemetry data, each random observation was considered to be independent even when gathered on the same fish on different days. To describe the habitat use data for telemetry observations the median, 25% and 75% values are reported for each parameter.

Additionally, depth and mean column velocity was analyzed using a bivariate table with four categories of depth and four categories of mean column velocity. First, utilization of the habitat was determined by tabulating the number of captures for each cell in the table, and then calculating the percent frequency of each cell in the table. Selection of the depth and velocity combinations was determined by dividing the percent frequency of occurrence in each cell with the percent frequency of the sampling effort for that cell (see sampling chapter for data on percent frequency of the sampling effort). For the telemetry data, observations of habitat use were compared to the general habitat availability collected during past research by NGPC. The habitat selection was normalized by dividing each cell value by the sum of all cell values. These values were standardized to a scale of 0 to 1 by dividing each cell value by the largest cell value (Bovee and Milhous 1978, Peters et al. 1989). In cases where undefined numbers would result in division by zero, the value was replaced with a zero.

Associated Species:

Associated species are those species captured in samples with shovelnose sturgeon. We considered that those species which were captured more frequently with the shovelnose sturgeon to be more highly associated than those which were less frequently captured with shovelnose sturgeon.

Movement:

GPS locations were recorded for each sample collected. All shovelnose sturgeon were scanned for a PIT tag to determine if they had been captured in the past. If they were untagged, the fish was given a unique numbered PIT tag. Selected individuals that were large enough (>300 g) were implanted with a uniquely tuned radio transmitter tag, released in the vicinity of their capture and monitored from boats and aircraft on a regular basis. These methods are detailed in Chapter 2 of this report.

We recorded the tag number, location and date of telemetry contacts for each shovelnose sturgeon. We tallied the number of telemetry contacts for each shovelnose sturgeon for each survey platform in each year. To determine the distance moved for an individual fish, we measured the minimum linear distance along the river channel from ortho-rectified aerial images of the river. The distance moved was divided by the number of days between contacts to calculate daily movement rate. For individual shovelnose sturgeon with more than 2 observations within a month, we calculated average monthly movement. The overall average monthly movement was the average of all individual monthly movement rates. For recaptured fish, we determined their minimum distance traveled and calculated their time at large.

Age and Growth:

Shovelnose sturgeon were measured for fork length and pectoral fin rays were removed from a subset of the shovelnose sturgeon for determination of age following protocols outlined by Devries and Frie (1996) for determination of age and growth.

Length-Weight:

We used the length categories and relative weight equation proposed by Quist et al. (1999) to determine the structure of the shovelnose sturgeon population in the lower Platte River. Length-weight relationships were developed by plotting the $\log_{10}$ length against $\log_{10}$ weight for all specimens. Linear regression was used to calculate the intercepts and slopes of the relationships (Anderson and Neuman 1996).

Population Density:

Population estimates for shovelnose sturgeon were calculated from drifted gill and trammel net catches using a simple area-density expansion (Everhart and Youngs 1981). The length of net drift was multiplied by the average width of the net drift to determine the area sampled. The number of shovelnose sturgeon in the net was then divided by the area sampled by the net to determine the density of shovelnose sturgeon in the drift (n/m^2). A probability of capture coefficient was developed using the average number of net drifts that were required to capture a radio tagged shovelnose sturgeon at a location. The average density of shovelnose sturgeon was divided by the sampling efficiency factor and then multiplied by the surface area of the lower Platte River at mean discharge to obtain an estimate of the total population in the river. Upper and lower bounds were estimated using the 25% and 75% percentile catch values.

RESULTS AND DISCUSSION

Distribution:

Shovelnose sturgeon were captured or tracked in the lower Platte River from the confluence of the Platte River with the Missouri River (RM 0) upstream to the confluence of the Loup River (RM 103). Radio telemetry tracking indicated that some fish moved between the Platte River and the Missouri River while other shovelnose sturgeon stayed in the Platte River all year. Historical records show that shovelnose sturgeon were found as far west as Casper, WY (Evermann and Cox 1896, Baxter and Stone 1995), but in recent years shovelnose sturgeon have not been captured west of Grand Island, NE (NGPC: collection permit records).

When viewing the plots of percent frequency of occurrence of fish caught per net (Figure 5.1), the fish had a clumped distribution in the river with most nets capturing few fish and a few nets capturing many fish. This pattern may result from the nets passing through groups of fish in locally suitable habitat or the aggregations of shovelnose sturgeon may be associated with spawning or other unknown reasons. Additionally, the data clearly show that trammel nets caught more shovelnose sturgeon per drift than gill nets.

Habitat Use:

Drifted Gill Nets: Shovelnose sturgeon were captured in 177 of the 323 drifted gillnets. Drifted gill nets were generally run through areas that were expected to have sturgeon. Mean column velocity and bottom velocity was lower where drifted gill nets caught shovelnose sturgeon than where they did not catch shovelnose sturgeon (Table 5.1). Most other parameters were similar between nets with fish and nets without fish. Sand substrate was the most frequent substrate where shovelnose sturgeon were captured (Table 5.2). The selectivity analysis for the combination of depth and mean column velocity suggests that the shovelnose sturgeon select moderately deep and moderately swift currents (Tables 5.3 to 5.5).

Drifted Trammel Nets: Shovelnose sturgeon were captured in 160 of 213 drifted trammel nets. Drifted trammel nets were a more effective capture method than drifted gill nets (Figure 5.1), probably because of the ability of the nets to snag the sharp scutes of the sturgeon. The trammel nets also appear to do less physical damage to the shovelnose sturgeon than the gill nets making the drifted trammel nets a better gear for sampling shovelnose sturgeon in the lower Platte River.

There were no differences in habitat conditions between areas where shovelnose sturgeon were collected and where they were not collected when sampling with trammel nets(Table 5.6). Sand was the most frequent substrate where shovelnose sturgeon were captured (Table 5.7). The selectivity analysis for the combination of depth and mean column velocity suggests that the shovelnose sturgeon select moderately deep and moderately swift currents (Tables 5.8 to 5.10).

The lack of difference between most habitat variables and shovelnose sturgeon occurrence may be the result of drifting trammel nets in shovelnose sturgeon habitat and therefore there is little difference between nets catching shovelnose sturgeon and those nets not catching shovelnose sturgeon. Overall, trammel net data supports the use of moderate depth with moderately swift currents by shovelnose sturgeon.

When comparing the discharge between nets that captured shovelnose sturgeon and nets that did not, pairwise comparisons showed that fish were caught at lower daily discharges (median = 3,970 cfs) than nets without shovelnose sturgeon (median = 4,500 cfs). This suggests a number of possibilities. First, the efficiency of the drifted nets may decrease as discharge increases. Second, the sturgeon are more spread out at higher discharges making the chance of encounter with the net decrease. Or possibly, the shovelnose sturgeon are in different habitats than we sampled at higher discharge.

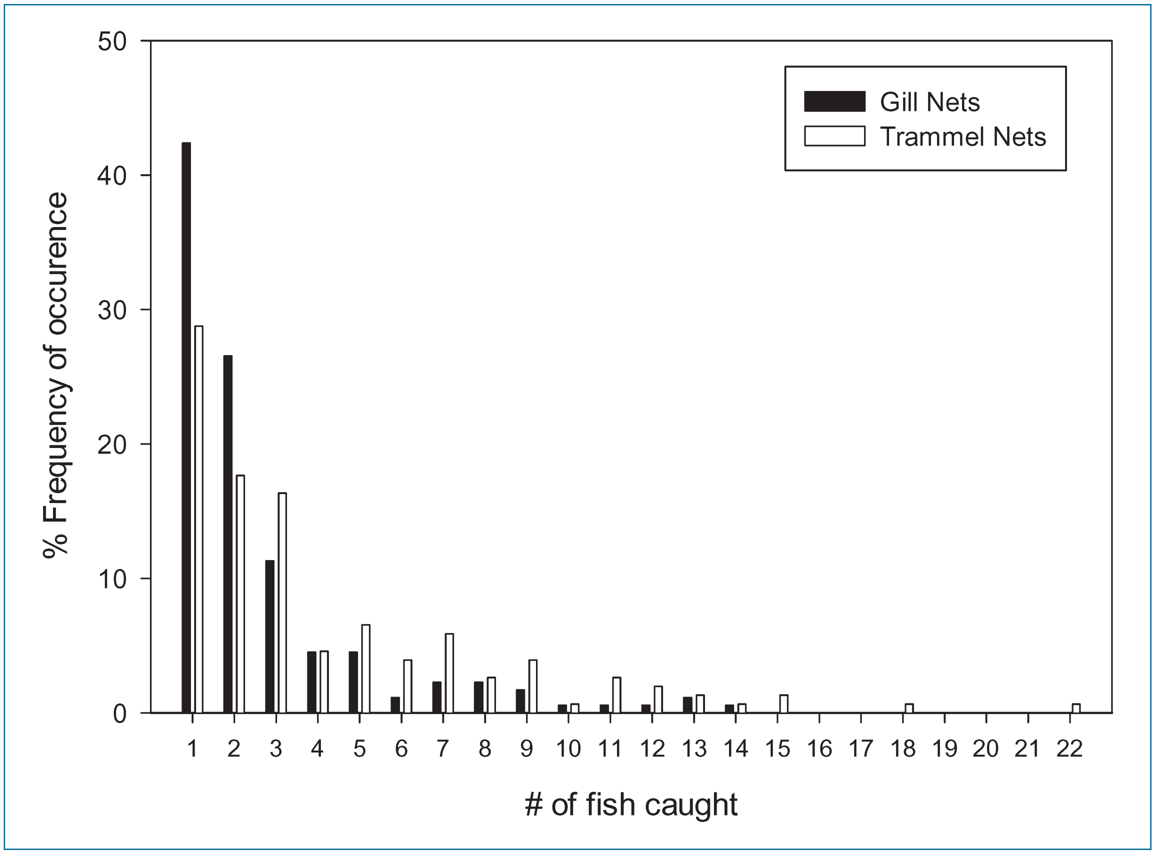

Figure 5.1. Distribution of percent frequency of occurrence of shovelnose sturgeon captured in drifted nets.

*Table 5.1. Comparisons of samples with shovelnose sturgeon to samples without for the drifted gillnet sampling in the lower Platte River, Nebraska. * Indicates where normality and equal variance of the data existed and means were compared using a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (ºC), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (µS/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	177	19	0.60	0.50	0.76	0.52
	No fish	146	33	0.64	0.51	0.77	
MCV	fish	177	20	0.52	0.46	0.61	0.006*
	No fish	146	33	0.58	0.49	0.68	
BV	fish	177	20	0.32	0.26	0.41	0.054
	No fish	146	33	0.35	0.28	0.46	
Temp	fish	177	16	25.2	22.6	27.4	0.41
	No fish	146	6	25.2	21.7	26.9	
DO	fish	177	17	9.3	8.0	10.8	0.77
	No fish	146	9	9.5	8.3	10.5	
Specific Conductivity	fish	177	21	535	435	684	0.26
	No fish	146	10	509	442	613	
TSS	fish	177	115	254	160	396	0.78
	No fish	146	95	211	175	307	

Table 5.2. Comparison of samples with shovelnose sturgeon to samples without for substrate in the drifted gillnet sampling in the lower Platte River, Nebraska.

	Number	Missing	% sand	% gravel	% silt	% rock
Substrate fish	177	15	96.9	1.5	1.5	0.0
Substrate none	146	16	98.5	0.4	1.2	0.0

Table 5.3. Shovelnose sturgeon number captured for the categories of depth and velocity for the drifted gillnet sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	1	2	0	0	3
	0.30-0.60	6	62	9	0	77
	0.60-0.90	0	31	31	0	62
	>0.90	1	4	10	0	15
	Total	8	99	50	0	157

Table 5.4. Shovelnose sturgeon percent use for the categories of depth and velocity for the drifted gillnet in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.6	1.3	0.0	0.0	1.9
	0.30-0.60	3.8	39.5	5.7	0.0	49.0
	0.60-0.90	0.0	19.7	19.7	0.0	39.5
	>0.90	0.6	2.5	6.4	0.0	9.6
	Total	5.1	63.1	31.8	0.0	100.0

Table 5.5. Shovelnose sturgeon normalized selected habitats for the categories of depth and velocity for the drifted gillnet sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	1.00	0.50	0.00	0.00
	0.30-0.60	1.00	0.65	0.37	0.00
	0.60-0.90	0.00	0.65	0.62	0.00
	>0.90	1.00	0.57	0.43	0.00

Trotlines: Shovelnose sturgeon were captured in 139 of the 224 trotlines set in the Platte River. Trotlines were an effective capture method during the colder water periods of the year. The trotline data differs from the entanglement nets in that the shovelnose sturgeon were caught a greater depths on trotlines (median = 1.4 m). There were no differences in habitat conditions between areas where shovelnose sturgeon were collected and where they were not collected when sampling with trotlines (Table 5.11). Sand substrate was again the most frequent substrate where shovelnose sturgeon were captured (Table 5.12). The selectivity analysis for the combination of depth and mean column velocity suggests that the shovelnose sturgeon's habitat is in deep and moderately swift currents (Tables 5.13 to 5.15).

The lack of difference between most habitat variables and shovelnose sturgeon occurrence may be the result of setting the trotlines in shovelnose sturgeon habitat and therefore there is little difference between trotlines catching shovelnose sturgeon and those trotlines not catching shovelnose sturgeon. Overall, trotlines extend the depth use range for shovelnose sturgeon into some of the deepest waters available in the river at least during the colder water periods when trotlines were used to capture fish.

*Table 5.6. Comparisons of samples with shovelnose sturgeon to samples without for the drifted trammel net sampling in the lower Platte River, Nebraska. * Indicates where normality and equal variance of the data existed and means were compared using a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (ºC), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (µS/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	160	25	0.65	0.52	0.90	0.273
	No fish	53	7	0.59	0.46	0.96	
MCV	fish	160	25	0.54	0.45	0.62	0.544
	No fish	53	7	0.52	0.42	0.63	
BV	fish	160	25	0.30	0.23	0.38	0.602
	No fish	53	7	0.29	0.23	0.41	
Temp	fish	160	22	22.1	17.8	26.3	0.717
	No fish	53	7	20.9	17.3	27.3	
DO	fish	160	24	10.1	9.0	11.9	0.466
	No fish	53	8	10.0	8.7	12.0	
Sp Cond	fish	160	25	499	405	637	0.781
	No fish	53	10	525	411	614	
TSS	fish	152	42	279	142	494	0.391
	No fish	53	23	332	214	404	
Turbidity	fish	160	48	200	74	396	0.34
	No fish	53	23	237	124	353	

Table 5.7. Comparison of samples with shovelnose sturgeon to samples without for substrate in the drifted trammel net sampling in the lower Platte River, Nebraska.

	Number	Missing	% sand	% gravel	% silt	% rock
Substrate fish	160	29	95.8	3.1	1.1	0.0
Substrate none	53	9	96.6	3.4	0.0	0.0

Table 5.8. Shovelnose sturgeon number captured for the categories of depth and velocity for the drifted trammel net sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	5	0	0	5
	0.30-0.60	3	44	9	0	56
	0.60-0.90	0	27	13	0	40
	>0.90	0	11	21	2	34
	Total	3	87	43	2	135

Table 5.9. Shovelnose sturgeon percent use for the categories of depth and velocity for the drifted trammel net sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	3.7	0.0	0.0	3.7
	0.30-0.60	2.2	32.6	6.7	0.0	41.5
	0.60-0.90	0.0	20.0	9.6	0.0	29.6
	>0.90	0.0	8.1	15.6	1.5	25.2
	Total	2.2	64.4	31.9	1.5	100.0

Table 5.10. Shovelnose sturgeon normalized selected habitats for the categories of depth and velocity for the drifted trammel net sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.96	0.00	0.00
	0.30-0.60	0.69	0.86	0.74	0.00
	0.60-0.90	0.00	0.87	1.00	0.00
	>0.90	0.00	0.85	0.87	0.77

*Table 5.11. Comparisons of samples with shovelnose sturgeon to samples without for the trotline sampling in the lower Platte River, Nebraska. * Indicates where normality and equal variance of the data existed and means were compared using a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (ºC), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (µS/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	139	23	1.40	1.12	1.77	0.023*
	No fish	85	10	1.26	0.97	1.53	
MCV	fish	139	22	0.73	0.62	0.83	0.484
	No fish	85	13	0.70	0.56	0.90	
BV	fish	139	45	0.36	0.27	0.46	0.488*
	No fish	85	23	0.35	0.26	0.47	
Temp	fish	139	5	14.2	11.8	16.2	0.748
	No fish	85	4	13.9	8.5	16.6	
DO	fish	139	7	11.0	10.5	12.0	0.265
	No fish	85	10	11.5	10.6	12.2	
Sp Cond	fish	139	9	595	549	661	0.421
	No fish	85	5	607	531	725	
TSS	fish	139	38	159	121	214	0.087
	No fish	85	26	147	113	179	
Turbidity	fish	139	51	77	56	116	0.106
	No fish	85	32	65	50	98	

Table 5.12. Comparison of samples with shovelnose sturgeon to samples without for substrate in the trotline sampling in the lower Platte River, Nebraska.

	Number	Missing	% sand	% gravel	% silt	% rock
Substrate fish	139	14	99.2	0.2	0.2	0.4
Substrate none	85	6	97.5	0.3	1.5	0.6

Table 5.13. Shovelnose sturgeon number captured for the categories of depth and velocity for the trotline sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	0	0	0	0
	0.30-0.60	0	0	0	0	0
	0.60-0.90	0	7	6	1	14
	>0.90	1	16	70	15	102
	Total	1	23	76	16	116

Table 5.14. Shovelnose sturgeon percent use for the categories of depth and velocity for the trotline sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	0.0	0.0	0.0	0.0
	0.30-0.60	0.0	0.0	0.0	0.0	0.0
	0.60-0.90	0.0	6.0	5.2	0.9	12.1
	>0.90	0.9	13.8	60.3	12.9	87.9
	Total	0.9	19.8	65.5	13.8	100.0

Table 5.15. Shovelnose sturgeon normalized selected habitats for the categories of depth and velocity for the trotline sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.00	0.00	0.00
	0.30-0.60	0.00	0.00	0.00	0.00
	0.60-0.90	0.00	0.42	0.10	0.05
	>0.90	0.39	0.61	1.00	0.69

Trawls: Shovelnose sturgeon were captured in 27 of the 157 trawls run in the Platte River. Trawl runs captured shovelnose sturgeon in water with slower bottom velocities than those run that did not capture sturgeon (Table 5.16). Tests for all other habitat variables measured showed no differences between runs that captured sturgeon and runs that did not. Shovelnose sturgeon were collected over gravel more frequently in trawl samples than in any other gear type, but still were captured over sand substrates 87.8% of the time (Table 5.17). The selectivity analysis for the combination of depth and mean column velocity supports the description of the shovelnose sturgeon's habitat in deep and moderately swift currents (Tables 5.18 to 5.20). This lack of difference between the habitat variables and shovelnose sturgeon occurrence within trawls may be the result of running the trawls in shovelnose sturgeon habitat.

Radio Telemetry: Shovelnose sturgeon were located 799 times during airboat surveys and 520 times during airplane surveys (Table 5.21). Shovelnose sturgeon were located during each month of the year. The analysis of habitat use included observations on 29 individual shovelnose sturgeon. On average, 29 surveys of habitat use were performed on each shovelnose sturgeon (range = 3 - 88).

*Table 5.16. Comparisons of samples with shovelnose sturgeon to samples without for the trawl sampling in the lower Platte River, Nebraska. * Indicates where normality and equal variance of the data existed and means were compared using a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (ºC), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (µS/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	27	0	1.23	1.04	1.62	0.345
	No fish	130	2	1.13	0.79	1.63	
MCV	fish	27	1	0.68	0.52	0.81	0.641*
	No fish	130	18	0.67	0.53	0.85	
BV	fish	27	1	0.27	0.17	0.37	0.015
	No fish	130	21	0.35	0.23	0.48	
Temp	fish	27	2	24.0	22.7	25.2	0.393
	No fish	130	8	24.8	21.2	26.4	
DO	fish	27	2	9.3	8.2	11.2	0.973*
	No fish	130	8	9.3	8.3	10.4	
Sp Cond	fish	27	2	585	537	705	0.823
	No fish	130	8	607	469	937	
TSS	fish	27	10	672	133	1090	0.321
	No fish	130	42	177	107	1224	

Table 5.17. Comparison of samples with shovelnose sturgeon to samples without for substrate in the trawl sampling in the lower Platte River, Nebraska.

	Number	Missing	% sand	% gravel	% silt	% rock
Substrate fish	28	1	87.8	8.5	1.9	1.9
Substrate none	129	9	93.8	4.5	0.4	1.2

Table 5.18. Shovelnose sturgeon number captured for the categories of depth and velocity for the trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	0	0	0	0
	0.30-0.60	0	0	0	0	0
	0.60-0.90	0	6	0	0	6
	>0.90	1	2	15	2	20
	Total	1	8	15	2	26

Table 5.19. Shovelnose sturgeon percent use for the categories of depth and velocity for the trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	0.0	0.0	0.0	0.0
	0.30-0.60	0.0	0.0	0.0	0.0	0.0
	0.60-0.90	0.0	23.1	0.0	0.0	23.1
	>0.90	3.8	7.7	57.7	7.7	76.9
	Total	3.8	30.8	57.7	7.7	100.0

Table 5.20. Shovelnose sturgeon normalized selected habitats for the categories of depth and velocity for the trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.00	0.00	0.00
	0.30-0.60	0.00	0.00	0.00	0.00
	0.60-0.90	0.00	0.67	0.00	0.00
	>0.90	1.00	0.27	0.58	0.19

The monthly average of physical habitat conditions measured at shovelnose sturgeon locations are presented in Table 5.22. Average depths used by shovelnose sturgeon were shallower than the yearly average during the months of May, July, August, September, October and November and deeper during March, April and June. This may be related to the annual fluctuation in Platte River discharge (Table 1.4). Average mean column velocity used by shovelnose sturgeon was also lowest during the months of July, August and September. Average monthly bottom velocity used by shovelnose sturgeon varied little from the annual average of 0.35 m/s, but was lowest during August.

Table 5.23 presents the monthly average water chemistry variables measured at shovelnose sturgeon locations. As expected, average temperatures recorded at shovelnose sturgeon locations were highest during the months of June, July and August and lowest during the months from November to March. Dissolved oxygen levels below 5 mg/L (the general lower limit for healthy fish populations (Boyd 1979)) were recorded during the months of May, June and August at shovelnose sturgeon locations. Specific conductivity readings and suspended solids concentrations in the vicinity of shovelnose sturgeon showed no distinguishable pattern.

According to the telemetry data, shovelnose sturgeon used deeper waters (median = 0.77 m) with moderately swift mean column velocities (median = 0.58 m/s) and slightly lower bottom velocities (median = 0.36 m/s) (Table 5.24). This pattern shows a general good agreement with conditions where sturgeon were captured by the gear types discussed earlier.

Shovelnose sturgeon were located in the river at a range of discharge levels with the median at 4,120 cfs. Substrate containing sand was used extensively by shovelnose sturgeon. Shovelnose sturgeon were observed over sand substrate during 96% of all observations(Table 5.25). Use of substrate containing gravel accounted for 3.5% of all observations. Shovelnose sturgeon rarely (<1%) used silt substrate.

Shovelnose sturgeon used a wide range of habitat conditions in the Platte River. Tables 5.26 – 5.28 show that shovelnose sturgeon used all but the slowest shallowest habitat conditions during our telemetry studies. However, they did show a selection for water over 0.3 m deep with mean column velocities over 0.3 m/s and the velocities used by shovelnose sturgeon tended to increase as the depths increased. These results fit into the spatial niches with intermediate to deep water with moderate to swift velocity (Hardy and Associates 1992).

At the focal location of each tracked sturgeon, we also recorded the presence or absence of structural features including the presence of sandbar ledges, underwater dunes and cover (mostly woody debris). Areas adjacent to or below shallow sunken sandbars, where secondary flows converged with the main channel, frequently held radio-tagged sturgeon. A distinctive ledge, where water depth sharply increased, was usually associated with the areas near shallow sunken sandbars. Shovelnose sturgeon were located within 10 m of a ledge in 38.2% of the observations and when located within this habitat, the shovelnose sturgeon were positioned in deeper water below the sandbar ledge. Shovelnose sturgeon frequently used underwater dunes being located in this channel structure in 51% of the observations. Overall, shovelnose sturgeon were located near structure in 71.1 % of observations. The use of instream cover was rare for shovelnose sturgeon as they were located near cover in less than 1 % of the observations.

The velocity use observations are in concordance with those found by other studies of shovelnose sturgeon, but studies in larger rivers have found that shovelnose sturgeon may use water depths which are greater than those available in the Platte River (Hurley et al. 1987, Curtis et al. 1997, Bramblett and White 2001). Substrate use by shovelnose sturgeon is often noted as being sandy (Quist et al. 1999) and the Platte River observations fit that description well. The other conditions we measured (ie. temperature, turbidity, etc.) are typical of tributaries of the Missouri River which support shovelnose sturgeon populations (Galat et al. 2005a). However, alterations in discharge levels and patterns in the Platte River could result in habitat deterioration for the shovelnose sturgeon similar to those documented by Cross and Moss (1987).

Associated Species:

As summarized in Chapter 2 each type of sampling gear assessed the shovelnose sturgeon population in a different way. For example, the drifted nets covered a wide range of habitat on each drift. Even when the majority of the drift was in the deeper, swifter channel habitat, the nets passed through shallow and slow waters near sandbars when the nets were deployed and retrieved. As a result, they caught the most species with shovelnose sturgeon, even though in the field, it seemed clear

Table 5.21. Number of radio-tagged shovelnose sturgeon locations by survey method and year.

Survey Method	2000	2001	2002	2003	2004	Total Number of Locations
Boat	79	188	268	164	100	799
Plane	50	182	128	72	88	520
Total	129	370	396	236	188	1319

Table 5.22. Physical habitat values during radio telemetry tracking for shovelnose sturgeon by month and year.

Species	Date	Avg Depth (m)	Min Depth (m)	Max Depth (m)	Avg MCV (m/s)	Min MCV (m/s)	Max MCV (m/s)	Avg BV (m/s)	Min BV (m/s)	Max BV (m/s)
Shovelnose Sturgeon	03/2002	1.13	0.64	2.55	0.60	0.24	0.76	0.35	0.14	0.54
Shovelnose Sturgeon	03/2004	1.02	0.54	2.53	0.65	0.48	0.92	0.36	0.29	0.57
Shovelnose Sturgeon	04/2002	1.11	0.56	2.26	0.67	0.42	1.04	0.38	0.22	0.56
Shovelnose Sturgeon	04/2003	1.00	0.55	1.66	0.67	0.37	1.00	0.40	0.24	0.54
Shovelnose Sturgeon	04/2004	1.20	0.54	2.32	0.68	0.40	1.02	0.37	0.19	0.64
Shovelnose Sturgeon	05/2001	0.93	0.47	1.58	0.69	0.14	1.12	0.42	0.16	0.70
Shovelnose Sturgeon	05/2002	0.95	0.37	2.48	0.69	0.20	1.11	0.38	0.11	0.65
Shovelnose Sturgeon	05/2003	0.61	0.28	1.37	0.56	0.29	0.99	0.37	0.23	0.52
Shovelnose Sturgeon	05/2004	0.78	0.39	1.32	0.63	0.26	1.22	0.43	0.18	0.84
Shovelnose Sturgeon	06/2001	1.15	0.45	3.09	0.66	0.40	1.08	0.42	0.21	0.72
Shovelnose Sturgeon	06/2002	0.90	0.23	1.72	0.62	0.34	1.03	0.34	0.14	0.57
Shovelnose Sturgeon	06/2003	0.74	0.29	1.74	0.50	0.07	0.81	0.30	-0.01	0.54
Shovelnose Sturgeon	06/2004	1.01	0.36	2.23	0.61	0.38	1.13	0.38	0.27	0.49
Shovelnose Sturgeon	07/2000	0.76	0.24	2.03	0.51	0.38	0.66	0.34	0.14	0.49
Shovelnose Sturgeon	07/2001	0.74	0.37	2.39	0.59	0.32	0.99	0.39	0.17	0.64
Shovelnose Sturgeon	07/2002	0.72	0.27	1.29	0.54	0.28	0.93	0.34	0.18	0.54
Shovelnose Sturgeon	07/2003	0.58	0.29	1.71	0.51	0.29	1.12	0.31	0.15	0.48
Shovelnose Sturgeon	08/2000	0.81	0.33	1.29	0.59	0.33	0.82	0.33	0.15	0.54
Shovelnose Sturgeon	08/2001	0.76	0.37	1.39	0.52	0.23	0.83	0.30	0.10	0.52
Shovelnose Sturgeon	08/2002	0.68	0.33	1.40	0.47	0.25	0.99	0.31	0.15	0.65
Shovelnose Sturgeon	08/2003	0.76	0.39	1.52	0.62	0.39	1.12	0.35	0.20	0.66
Shovelnose Sturgeon	09/2000	0.85	0.35	1.69	0.58	0.33	0.87	0.37	0.19	0.47
Shovelnose Sturgeon	09/2001	0.81	0.38	1.57	0.60	0.34	1.09	0.40	0.24	0.61
Shovelnose Sturgeon	09/2002	0.72	0.43	1.36	0.53	0.28	0.83	0.32	0.18	0.42
Shovelnose Sturgeon	09/2003	0.73	0.29	1.62	0.61	0.12	0.77	0.40	0.11	0.60
Shovelnose Sturgeon	10/2000	0.95	0.32	2.49	0.62	0.29	0.87	0.31	0.09	0.45
Shovelnose Sturgeon	10/2001	1.01	0.51	1.66	0.63	0.43	0.92	0.36	0.13	0.51
Shovelnose Sturgeon	10/2002	0.77	0.28	1.30	0.50	0.31	0.68	0.28	0.14	0.46
Shovelnose Sturgeon	10/2003	0.61	0.30	0.84	0.62	0.36	0.76	0.45	0.27	0.65
Shovelnose Sturgeon	11/2001	0.98	0.44	1.66	0.61	0.39	0.86	0.30	0.19	0.43
Shovelnose Sturgeon	11/2002	0.74	0.48	1.63	0.46	0.34	0.57	0.32	0.17	0.47
Shovelnose Sturgeon	11/2003	0.52	0.29	0.76	0.38	0.30	0.47	0.29	0.20	0.38
Shovelnose Sturgeon	12/2001	0.95	0.59	1.23	0.62	0.41	0.82	0.31	0.22	0.45
	Averages	0.85	0.39	1.75	0.59	0.31	0.92	0.35	0.17	0.56

Table 5.23. Average water chemistry values at the time of radio telemetry tracking of shovelnose sturgeon.

Species	Date	Avg Temp (˚C)	Min Temp (˚C)	Max Temp (˚C)	Avg DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)	Avg Sp. Cond (µS/cm)	Min Sp. Cond (µS/cm)	Max Sp. Cond (µS/cm)	Avg TSS (mg/L)	Min TSS (mg/L)	Max TSS (mg/L)
Shovelnose Sturgeon	03/2002	5.94	3.20	10.80	11.96	10.55	13.03	680	541	1084	132	39	240
Shovelnose Sturgeon	03/2004	9.08	6.90	11.40	12.95	10.47	17.90	532	435	691	98	56	117
Shovelnose Sturgeon	04/2002	15.50	7.90	21.40	13.02	9.92	16.63	645	381	789	130	98	171
Shovelnose Sturgeon	04/2003	15.14	7.90	20.30	11.41	10.01	13.09	580	365	968	201	119	340
Shovelnose Sturgeon	04/2004	16.00	9.50	20.40	11.97	8.48	16.68	590	407	786	108	71	179
Shovelnose Sturgeon	05/2001	18.30	13.50	25.00	11.31	7.79	15.50	568	372	698	255	67	740
Shovelnose Sturgeon	05/2002	18.73	12.10	27.30	10.05	3.12	17.33	549	422	948	407	87	2356
Shovelnose Sturgeon	05/2003	18.20	13.30	24.60	9.78	8.69	11.68	468	405	494	582	147	1122
Shovelnose Sturgeon	05/2004	20.49	16.80	24.00	8.64	7.31	11.92	553	331	1015	503	101	2368
Shovelnose Sturgeon	06/2001	22.63	15.80	29.40	10.17	6.92	13.43	579	292	910	217	49	867
Shovelnose Sturgeon	06/2002	25.06	21.10	29.80	8.79	3.74	14.82	622	326	1148	591	50	3564
Shovelnose Sturgeon	06/2003	23.21	19.60	28.20	9.86	4.03	13.55	492	183	727	530	138	2108
Shovelnose Sturgeon	06/2004	22.74	17.50	26.70	8.45	7.26	10.77	468	280	963	1282	316	2848
Shovelnose Sturgeon	07/2000	26.50	25.20	28.50	8.75	7.07	10.90	596	471	727	195	119	232
Shovelnose Sturgeon	07/2001	27.04	23.20	32.60	8.66	5.26	11.64	641	405	1089	218	46	922
Shovelnose Sturgeon	07/2002	28.97	25.20	31.90	10.39	5.13	14.41	708	347	1327	95	20	154
Shovelnose Sturgeon	07/2003	26.98	22.90	30.60	8.62	6.22	10.09	534	344	963	180	34	422
Shovelnose Sturgeon	08/2000	26.85	22.10	30.80	9.80	6.31	12.15	930	371	1717	133	77	350
Shovelnose Sturgeon	08/2001	27.50	24.00	32.10	9.82	6.80	15.23	714	411	1077	134	87	223
Shovelnose Sturgeon	08/2002	25.83	21.00	29.50	9.43	1.82	12.51	632	280	1435	394	71	2516
Shovelnose Sturgeon	08/2003	27.91	23.20	31.30	10.09	7.03	15.41	620	322	1211	85	43	123
Shovelnose Sturgeon	09/2000	20.12	16.00	25.50	11.05	8.96	12.31	781	420	1672	144	111	172
Shovelnose Sturgeon	09/2001	21.55	16.30	27.40	10.44	8.24	13.99	695	422	1150	145	96	253
Shovelnose Sturgeon	09/2002	21.45	16.10	27.40	9.30	6.45	12.30	575	316	1011	113	83	164
Shovelnose Sturgeon	09/2003	18.02	12.70	24.10	10.16	7.88	13.52	550	222	1320	167	43	358
Shovelnose Sturgeon	10/2000	16.28	11.60	19.00	11.24	9.45	13.54	584	415	974	159	90	250
Shovelnose Sturgeon	10/2001	13.19	10.30	20.10	10.39	8.24	12.51	600	369	843	117	83	203
Shovelnose Sturgeon	10/2002	11.00	4.00	17.70	12.38	9.31	13.90	647	101	1161	-	-	-
Shovelnose Sturgeon	10/2003	13.59	8.60	20.20	11.56	7.13	12.92	451	211	845	97	63	122
Shovelnose Sturgeon	11/2001	14.67	13.60	15.60	10.50	9.64	11.83	673	492	1163	82	59	112
Shovelnose Sturgeon	11/2002	6.29	5.10	8.00	11.78	10.76	12.84	701	480	965	-	-	-
Shovelnose Sturgeon	11/2003	6.05	3.70	8.40	12.33	11.24	13.42	555	448	663	110	110	110
Shovelnose Sturgeon	12/2001	9.22	9.10	9.50	11.33	11.21	11.56	658	443	1101	228	170	266
	Averages	18.79	14.52	23.32	10.50	7.65	13.43	611	364	1019	253	88	773

Table 5.24. Habitat characteristics at tracked shovelnose sturgeon locations.

Parameter	Number	Missing	Median	25%	75%
Depth	608	8	0.77	0.57	1.07
MCV	608	10	0.58	0.47	0.70
BV	608	17	0.36	0.28	0.43
Temp	608	23	21.1	16.3	25.9
DO	608	31	10.2	8.8	11.6
Sp Cond	608	28	560	452	722
TSS	608	100	143	107	224
Turbidity	608	446	91	52	345

Table 5.25. Substrate texture at tracked shovelnose sturgeon locations.

	Number	Missing	% sand	% gravel	% silt	% rock
Substrate fish	608	12	96.1	3.5	0.4	0.0

Table 5.26. Shovelnose sturgeon number captured for the categories of depth and velocity for the telemetry sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	7	2	0	9
	0.30-0.60	9	131	25	0	165
	0.60-0.90	11	107	79	2	199
	>0.90	3	49	136	37	225
	Total	23	294	242	39	598

Table 5.27. Shovelnose sturgeon percent use for the categories of depth and velocity for the telemetry sampling data.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	1.2	0.3	0.0	1.5
	0.30-0.60	1.5	21.9	4.2	0.0	27.6
	0.60-0.90	1.8	17.9	13.2	0.3	33.3
	>0.90	0.5	8.2	22.7	6.2	37.6
	Total	3.8	49.2	40.5	6.5	100.0

Table 5.28. Shovelnose sturgeon normalized selected habitats for the categories of depth and velocity for the telemetry sampling data.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.01	0.03	0.00
	0.30-0.60	0.11	0.22	0.06	0.00
	0.60-0.90	0.34	0.40	0.21	0.12
	>0.90	0.27	1.00	0.53	0.63

that different species were being captured in different habitats during a run. Trotlines were selective in capturing only fish species that consume nightcrawlers and this limited the number of species observed with sturgeon caught by this method. Trawls were specifically used to target smaller fishes than the other gears, but still captured shovelnose sturgeon.

Drifted gill nets captured 23 species of fish in addition to shovelnose sturgeon (Table 5.29). The most frequently captured species on drifted gill nets that also captured shovelnose sturgeon were goldeye, shortnose gar, quillback and river carpsucker. Drifted trammel nets captured 24 species of fish in addition to shovelnose sturgeon (Table 5.30). The most frequently captured species on drifted trammel nets that also captured shovelnose sturgeon were goldeye, quillback, river carpsucker, and shortnose gar. The consistent pattern between drifted gill and trammel nets suggests that goldeye, quillback, shortnose gar and river carpsucker have some overlap in their habitats in the lower Platte River.

Trotlines captured three species of fish in addition to shovelnose sturgeon (Table 5.31). The most frequently captured species on trotlines that also captured shovelnose sturgeon was pallid sturgeon. Trawls captured 28 species of fish in addition to shovelnose sturgeon (Table 5.32). The most frequently captured species in trawls that also captured shovelnose sturgeon were shoal chubs, channel catfish, sand shiner and river shiner.

Seining in proximity to the locations of radio-tagged shovelnose sturgeon captured 9 species of fish in 39 seine hauls (Table 5.33). Shoal chubs were the most common species and red shiners were only the fourth most common species. Chubs in general made up 42% of the catch in the 3/8th inch seines near sturgeon, where chubs made up only 14 % of the catch in all other ⅜th inch seines.

Overall, of the larger species, goldeye, quillback, river carpsucker, shortnose gar and channel catfish show some association with shovelnose sturgeon. While for the smaller species, the shoal chubs and silver chubs and sand shiners and river shiners appear to associate with shovelnose sturgeon habitats.

Movement:

Thirty-three shovelnose sturgeon (569-693 mm fork length; 750-1,250 g) were implanted with radio transmitters between 2000 and 2004. Data regarding 5 of the radio -tagged fish was removed from the analysis because the transmitters carried by these individuals became stationary shortly after the fish's release. Recovery of 4 of the 5 transmitters confirmed suspicions that these fish had either died or expelled the transmitter following their release. Additionally, only fish that were located at least twice during a month on different days were included in the analyses. The remaining 28 fish included in analysis of shovelnose movement were located 403 times from the air and 555 times from the airboat.

Table 5.29. Frequency of occurrence for fish species caught during drifted gill net runs with shovelnose sturgeon.

Common Name	Frequency of occurrence
Goldeye	50
Shortnose Gar	42
Quillback	38
River Carpsucker	24
Channel Catfish	18
Longnose Gar	13
Gizzard Shad	13
Common Carp	10
Blue Sucker	9
Freshwater Drum	7
Mooneye	7
Bigmouth Buffalo	5
Smallmouth Buffalo	5
Shorthead Redhorse	4
Sauger	4
Walleye	3
Paddlefish	1
Black Crappie	1
Bighead Carp	1
Pallid Sturgeon	1
Flathead Catfish	1
Striped Bass Hybrid (wiper)	1
Grass Carp	1

Table 5.30. Frequency of occurrence for fish species caught during drifted trammel net runs with shovelnose sturgeon.

Common Name	Frequency of occurrence
Goldeye	70
Quillback	62
River Carpsucker	45
Shortnose Gar	43
Channel Catfish	38
Common Carp	32
Blue Sucker	25
Sauger	16
Longnose Gar	13
Bighead Carp	12
Grass Carp	12
Smallmouth Buffalo	11
Freshwater Drum	9
Flathead Catfish	7
Gizzard Shad	7
Shorthead Redhorse	5
Paddlefish	4
Pallid Sturgeon	3
Walleye	3
White Crappie	2
Bigmouth Buffalo	2
Blue Catfish	1
Saugeye	1
Black Crappie	1

Table 5.31. Frequency of occurrence for fish species caught during trotline samples that also captured shovelnose sturgeon

Common Name	Frequency of occurrence
Pallid Sturgeon	8
Common Carp	2
Channel Catfish	1

Table 5.32. Frequency of occurrence for fish species caught during trawl runs with shovelnose sturgeon.

Common Name	Frequency of occurrence
Channel Catfish	15
Shoal Chub	11
Sand Shiner	11
Silver Chub	8
River Shiner	7
Red Shiner	5
Emerald Shiner	4
River Carpsucker	3
Freshwater Drum	3
Plains Minnow	2
Johnny Darter	2
Green Sunfish	1
Western Silvery Minnow	1
Flathead Chub	1
Fathead Minnow	1
Saugeye	1
Common Carp	1
Suckermouth Minnow	1
Blue Catfish	1
Quillback	1

Table 5.33. Number of fish by species caught in 3/8th inch seines near radio-tagged shovelnose sturgeon in 39 different seine hauls.

Common Name	July	August	Total
Shoal Chub	4	36	40
Sand Shiner	26	5	31
River Shiner	5	17	22
Red Shiner	7	9	16
Plains Minnow	1	14	15
Silver Chub	8	6	14
Emerald Shiner	3	2	5
River Carpsucker	2	0	2
Common Carp	0	1	1
Total	56	90	146

Rate of movement by shovelnose sturgeon ranged from 0.07 to 14,014 m/d. However, 70% of all movement rates were less than 350 m/d. Most movement by study fish occurred during the spring (Figure 5.2), although not all fish moved at the same rate each month (Table 5.34). Shovelnose sturgeon typically moved upstream during April and May. Downstream movement consistently occurred in June. The maximum total upstream movements in April and May of each year showed that fish 161 moved upstream 139.2 km in 2001, fish 281 moved upstream 72.2 km in 2002, fish 241 moved upstream 85.7 km in 2003 and fish 601 moved upstream 42.2 km. On average, each radio-tagged shovelnose moved upstream 7.2 km during April and 19.4 km upstream in May. Long distance downstream movements were observed in June. Fish 101 moved downstream 81.2 km in June 2001, fish 241 moved downstream 47.4 km in June

2002, fish 341 moved downstream 85 km in June 2003 and fish 140 moved downstream 36.7 km in June 2004. On average, each shovelnose sturgeon moved 13.7 km downstream during the month of June. The greatest distance between two contact locations in the lower Platte River during any year of the study was 141 km.

Five shovelnose sturgeon tracked during this study moved into the Missouri River. Three of these fish migrated out of the Platte River between 1 November and 4 December 2000 and returned to the Platte River the following spring. Two additional radio-tagged shovelnose sturgeon moved into the Missouri River during September of 2002. Contact with these shovelnose sturgeon was not reestablished prior to 15 November 2002, the estimated expiration data of the transmitters. Besides the 5 shovelnose sturgeon that moved out of the Platte River during the fall of 2000 and 2002, shovelnose sturgeon were generally sedentary from October through March of each year of the study. From October through March, 90% of movement rates by shovelnose sturgeon did not exceed 350 m/d.

Recaptures:

During the regular sampling and at times when radio transmitters were about to expire because their batteries were nearing the end of their expected life, we recaptured some of the previously PIT-tagged individual sturgeon. The results provide some interesting insights, but in general, not as much detail as was afforded by telemetry. Table 5.35 summarizes the recaptures of PIT-tagged shovelnose sturgeon during the project. Most of these fish were at large for a day or less and were captured in the same area as they were released. In addition, a shovelnose sturgeon (PIT tag number: AVID020286127) was tagged by Rob Hofpar during his study of shovelnose sturgeon on the lower Platte River during 1996. This specimen was at large for over 5 years and it was recaptured at the mouth of the Elkhorn River where it was initially tagged.

Shovelnose sturgeon time at large between captures ranged from less than a day to almost 3 years for specimens initially tagged during our study. Seven individuals were at large for over a year, five from 1 month to a year and 14 for less than a month. Of particular note was one shovelnose sturgeon (PIT tag number: 042035277) that was first captured on 11 August 2000 and at that time it was implanted with a radio tag with the frequency 49.201 mHz. This fish was tracked with this transmitter until 12 September 2001. At that time the fish was recaptured and re-implanted with another radio transmitter with the frequency 49.401 mHz. It was then tracked until the signal was last located on 12 November 2002. On 10 April 2004 during an ichthyology class field trip, we recaptured this fish about 1 km downstream from Nebraska State Highway 50 near Louisville, NE with the expired radio transmitter still in place.

The distances moved and survival duration for shovelnose sturgeon provide support for two contentions. First, shovelnose sturgeon may move upstream one year and then remain in nearly the same location during another year. Whether this is related to spawning is not currently known, but the time of movement overlaps the time when larval sturgeon were found in samples. Second, the use of radio-transmitters in the fish may provide a valid description of habitats used by untagged sturgeon. The recaptures of fish implanted with transmitters that appear relatively healthy

Table 5.34. Average movement rate (m/day) of shovelnose sturgeon with at least 2 observations within the month. Positive values denote upstream movement and negative values denote downstream movement.

Fish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
21	-11	-20	-200	804	375	-379	-378	190	215	491	-91	-30	81
81	3	1	-48	204	-	-83	58	-154	-16	152	-41	-5	6
101	0	-17	-8	329	795	-2,187	-27	-159	-76	11	-32	-44	-118
121	-	-	-	1,702	2,434	-605	-2,078	16	-26	736	-371	-	226
140	-	-	-	104	793	-1,648	-	-	-	-	-	-	-250
161	-2	-6	-498	1,945	2,080	-2,451	-1,743	-68	198	116	-44	-75	-46
181	-	-	-	-	-	-	-621	-45	-	-	-	-	-333
191	-	-	-	-75	-38	-	-	-	-	-	-	-	-56
201	-39	-26	-97	219	328	871	-191	-422	-135	-125	8	46	37
241	-	13	-	-50	1,691	-1,550	-7	569	568	5	227	-65	140
250	-	-	-	67	-508	442	-	-	-	-	-	-	0
261	-	-	-	-	-	-240	-	-	-	-	-	-	-240
271	-	-	-	34	-310	-163	-	-	-	-	-	-	-146
281	-	-193	-	-44	1,188	517	-341	-2,620	-1,195	-4	58	-43	-268
301	-	-54	-	-38	724	-708	-39	144	405	75	-44	-19	45
341	-	-	-	-	-	-3,456	-101	-27	-	-	-	-	-1,194
381	-	-106	-11	269	1,034	-1,216	478	-899	-132	14	-129	129	-52
501	-	-	-	771	9	29	608	115	-	-116	-1,030	-	55
521	-	23	-12	-24	-158	-172	-216	-5	-187	478	104	73	-9
581	-	-	-	51	-983	-4	-86	51	14	28	34	-	-112
601	-	-	-	683	1,026	-1,351	-	-	-	-	-	-	119
602	-130	-7	243	66	-767	-526	1,327	122	-1,135	-1	-	-	-81
641	-	-	-	-	3,025	1,380	-3,953	102	-	40	-	-	119
661	-	-168	-45	34	444	-	-	-	-	10	14	-212	11
761	-	-	-	-	769	607	-285	-76	-571	-439	-	-	1
821	-	-	-	-	230	-	-642	-	276	-	-	-	-45
841	-	-	-	-	613	-	-	-	-	-	-	-	613
882	-	-	379	4	-	-	-	-	-	-	-	-	191
Average	-30	-47	-30	336	643	-586	-434	-176	-120	86	-96	-22	-39

Table 5.35. Location and date of initial release and location and date of subsequent recapture(s) of shovelnose sturgeon PIT tagged in the lower Platte River, NE.

PIT Tag Number	1st Date caught	1st Location (RM)	2nd date caught	2nd Location (RM)	3rd date caught	3rd Location(RM)
Avid 020286127	6/19/1996	Elkhorn R(32.8)	8/3/2001	Elkhorn R. (32.8)		
Avid 041828111	7/18/2000	Louisville (16.3)	9/26/2001	Louisville(16.3)		
422E237C2F	8/10/2000	Louisville (16.3)	9/19/2001	Louisville(16.3)		
421F340C09	5/3/2001	.5 mi. downstream from Hwy 50(15.8)	3/30/2004	Schilling(0.5)		
4234402F61	6/22/2001	Louisville(16.3)	8/9/2001	Louisville(16.3)		
42352B6C39	6/22/2001	Louisville(16.3)	8/9/2001	Louisville(16.3)		
423523704C	6/22/2001	Louisville(16.3)	5/30/2002	Louisville(16.3)		
422E1E3D41	7/19/2001	Louisville(16.3)	3/26/2003	1 mi downstream from Hwy 50(15.3)		
422E0E5B79	9/12/2001	Louisville(16.3)	4/10/2004	Louisville(16.3)		
4179367444	4/5/2002	2 mi downstream from Hwy 50(14.3)	5/27/2003	Fremont(57.0)		
422E0E5432	5/23/2002	Louisville(16.3)	6/25/2002	Schilling(0.5)		
4311516F4B	6/3/2002	Elkhorn R.(32.8)	6/15/2004	Downstream from Elkhorn R.(32.5)		
423A5C3D3D	7/16/2002	Elkhorn R.(32.8)	7/18/2002	Elkhorn R.(32.8)		
423A6D5D28	9/14/2002	Louisville(16.3)	9/19/2002	Louisville(16.3)		
4237766935	9/14/2002	Louisville(16.3)	9/19/2002	Louisville(16.3)		
423A6E3349	9/14/2002	Louisville(16.3)	9/19/2002	Louisville(16.3)		
43111F3757	6/24/2003	Leshara(48.8)	7/14/2003	Louisville(16.3)		
4311697E3A	3/24/2004	Cedar Creek(13.0)	6/3/2004	Schramm(22)		
4315423B15	3/30/2004	Schilling(0.5)	4/13/2004	Schilling(0.5)		
4310777B37	4/2/2004	Omaha well field(6.0)	4/7/2004	Omaha well field(6.0)		
43116A317B	4/2/2004	Omaha well field(6.0)	4/22/2004	Omaha well field(6.0)		
4311560E6D	4/2/2004	Omaha well field(6.0)	6/8/2004	Upstream from Elkhorn R.(33.0)	6/29/2004	Guard Camp(28.8)
43110F4325	4/6/2004	Omaha well field(6.0)	4/27/2004	Cedar Creek(13.0)		
43110B2749	4/8/2004	Downstream from rookery (10.0)	4/27/2004	Rookery(10.5)		
4311581F0C	4/8/2004	Schilling(0.5)	5/3/2004	Cedar Creek(13.0)		
4312790607	5/27/2004	Louisville(16.3)	4/22/2004	Omaha well field		
4311513E6F	6/8/2004	Upstream from Elkhorn R.(33.0)	6/15/2004	Downstream from Elkhorn R.(32.5)		

and the subsequent survival after re-implantation suggest that the sturgeon are physically able to deal with the stresses of transmitter implantation and return to normal conditions.

Population Characteristics:

During this study, we collected 1,338 shovelnose sturgeon from the lower Platte River. These were captured from drifted gill nets (n = 420), drifted trammel nets (n = 534), trotlines (n = 340) and benthic trawls (n = 44). Data from these specimens were used in the study of stock characteristics of shovelnose sturgeon in the lower Platte River (Shuman et al. 2007) and that information is summarized in this section.

These shovelnose sturgeon ranged in length from 329 to 797 mm fork length with 1,164 (87%) of the individuals between 500 and 649 mm and 323 (24.1%) of them in the 575 to 599 mm length category.

Age and Growth:

Fin rays were collected from 21 shovelnose sturgeon in 2001 and 44 shovelnose sturgeon in 2002. Ages determined from these specimens ranged from 5 to 14 years (Figure 5.3). The three readers who examined these fin rays agreed on the age of only one fish, but two of the three agreed on the ages of 24 fish. Most (75 %) of the fish where the readers agreed ranged between age 7 and age 9 and these individuals were between 469 and 663 mm fork length. No individuals were determined to be younger than age 5.

Quist et al. (1999) proposed relative stock density (RSD) length categories for stock (250-379 mm), preferred (380-509 mm), quality (510-639 mm), memorable (640-809 mm) and trophy (> 810 mm) sizes of shovelnose sturgeon. Using these categories the shovelnose sturgeon we captured fit primarily into the preferred and memorable classes (Table 5.36). Incremental RSD preferred - memorable values were 83 and 78 in reaches upstream and downstream from the mouth of the Elkhorn River. In areas sampled from near Louisville downstream to the mouth of the Platte RSD preferred – memorable values were 86 and 89. However, the RSD quality – preferred values increased in upstream reaches while the RSD memorable – trophy values declined in upstream reaches (Shuman et al. 2007). This indicates that larger size shovelnose sturgeon were more frequently captured in the downstream reaches of the Platte River.

Because shovelnose sturgeon are long lived species and most of their skeletons are cartilaginous, determination of growth rates has been challenging (Morrow et al. 1998). Helms (1973) working in the Mississippi River and Fogle (1963) working in the Missouri River, found large variations in length at age for shovelnose sturgeon. Fogle (1963) found that shovelnose sturgeon growth was rapid at first, but slowed to about 70 mm per year by age 5. Growth of shovelnose sturgeon from the Platte River (Shuman et al. 2007) is intermediate to that reported from the Missouri River (Fogle 1963) and the Mississippi River (Helms 1974).

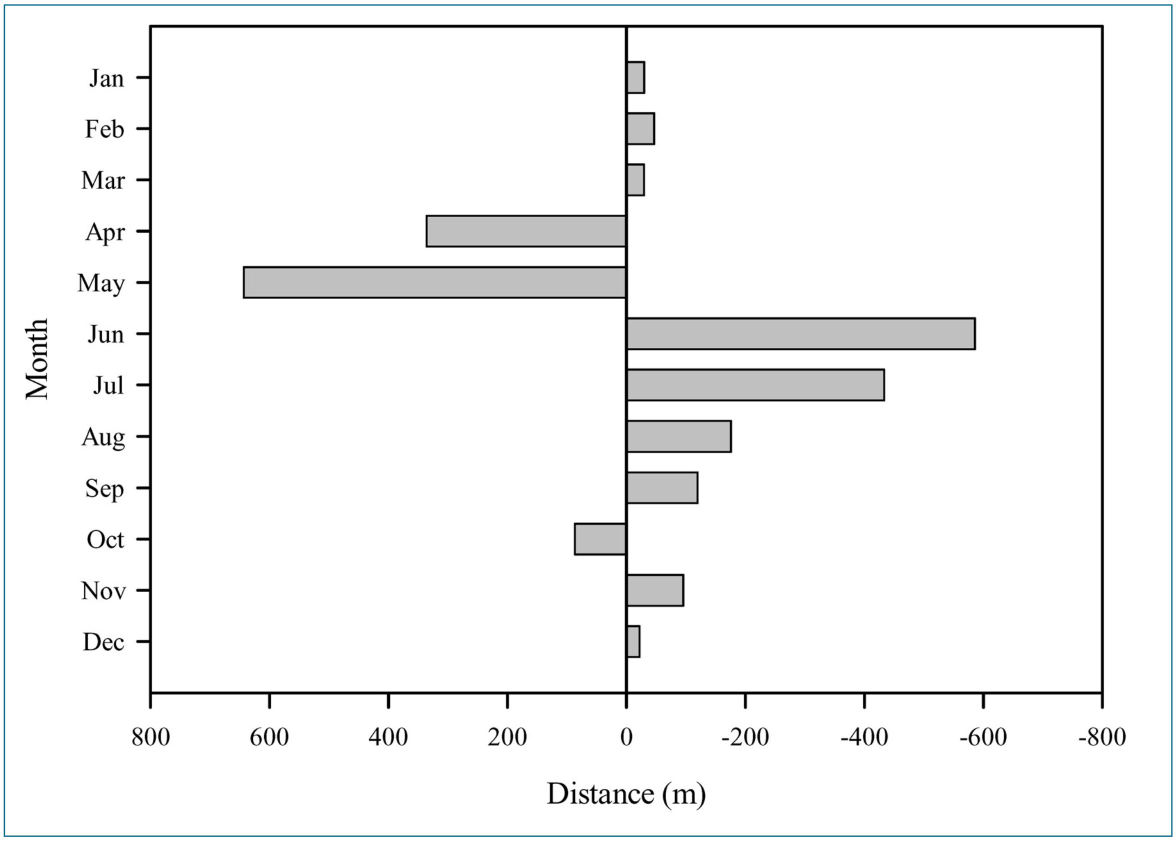

Figure 5.2. Average monthly movement rate (m/d) for shovelnose sturgeon. Positive values denote upstream movement and negative values denote downstream movement.

Length / Weight:

Indexes of condition for shovelnose sturgeon fall into two main types, the Fulton condition factors (K) and relative weight (Wr) by Anderson and Neumann (1996). Most of the condition values surveyed by Carlander (1969) are listed K(TL) which means that they were calculated using total lengths rather than the fork length measurements we typically use today. The development of a standard weight equations for shovelnose sturgeon (Quist et al. 1999) has allowed use of the relative weight method of assessing condition to be used for management and evaluation of shovelnose sturgeon populations in the Platte River. Shuman et al. (2007) calculated the fork length, weight relationship to be: log10 weight = -5.611+3.060*$\log_{10}$ fork length (Figure 5.4). The mean Wr value for shovelnose sturgeon from the lower Platte River was 86 and there was no significant difference between years. As fish increased in size their average Wr values generally decreased.

Based on the recommendations developed by Quist et al. (1999) the shovelnose sturgeon populations in the Platte River appear to be healthy.

Population Density:

Over the four years 1,129 shovelnose sturgeon were captured in drifted gill net (n=323) and trammel net runs (n=213). After applying the capture coefficient (0.308) our median population estimate was 9.6 shovelnose sturgeon/ha with confidence limits from 9.2 to 27/ha. Based on these density values we estimate the shovelnose sturgeon population of the lower Platte River is between 23,000 and 69,000.

Population estimates for large river fishes are difficult to attain because the species are generally mobile and obtaining a large enough sample to meet the assumptions of most population estimators is challenging. Shovelnose sturgeon move long distances most years and even though the lower Platte River has been intensively netted and fished for 5 years or more, we seldom catch tagged individuals. Several studies have attempted to use mark and recapture to estimate the populations of shovelnose sturgeon in the Missouri River, South Dakota (Schmulbach 1974), the Mississippi River, Iowa (Helms 1972) and the Chippewa and Red Cedar Rivers, Wisconsin (Christiansen 1975). Table 5.37 compares shovelnose sturgeon populations on the basis of number per mile of river. All the other studies used mark and recapture approaches. We used data from our standard population surveying techniques to estimate sturgeon populations in the Platte River and our results fit well within the range of population densities calculated by other researchers.

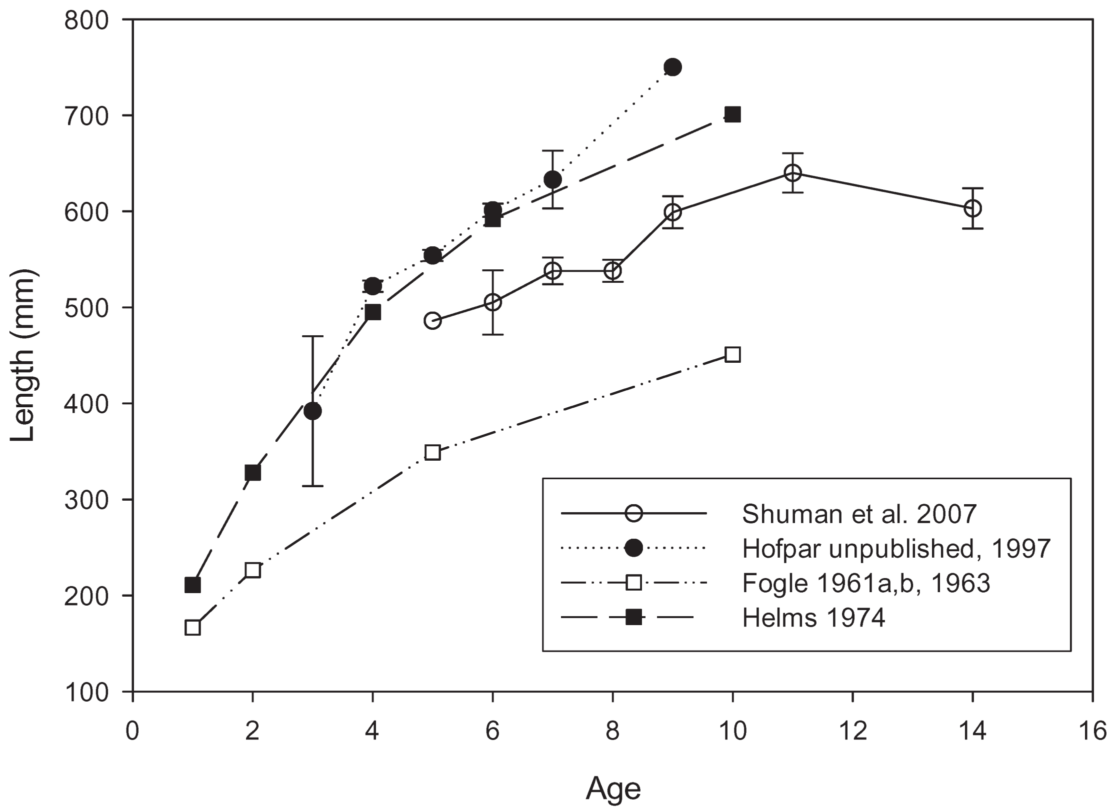

Figure 5.3. Age at length relationship for shovelnose sturgeon from the lower Platte River (Shuman, Hofpar) and for Missouri River (Fogle) and Mississippi River (Helms)

Table 5.36. Incremental relative stock density (RSD) indices by year and reach for shovelnose sturgeon captured from the lower Platte River, NE

	Stock - Quality 250 – 379 mm	Quality – Preferred 380 – 509 mm	Preferred - Memorable 509 – 639 mm	Memorable - Trophy 640 – 809 mm
2000	1	4	92	3
2001	< 1	6	88	5
2002	0	9	84	7
2003	< 1	13	82	5
2004	< 1	19	77	4
Years Overall	**1**	**12**	**82**	**5**
Reach 1	0	4	86	10
Reach 2	0	7	89	4
Reach 3	< 1	11	83	6
Reach 4	1	19	78	2

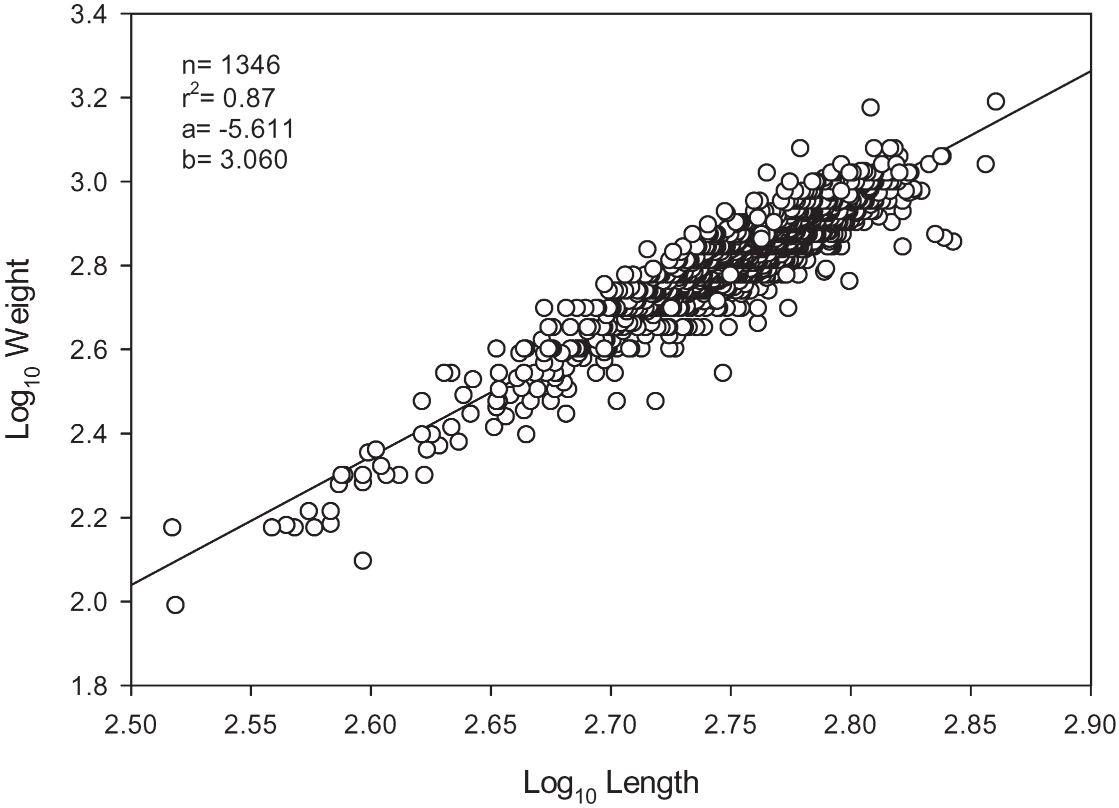

Figure 5.4. Length weight relationship for shovelnose sturgeon from the lower Platte River, NE.

Table 5.37. Comparison of population densities of shovelnose sturgeon among the Missouri River, South Dakota; the Mississippi River, Iowa; the Chippewa and Cedar rivers, Wisconsin and the lower Platte River, Nebraska.

River, State (Reference)	Number per km
Unchannelized Missouri River, South Dakota (Schmulbach 1974)	2500
Mississippi River, Iowa (Helms 1974)	1,030
Chippewa and Cedar River, Wisconsin (Christiansen 1975)	100
lower Platte River, Nebraska	142 - 426

Sturgeon chub sampled in the lower Platte River

CHAPTER 6
FOOD HABITS OF SHOVELNOSE STURGEON IN THE LOWER PLATTE RIVER

INTRODUCTION

One of the most direct links between a species and its association with other species is via the food resources that it consumes. During the period 2001 to 2002, shovelnose sturgeon stomachs were sampled to find the composition of their diet (Shuman 2003, Shuman and Peters 2007). Studies of shovelnose sturgeon food habits indicate that shovelnose sturgeon consume a diversity of prey, but primarily consume insects of the orders Diptera, Trichoptera and Ephemeroptera (Hoopes 1959, Held 1969, Modde and Schmulbach 1977, Carlson et al. 1985, Hofpar 1997). For the most part these studies have limited their taxonomic resolution to the family level and only Modde and Schmulbach (1977) evaluated any relation of what was consumed to what was available as a food resource.

One of the limitations of diet analysis is in many cases the study animals must be sacrificed to obtain reliable information. Pulsed gastric lavage (PGL) was developed by Foster (1977) and has been used successfully on many species. Hofpar (1997) used gastric lavage on shovelnose sturgeon in the Platte River and Brosse et al. (2002) used it on Siberian sturgeon. Both of these studies found no problems with the use of PGL. However, there have been several reports of water being forced into the air bladder of sturgeon during the lavage process (Sprague et al. 1993). This potentially serious problem has resulted in a restriction being placed on the use of this technique on endangered species like pallid sturgeon.

The objectives were first to determine the diet composition of shovelnose sturgeon in the Platte River and second to test the safety of PGL for pallid sturgeon by running a series of controlled survival tests on wild caught shovelnose strugeon.

METHODS

Sturgeon were sampled from the Platte River by drifting 30.5 m long by 1.8m deep gill nets with alternating panels of 2.5 cm and 5.1 cm bar mesh netting through areas of appropriate habitat as indicated by previous studies of habitat use (Hofpar 1997, Snook 2001). Sturgeon captured were first measured for fork length and morphological index characters, weighed and tagged with a PIT tag, prior to gastric lavage.

PGL was accomplished by inserting a flexible, 6mm diameter plastic tube through the sturgeon's mouth, into the anterior portion of the digestive tract and pulsing water from a pressurized sprayer tank into the stomach. During this procedure, the abdomen of the fish was gently massaged. Materials washed from the stomach were caught in a 595 µm mesh sieve and transferred to labeled jars, fixed with 10% formalin, and transported to the lab for identification and enumeration.

To evaluate abundance of macroinvertebrate taxa in the Platte River, the organisms drifting in the area were collected using 0.5 mm mesh nets set to collect larval fish (see Chapter 8 for details). These samples were considered to be representative of the invertebrate taxa which would be most available to sturgeon and other fish species when they settle to the substrate in areas of slow current and eddies where the fish feed.

To study the effects of PGL on shovelnose sturgeon 72 fish were captured and handled in the field just as they were for food habits studies. The only exception was that they were not subjected to PGL in the field. A total of nine experimental runs of eight fish each were performed. Each batch of eight fish was transported to UNL where they were randomly assigned to two holding tanks (four to each tank) for a 4-6 day acclimation period. After acclimation, PGL was performed on six fish while two randomly chosen control fish were handled in the same way and for the same duration as the PGL fish but their stomachs was not lavaged. All fish were returned to their tank, where they were held for a 15-day observation period.

During the acclimation and observation period temperature, dissolved oxygen, conductivity, and salinity were monitored daily with a hand held meter, and nitrite and ammonia concentrations were monitored using specific test kits. Fish were not fed during the acclimation or observation periods. Sodium chloride (1 mg/L) was added to the tanks for batches 7,8 and 9 to reduce handling stress on these fish. In addition, fish in batch 7 were treated with 55 mg/kg oxytetracycline hydrochloride because of a Columnaris infection.

Logistic regression was used to test whether survival of control fish was greater than survival of experimental fish. Analysis of variance was used to test for differences in temperature, dissolved oxygen, nitrite, ammonia, conductivity and salinity among batches. If significance was detected, Tukey's multiple comparison test was performed to identify specific differences. All tests were performed using SAS software.

RESULTS

During 2001 and 2002, 211 shovelnose sturgeon ranging from 450 to 718 mm fork length were sampled using gastric lavage. These contents were comprised primarily of aquatic insects belonging to 36 genera, in 16 families from 6 orders; two families of fish and a few terrestrial insects (Tables 6.1, 6.2). In many cases the invertebrates were still alive when they were flushed from the stomachs of the sturgeon. Of particular note was that very little detritus or inorganic matter was found in the stomachs of sturgeon.

The order Diptera was the most abundant order of the food items in the diets of shovelnose sturgeon, averaging 1,977 and 1,187 per stomach in 2001 and 2002, respectively. The family Chironomidae was the most diverse Dipteran family with 19 genera identified from sturgeon stomachs. The second most abundant and diverse order of insects in sturgeon stomachs was Ephemeroptera, which averaged 27 and 70 per stomach during 2001 and 2002, respectively. Most of the remainder of the sturgeon's diet was comprised of Trichopterans. Two other orders of insects (Odonata and Plecoptera), two families of fishes (Sciaenidae and Cyprinidae) and a few terrestrial insects were also found in sturgeon stomachs (Table 6.2).

To test the survival of shovelnose sturgeon subjected to PGL, nine tests each containing eight fish were conducted. These 72 shovelnose sturgeon were captured in 56 gill net drifts (N=56 sturgeon) and four trammel net drifts (N=16 sturgeon).

No significant difference (p=0.7094) was detected between survival of PGL and control fish for all nine tests. Survival was 100% during tests 1, 2, 3, 4, 7, 8 and 9 (Table 6.3). Mortality during test 5 consisted of two PGL fish and no control fish for a mortality rate of 44%. During test 6 five of the six PGL fish and both control fish expired, for mortality rates of 83% and 100%, respectively.

Water temperatures during the tests ranged from 16.7 to 28.1°C with an overall mean of 20°C. There was a significant difference of temperature among the nine tests (p=0.0001), but the variation of temperature within a test remained relatively constant (Shuman 2003). However, there seemed to be no direct relationship between temperature during a test and mortality of the fish in the test, since tests 5 and 6, when mortality occurred were near the center of the temperature range. Dissolved oxygen concentrations during the tests ranged from 6.9 to 9.5 mg/L with an overall mean of 8.1mg/L. A significant difference among tests was detected for dissolved oxygen concentrations (p=0.0016). However, no relationship between dissolved oxygen concentrations during a test and mortality was detected, since the concentrations for tests 5 and 6 were near the center of the range of values. Conductivity levels among tests were significantly different, but most of the difference was due to the addition of sodium chloride to the water during tests 7, 8 and 9. There was no detectable relationship between conductivity level and mortality of sturgeon during the tests. Ammonia concentrations were significantly different among tests (p=0.0003), but there were no detectable relationships between ammonia concentrations and sturgeon mortality during the tests. Nitrite concentrations afford the only potential cause and effect relationship between a chemical factor and mortality of test sturgeon. Concentrations of nitrite were significantly higher during tests 5 and 6 than during all other tests (p<0.0001). Nitrite levels during tests 5 and 6 were above 5 mg/L for eight and seven days, respectively. This corresponded to the only times when sturgeon died during the nine test runs.

DISCUSSION

Our analysis of shovelnose sturgeon food habits agrees, in general with findings by Modde and Schmulbach (1977) and Hofpar (1997) who considered them to be opportunistic benthivores. However, the predominance of chironomids in the diet seems to indicate that they are selecting for these larvae.

Recent advances in gastric lavage reported here from Shuman (2003), and Shuman et al. (2007) and colonic flushing (George et al. 2005) show that they hold great promise to understanding the food habits of pallid sturgeon in the lower Platte River. Although we were unable to sample stomach contents of pallid sturgeon, the information gained by a study of pallid sturgeon food habits may clarify whether pallid sturgeon choose habitats based on habitat characteristics or the presence of favorable food items. George et al. (2005) found that pallid sturgeon from the Mississippi River consumed shoal chub and this species is common in the lower Platte River.

Shuman (2003) and Shuman and Peters (2007) found that there was no significant difference between survival of lavaged shovelnose sturgeon and non-lavaged shovelnose sturgeon in the laboratory. These results combined with other studies on pallid sturgeon formed the basis for the U.S. Fish and Wildlife Service’s recommendation to allow PGL on pallid sturgeon in the field as of 2006. Unfortunately, approval to PGL pallid sturgeon stomachs came too late for us to use this technique during 2006.

Table 6.1. List of taxa found in shovelnose sturgeon stomach contents and drift in the Platte River.

	FAMILY	GENUS or SPECIES	STOMACH CONTENTS	DRIFT
Diptera			**x**	**x**
	Ceratopogonidae:		x	x
	Chaoboridae	*Chaoborus sp.*	x	
	Simuliidae	*Simulium sp.*	x	x
	Tabanidae		x	x
	Tipulidae		x	x
	Chironomidae		x	x
	Chironominae		x	x
		Chernovskiia sp.	x	x
		Chironomus sp.	x	x
		Cryptochironomus sp.	x	x
		Cyphomella spp./ Paracladopelma sp.	x	x
		Dicrotendipes sp..	x	
		Glyptotendipes spp.		x
		Harnischia sp.	x	
		Lauterborniella sp.	x	
		Parachironomus sp.		x
		Paracladopelma sp.	x	
		Paratendipes sp.	x	
		Polypedilum sp.	x	x
		Robackia sp.	x	x
		Saetheria sp..	x	x
		Stenochironomus sp.		x
		Tribelos sp.	x	x
		Cladotanytarsus sp.	x	
		Paratanytarsus sp.	x	
		Rheotanytarsus sp.	x	
		Sublettea sp.	x	
		Tanytarsus sp.	x	x
	Tanypodinae:	*Ablabesmyia sp.*	x	x
	Orthocladiinae			
		Orthocladius/Cricotopus sp.		x
		Nanocladius spp.		x

(Table 6.1. continued)

	FAMILY	GENUS or SPECIES	STOMACH CONTENTS	DRIFT
Ephemeroptera			**x**	**x**
	Baetidae		x	x
	Caenidae		x	x
		Amercaenis ridens	x	x
		Brachycercus sp.	x	
		Caenis sp.	x	x
		Cercobrachys sp.	x	x
	Ephemeridae	*Hexagenia sp.*		x
	Heptageniidae	*Heptagenia sp*	x	x
	Polymitarcyidae		x	x
		Ephoron sp.	x	x
		Totorpus sp.	x	x
	Pseudironidae	*Pseudiron sp.*	x	
Odonata			**x**	
	Gomphidae		x	
		Gomphus sp.	x	
		Progomphus sp.	x	
Plecoptera			**x**	**x**
	Perlidae	*Acroneuria sp.*	x	x
	Perlodidae	*Isoperla sp.*	x	x
Trichoptera			**x**	**x**
	Hydropsychidae		x	x
		Cheumatopsyche sp.	x	x
		Hydropsyche sp.	x	x
		Potomyia flava	x	x
				x
	Leptoceridae	*Nectopsyche sp.*		x
Hemiptera				**x**
	Corixidae			x
Gastropoda				x
Cladocera		*Daphnia sp.*		x
Fish			**x**	**x**
	Scianenidae	*Aplodinotus grunniens*	x	
	Cyprinidae		x	
Terrestrial insects			x	x

Table 6.2. Number, frequency of occurrence, and percent composition by number of food items by year found in shovelnose sturgeon stomach rations during 2001 and 2002.

	2001 n= 169			2002 n= 42		
	Number	Occurrence	Composition	Number	Occurrence	Composition
Chironomidae	**334182**	**95.9%**	**96.0%**	**49844**	**100.0%**	**89.0%**
Chernovskiia sp.	93111	85.2%	26.8%	9001	88.1%	16.0%
Saetheria sp.	41986	66.1%	12.1%	12369	59.5%	22.0%
Paracladopelma sp.	141390	88.2%	40.7%	9171	81.0%	16.3%
Robackia sp.	30838	71.6%	8.9%	12529	95.2%	22.3%
Polypedilum sp.	3315	30.2%	1.0%	1191	57.1%	2.1%
Paratendipes sp.	12485	50.5%	3.6%	3284	40.5%	5.8%
Paratanytarsus sp.	396	6.7%	0.1%	0	0.0%	0.0%
Cryptochironomus sp.	5022	43.2%	1.4%	945	42.9%	1.7%
Tanytarsus sp.	871	15.4%	0.3%	97	19.0%	0.2%
Chironomus sp.	1132	16.0%	0.3%	215	19.0%	0.4%
Cyphomella/ Paracladopelma sp.	2514	26.9%	0.7%	975	38.1%	1.7%
Lauterbornella sp.	322	5.9%	0.1%	0	0.0%	0.0%
Rheotanytarsus sp.	11	0.6%	0.0%	0	0.0%	0.0%
Harnishia sp.	29	0.6%	0.0%	0	0.0%	0.0%
Sublettea sp.	158	1.8%	0.0%	0	0.0%	0.0%
Cladotanytarsus sp.	150	1.8%	0.0%	0	0.0%	0.0%
Tribelos sp.	1	0.8%	0.0%	0	0.0%	0.0%
Dicrotendipes sp.	50	1.2%	0.0%	8	2.4%	0.0%
Tanypodinae	**401**	**7.7%**	**0.1%**	**59**	**6.8%**	**0.1%**
Ablabesmia sp.	401	7.7%	0.1%	59	6.8%	0.1%
Ephemeroptera	**4542**	**82.2%**	**1.3%**	**2977**	**85.7%**	**5.3%**
Isonychia sp.	2197	72.8%	0.6%	1419	66.7%	2.5%
Cercobrachus sp.	1969	71.6%	0.6%	1420	78.6%	2.5%
Brachycerus sp.	73	18.9%	0.0%	45	28.6%	0.1%
Amercaenis ridens	20	6.7%	0.0%	2	6.8%	0.0%
Caenis sp.	2	1.2%	0.0%	0	0.0%	0.0%
Baetidae	209	27.8%	0.1%	74	35.7%	0.1%
Heptageniidae	15	6.5%	0.0%	6	7.1%	0.0%
Ephoron sp.	27	6.1%	0.0%	1	2.4%	0.0%
Tortopus sp.	4	1.8%	0.0%	0	0.0%	0.0%
Pseudiron sp.	2	1.2%	0.0%	10	7.1%	0.0%
Trichoptera	**2140**	**57.4%**	**0.6%**	**200**	**42.9%**	**0.4%**
Potomyia flava	1682	66.5%	0.5%	189	47.6%	0.3%
Hydropsyche sp.	64	19.5%	0.0%	2	6.8%	0.0%
Cheumatopsyche sp.	104	33.1%	0.0%	9	16.3%	0.0%
Plecoptera	**2**	**1.2%**	**0.0%**	**0**	**0.0%**	**0.0%**
Perlidae sp.	1	0.6%	0.0%	0	0.0%	0.0%
Isoperla sp.	1	0.6%	0.0%	0	0.0%	0.0%

(Table 6.2. continued)

Diptera	**84**	**3.0%**	**0.0%**	**12**	**6.8%**	**0.0%**
Ceratopogoninae	78	1.8%	0.0%	11	2.4%	0.0%
Chaoborous sp.	1	0.6%	0.0%	0	0.0%	0.0%
Tibanidae	1	0.6%	0.0%	0	0.0%	0.0%
Tipulidae	4	2.4%	0.0%	0	0.0%	0.0%
Simulium sp.	0	0.0%	0.0%	1	2.4%	0.0%
Odonata	**11**	**5.3%**	**0.0%**	**2**	**6.8%**	**0.0%**
Gomphus sp.	10	5.3%	0.0%	2	6.8%	0.0%
Progomphus sp.	1	0.6%	0.0%	0	0.0%	0.0%
Terrestrial	**11**	**5.3%**	**0.0%**	**2**	**6.8%**	**0.0%**
Larval fish	**5**	**2.4%**	**0.0%**	**0**	**0.0%**	**0.0%**
Cyprinidae sp.	3	1.8%	0.0%	0	0.0%	0.0%
Aplodinotus grunniens	2	1.2%	0.0%	0	0.0%	0.0%

Table 6.3. Number of deaths and percent survival of shovelnose sturgeon subjected to pulsed gastric lavage during nine laboratory experiments with eight individuals per experiment.

	Control Deaths	Treatment Deaths	Control Percent surviving	Treatment Percent Surviving
Batch 1	0	0	100	100
Batch 2	0	0	100	100
Batch 3	0	0	100	100
Batch 4	0	0	100	100
Batch 5	0	2	100	67
Batch 6	2	5	0	17
Batch 7	0	0	100	100
Batch 8	0	0	100	100
Batch 9	0	0	100	100

CHAPTER 7

HABITAT USE AND POPULATION CHARACTERISTICS BY CHUB SPECIES (STURGEON CHUB, SHOAL CHUB, SILVER CHUB AND FLATHEAD CHUB) IN THE LOWER PLATTE RIVER

INTRODUCTION

Chubs of the genus Macrhybopsis and the genus Platygobio belong to the minnow family (Cyprinidae) and they tend to be species which inhabit turbid rivers like the Missouri River and its tributaries (Cross 1967, Pflieger 1997). They tend to be bottom dwelling species and they share habitats similar to those used by pallid sturgeon and shovelnose sturgeon. In addition, several studies have documented that sturgeon chub (Gerrity et al. 2006) and shoal chub (George et al. 2005) are common in the diets of pallid sturgeon. Peters et al. (1989) and Peters and Holland (1994) presented univariate habitat suitability criteria (depth and velocity) for speckled (shoal) chub, silver chub and flathead chub. An unpublished report (Peters and Holland) developed a spatial niche approach to habitat analysis in the Platte River that was used by Hardy and Associates (1992) in their habitat analysis of the central Platte River.

When this study began the sturgeon chub was being considered for listing as an endangered species and one of our primary objectives was to document habitat use, habitat selection and species associated with sturgeon chub in the lower Platte River. In addition, since sturgeon chub are rare, this study was expanded to include all chub species in the lower Platte River. Kopf (2003) studied the habitat use by chubs, including sturgeon chub, in the lower Platte River and her study comprises a major portion of the results presented in this chapter.

Our objectives were to

1. Determine the distribution and the habitats used by the chub species in the lower Platte River.

2. Determine the population characteristics of the chub populations in the lower Platte River in terms of the age and growth, length-weight relationships, population density, reproductive status and their species associations.

METHODS

Chubs were captured primarily by the use of trawls and seines (for a description of sampling methodology and effort see Chapter 2). All specimens were fixed in 10% formalin and returned to the laboratory for further study. In the laboratory, specimens were identified, measured, weighed and examined to determine their sex and spawning condition.

Distribution:

GPS locations were recorded for each sample collected. This was used to describe the distribution of each species within the lower Platte River.

Habitat Use:

Habitat use for each species was described by comparing samples with the species to samples without the species for each sampling gear. Where normality and equal variance of the data existed, the means were compared with a t-test. Where normality or equal variance did not exist, data were rank transformed, and compared with a Mann-Whitney Rank Sum Test.

Additionally, depth and mean column velocity was analyzed using a bivariate table with four categories of depth and four categories of mean column velocity. First, utilization of the habitat was determined by tabulating the number of captures for each cell in the table, and then calculating the percent frequency of each cell in the table. Selection of the depth and velocity combinations was determined by dividing the percent frequency of occurrence in each cell with the percent frequency of the sampling effort for that cell (see sampling chapter for data on percent frequency of the sampling effort). The habitat selection was normalized by dividing each cell value by the sum of all cell values. These values were standardized to a scale of 0 to 1 by dividing each cell value by the largest cell value (Bovee and Milhous 1978, Peters et al. 1989). In cases where undefined numbers would result in division by zero, the value was replaced with a zero.

Age and Growth:

Length-frequency distributions were developed using total length measurements. When the total number of specimens captured allowed, length frequency histograms were used to identify cohorts (year classes) of individuals (DeVries and Frie 1996).

Length-Weight:

Length-weight relationships were developed by plotting the $\log_{10}$ length against $\log_{10}$ weight for all specimens. Linear regression was used to calculate the intercepts and slopes of the relationships. When there were insufficient numbers of specimens to develop a length-weight relationship, we used a Fulton condition index, where $K = \text{weight} * 100{,}000 / \text{length}^3$ (Anderson and Neuman 1996).

Population Density:

Population density estimates were based on measures of catch per unit area (CPUA) (Yu 1996). CPUA was calculated by multiplying the length of a trawl run by the width of the trawl mouth to estimate the area sampled. Next, area sampled was divided into the number of individuals of each species caught in a sample to obtain an estimate of catch per unit area. CPUA was standardized to a number of fish per 100 m2. Overall population density was the average standardized CPUA for the entire lower Platte River in each year, while site population density was the average standardized CPUA for a given region of the river.

Reproductive Status:

Individuals large enough to be considered adults were dissected to examine their gonads and determine their gender and reproductive status. Gonads were then weighed and the gonadosomatic index (GSI) was calculated. GSI equals the gonad weight (X100) divided by the total weight of the fish (Strange 1996). Plots of GSI values by sampling date were then used to identify spawning times for each species. These data along with larval fish sampling provided insight about chub spawning times.

Associated Species:

Associated species are those species captured in samples with species of concern. We considered that those species which were captured more frequently with the species of concern to be more highly associated than those which were less frequently captured with the species of concern.

RESULTS AND DISCUSSION

Sturgeon Chub Distribution:

A total of five sturgeon chub was captured at two locations during the 2000 to 2004 study period (Figure 7.1). Three of these specimens were captured at Louisville on 20 August 2000, one was captured at Louisville on 30 May 2002 and one was captured at Schilling on 26 June 2002. Since we only found sturgeon chub in the lowest reaches of the Platte River it seems that we are seeing a trend similar to those documented by Cross and Moss (1987) and Pflieger and Grace (1987).

Sturgeon chub are endemic to the Missouri River and its tributaries which flow in from the west and along with the Mississippi River downstream from the Missouri River (Bailey and Allum 1962, Lee et al. 1980, Pflieger 1997, Etnier and Starnes 1993). During recent years, sturgeon chubs have been collected widely during surveys in the Missouri River main stem (Galat et al. 2005b) and several of its tributaries (Werdon 1992). Because of their apparently greater abundance than previously thought, the sturgeon chub did not receive Federal endangered species or threatened species status, even though their overall distribution has been constricted (Werdon 1993). However, sturgeon chub are considered a threatened species in Nebraska. The first documented collection of sturgeon chubs in Nebraska was from Bazile Creek and the Platte River near Grand Island (Evermann and Cox 1896). Johnson (1942) considered sturgeon chub to be abundant in the Republican River and he indicated that sturgeon chub were found in the Platte River downstream from Gothenburg and in the Elkhorn River downstream from Winslow. Collections, since 1980, have only found sturgeon chub in the lower Platte River and the Missouri River (Schainost and Koneya 1999), and there are no recent records from the Republican River.

Habitat Use:

Water depths where sturgeon chubs were caught ranged from 1.04 to 1.4 m and averaged 1.3 m. Bottom velocities where sturgeon chubs were caught ranged from 0.21 to 0.46 m/s and averaged 0.30 m/s. Four of the five sturgeon chub were found at sites where substrates were composed of 90% sand and 10% gravel. The other sturgeon chub was found where the substrate was composed of 75% sand and 25% gravel.

The conditions where sturgeon chubs were collected during this study were deeper water and in slower velocities than that where Peters et al. (1989) collected a sturgeon chub in 1987. The sandy conditions were similar between our study and Peters et al. (1989). Other studies (Werdon 1992, Herzog and Ostendorf 2002) found sturgeon chubs in areas that have water velocities over 0.4 m/s in depths less than 2 m deep. The typical substrates in areas where these studies found sturgeon chubs were gravel and rubble. Overall, sturgeon chub appear to fit into the deep water (>0.6 m) moderate (0.3-0.6 m/s) to swift water (>0.6 m/s) spatial niches proposed for the shallow water fish community by Peters and Holland and used by Hardy and Associates (1992).

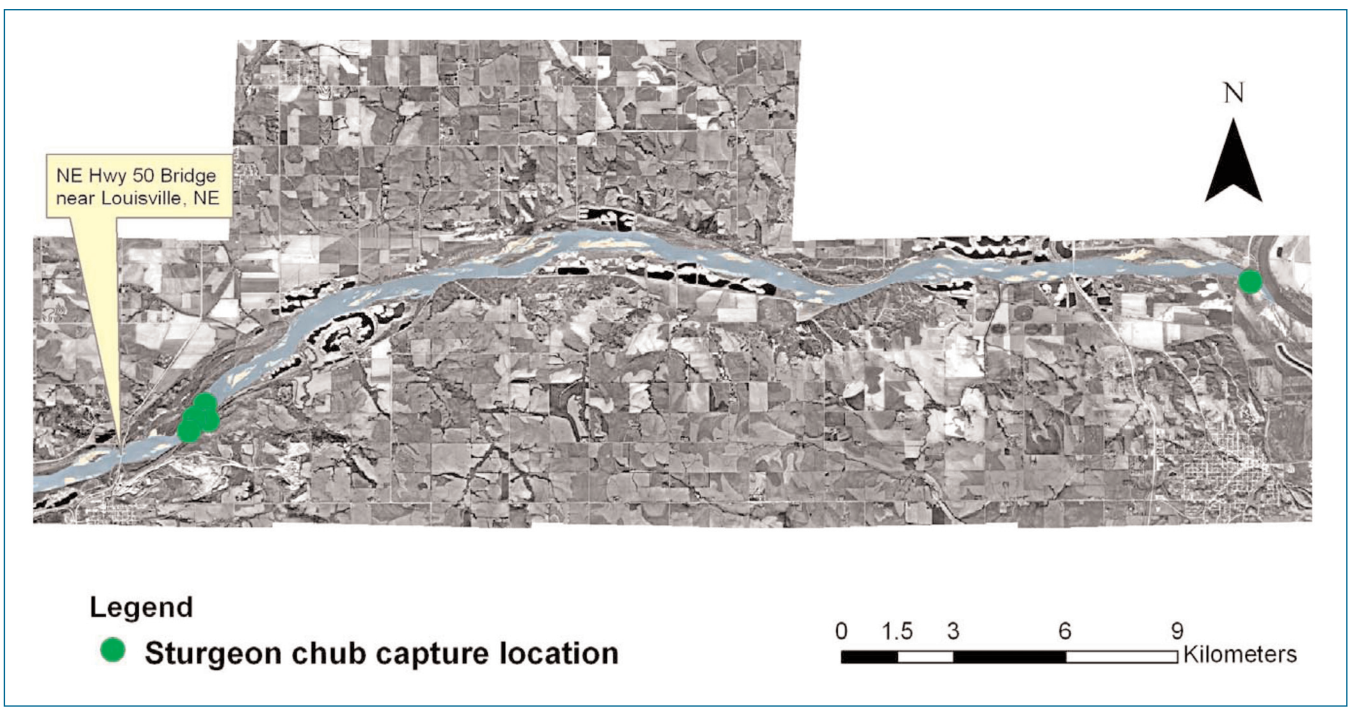

Figure 7.1. Map of locations where sturgeon chub were captured from 2000 to 2004 in the lower Platte River, Nebraska

One of the primary habitat characteristics noted for sturgeon chub is their apparent dependence on turbid water (Stewart 1981, Werdon 1992). Turbidity at sites where sturgeon chub sampled during this project ranged from 70 to 130 NTU which was typical for the lower Platte River during the study period from 2000 to 2004, but these values are considerably lower than the 500 JTU values reported by Werdon (1992) from the Powder River, WY.

Only two sturgeon chub were captured in the trawls in the lower Platte River during this study. Both individuals were captured in 2002. Although, this species is of high interest, given the small sample size it is hard to conclude much about the habitat use or selection of Platte River sturgeon chub. The first sturgeon chub was found 30 May 2002 at the Louisville site with a length of 92.9 mm over 90% sand 10% gravel substrate at 1.4 m and a bottom velocity of 0.46 m/s. The second was captured 26 June 2002 at the Plattsmouth site with a length of 52.2 mm over 75% sand 25% gravel substrate at 1.1 m and a bottom velocity of 0.21 m/s. Findings were consistent with other sturgeon chub collections throughout the Missouri River basin cited as using fast velocities over gravel substrate (Werdon 1992).

Age and Growth:

Sturgeon chub live up to four years and attain lengths up to 96mm in Wyoming (Stewart 1981) but seldom attain lengths of over 75mm in Missouri where they seldom live past age 2 (Pfleiger 1997). Even though we attempted to focus our collection efforts to sample sturgeon chub, we were able to capture only five during this study (Table 7.1). One additional specimen used in the age and growth analysis for the lower Platte River was captured in 1987 near Fremont, NE (Peters et al. 1989). These fish ranged in size from 52.5 to 92.4 mm total length. There were not enough data to compile a meaningful histogram. Werdon (1992) found up to three age classes and Stewart (1981) found that age 0 sturgeon chub in the Powder River, WY ranged from 38 to 48 mm in length. Age 1 individuals ranged from 55.3 to 80 mm, age 2 individuals ranged from 68.6 to 92.7 mm and age 3 individuals ranged from 81.3 to 91.4 mm. However, Everett (1999) found that age 3 individuals ranged from 73-86 mm. Based on these results, the smallest individual was likely age 1, while the rest of the specimens were either age 2 or age 3. This is supported by our observations that the 4 largest individuals were all sexually mature (3 females and 1 male) and the 52.5 mm specimen was apparently immature. However in some localities (Stewart 1981), sturgeon chub may be similar to shoal chub in their life history with most of the individuals living only through two summer seasons and expiring after spawning at age one.

Length-Weight:

The small number of sturgeon chubs did not allow calculation of a meaningful length-weight regression. Condition factors for the three fish identified as female ranged from 0.70 to 0.77 and averaged 0.74 while the condition factor value for the male fish was 0.54. From data presented by Stewart (1981), we calculated condition factors for sturgeon chubs and they ranged from 0.29 to 0.87 with a mean of 0.59. Our values fall within this range.

Population Density:

No estimate of density was attempted for sturgeon chubs because the number captured during this study was too small.

Reproductive Status:

One sturgeon chub (64.4 mm, captured on 20 August 2000) contained identifiable eggs and had a GSI value of 6.6. In contrast, two larger females captured on that same date had no identifiable eggs and GSI values of 1.2 and 1.4, suggesting that they had already spawned. Stewart (1981) collected no gravid females from the Powder River, WY after 26 July. One identifiable male was captured on 30 May 2002 and it had a GSI of 0.8, but there was no evidence of breeding tubercles on this specimen. Cross (1967) stated that male sturgeon chub collected in late June had well developed breeding tubercles. Most studies of sturgeon chub spawning indicate that reproduction takes place from May to late June

Table 7.1. Length, body weight, gonad weight, sex, Fulton's condition factor (K), and gonadosomatic index (GSI) for sturgeon chub collected in the Platte River, Nebraska, 2000-2002. (= fish too small to determine values)*

Date	Location	Length (mm)	Body weight (grams)	Gonad Weight (grams)	Sex	Fulton's K	GSI
8/20/2000	Louisville RM 15.5	64.4	2.065	0.137	Female	0.77	6.6
8/20/2000	Louisville RM 15.5	78.5	3.387	0.041	Female	0.70	1.2
8/20/2000	Louisville RM 15.5	80.9	3.936	0.056	Female	0.74	1.4
5/30/2002	Louisville RM 15.5	92.4	4.908	0.037	Male	0.54	0.8
6/26/2002	Schilling RM 0.5	52.5	0.785	*	*	0.62	*

at water temperatures between 18 and 23°C (Werdon 1992). These temperatures are typically attained in the Platte River during late May and early June.

Associated Species:

We collected seven species, silver chub, shoal chub, plains minnow, red shiner, sand shiner, channel catfish and sauger in the same trawl hauls as sturgeon chub (Table 7.2). Collection records from the University of Michigan Museum of Zoology show that Schultz and DeLacy collected 12 species, plains minnow, brassy minnow, red shiner, sand shiner, river shiner, bigmouth shiner, plains killifish, plains topminnow, longnose dace, creek chub and green sunfish along with three sturgeon chub from the Platte River near Gothenburg, NE on 8 September 1931. Gould (1997) found literature references to 48 species that had been found associated with sturgeon chub. Several studies have mentioned strong associations with either flathead chub, (Stewart 1981, Werdon 1992) or speckled chub (Gelwicks et al. 1996, Werdon 1992, Peters et al. 1989). Associations with longnose dace seem surprising, since Werdon (1992) and Stewart (1981) both state that longnose dace apparently replace sturgeon chubs in clear water conditions.

Shoal Chub Distribution:

Shoal chub, previously known as speckled chub, are quite widespread in eastern Nebraska. Since 1970 they have been collected from the main stem of the Platte River as far west as Kearney and up the Loup and Elkhorn River systems. There are no records of shoal chub being collected from the Republican River system or the Big Blue River system since 1970. Yu (1996) reported speckled chubs from Clarks to North Bend on the Platte River in 1992 and 1993.

Habitat use:

Trawls: Shoal chubs were captured in 75 of the 157 trawls run in the Platte River. Water depth, water temperature, dissolved oxygen concentrations and specific conductivity were higher where shoal chubs were collected than where they were not. Total suspended solids and turbidity values were lower where shoal chubs were collected than where they were not collected (Table 7.3). All of these differences are concordant with a relationship among the parameters and differences in discharge. Shoal chubs were captured more frequently ($p < 0.01$) at lower discharge rates (median = 2,790 cfs), than observed in trawls that caught no shoal chubs (median = 5,650 cfs). The results of these analyses suggest that shoal chubs are more densely distributed or are more easily captured at lower water level conditions than at higher water level conditions.

Sand was the most frequent substrate texture found in areas sampled which contained shoal chubs and those samples which did not contain them (Table 7.4). Gravel texture substrate was the second most frequent substrate type in trawl samples which contained shoal chubs and those that did not. Silt texture substrate was only noted in areas of trawl samples that contained shoal chubs and rock substrate was only noted in areas of trawl samples that did not contain shoal chubs.

Table 7.2. Species captured in trawl runs that also captured sturgeon chubs in the lower Platte River, Nebraska, 2000 – 2004.

SPECIES	RM 15.5 09/19/2000	RM 15.5 09/19/2000	RM 15.5 05/30/2002	RM 0.5 06/26/2002
Sturgeon chub	1	2	1	1
Shoal chub	11	7	0	1
Silver chub	4	4	0	0
Plains minnow	3	7	0	0
Red shiner	1	0	0	0
Sand shiner	0	1	0	0
Channel catfish	1	5	0	2
Sauger	0	1	0	0

Shoal chub were most frequently captured by trawls at depths greater than 0.6 m and at mean column water velocities greater than 0.3 m/s (Table 7.5, Table 7.6). The highest normalized selected values show the influence of small sample size on this measure of selection (Table 7.7). From these tables and our analysis of trawl selectivity (Chapter 2) we conclude that shoal chub show a selection for water greater than 0.6 m deep with mean column water velocities that increase from 0.3 to 0.6 m/s to velocities up to 0.9 m/s at depths greater than 0.9 m.

Percent frequency of occurrence of the number of shoal chubs (Figure 7.2) suggests that fish are not randomly distributed in the river with most trawls capturing a small number of fish (< 10) and a few nets capturing many fish (maximum = 608). This means that in most areas of the river no or few shoal chubs would be captured by a trawl, but in some areas large numbers of shoal chubs would be caught in a single sample. Possibly this is related to the trawl passing through favorable habitats for the shoal chub or that shoal chub aggregate for other reasons.

Seines: A total of 258 shoal chub was captured in 252 seine hauls. Shoal chub did not use any habitat variable in a proportion different from which it was sampled (Table 7.8). Shoal chubs were captured by seines in moderate current at moderate water depths.

Table 7.9 shows that there was a higher frequency of occurrence of sand and gravel substrates in seine samples that contained shoal chub and a higher frequency of occurrence of silt and rock substrate in seine samples that did not contain shoal chub. This may indicates a selection of sand and gravel substrates, but not for silt substrates. This is similar to the conclusions of Peters and Holland (1994) except for silt which they found to be suitable if combined with cover.

Shoal chub were most frequently caught by seines (Table 7.10, Table 7.11, Table 7.12) at depths less than 0.6 m and at mean column velocities less than 0.6 m/s. Seines caught shoal chubs in water deeper than 0.9 m with water velocities over 0.6 m/s, but the small number of samples in these habitat categories make these data difficult to interpret.

Peters and Holland (1994) considered shoal (speckled) chubs to be indicators of habitats with moderate to swift current flow in shallow water sections of the Platte River. Our collections of shoal chubs with seines corroborate those findings, but our trawl data expand the habitat into deeper and swifter conditions. Using the spatial niche classification (Hardy and Associates 1992) shoal chubs would fit into the moderate to swift velocity (0.3 - >0.6 m/s) / shallow (< 0.3 m) to deep (>0.6 m) conditions with a preference toward the deeper and swifter classes. This agrees with studies in other systems that have found water depth to be less important than current velocity in their habitat selection (Pflieger 1997). Since shoal chub probably spend most of their time close to the substrate it is likely that mean column velocities in deep water have little influence on the actual current which they experience.

Age and growth:

Shoal chub are small fish that seldom live past age 2 and most specimens die after age 1 (Cross 1967, Pflieger 1997). Shoal chub were by far the most abundant of the chub species encountered in the lower Platte River during this study. Most of the shoal chub caught during this study were between 30 and 40 mm total length and none were larger

*Table 7.3. Comparisons of samples with and without shoal chubs for the trawl sampling in the lower Platte River, Nebraska. * Denotes where normality and equal variance of the data existed and the data were compared with a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (ºC), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (S/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	75	1	1.03	0.74	1.24	<0.001
	No fish	82	1	1.45	1.07	1.94	
MCV	fish	75	7	0.63	0.52	0.85	0.265*
	No fish	82	12	0.73	0.57	0.86	
BV	fish	75	8	0.33	0.23	0.44	0.505
	No fish	82	14	0.34	0.21	0.56	
Temp	fish	75	3	25.4	22.0	26.8	0.032
	No fish	82	7	23.9	21.2	25.8	
DO	fish	75	3	9.9	8.9	11.3	<0.001*
	No fish	82	7	8.8	7.9	9.6	
Sp Cond	fish	75	3	805	517	1163	<0.001
	No fish	82	7	567	490	659	
TSS	fish	75	18	124	88	180	<0.001
	No fish	82	34	768	372	1368	
Turbidity	fish	75	18	65	45	126	<0.001
	No fish	82	34	1044	337	1919	

Table 7.4. Comparison of percent frequencies of samples with and without shoal chub, by substrate texture, during trawl sampling in the lower Platte River, Nebraska.

	Size	Missing	% sand	% gravel	% silt	% rock
Substrate fish	75	1	93.1	6.2	0.7	0.0
Substrate none	82	7	91.0	4.4	0.0	3.0

Table 7.5. Number of shoal chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	0	0	0	0
	0.30-0.60	1	8	0	0	9
	0.60-0.90	0	16	7	1	24
	>0.90	1	4	18	12	35
	Total	2	28	25	13	68

Table 7.6. Percent use by shoal chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	0.0	0.0	0.0	0.0
	0.30-0.60	1.5	11.8	0.0	0.0	13.2
	0.60-0.90	0.0	23.5	10.3	1.5	35.3
	>0.90	1.5	5.9	26.5	17.6	51.5
	Total	2.9	41.2	36.8	19.1	100.0

Table 7.6. Percent use by shoal chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	0.0	0.0	0.0	0.0
	0.30-0.60	1.5	11.8	0.0	0.0	13.2
	0.60-0.90	0.0	23.5	10.3	1.5	35.3
	>0.90	1.5	5.9	26.5	17.6	51.5
	Total	2.9	41.2	36.8	19.1	100.0

Table 7.7. Normalized selected habitats for shoal chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.00	0.00	0.00
	0.30-0.60	1.00	0.80	0.00	0.00
	0.60-0.90	0.00	0.89	0.47	1.00
	>0.90	0.50	0.27	0.35	0.57

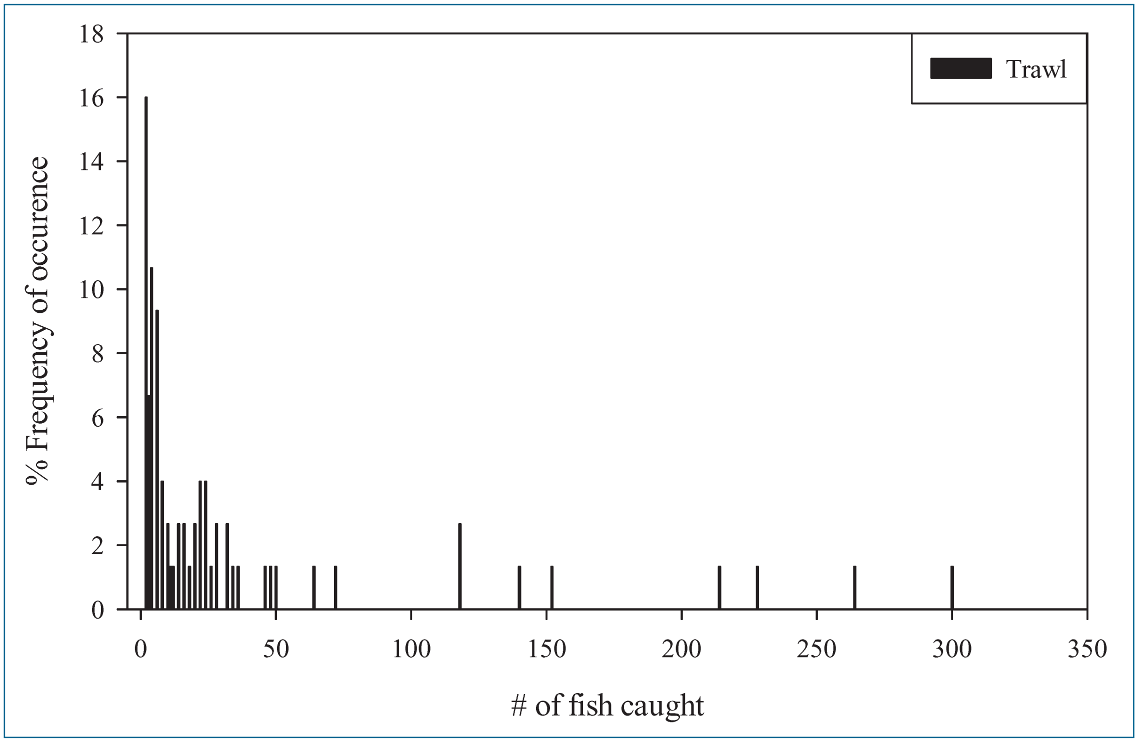

Figure 7.2 Percent frequency of the occurrence of shoal chubs in trawl samples in the lower Platte River, Nebraska.

*Table 7.8. Comparisons of samples with and without shoal chubs for the seine sampling in the lower Platte River, Nebraska . * Denotes where normality and equal variance of the data existed and the data were compared with a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (°C), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (S/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	52	9	0.38	0.31	0.53	0.251
	No fish	200	31	0.49	0.29	0.67	
MCV	fish	52	11	0.34	0.20	0.48	0.055*
	No fish	200	50	0.25	0.09	0.42	
Temp	fish	52	10	24.7	19.5	27.2	0.213
	No fish	200	47	23.6	17.7	26.1	
DO	fish	52	10	9.1	7.3	11.6	0.293
	No fish	200	47	8.6	7.3	10.9	
Sp Cond	fish	52	11	508	445	653	0.347
	No fish	200	51	505	439	572	
TSS	fish	52	31	133	97	245	0.454
	No fish	200	116	155	114	277	

than 70 mm (Kopf 2003). From an analysis of length frequency distributions Kopf (2003) determined that shoal chub live for about 2 years and in that time they may attain a size of up to 73.3 mm total length. During their first year of life, they grow to about 35 or 40 mm total length and these fish then overwinter to form the main breeding stock for the coming year. Cross (1967), Becker (1983) and Pfleiger (1997) reported similar ages and lengths.

Length-Weight:

Length-weight regressions for shoal chubs were calculated by Kopf (2003). The regression for males was Log_{10} W = -5.494 + (3.190 (Log_{10} Total Length)) and for females it was Log_{10} W = -5.742 + (3.342 (Log_{10} Total Length)). Fulton condition factors (K(TL)) averaged 0.662 for males and 0.668 for females, and showed no significant differences due to size of fish or month through the sampling

Table 7.9. Comparison of percent frequencies of samples with and without shoal chub, by substrate texture, during seine sampling in the lower Platte River, Nebraska.

	Size	Missing	% sand	% gravel	% silt	% rock
Substrate fish	52	13	84.5	4.6	10.9	0.0
Substrate none	200	39	74.8	0.5	24.5	0.8

Table 7.10. Number of shoal chub captured in combined depth and velocity categories during seine sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	5	3	0	0	8
	0.30-0.60	12	13	1	0	26
	0.60-0.90	1	4	0	0	5
	>0.90	0	1	1	0	2
	Total	18	21	2	0	41

Table 7.11. Percent use by shoal chub captured in combined depth and velocity categories during seine sampling in the lower Platte River, Nebraska .

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	12.2	7.3	0.0	0.0	19.5
	0.30-0.60	29.3	31.7	2.4	0.0	63.4
	0.60-0.90	2.4	9.8	0.0	0.0	12.2
	>0.90	0.0	2.4	2.4	0.0	4.9
	Total	43.9	51.2	4.9	0.0	100.0

Table 7.12. Normalized selected habitats for shoal chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.42	0.63	0.00	0.00
	0.30-0.60	0.90	1.00	0.73	0.00
	0.60-0.90	0.09	0.65	0.00	0.00
	>0.90	0.00	0.58	0.97	0.00

season (May to September). Swingle (1965) reported a condition factor of 0.39 to 0.83 for speckled chub in Alabama, and a length weight regression of Log_{10} W = -4.61 + (2.77 (Log_{10} Total Length)). It appears that shoal chub in the lower Platte River have similar body shapes as speckled chubs in Alabama.

Population Density:

The density of shoal chubs ranged from 0.973 to 12.579 /100m^2 during 2001 and 2002, respectively. Their density generally increased in samples collected downstream from the Elkhorn River (Table 7.13). These densities are generally higher than those reported by Yu (1996) who found the density of shoal chubs to be less than 1/100m^2 at study sites from Clarks to North Bend, Nebraska. The only exception was his value of 6.5/100m^2 at Columbus, Nebraska in 1992. However, Yu (1996) used electrofishing grids which sampled water < 1meter deep in contrast to the trawls which sample deeper water more effectively. Yu (1996) did not find any shoal chubs in the Louisville area where Kopf (2003) reported high densities of this species.

Reproductive Status:

All of the 26 female shoal chubs that contained well developed eggs were larger than 45 mm and all of the females in the 65 and 70 mm size categories contained eggs.

Table 7.13. Comparison of shoal chub densities for locations along the Platte River from Clarks, NE to the confluence with the Missouri River. Data adapted from Yu (1996) and Kopf (2003).

Location (River Mile)	1992 (Yu 1996)	1993 (Yu 1996)	2001 / 2002 (Kopf 2003)
Clarks (134-135)	0.125	0.125	-
Columbus (100-101)	6.500	0.250	-
Rogers (80-81)	0.375	0	-
North Bend (69-70)	0.625	0.625	-
Leshara (48-49)	-	-	2.831
Elkhorn (32-33)	-	-	1.680
Louisville (15-16)	0	0	9.217
Schilling WMA(0-1)	-	-	9.770

Table 7.14. Frequency of occurrence by species associated with shoal chub from trawl and seine samples collected in the lower Platte River, Nebraska.

Species common name	Frequency of occurrence from trawls	Frequency of occurrence from seines	Frequency of occurrence total
Channel catfish	52	9	61
River shiner	41	9	50
Sand shiner	41	7	48
Silver chub	27	11	38
Red shiner	23	9	32
River carpsucker	11	6	17
Freshwater drum	10	3	13
Shovelnose sturgeon	11	1	12
Emerald shiner	5	5	10
Plains minnow	3	4	7
Quillback	4	1	5
Flathead chub	2	2	4
Fathead minnow	2	1	3
Flathead catfish	3	0	3
Suckermouth minnow	3	0	3
Bigmouth shiner	2	0	2
Blue catfish	2	0	2
Bluegill	2	0	2
Johnny darter	2	0	2
Sauger	2	0	2
White perch	2	0	2
Blue sucker	1	0	1
Western silvery minnow	1	0	1
Green sunfish	1	0	1

GSI for female shoal chubs averaged 2.178 and the highest value was 14.588. All individuals that exhibited GSI values over 5.00 occurred between 23 May and 1 August during 2002. This agrees with information from larval fish collections reported in Chapter 8 of this study and with those found by Becker (1983) in Wisconsin.

Associated Species:

Shoal chubs were collected in association with 24 species of fish, 24 species from trawls and 13 species from seines (Table 7.14). Channel catfish were collected most frequently (61 times), river shiner (50 times), sand shiner (48 times), silver chubs (38 times) and red shiner (32 times). Becker (1983) collected 11 species of fish with speckled chubs in Wisconsin with the five most common species being, in order of abundance, spotfin shiner, bullhead minnow, emerald shiner and western sand darter.

Silver Chub Distribution:

Silver chubs were captured in 37 of the 140 trawl runs and in 61 of the seine hauls in the lower Platte River. Nebraska Game and Parks Commission records indicate that silver chub have been collected from the Platte River as far west as Kearney, the lower reaches of the Loup River, the Elkhorn River and the Niobrara River since 1970. Prior to 1970, records indicate that they were also collected in the upper Republican River and from sites farther up the Elkhorn River. Peters and Holland (1994) collected silver chub from as far west in the Platte River as Clarks, NE.

Habitat use:

Trawls: Differences between conditions where silver chubs were collected and where they were not collected were not significant for the habitat variables of mean column velocity, bottom velocities, temperature, total suspended solids and turbidity (Table 7.15). Silver chubs were collected at sites which were shallower than those where they were not collected. Dissolved oxygen concentrations at sites where silver chubs were collected were higher than those where they were not collected. Specific conductivities at sites where silver chubs were collected were higher than those at sites where they were not collected.

Percent frequencies of substrate textures in trawl sample areas where silver chub were collected were nearly identical to those from samples where they were not collected (Table

*Table 7.15. Comparisons of samples with silver chubs to samples without for the trawl sampling in the lower Platte River, Nebraska. * Denotes where normality and equal variance of the data existed, the means were compared with a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (ºC), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (S/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	41	0	0.85	0.64	1.38	0.005
	No fish	116	2	1.24	0.90	1.69	
MCV	fish	41	4	0.53	0.44	0.73	0.095*
	No fish	116	15	0.72	0.55	0.85	
BV	fish	41	5	0.31	0.21	0.39	0.14
	No fish	116	17	0.36	0.22	0.51	
Temp	fish	41	1	24.8	22.3	25.7	0.766
	No fish	116	9	24.3	21.2	26.5	
DO	fish	41	1	9.8	8.7	11.3	0.033*
	No fish	116	9	9.3	8.1	10.2	
Sp Cond	fish	41	1	699	558	1260	0.007
	No fish	116	9	584	485	788	
TSS	fish	41	6	124	82	1284	0.062
	No fish	116	46	284	131	1078	
Turbidity	fish	41	6	65	45	1644	0.063
	No fish	116	46	235	70	1640	

Table 7.16. Comparison of percent frequencies of samples with and without silver chub, by substrate texture, during seine sampling in the lower Platte River, Nebraska.

	Size	Missing	% sand	% gravel	% silt	% rock
Substrate fish	41	1	94.9	5.1	0.0	0.0
Substrate none	116	8	91.4	5.8	0.0	2.8

Table 7.17. Number of silver chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0	0	0	0	0
	0.30-0.60	1	7	0	0	8
	0.60-0.90	0	10	2	0	12
	>0.90	0	2	11	4	17
	Total	1	19	13	4	37

Table 7.18. Percent use by silver chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)				
		<0.30	0.30-0.60	0.60-0.90	>0.90	Total
Depth (m)	<0.30	0.0	0.0	0.0	0.0	0.0
	0.30-0.60	2.7	18.9	0.0	0.0	21.6
	0.60-0.90	0.0	27.0	5.4	0.0	32.4
	>0.90	0.0	5.4	29.7	10.8	45.9
	Total	2.7	51.4	35.1	10.8	100.0

Table 7.19. Normalized selected habitats for silver chub captured in combined depth and velocity categories during trawl sampling in the lower Platte River, Nebraska.

		mean column velocity (m/s)			
		<0.30	0.30-0.60	0.60-0.90	>0.90
Depth (m)	<0.30	0.00	0.00	0.00	0.00
	0.30-0.60	1.00	0.70	0.00	0.00
	0.60-0.90	0.00	0.56	0.13	0.00
	>0.90	0.00	0.13	0.21	0.19

7.16). Rock substrates were found only in areas where silver chub were not collected.

Most silver chub were captured by trawls in habitats more than 0.6 m deep with water velocities less than 0.90 m/s (Tables 7.17, 7.18, 7.19). The high selection values for the habitats in slow to moderate current velocities (<0.60 m/s) and in depths >0.6 m are concordant with the conclusions of other studies (Peters and Holland 1994).

In the plots of percent frequency of occurrence of the number of silver chub caught per net a median around 2 fish is observed (Figure 7.3). This suggests that fish frequently occur in small groups in the river, with a few trawls capturing many fish (maximum = 40).

Seines: As shown in Table 7.20 locations where silver chubs were collected in seines did not differ from those where they were not collected for depth, mean column velocity, dissolved oxygen concentration or specific conductivity. However, water temperature was higher and total suspended solids loads were lower at locations where silver chub were collected.

Silver chub were collected using seines at a slightly higher percent of frequency (Table 7.21) over sand and at slightly lower frequencies over gravel, silt and rock than locations that had no silver chub.

Silver chub were captured with seines most frequently from areas that were less than 0.9 m deep with water velocities less than 0.6 m/s (Tables 7.22, 7.23, 7.24).

Silver chub tend to be fishes of larger deeper sections of rivers and their backwaters and they seem to prefer somewhat reduced turbidities (Cross 1967, Cross and Moss 1987, Pflieger 1997). Peters and Holland (1994) considered silver chubs to be an open water generalist species because it used a wide range of depths with no distinct preference for current velocity. This places them in the deep (> 0.6 m), slow to moderate current velocity (<0.6 m/s) categories in the spatial niche classification (Hardy and Associates 1992).

Age and growth:

Silver chub specimens may reach lengths greater than 150 mm at age 3 in Wisconsin (Becker 1983) and some specimens from Lake Erie have attained age 4 and lengths over 200 mm (Kinney 1954). Silver chub were the second most abundant chub species encountered in the lower Platte River during the study. Specimens ranged in size from 20 to

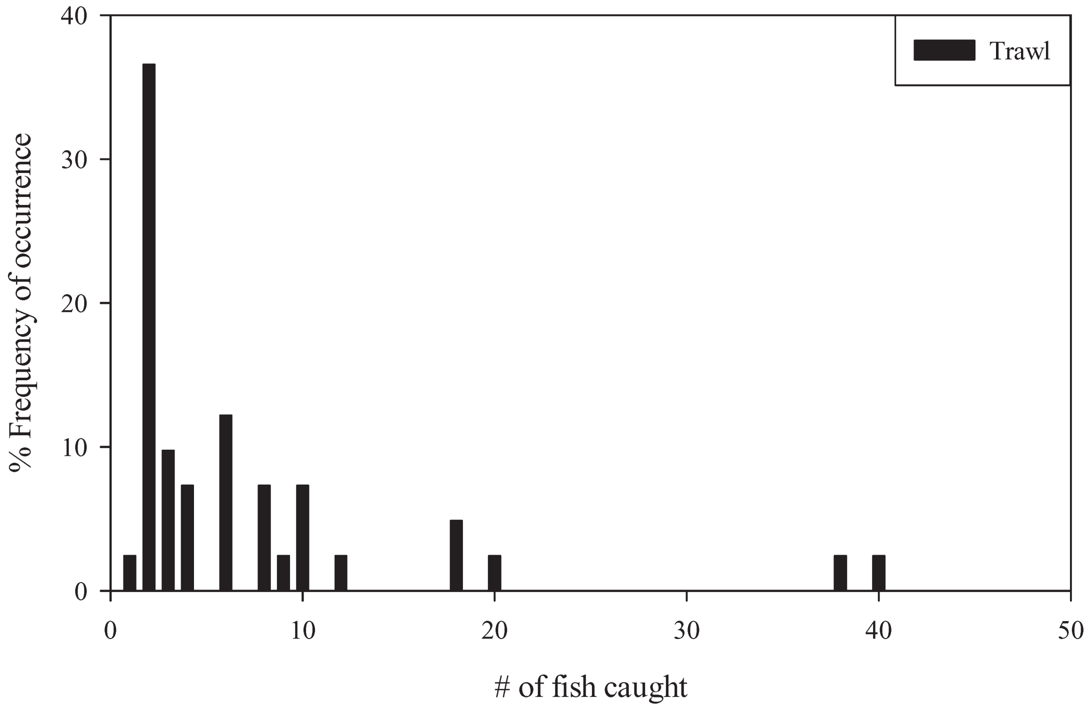

Figure 7.3 Percent frequency of the occurrence of silver chub in trawl samples in the lower Platte River, Nebraska.

*Table 7.20. Comparisons of samples with silver chubs to samples without for the seine sampling in the lower Platte River, Nebraska . * Denotes where normality and equal variance of the data existed, the means were compared with a t-test. (MCV= mean column velocity (m/sec), BV = bottom velocity (m/sec), Temp = temperature (ºC), DO = dissolved oxygen (mg/L), Sp Cond = specific conductivity (S/cm), TSS = total suspended solids (mg/L)*

Parameter	Fish/no fish	Number	Missing	Median	25%	75%	p value
Depth	fish	43	11	0.37	0.27	0.53	0.056
	No fish	209	29	0.47	0.31	0.68	
MCV	fish	43	13	0.22	0.09	0.35	0.176*
	No fish	209	48	0.27	0.13	0.45	
Temp	fish	43	15	26.1	23.8	29.1	<0.001
	No fish	209	42	23.3	17.7	26.1	
DO	fish	43	15	8.3	7.0	11.7	0.814
	No fish	209	42	8.7	7.3	10.8	
Sp Cond	fish	43	15	528	458	715	0.171
	No fish	209	47	505	439	580	
TSS	fish	43	33	112	97	144	0.047
	No fish	209	114	163	115	282	

Table 7.21. Comparison of samples with silver chub to samples without for substrate from the seine sampling in the lower Platte River, Nebraska.

	Size	Missing	% sand	% gravel	% silt	% rock
Substrate fish	43	14	77.2	1.3	21.5	0.5
Substrate none	209	38	73.4	1.6	23.8	1.1

Table 7.22. Number of silver chub captured in combined depth and velocity categories during seine sampling in the lower Platte River, Nebraska.

Depth (m)	mean column velocity (m/s) <0.30	0.30-0.60	0.60-0.90	>0.90	Total
<0.30	6	2	0	0	8
0.30-0.60	9	8	1	0	18
0.60-0.90	3	1	0	0	4
>0.90	0	0	0	0	0
Total	18	11	1	0	30

Table 7.23. Percent use by silver chub captured in combined depth and velocity categories during seine sampling in the lower Platte River, Nebraska.

Depth (m)	mean column velocity (m/s) <0.30	0.30-0.60	0.60-0.90	>0.90	Total
<0.30	20.0	6.7	0.0	0.0	26.7
0.30-0.60	30.0	26.7	3.3	0.0	60.0
0.60-0.90	10.0	3.3	0.0	0.0	13.3
>0.90	0.0	0.0	0.0	0.0	0.0
Total	60.0	36.7	3.3	0.0	100.0

Table 7.24. Normalized selected habitats by silver chub captured in combined depth and velocity categories during seine sampling in the lower Platte River, Nebraska.

Depth (m)	mean column velocity (m/s) <0.30	0.30-0.60	0.60-0.90	>0.90
<0.30	0.69	0.57	0.00	0.00
0.30-0.60	0.92	0.84	1.00	0.00
0.60-0.90	0.39	0.22	0.00	0.00
>0.90	0.00	0.00	0.00	0.00

110 mm total length. Even though numbers were low, all specimens captured in May and June 2001 and 2002 were over 75 mm (Kopf 2003). By July and August, substantial numbers of individuals less than 60 mm appear in the collections along with those larger than 80 mm and by September there were three apparent cohorts (age classes) (Kopf 2003). From this it appears that silver chubs in the Platte River attain a length of about 40 mm by the end of their first summer of growth (age 0) and between 70 and 90 mm by the end of their second summer (age 1). This is somewhat slower than the growth reported by Becker (1983). He reports mean lengths at annulus formation of 79, 127 and 146 mm for ages 1, 2 and 3, respectively. It also appears that in the Platte River, fish first spawn at age 1 and these fish make up a majority of the spawning population.

Length-Weight:

The length-weight regression for silver chubs was calculated by Kopf (2003). The regression for males was Log_{10} W = -5.364 + (3.134 (Log_{10} Total Length)) and for females it was Log 10W = -6.388 + (3.673 (Log_{10} Total Length)). Fulton condition factors (K(TL)) averaged 0.124 for males and 0.868 for females and showed no significant difference due to size of fish or month through the sampling season (May to September) even though high values occurred during the months of July through September. Swingle 1965 found Fulton condition factors ranging from 0.75 to 0.89 for silver chub in Alabama. A length weight relationship of Log $_{10}$W = -4.876 + (3.062 (Log_{10} Standard Length)) was reported by Kinney (1954) in western Lake Erie. Our data show that the male fish are thinner than those reported by Swingle.

Population Density:

Based on the average area sampled by trawls during our study the catch per unit area of silver chubs ranged from 0.42 to 1.33/100m^2 during 2001 and 2002, respectively. The density tended to increase from less than 0.5fish/100m^2 at the Leshara and the Elkhorn River sites to over 1.33/100m^2 at the Schilling site (Table 7.25). This pattern of increasing density downstream agrees, in general, with that found by Yu (1996), except that in 1992 he also found high densities of silver chub (1.25/100m^2) at Columbus, NE. In contrast, Yu (1996) generally found densities of silver chubs along the

Clarks to Louisville length of the Platte River to be below $0.5/100m^2$. This may indicate that silver chub are using shallow water, sampled by grid electrofishing and deeper water, sampled by trawls at about the same densities in the lower Platte River and it may be further evidence of their habitat generalist tendencies (Cross 1967, Becker 1983).

Reproductive Status:

All of the 8 female silver chubs that contained well developed eggs were larger than 75 mm. GSI values for female silver chubs ranged from 0.299 to 5.698 and averaged 0.868. The maximum value agrees closely with the GSI value of 5 reported by Becker (1983) for fish from the Wisconsin River.

Associated Species:

Silver chub were collected with 28 species of fish, 17 species in seine samples and 24 species in trawl samples (Table 7.26). Shoal chub and channel catfish were collected most frequently with silver chubs (38) followed by river shiner (36) and sand shiner (34). This diverse assemblage of associated species supports the observation of Cross and Moss (1987) who considered silver chubs to be tolerant of the greatest diversity of river habitats from backwaters to open channels. Becker (1983) collected 23 species of fish with silver chub in the Wisconsin River. Shorthead redhorse, northern hog sucker, golden redhorse and spotfin shiner were the most common species, in order of abundance, in those collections of silver chub.

Flathead Chub Distribution:

Flathead chub are the most widespread of the chub species in Nebraska, having been collected in the Platte River system all the way to the Wyoming state line, but recent studies by Lynch and Roh (1996) failed to find them in the North Platte River drainage. They have also been collected in the Niobrara River to west of Valentine and into the headwaters of the Loup River and Elkhorn River systems. They were formerly (pre 1970) found in the Republican River system, but there are no recent records for them in this river.

Habitat use:

Flathead chubs were captured at depths which ranged from 0.23 m to 1.16 m and bottom velocities from 0.24 to 0.56 m/s (Kopf 2003). Substrate texture ranged from 75% sand and 25% gravel to 100% sand with the latter condition being the most frequently occurring condition. Flathead chub inhabit a wide range of habitat conditions from quiet pools to swift main channels (Olund and Cross 1961, Cross 1967). In the Platte River (Peters and Holland 1994) found that they primarily used water depths less than 0.45m with current velocities of 0.1 to 0.4 m/s. Hardy and Asscociates (1992) indicated that their preference was for shallow depths (< 0.3 m) with slow to moderate velocities (< 0.6 m/s). Our results would expand the depth range to deep (>0.6 m) on that scale. Werdon (1992) considered flathead chub to be characteristic of higher velocity areas within the Missouri River basin. In our collection with the trawl, flathead chub were found in moderate velocity habitats and depths ranging to over 1 m.

Age and Growth:

Flathead chub may grow to nearly 250 mm (Pflieger 1997) and live to age 4. Flathead chub were uncommon in our collections during this study (Kopf 2003). The 16 specimens captured ranged in size from 29.8 to 95.6 mm total length. All specimens less than 45 mm were judged to be immature, since their gender could not be determined. It seems unlikely that fish between 30 and 40 mm caught during July would be age 0 and therefore we assign them to age class 1. However, several of the fish in the 45 to 55 mm size category were identified as males. The smallest individuals identified as females were over 70 mm total length. It may be that flathead chub females do not mature until they are age 2, but that males mature at age 1. This is corroborated by the findings of Fisher et al. (2002), who found that female flathead chubs don't mature until age 3 and may live to age 5. In contrast, Fisher et al. (2002) also state that all flathead chubs less than 100 mm are age 1 or younger. This does not fit our data from the Platte River.

Length-Weight:

No length-weight regression for flathead chubs collected during this study was calculated. Condition factors for the

Table 7.25. Comparison of silver chub densities (N/100 m2) for locations along the Platte River from Clarks, NE to the confluence with the Missouri River. Data adapted from Yu (1996) and Kopf (2003).

Location (River Mile)	1992 (Yu 1996)	1993 (Yu 1996)	2001 / 2002 (Kopf 2003)
Clarks (134-135)	0	0.13	-
Columbus (100-101)	1.25	0.13	-
Rogers (80-81)	0.38	0.25	-
North Bend (69-70)	0.13	0	-
Leshara (48-49)	-	-	0.50
Elkhorn R. (32-33)	-	-	0.42
Louisville (15-16)	1.00	0.50	0.78
Schilling WMA(0-1)	-	-	1.33

Table 7.26. Frequency of occurrence by species associated with silver chub from trawl and seine samples collected in the lower Platte River, Nebraska.

Species common name	Frequency of occurrence from trawls	Frequency of occurrence from seines	Frequency of occurrence total
Channel catfish	30	8	38
Shoal chub	27	11	38
River shiner	26	10	36
Sand shiner	26	8	34
Red shiner	9	11	20
River carpsucker	7	6	13
Emerald shiner	5	7	12
Freshwater drum	6	3	9
Shovelnose sturgeon	8	1	9
Plains minnow	3	3	6
Quillback	4	2	6
Flathead chub	0	3	3
Brassy minnow	2	1	3
Common carp	1	1	2
Fathead minnow	1	1	2
Suckermouth minnow	2	0	2
Johnny darter	2	0	2
Sauger	2	0	2
Flathead catfish	2	0	2
Blue catfish	2	0	2
White perch	2	0	2
Gizzard shad	0	1	1
Bigmouth buffalo	0	1	1
Blue sucker	1	0	1
Bigmouth shiner	1	0	1
Green sunfish	1	0	1
Bluegill	1	0	1

specimens collected ranged from 0.649 to 1.144 and averaged 0.787. Fogle (1963) reported an average condition factor of 0.71 for flathead chubs in South Dakota. Our data is similar to that reported for South Dakota.

Population Density:

Flathead chub densities calculated during this study were small, ranging from 0.04 to 0.07/100m^2. No flathead chubs were collected at the Leshara site and their densities were highest in collections at the Elkhorn River site (Table 7.27). Yu (1996) collected flathead chub from Columbus to North Bend in the lower Platte River at densities up to 2.63/100m^2 at North Bend in 1993 (Table 7.27).

Reproductive Status:

Females comprised 4 and males 8 of the 16 flathead chub for which gender could be determined. The GSI values for the female flathead chubs ranged from 0.26 to 1.25. These fish were caught in May and early June. If these fish spawn in July and August as Martyn and Schmulbach (1978) found in South Dakota, then their eggs may have been still in development. Additionally, since these fish were small for mature females, they may have been a year away from reproduction (Fisher et al. 2002).

Associated Species:

Flathead chub were collected in association with 15 other species of fish, nine in trawls and 14 in seines (Table 7.28). River shiners occurred most frequently with flathead chubs (6) followed by red shiner (5) and then shoal chubs and silver chubs (4). Several authors have pointed to the common association among flathead chubs and other chub species (Stewart, 1981 Werdon 1992, Gelwicks et al. 1996) and this is similar to what we observed in our collections.

Table 7.27. Comparison of flathead chub densities (N/100 m^2) for locations along the Platte River from Clarks, NE to the confluence with the Missouri River. Data adapted from Yu (1996) and Kopf (2003).

Location (River Mile)	1992 (Yu 1996)	1993 (Yu 1996)	2001 / 2002 (Kopf 2003)
Clarks (134-135)	0	0	-
Columbus (100-101)	0	0.25	-
Rogers (80-81)	0.25	0.13	-
North Bend (69-70)	0	2.63	-
Leshara (48-49)	-	-	0
Elkhorn R. (32-33)	-	-	0.12
Louisville (15-16)	0	0	0.03
Schilling WMA(0-1)	-	-	0.05

Table 7.28. Frequency of occurrence by species associated with flathead chub from trawl and seine samples collected in the lower Platte River, Nebraska.

Species common name	Frequency of occurrence from trawls	Frequency of occurrence from seines	Frequency of occurrence total
River shiner	2	4	6
Red shiner	2	3	5
Shoal chub	2	2	4
Silver chub	1	3	4
Emerald shiner	2	1	3
Channel catfish	2	1	3
Freshwater drum	0	3	3
Plains minnow	0	2	2
River carpsucker	0	2	2
Sand shiner	1	1	2
Shovelnose sturgeon	1	1	2
Fathead minnow	0	1	1
Common carp	0	1	1
Bigmouth buffalo	0	1	1
Bluegill	1	0	1

CHAPTER 8

PHENOLOGY AND RELATIVE ABUNDANCE OF LARVAL FISHES IN THE LOWER PLATTE RIVER NEBRASKA

INTRODUCTION

Until recently, most studies of river fishes have largely ignored their eggs, larvae and other early life stages (Brown and Coon 1994, Scheidegger and Bain 1995, Wolf et al. 1996). However, the presence of the larval stage of a species can give an indication of the spawning success for that year and provide an early indication of the year-class-strength later in the life of that cohort (Hergenrader et al. 1982, Franzin and Harbicht 1992). Prior to the studies of Hofpar (1997) and Reade (2000) Hergenrader et al. (1982) collected a limited amount of information on larval fish in the Platte River. Both Hofpar and Reade collected larval sturgeon and Reade (2000) collected chub larvae, but Hergenrader et al. (1982) collected neither of these taxa in the Platte River.

The objective of this study was to document the phenology and relative abundance of larval recruitment for pallid sturgeon, shovelnose sturgeon, sturgeon chub and associated species in the lower Platte River.

METHODS

Larval fish were sampled at four sites in the lower Platte River to describe the chronology of reproduction and hatching of all species in the lower Platte River following the protocol developed by Reade (2000). These sites were located near Two Rivers SRA (RM 41), US Highway 6 Bridge (RM 27.9), Nebraska Highway 50 Bridge (RM 15.5) and Schilling WMA (RM 0.5 – 2.8). Nets used for larval fish sampling were rectangular, 0.5 m high by 1.0 m wide by 5 m long made from 0.6 mm mesh Nytex. Each net was equipped with a current meter to measure average water velocity through the net during the time it was deployed, which in turn allowed determination of the water volume sampled. Nets were typically set in pairs for up to 15 minutes as determined by visual inspection of net clogging. A sample at a site consisted of 4 net sets. Time of sampling began at either midnight (0000 hours); 0300 hours; 0600 hours; 0900 hours; noon (1200 hours); 1500 hours; 1800 hours; or 2100 hours. Samples were preserved in 10% formalin in the field and transported to the lab for analysis.

Sampling commenced in May and continued through July of 2000 and 2001 but generally terminated by the end of June during 2002, 2003 and 2004. During 2000, 2001 and 2002 time for regular sampling was chosen at random and each site was sampled once per month starting the first week in May and continuing until August. In addition, the site at the US Highway 6 Bridge was sampled every 3 hours for a 24-hour period on weeks alternating with the regular sampling to determine diel periodicity of larval drift. In 2003, the sampling protocol was modified to try to identify more specifically the timing and location of sturgeon spawning in the areas downstream from the mouth of the Elkhorn River (RM 32.8). A site near the Nebraska Highway 50 Bridge (RM 15.5) and the site at the Highway 6 Bridge (RM 27.9) were sampled simultaneously every other week at three-hour intervals commencing at 1800 hr and concluding at 0600 hr. In 2004, the site at RM 15.5 was moved to the vicinity of the Schilling WMA (RM 0-0.5). The final sampling, commenced on 9 June at 18:00 hours and was completed on 10 June at 06:00 hours, was set immediately downstream from a radio tagged shovelnose sturgeon which had remained stationary over the previous week near the Nebraska Highway 50 Bridge (RM 15.5). These samples were collected because it was suspected that this behavior indicated potential spawning activity.

In the laboratory, specimens were sorted from extraneous material, identified to the lowest taxonomic category practicable, categorized by developmental stage, and enumerated. The number of each taxon and developmental stage was expressed per unit of water volume and number per net. All specimens were retained as vouchers and are either in the collections of the Nebraska State Museum or at the larval fish laboratory at Colorado State University in Fort Collins, Colorado.

RESULTS AND DISCUSSION

Six sites in the lower Platte River were sampled from 2000 to 2004. In addition, Reade (2000) also sampled sites near Columbus at RM 106 (32 samples) and North Bend at RM 72.5 (28 samples) in 1998 and 1999. The site near Two Rivers State Recreation Area at RM 41 was sampled from 1998 to 2002 (68 samples). The site at the US Highway 6 Bridge (RM 27.9) was sampled from 1998 to 2004 (1,362 samples). The site downstream from the Nebraska Highway 50 Bridge (RM 15.5) was sampled from 2000 to 2004 (193 samples). The site near Schilling WMA (RM 0.5 to 2.8) was sampled in 2002 and 2004 (154 samples).

The number of larvae collected, by family by year from 2000 to 2004, is summarized in Table 8.1 along with results from Reade (2000) who sampled using a similar protocol. This presentation includes fish from all sampling efforts in each year. The highest catch of larvae occurred in 2004 and the lowest catch of larvae occurred in 2001. The number and taxa of eggs and larvae collected by location from the lower Platte River is summarized in Table 8.2 and the number and taxa of juveniles collected by location from the lower Platte River is summarized in Table 8.3.

Sturgeon larvae were collected from the US Highway 6 Bridge to the mouth of the Platte River. Macrhybosis spp. (chub) larvae were collected at all sites except North Bend. Goldeye eggs were collected from the US Highway 6 Bridge to the mouth of the Platte River. Gizzard shad larvae, cyprinid larvae, common carp larvae, catostomid larvae and fish eggs, were collected at all six sites. Lepomis spp. larvae were collected at all sites except North Bend. Freshwater drum were collected at all sites except Columbus. Blue sucker larvae were collected at North Bend, the US Highway 6 Bridge , Louisville and Schilling WMA. Sander spp. larvae were collected from Two Rivers SRA to the mouth of the

Platte River. Channel catfish larvae were collected at Columbus, the US Highway 6 Bridge and Louisville. Brook silversides larvae were collected at Two Rivers SRA, the US Highway 6 Bridge and Louisville. Yellow perch larvae were collected at North Bend, Two Rivers SRA and the US Highway 6 Bridge. Mosquitofish larvae were collected at Columbus and Two Rivers SRA. Goldeye, centrarchid and Pomoxis spp. larvae were collected at the US Highway 6 Bridge and Schilling. Other larval taxa were collected only at the US Highway 6 Bridge.

Sturgeon larvae:

Between 1998 and 2004, 14 sturgeon (family Acipenseridae: Scaphirhynchus spp.) larvae were collected (Table 8.2 and Figures 8.1 and 8.2) between the dates of 15 May and 9 June During 1998 and 1999 Reade (2000) collected three sturgeon larvae between the dates of 26 May during 1999 and 23 and 24 June during 1998 (Table 8.4, Figures 8.1 and 8.2). In addition, Hofpar (1997) collected one sturgeon larva on June 10, 1996 near Fremont, NE (RM 57). The three larvae collected during the 2000 to 2002 sampling years were collected at the U.S. Highway 6 Bridge (RM 27.9). Of the three larvae collected during 2003, one was collected at the U.S. Highway 6 Bridge on 15 May, and the other two were collected downstream of the Nebraska Highway 50 Bridge at RM 15.5, one each on 15 May and 23 May. In 2004, four out of the five Scaphirhynchus spp. larvae were collected on 27 and 28 May at the US Highway 75 Bridge at RM 2.8. The change in sampling location was the result of the effect of high discharge in the Missouri River that had backed the Platte River up near the bridge. Usually we would have sampled at the Schilling WMA (RM 0.5). The fifth larva sampled in 2004 was collected on 9 June near the Nebraska Highway 50 Bridge at RM 15.5 during the collections downstream from the radio-tagged shovelnose sturgeon.

Based on morphological features, all sturgeon larvae collected are probably less than 1 day post hatch (Darryl Snyder: personal communication). Sturgeon larvae this young can only be identified to genus and not to species unless DNA analysis is used. DNA analysis was not possible, because the samples were fixed in formalin. All sturgeon larvae, with one exception, were collected following increases in water temperature. A relationship between sturgeon spawning and discharge is still unclear, but all except the specimen collected during 2000 were associated with a decline in discharge. In 2001, 2003 and 2004, collection sturgeon larvae were captured following peak discharges greater than 21,000 cfs. This agrees with the

Table 8.1. Summary of the number of larvae collected by family, from the lower Platte River, NE.

Year (volume m^3) Family	1998 (29,156)	1999 (28,121)	2000 (26,154)	2001 (26,730)	2002 (26,334)	2003 (25,834)	2004 (22,303)
Acipenseridae	1	2	1	1	1	3	5
Lepisosteidae	-	2	1	9	3	-	-
Hiodontidae	-	-	-	-	-	-	3
Clupeidae	161	113	113	181	196	24	3
Cyprinidae	5,249	14,418	2,267	1,671	3,619	3,409	4,546
Catostomidae	505	1,349	331	195	95	566	2,387
Ictaluridae	29	14	20	17	12	5	-
Atherinidae	4	3	1	-	2	1	-
Poeciliidae	1	-	9	-	-	-	-
Centrarchidae	84	54	12	27	13	-	-
Percidae	3	3	4	2	2	3	-
Sciaenidae	126	110	112	178	196	24	284
Total	**6,163**	**16,068**	**2,871**	2,281	**4,139**	**4,035**	**7,228**

Table 8.2. Fish larvae collected at all study sites in the lower Platte River, Nebraska during larval drift net sampling from 1998 to 2004.

Taxon	Columbus	North Bend	Two Rivers	US Highway 6	Louisville	Schilling WMA
Scaphirhynchus spp.				7	3	4
paddlefish				1		
Lepisosteus spp.				1		
Shortnose gar				15		
goldeye				1		2
Gizzard shad	4	8	6	432	15	18
Cyprinids	84	128	256	13607	5946	858
carp	150	11	3	4556	225	54
Macrhybopsis spp.	1	0	27	8625	594	74
Catostomids	43	94	30	2534	1970	668
Blue sucker		1		52	9	39
Ictalurids				4		
Channel catfish	1			73	4	
Flathead catfish				15		
Western mosquitofish	1		1	0		
Brook silversides			1	8	2	
Centrarchids				18		9
Lepomis spp.	2		2	117	8	9
Largemouth bass				7		
Pomoxis spp.				19		1
Percids				1		
Johnny darter				1		
Yellow perch		1	1	3		
Sander spp.			3	3	3	1
Freshwater drum		2	36	579	337	83

findings of Reade (2000) who collected larvae in 1998 and 1999. In 2000 and 2002, peak discharges greater than 21,000 cfs were not present early in May, but sturgeon larvae were still collected.

Christiansen (1975) found that shovelnose sturgeon spawned late in May through early June in Wisconsin when water temperatures were between 19 and 21°C. Coker (1930) considered the peak of the spawning season to be early May on the Mississippi River in Iowa. Cross (1967) suggested that sturgeons only enter streams tributary to the Missouri River during years when discharge is high enough to allow spawning. The conditions when we collected sturgeon larvae (Table 8.4) are similar to these published accounts.

When sturgeon larvae were collected, there were two taxa of eggs, 16 taxa of larvae and 27 taxa of juvenile and adult life stages present during the same samplings (Table 8.5). Cyprinid (minnow) larvae, catostomid (sucker) larvae and fish eggs were present during 100 percent of the samplings when sturgeon larvae were collected. Red shiner juvenile/adults and common carp larvae were present during 90 percent of the same samplings. River shiner juvenile/adults, chub larvae and freshwater drum larvae were each present during 70 percent of the same samplings. The other taxa collected were present during 60 percent or fewer of the samples when sturgeon larvae were collected (Table 8.5).

Chub larvae:

A total of 9,321 chub larvae (Macrhybopsis spp.) were collected between 2000 and 2004. Macrhybopsis spp. larvae were collected from 11 May to 15 August at temperatures ranging from 13.6 to 31.0°C (Figure 8.3). Mean daily discharge, when chubs were collected ranged from 1,410 to 34,900 cfs (Figure 8.4). Chub larvae in the Platte River were in low numbers during the discharge events and high following the peaks of these events. The highest numbers of chub larvae that Reade (2000) collected followed a large (39,370 cfs) discharge event in 1999. Robinson et al. (1998) noted that larval stages of four native fishes in the Little Colorado River probably peaked during the descending limb of spring runoff peaks. Because of the preponderance of shoal chub present in the samples collected by trawl and seine it is

Table 8.3. Juvenile and adult fish collected during larval drift net sampling at all sites from 1998 to 2004.

Taxon	Columbus	North Bend	Two Rivers	Highway 6	Louisville	Schilling WMA
Shortnose gar				1		
Longnose gar				1		
Gizzard shad	7	43	1	119		10
Cyprinids	23	1	51	586	14	13
Red shiner	12	1	272	461	53	34
Common carp	2	2	1	377	3	3
Hybognathus spp.	2			19	2	
Plains minnow	2			26		
Macrhybopsis spp.				47	2	1
Shoal chub		3		94	13	1
Silver chub				12	1	1
Notropis spp.				30	2	13
Emerald shiner	2		3	28	2	5
River shiner	1	1	10	208	26	7
Sand shiner		1	7	135	14	74
Fathead minnow	4		10	152	1	
Flathead chub	1		1			
Rudd					3	
Catostomids	1			9	1	
Carpiodes spp.		1		142	1	1
River carpsucker				2		1
Shorthead redhorse				4		
Black bullhead				1		
Channel catfish	2	1	1	199	73	12
Flathead catfish				32		5
Grass pickerel				1		
Northern pike				1		
Western mosquitofish	2	1	1	2		
Brook silversides	1		5	7		1
Brook stickleback		1		18	1	
Centrarchids				9		
Lepomis spp.	1	5	1	201	17	24
Green sunfish				1	1	
Bluegill	2			48	3	1
Micropterus spp.				2		
Largemouth bass	1	2		89	1	1
White crappie		1		51	2	10
Johnny darter				1		
Yellow perch				2		
Sander spp.				0		1
Sauger				1		
Walleye				1	2	
Freshwater drum		1		42	1	

Larval drift net

most likely that the larval specimens can be attributed to this species. Cross (1967) and Pflieger (1997) both considered the reproduction for speckled chubs to extend from May into August at water temperatures over 20 °C.

Two taxa of eggs, 22 taxa of larvae, and 39 taxa of juvenile and adult life stages were collected during the same samplings as chub larvae (Table 8.6). Cyprinid larvae were present during 100 % of the sampling when chub larvae were collected. Fish eggs were present in 98.1 % of the same samplings, and catostomid larvae were present in 90.6 % of the same samplings. Freshwater drum larvae, red shiner juvenile/adults and gizzard shad larvae were present in 81.1, 75.5 and 71.7 % of the same samplings as chub larvae, respectively. Larval common carp and cyprinid juvenile/adults were present in 69.8 and 66.0 % of the same samplings as chub larvae, respectively. The other taxa and life stages we collected were present in less than 53 % of the same samplings as chub larvae (Table 8.6).

Other larval taxa:

Gar larvae (Lepisosteidae) were collected in 4 out of the 7 years (Table 8.1). Most of these were identified as shortnose gar. Gar larvae were collected as early as 4 June and as late as 2 July. In Kansas gars spawn in May and early June (Cross 1967). In South Dakota shortnose gar spawned at water temperatures between 19 and 24°C which occurred between the dates of 20 May and early July (Carlander 1969).

A total of 791 gizzard shad (Clupeidae) larvae (1.8% of the total) was collected between 1998 and 2004 (Table 7.1). Larvae were collected from 11 May to 3 August at water temperatures ranging from 16.2 to 29.9 °C (Figure 8.5). Mean daily discharge ranged from 1,480 to 34,900 cfs when gizzard shad larvae were collected (Figure 8.6). The lower number collected during 2003 and 2004 is probably related to our truncating the sampling season to May and June. Cross (1967) states that gizzard shad usually spawn from late May into June, but there may be a second spawning later in June. This falls well within the period when we collected gizzard shad larvae. Gizzard shad comprised 5.5% of the larval fish that Hergenrader et al. (1982) collected in the Platte River.

Minnow larvae (Cyprinidae) outnumbered all other families of fish in the drift (82.2%) with a total of 35,179 larvae (Table 8.1). Common carp and chub (Macrhybopsis

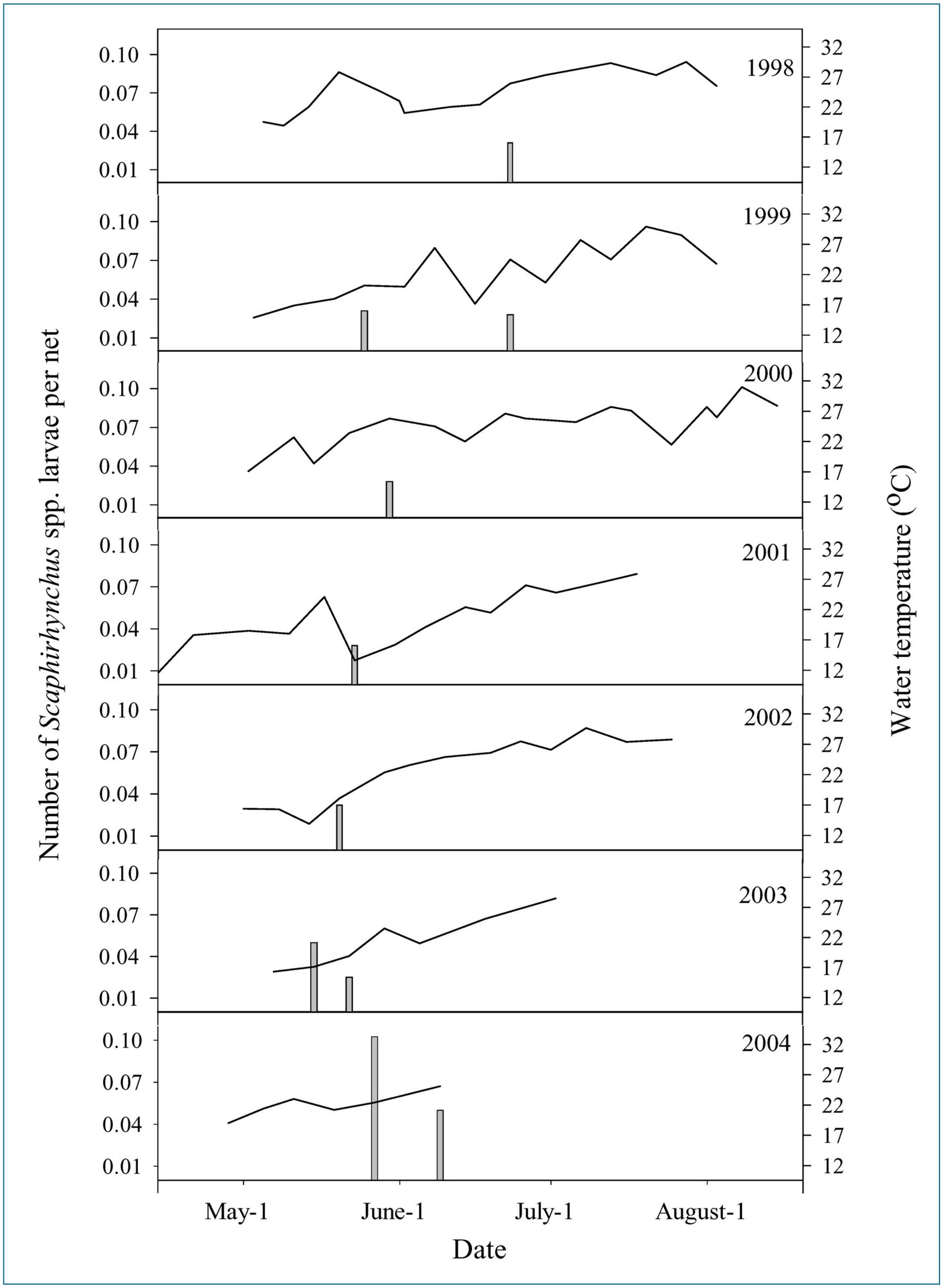

Figure 8.1. Number of sturgeon larvae per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

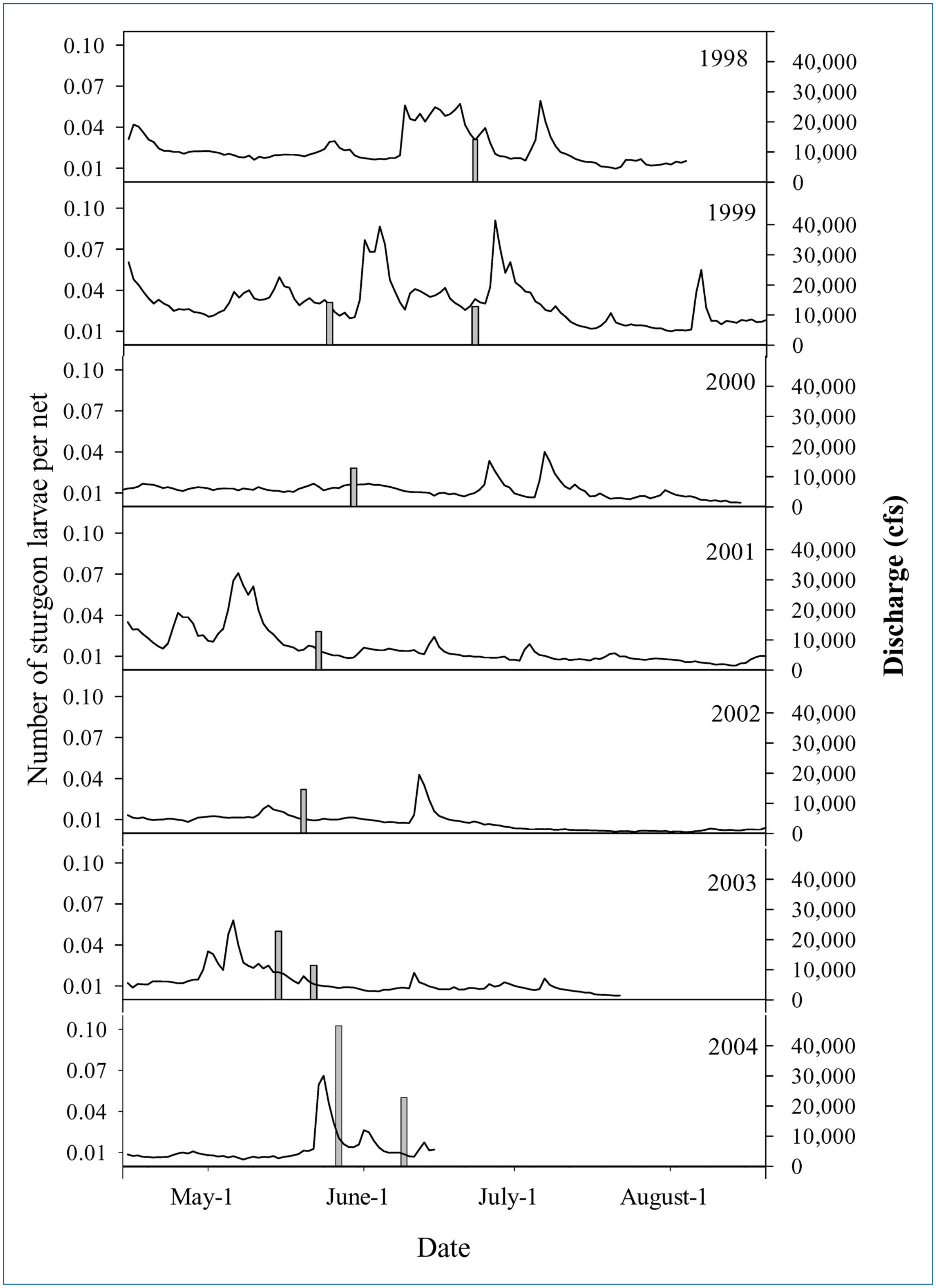

Figure 8.2. Number of sturgeon larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

Table 8.4. Year, (time of day) and water temperature (°C) at the time when sturgeon larvae were captured in the lower Platte River, Nebraska, 1998 to 2004. Locations of sampling sites are near the US 73, 75 Bridge (RM 2.8), near the NE 50 Bridge (RM 15.5), and near the US 6 highway Bridge (RM 27.9). Collections by Reade (2000) are indicated by an asterisk (*).

MONTH/ DAY	RM 2.8	RM 15.5	RM 27.9	TEMPERATURE
May 15	2003 (18:00)			18.1
May 15			2003 (21:00)	17.8
May 21			2002 (06:00)	15.8
May 23			2001 (21:00)	13.6
May 23	2003 (03:00)			18.5
May 26			1999 (00:00)*	20.5
May 27		2004 (18:00)		22.9
May 28		2004 (03:00)		21.3
May 28		2004 (03:00)		21.3
May 28		2004 (06:00)		20.7
May 31			2000 (03:00)	24.8
June 9	2004 (18:00)			27.1
June 23		1998 (21:00)*		27.4
June 24		1999 (03:00)*		25.2

spp.) larvae were the only taxa that could be separated from other cyprinid larvae. Therefore, our reference to cyprinids refers only to those larvae that could not be identified beyond the family level. A total of 20,816 cyprinid larvae (48.7%) was collected between 1998 and 2004. Cyprinid larvae were collected from 10 May to 15 August and water temperatures ranged from 13.6 to 31.0 °C (Figure 8.7). Mean daily discharge ranged from 593 to 34,900 cfs when cyprinid larvae were collected (Figure 8.8). Cyprinids comprised 30% of the larval fish that Hergenrader et al. (1982) collected in the Platte River.

A total of 4,998 common carp larvae (11.7%) was collected between 1998 and 2004. Larvae were collected between 13.6 and 29.9 °C (Figure 8.9). Mean daily discharge ranged from 1,010 to 34,900 cfs when larvae were collected (Figure 8.10). Carp spawning may occur from April to August in Wisconsin (Becker 1983) and March to September in Missouri (Pflieger 1997). Mraz and Cooper (1957) found that the greatest activity occurs between the temperatures of 18 and 24 °C. Carp comprised 9.3% of the larval fish that Hergenrader et al. (1982) collected in the Platte River.

A total of 5,428 sucker (Catostomidae) larvae (12.7%) was collected from 1998 to 2004. This constitutes 12.7 percent of all larvae collected (Table 8.1). Of the 5,428 sucker larvae collected, 26.6 % of these were collected on 9 and 10 June 2004 near the Nebraska Highway 50 Bridge. Catostomids comprised 46.5% of the larval fish that Hergenrader et al. (1982) collected in the Platte River.

Blue sucker were the only larvae identifiable beyond the family level. Therefore, all other sucker larvae are referred to as catostomids. Catostomids were collected from 28 April to 3 August at water temperatures ranging from 13.6 to 29.9 °C (Figure 8.11) and mean daily discharges between 1,700 and 34,900 cfs (Figure 8.12). The most abundant juvenile and adult sucker species in the lower Platte River are the river carpsucker and the quillback. Cross (1967) and Pflieger (1997) considered that their spawning seasons in Kansas and Missouri extended from late May to late July. Other species

Table 8.5. Percent occurrence of other taxa and life stages during sampling times when Scaphirhynchus spp. larvae were collected. Percentages are based on occurrence during the same samplings.

Taxon	Life stage	Percent occurrence
Unidentifiable	Eggs	100
Cyprinids	Larvae	100
Catostomids	Larvae	100
Red shiner	Juv/Ad	90
Common carp	Larvae	90
River shiner	Juv/Ad	70
Macrhybopsis spp.	Larvae	70
Freshwater drum	Larvae	70
Sand shiner	Juv/Ad	60
Gizzard shad	Larvae	60
Cyprinids	Juv/Ad	50
Common carp	Juv/Ad	40
Bluegill	Juv/Ad	40
Pomoxis spp.	Larvae	40
Carpiodes spp.	Juv/Ad	30
Brook stickleback	Juv/Ad	30
Lepomis spp.	Juv/Ad	30
Largemouth bass	Juv/Ad	30
Blue sucker	Larvae	30
Lepomis spp.	Larvae	30
Goldeye	Eggs	20
Gizzard Shad	Juv/Ad	20
Shoal chub	Juv/Ad	20
Emerald shiner	Juv/Ad	20
Fathead minnow	Juv/Ad	20
Catostomids	Juv/Ad	20
Centrarchids	Larvae	20
Hybognathus spp.	Juv/Ad	10
Plains minnow	Juv/Ad	10
Macrhybopsis spp.	Juv/Ad	10
Notropis spp.	Juv/Ad	10
Channel catfish	Juv/Ad	10
Grass pickerel	Juv/Ad	10
Western mosquitofish	Juv/Ad	10
Brook silversides	Juv/Ad	10
White crappie	Juv/Ad	10
Johnny darter	Juv/Ad	10
Sauger	Juv/Ad	10
Freshwater drum	Juv/Ad	10
Paddlefish	Larvae	10
Channel catfish	Larvae	10
Brook silversides	Larvae	10
Largemouth bass	Larvae	10
Johnny darter	Larvae	10
Yellow perch	Larvae	10
Sander spp.	Larvae	10

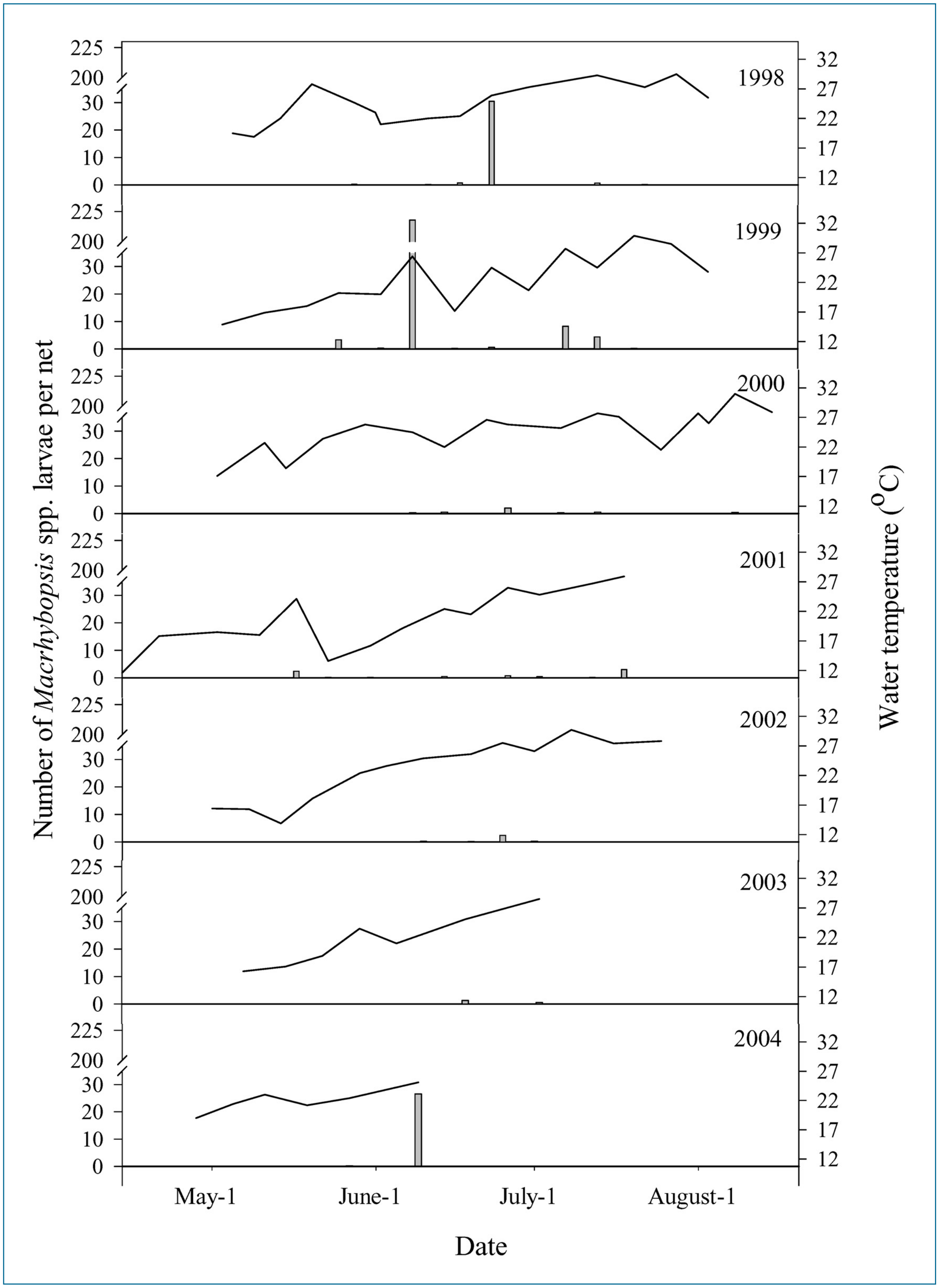

Figure 8.3. Number of chub larvae per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

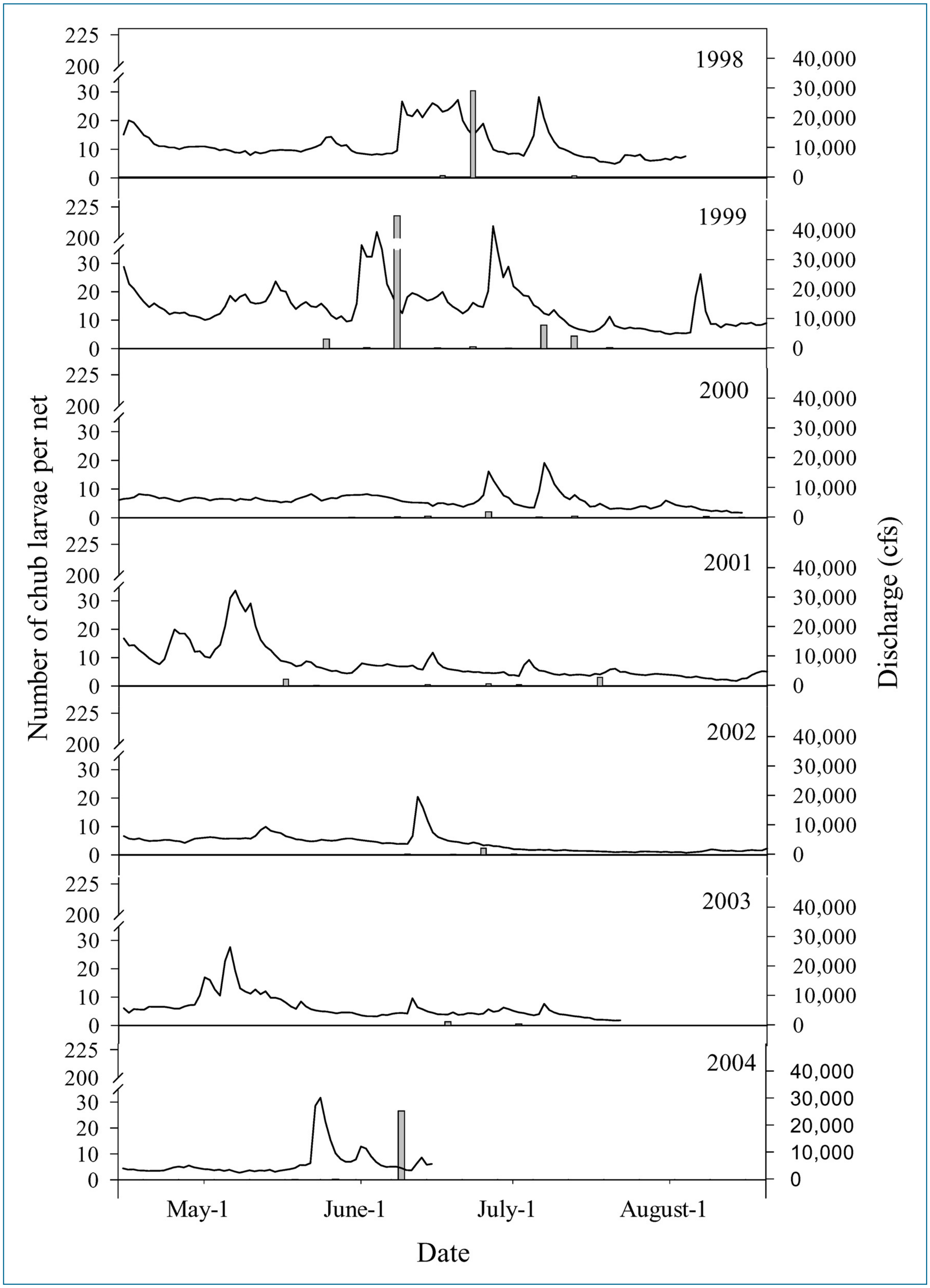

Figure 8.4. Number of chub larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

Table 8.6. Percent occurrence of other taxa and life stages during sampling times when chub larvae (Macrhybopsis spp.) were collected. Percentages are based on occurrence during the same samplings.

Taxa	Life stage	Percent occurrence
Cyprinids	Larvae	100.0
unidentifiable	Eggs	98.1
Catostomids	Larvae	90.6
Freshwater drum	Larvae	81.1
Red shiners	Juv/Adult	75.5
Gizzard shad	Larvae	71.7
Common carp	Larvae	69.8
Cyprinids	Juv/Adult	66.0
River shiner	Juv/Adult	52.8
Lepomis spp.	Larvae	49.1
Channel catfish	Juv/Adult	47.2
Sand shiner	Juv/Adult	39.6
unidentifiable	Larvae	39.6
Common carp	Juv/Adult	37.7
Carpiodes spp.	Juv/Adult	37.7
Lepomis spp.	Juv/Adult	34.0
Shoal chub	Juv/Adult	32.1
Falthead minnow	Juv/Adult	32.1
Gizzard shad	Juv/Adult	28.3
Notropis spp.	Juv/Adult	26.4
White crappie	Juv/Adult	26.4
Emerald shiner	Juv/Adult	24.5
Bluegill	Juv/Adult	24.5
Largemouth bass	Juv/Adult	24.5
Macrhybopsis spp.	Juv/Adult	22.6
Freshwater drum	Juv/Adult	22.6
Channel catfish	Larvae	22.6
Plains minnow	Juv/Adult	18.9
Silver chub	Juv/Adult	17.0
Pomoxis spp.	Larvae	17.0
Hybognathus spp.	Juv/Adult	15.1
Brook stickleback	Juv/Adult	15.1
Centrarchids	Larvae	15.1
Catostomids	Juv/Adult	13.2
Scaphirhynchus spp.	Larvae	13.2
Brook silversides	Larvae	13.2
Flathead catfish	Juv/Adult	11.3
Shortnose gar	Larvae	9.4
Brook silversides	Juv/Adult	7.5
Centrarchids	Juv/Adult	7.5
Blue sucker	Larvae	7.5
River carpsucker	Juv/Adult	5.7
Shorthead redhorse	Juv/Adult	5.7
Walleye	Juv/Adult	5.7

Table 8.6. (continued)

Taxon	Life stage	Percent occurrence
Ictalurids	Larvae	5.7
Flathead catfish	Larvae	5.7
Largemouth bass	Larvae	5.7
Goldeye	Eggs	3.8
Western mosquitofish	Juv/Adult	3.8
Green sunfish	Juv/Adult	3.8
Yellow perch	Juv/Adult	3.8
Longnose gar	Juv/Adult	1.9
Shortnose gar	Juv/Adult	1.9
River shiner	Juv/Adult	1.9
Grass pickerel	Juv/Adult	1.9
Largemouth bass	Juv/Adult	1.9
Johnny darter	Juv/Adult	1.9
Sander spp.	Juv/Adult	1.9
Sauger	Juv/Adult	1.9
Lepisosteus spp.	Larvae	1.9
Percids	Larvae	1.9
Johnny darter	Larvae	1.9
Yellow perch	Larvae	1.9
Sander spp.	Larvae	1.9

like northern shorthead redhorse and white sucker may spawn as early as late April (Cross 1967) and may constitute some of the early larvae in our collections.

A total of 101 blue sucker larvae (0.2%) was collected from 1998 to 2004. These larvae were collected from 2 May to 3 June at water temperatures ranging from 14.9 and 23.6 °C (Figure 8.13) at mean daily discharges between 4,310 and 15,470 cfs (Figure 8.14). Our collections dates for blue sucker larvae agree with observations of adults in breeding condition and collections of larvae from Kansas (Cross 1967) and Missouri (Pflieger 1997).

A total of 1,030 freshwater drum (Sciaenidae) larvae (2.4%) was collected from 1998 to 2004 (Table 8.1). Freshwater drum comprised 3.5% of the larval fish that Hergenrader et al. (1982) collected in the Platte River.

Drum larvae were collected from 11 May to 3 August at water temperatures ranging from 13.6 to 29.9°C (Figure 8.15) with mean daily discharges between 1,700 and 34,900 cfs (Figure 8.16). In Wisconsin drum spawned in the Mississippi river at temperatures between 19 and 22ºC (Becker 1983). Most summaries of drum spawning seasons emphasize dates between early May and late June (Becker 1983, Cross 1967, Pflieger 1997), but Schneider and Hasler (1960) note that drumming, which is thought to be related to spawning activity may continue into August.

Larvae of goldeye, channel catfish, flathead catfish, mosquitofish, brook silversides, Lepomis spp., largemouth bass, yellow perch and Percidae were collected between 1998 and 2004. Because these taxa, combined represent less than one percent of all larvae collected, no further analyses were conducted.

From 1998 to 2004, 32,284 fish eggs were collected. Eggs were collected during all sampling events, except three, at a range of temperatures (Figure 8.17) and discharges (Figures 8.18). The three sampling events with no eggs were 14 April 2001, 1 May 2002, and 16 May 2002. Hergenrader et al. (1982) collected 159 fish eggs from the Platte River.

Conclusions:

The collection of sturgeon and chub larvae in the lower Platte River confirms the use of this river for reproduction by these taxa. As stated earlier, sturgeon were collected downstream of the Elkhorn River and chubs were collected downstream of Columbus. However, since the larvae could not be identified to species, this does not confirm or eliminate the spawning of pallid sturgeon or sturgeon chub in the Platte River. It is probable, given the large number of adult shovelnose sturgeon and other chub species in comparison to pallid sturgeon and sturgeon chub that the larvae were not the species of concern. Yet the documentation of spawning by these genera suggests the potential for spawning by these rare species.

Since we caught and tracked shovelnose sturgeon to the vicinity of Columbus during our studies of habitat at times when sturgeon spawning could be occurring it raises the possibility that sturgeon may be spawning farther upstream than we collected their larvae. In addition, Hofpar (1997) caught sturgeon larvae as far upstream as Fremont, NE (RM 57) during a time when flows in the Platte River were higher. Several collections of large numbers of chubs also occurred at times of higher flows on the lower Platte River. This makes the period from late April to early June particularly important to the life history of sturgeon and chub species in the Platte River.

Cross and Moss (1987) discussed the influences of flow regulation and limitation on the species diversity in Kansas rivers. In addition, Dieterman and Galat (2004) pointed to the importance of long distances of undammed rivers to maintain the thermal regime and long drift corridors to allow for the development of chub larvae. The continuing loss of flow volume and fluctuation is almost certainly confining quality habitat for sturgeons and chubs and associated species to more downstream reaches of the Platte River.

Pulsed gastric lavage (PGL) of sturgeon to determine their diet.

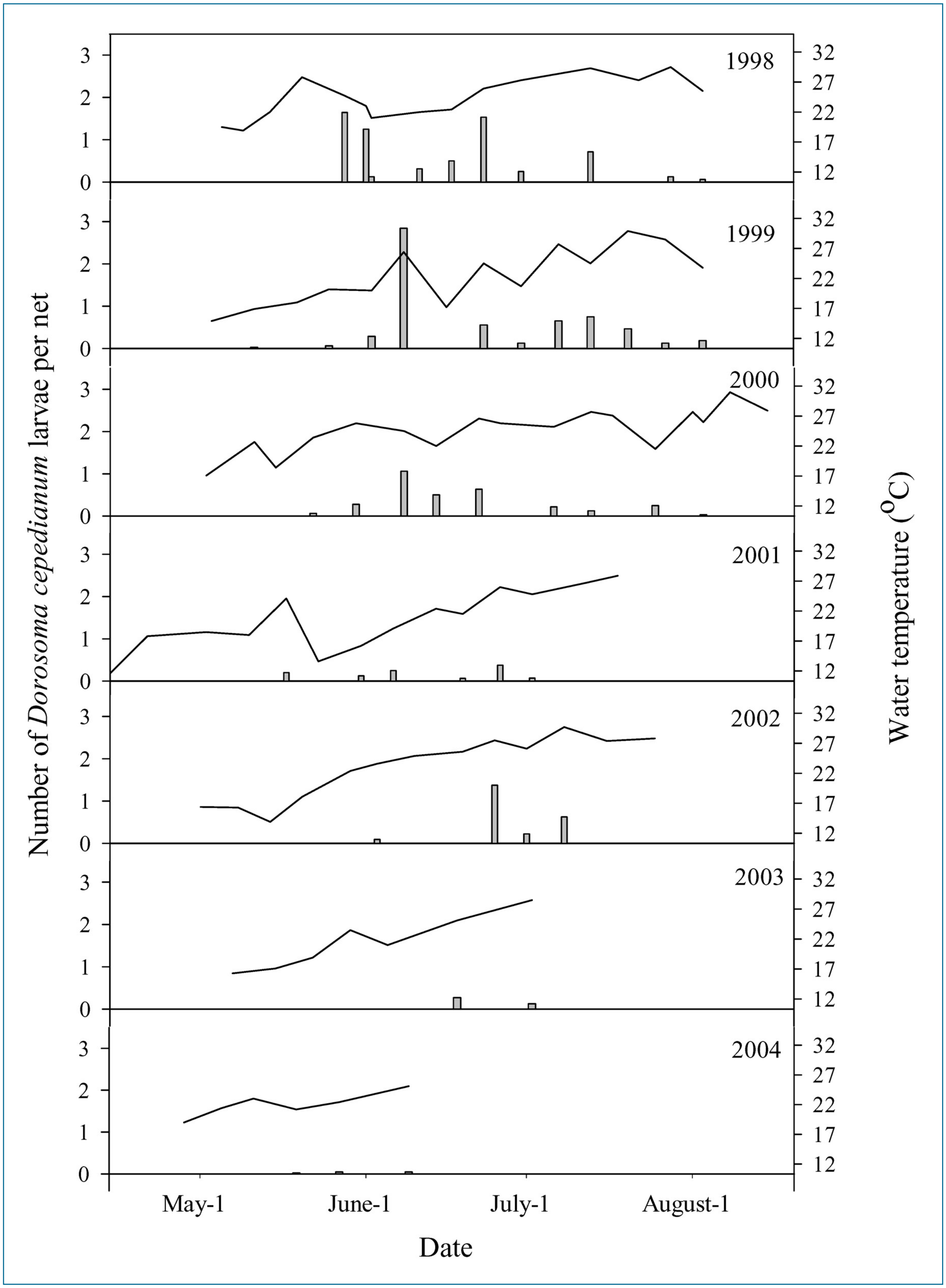

Figure 8.5. Number of gizzard shad larvae per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

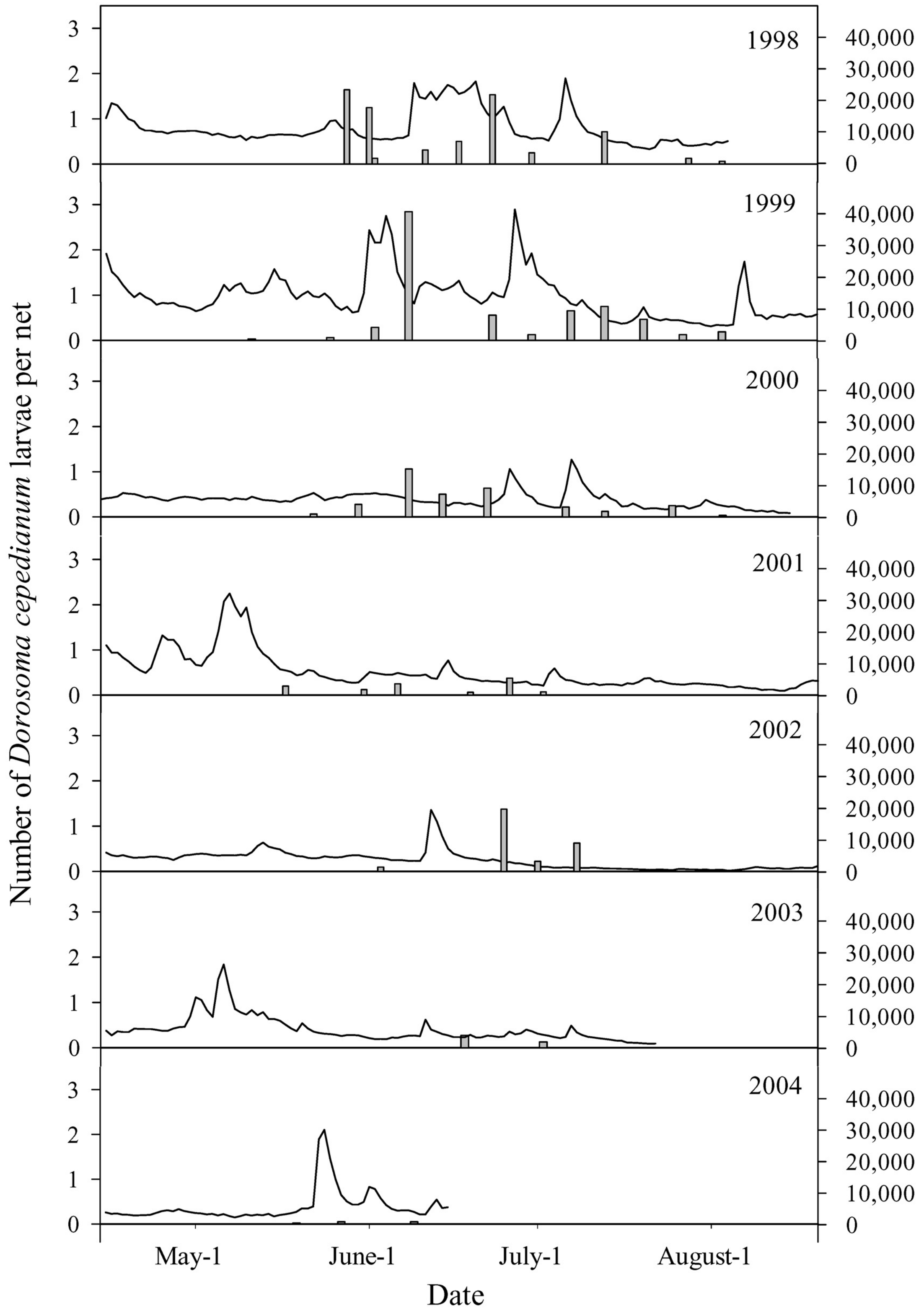

Figure 8.6. Number of gizzard shad larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

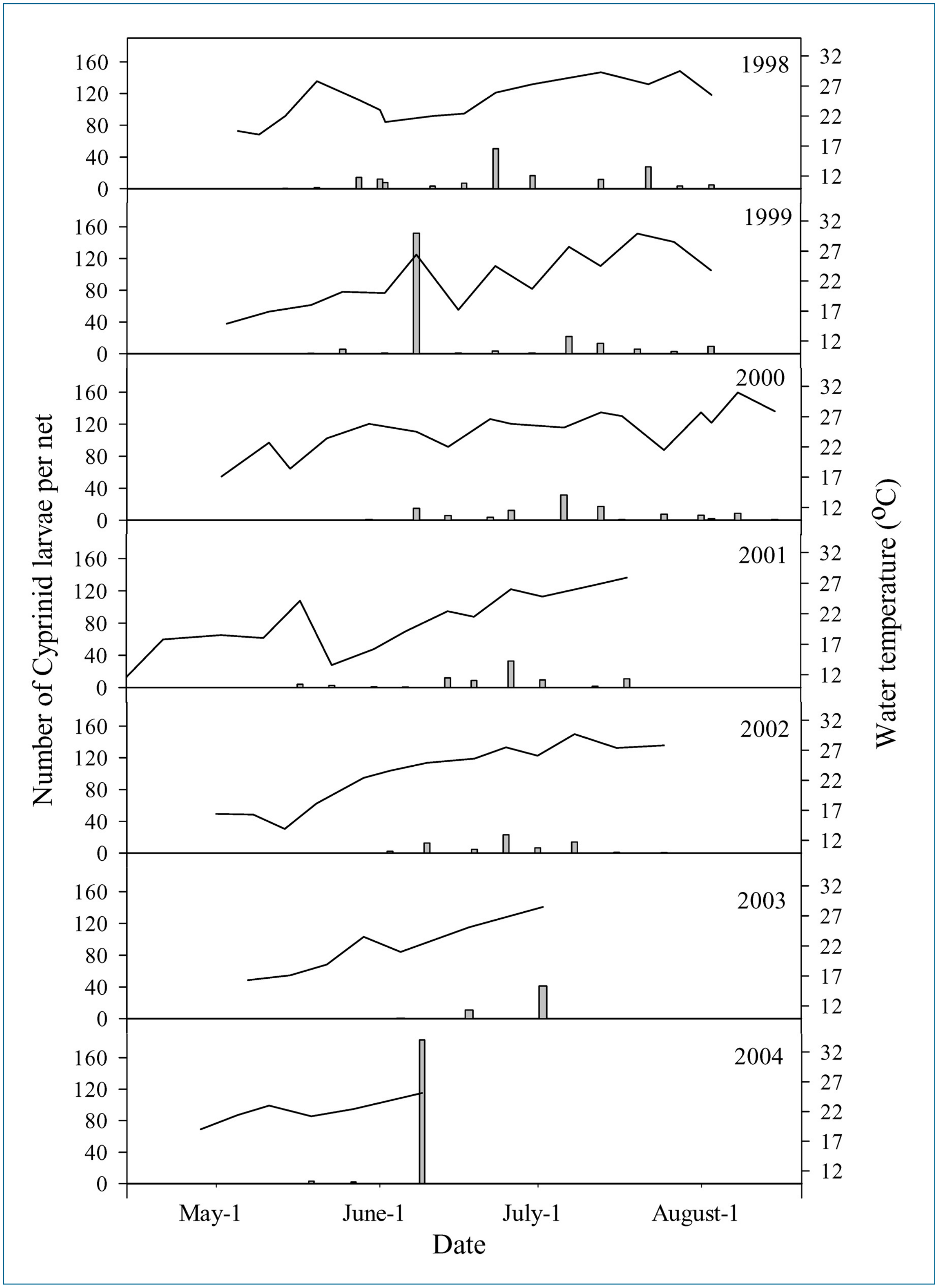

Figure 8.7. Number of cyprinid larvae per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

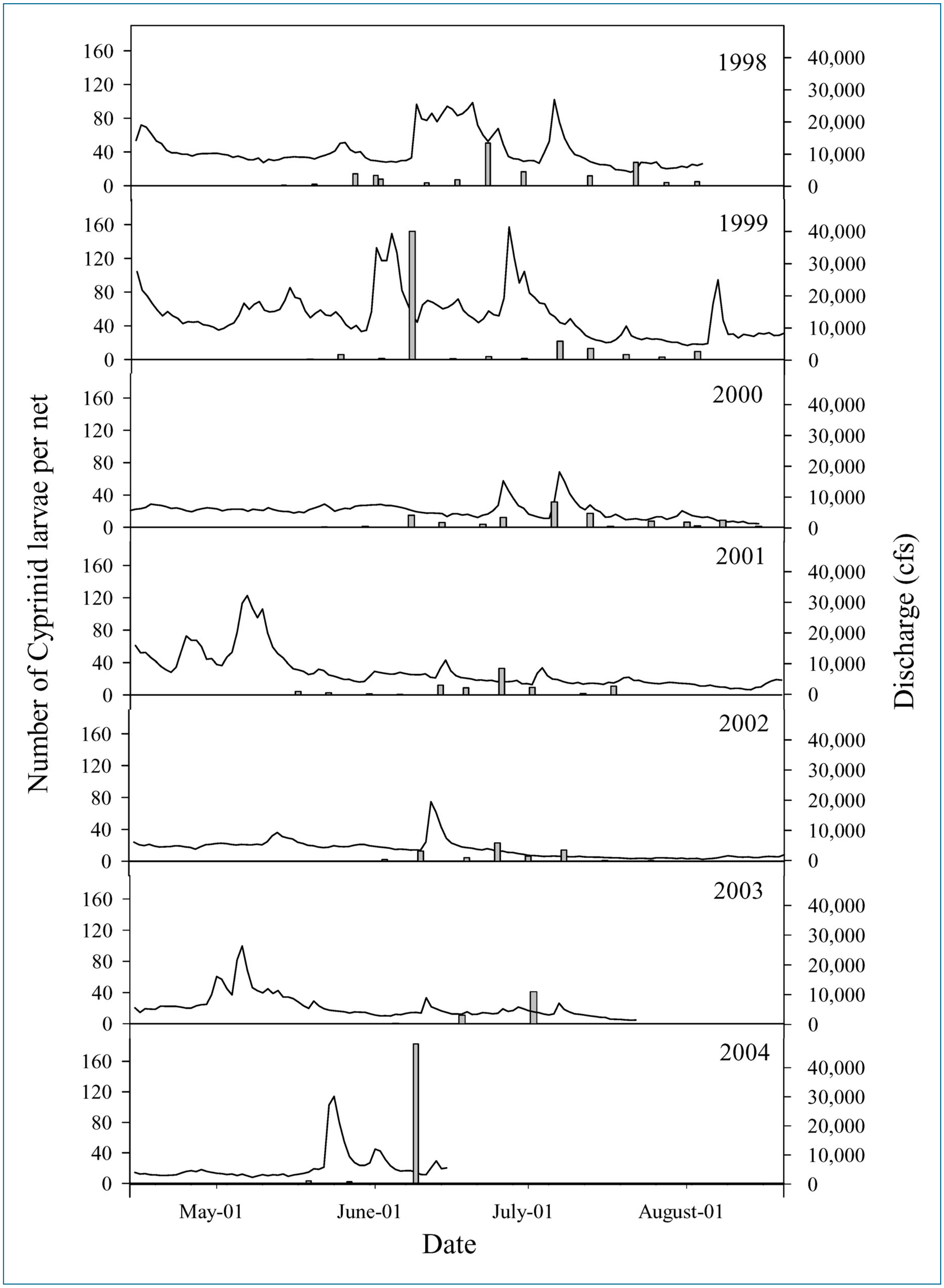

Figure 8.8. Number of cyprinid larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

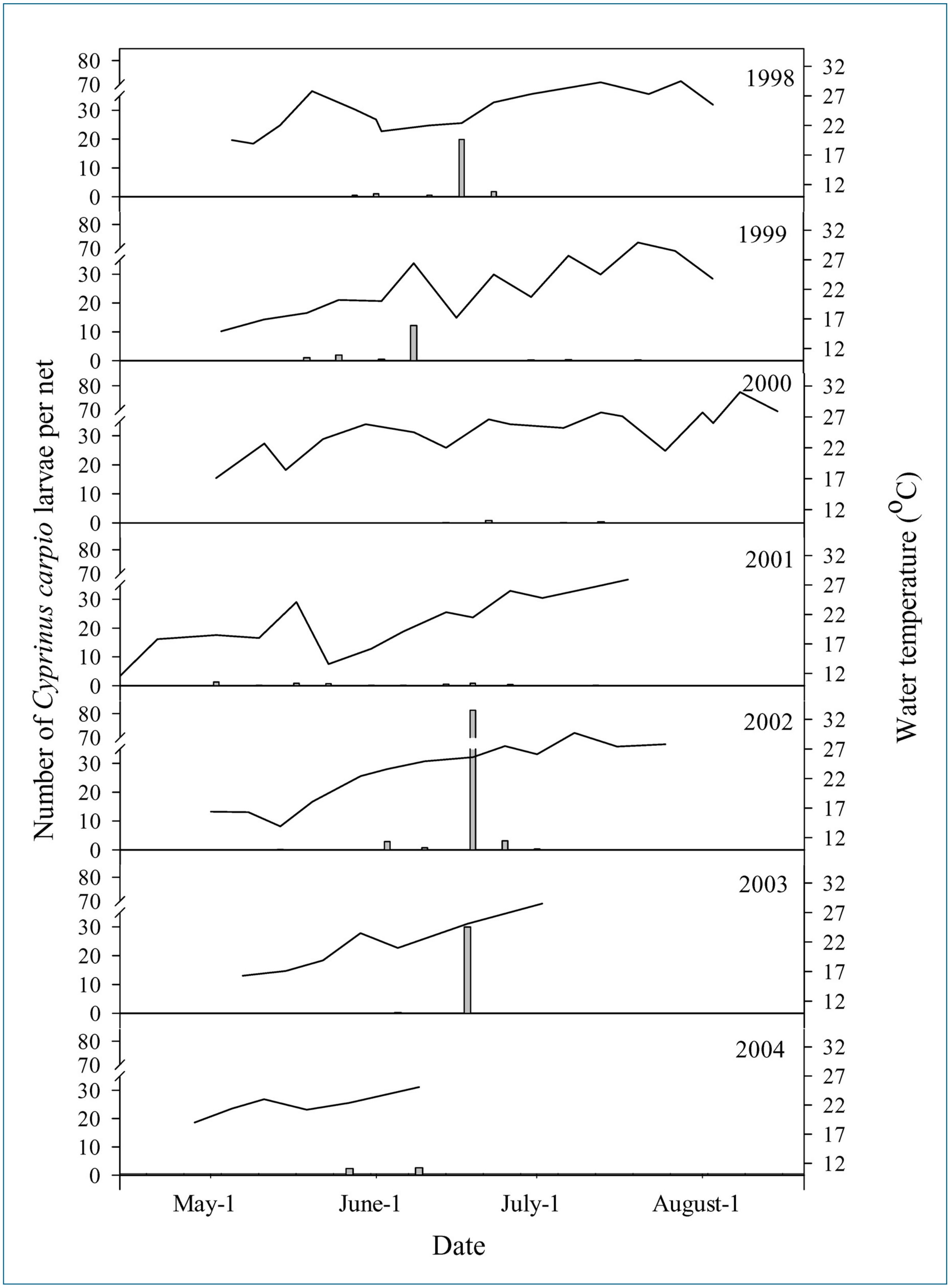

Figure 8.9. Number of common carp larvae per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

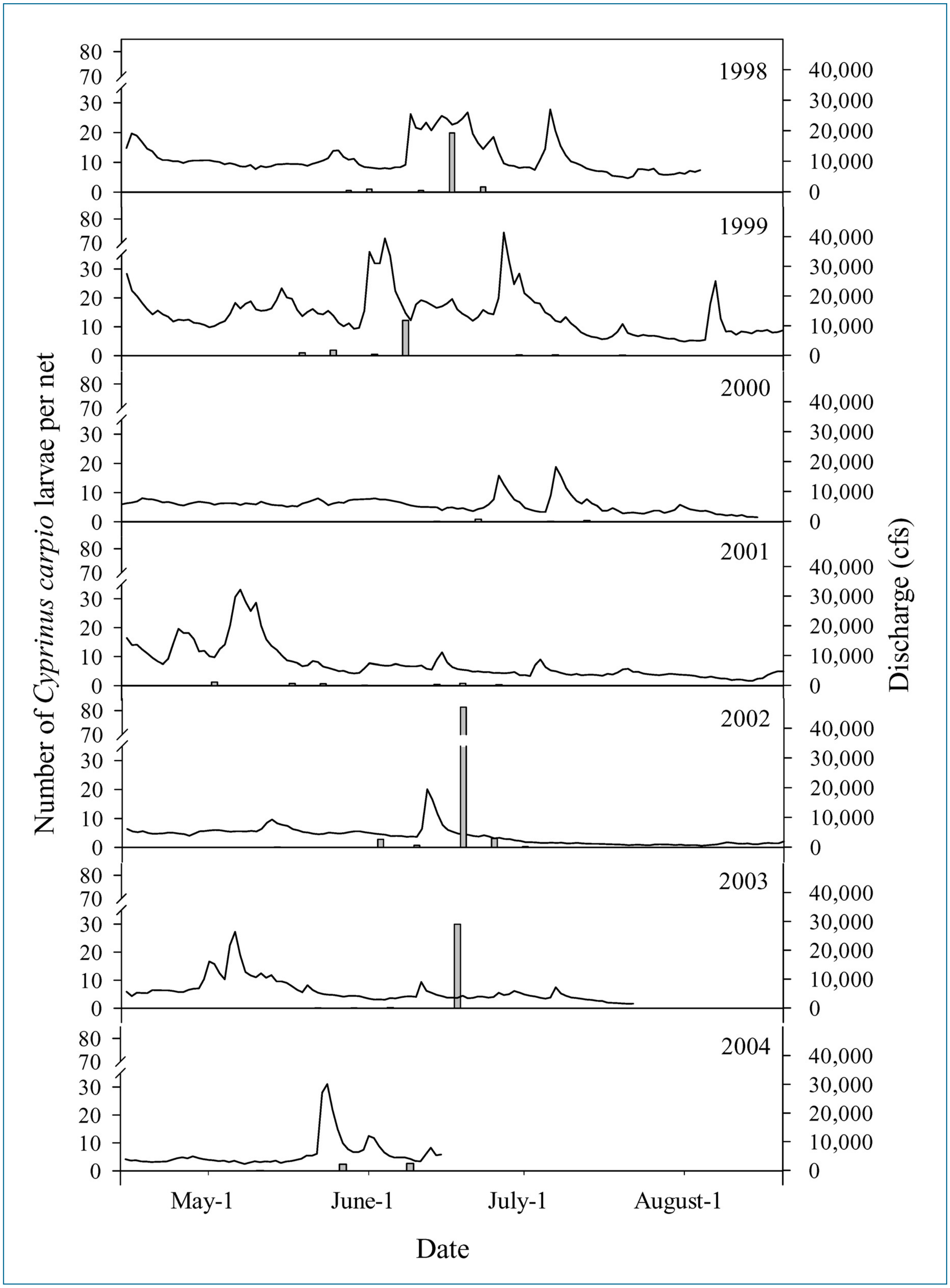

Figure 8.10. Number of common carp larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

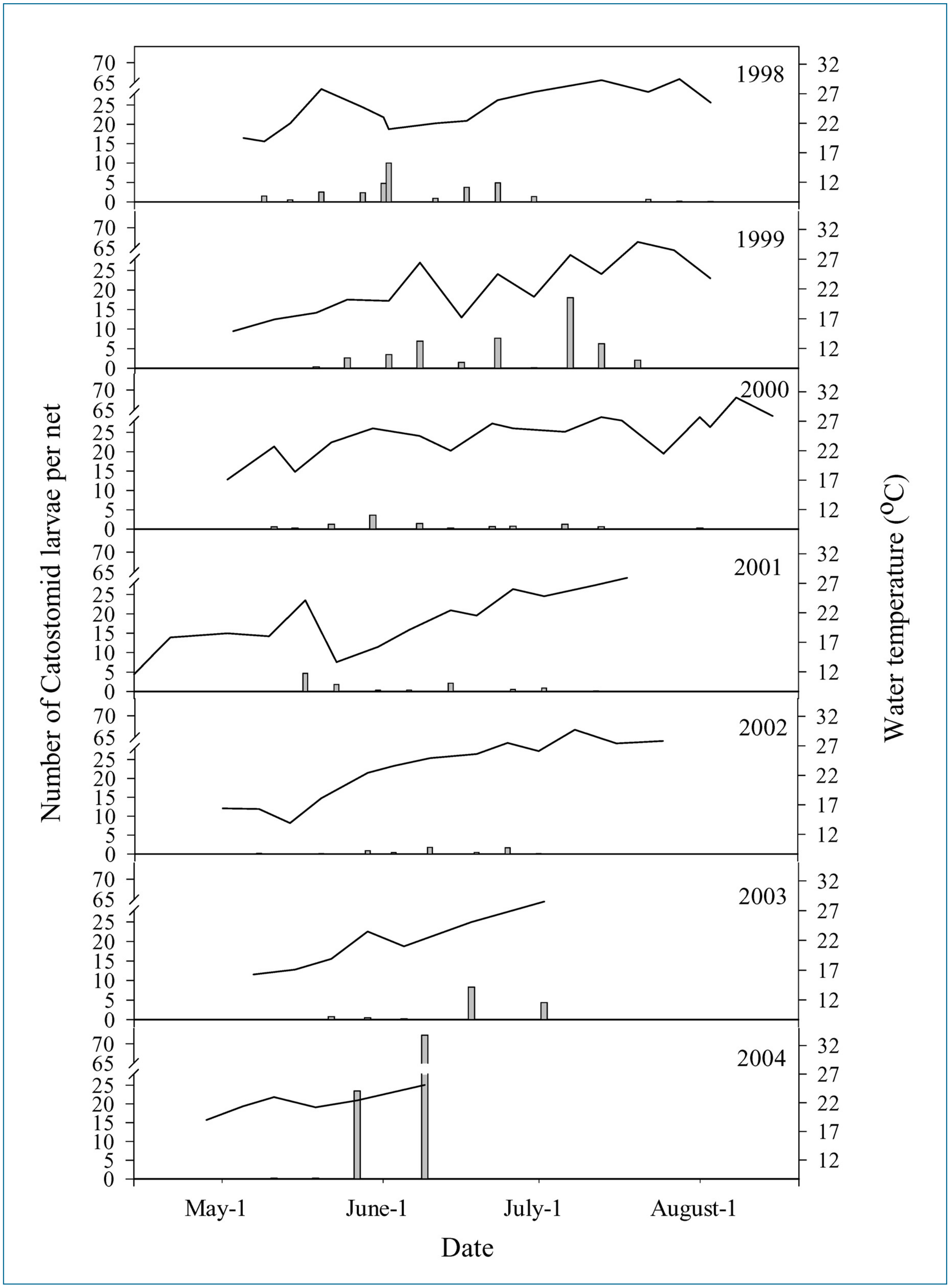

Figure 8.11. Number of Catostomid larvae per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

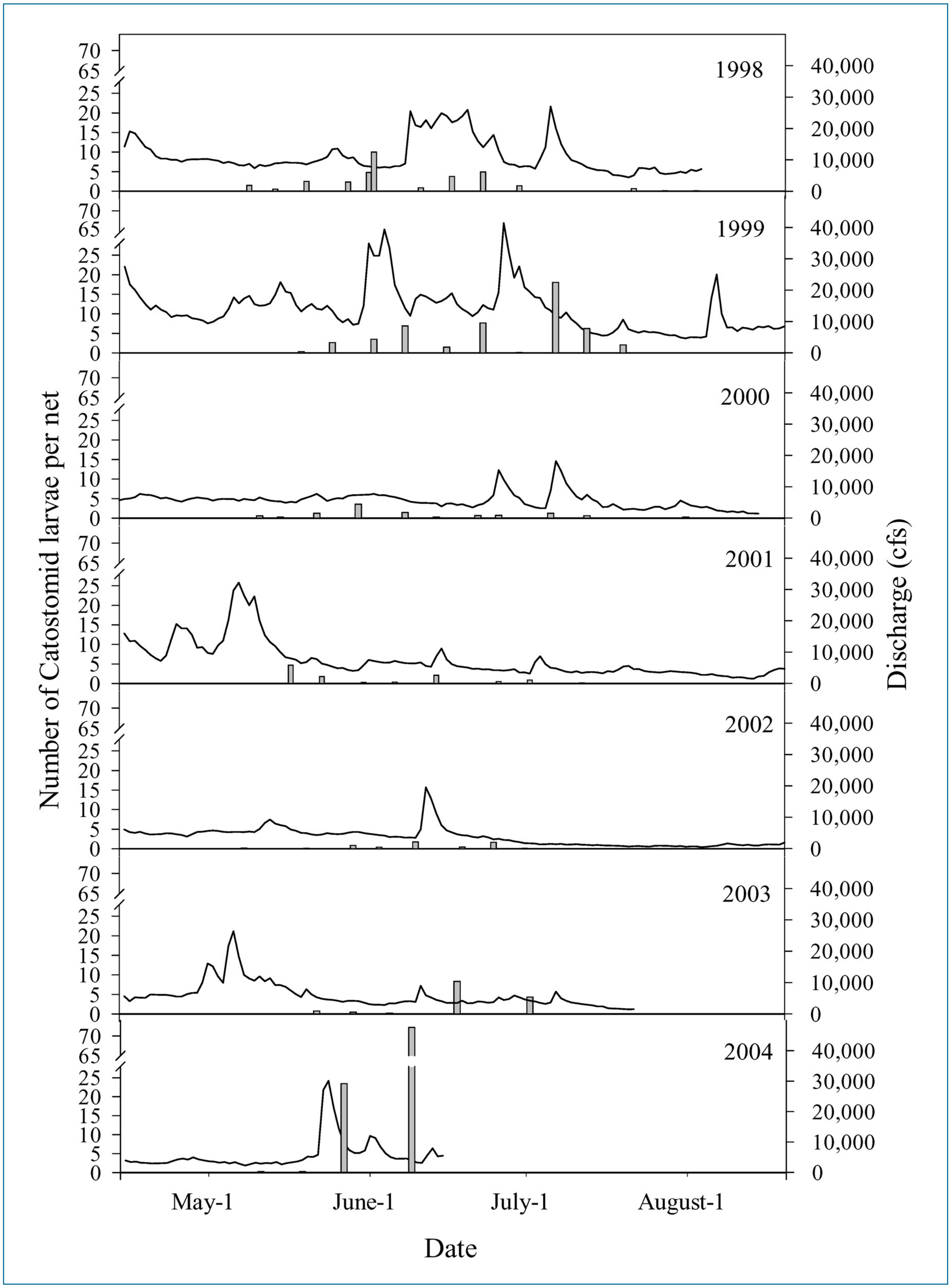

Figure 8.12. Number of catostomid larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

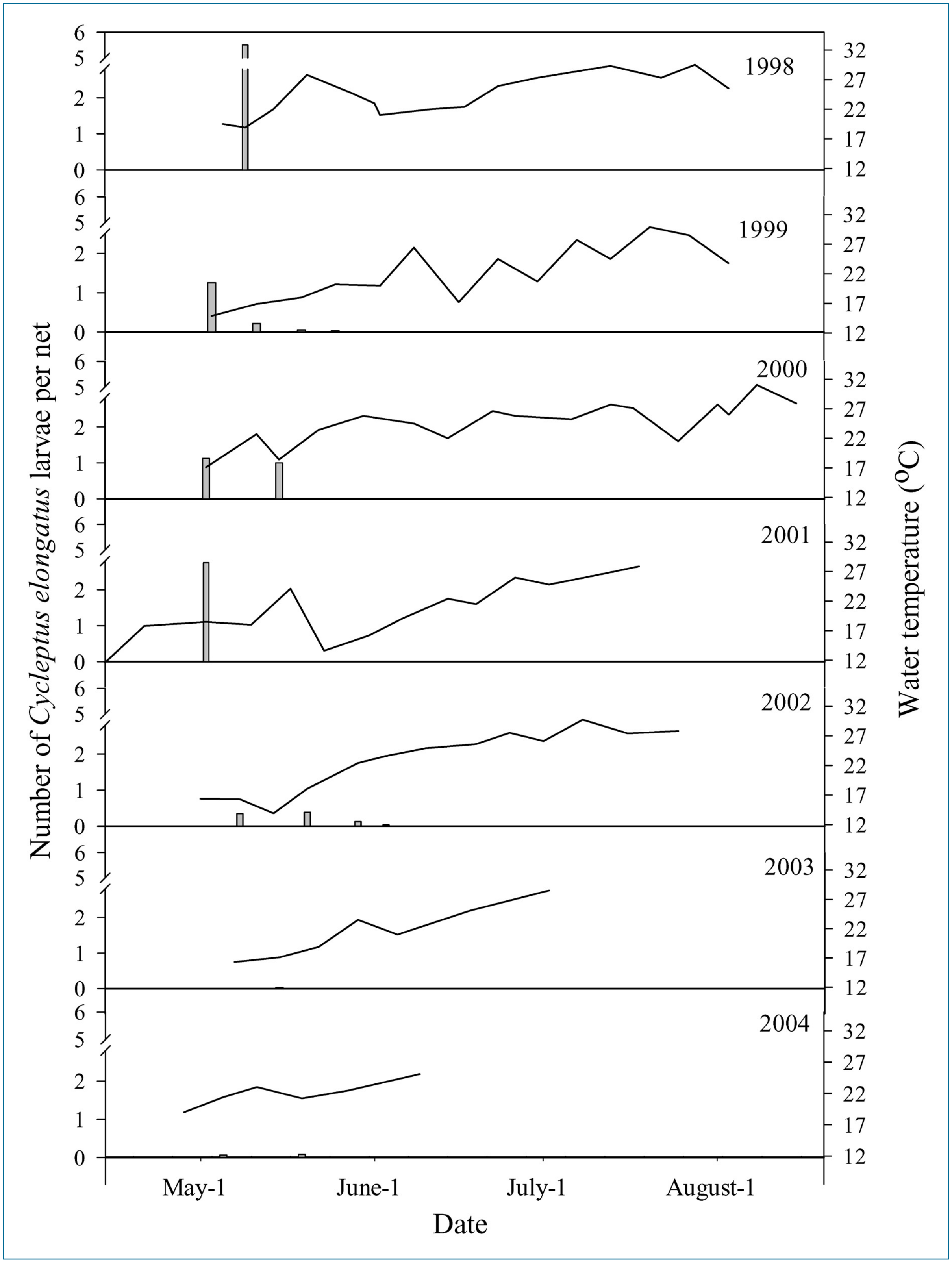

Figure 8.13. Number of blue sucker larvae per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

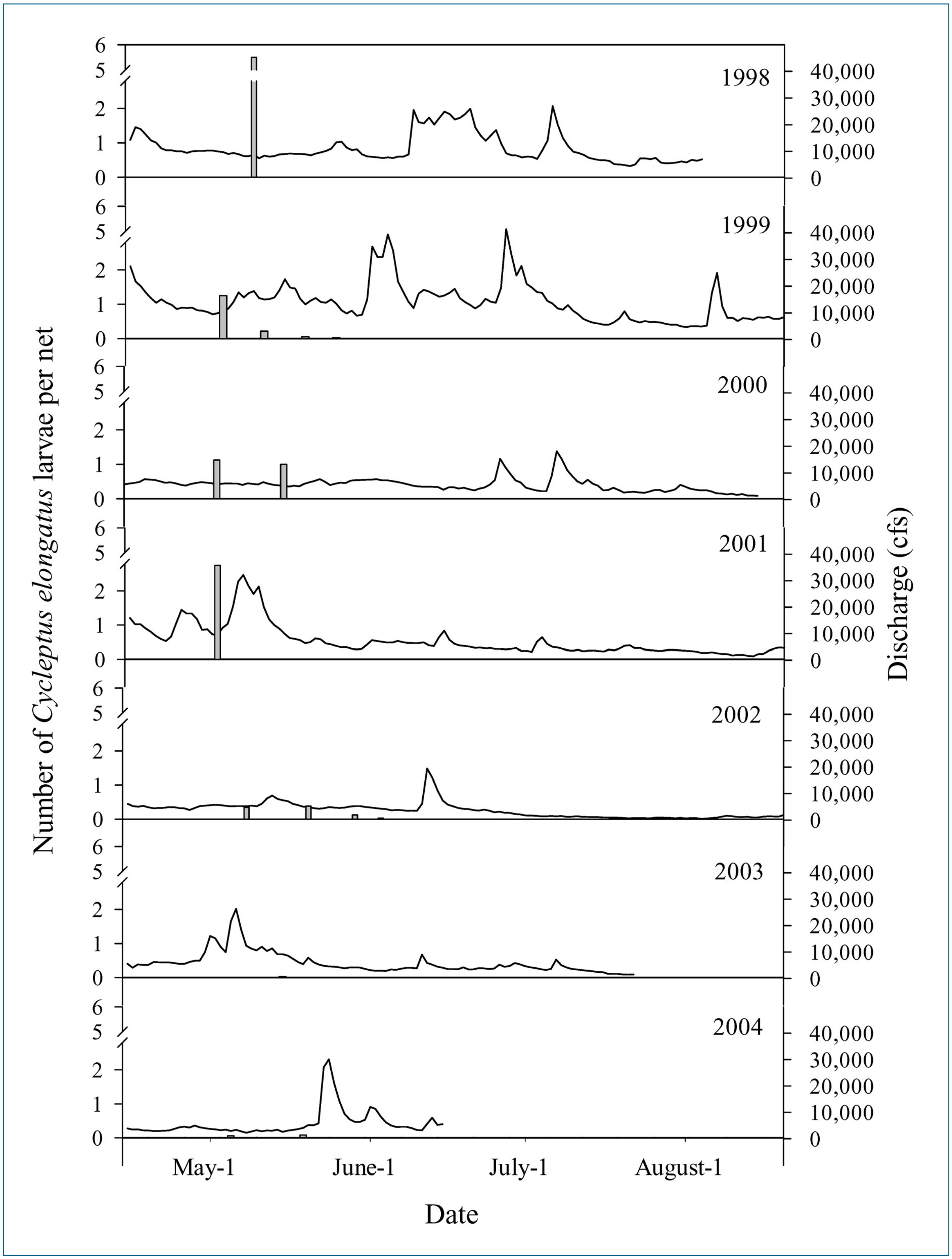

Figure 8.14. Number of blue sucker larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

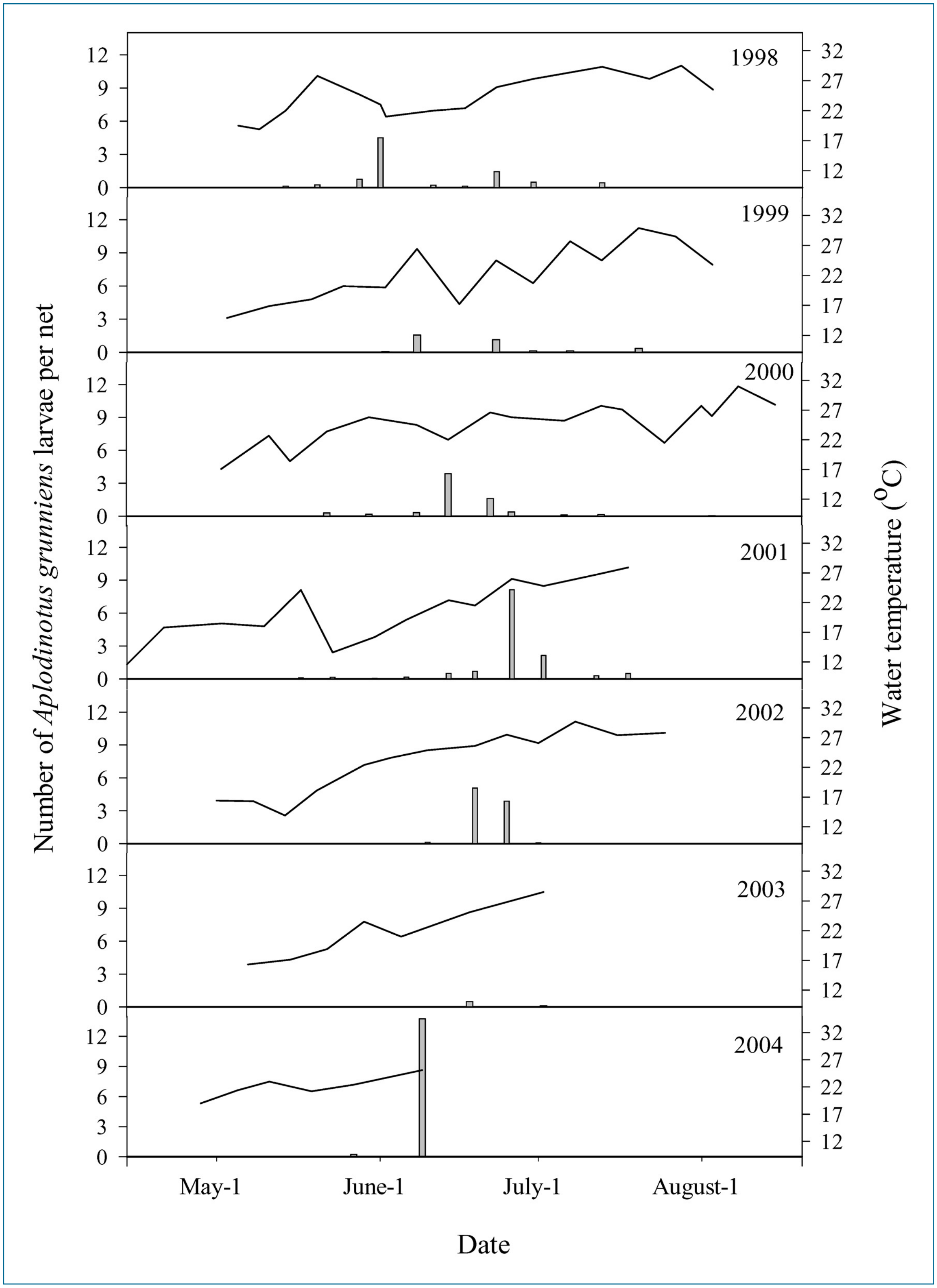

Figure 8.15. Number of freshwater drum per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

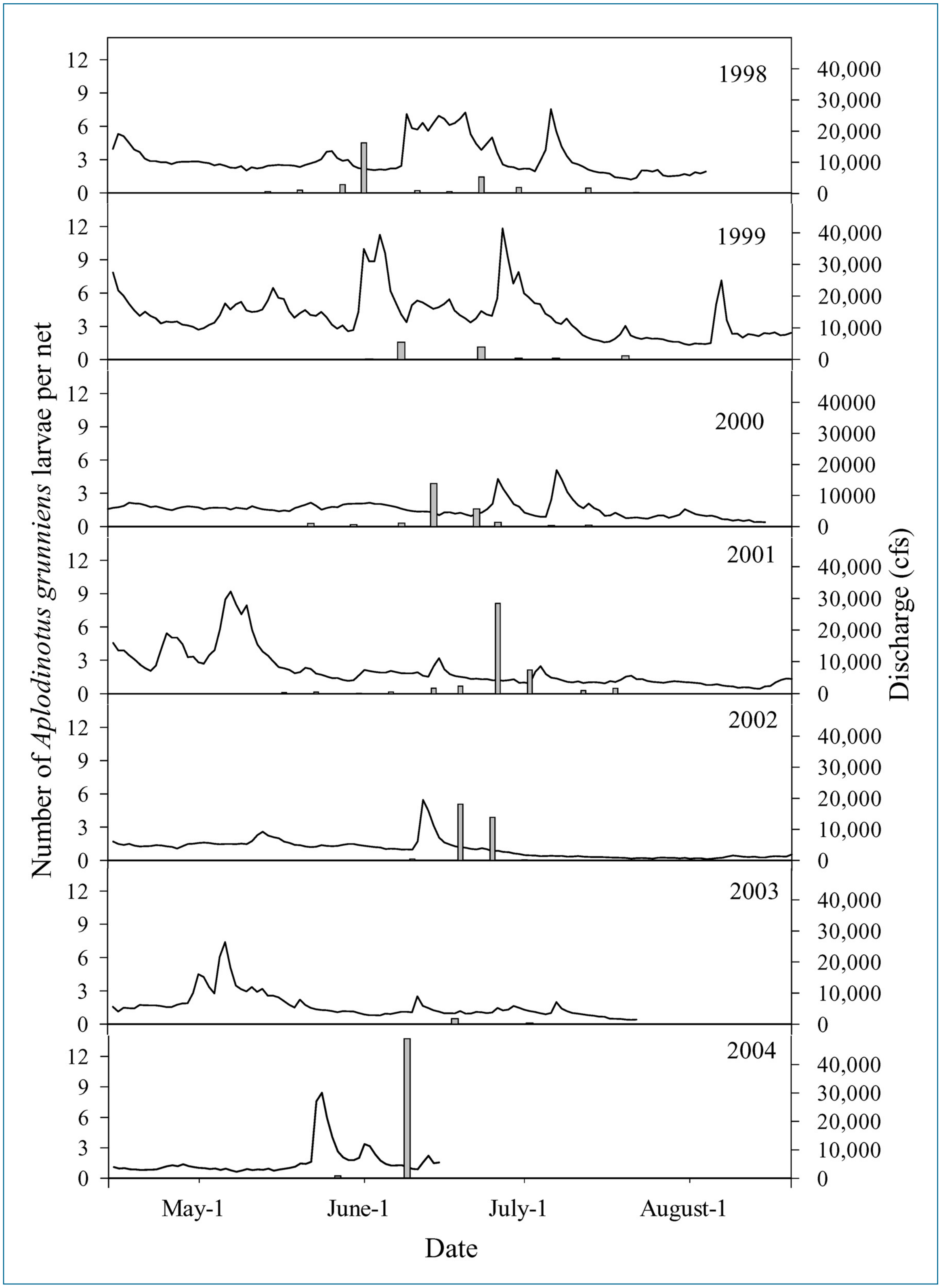

Figure 8.16. Number of freshwater drum larvae per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

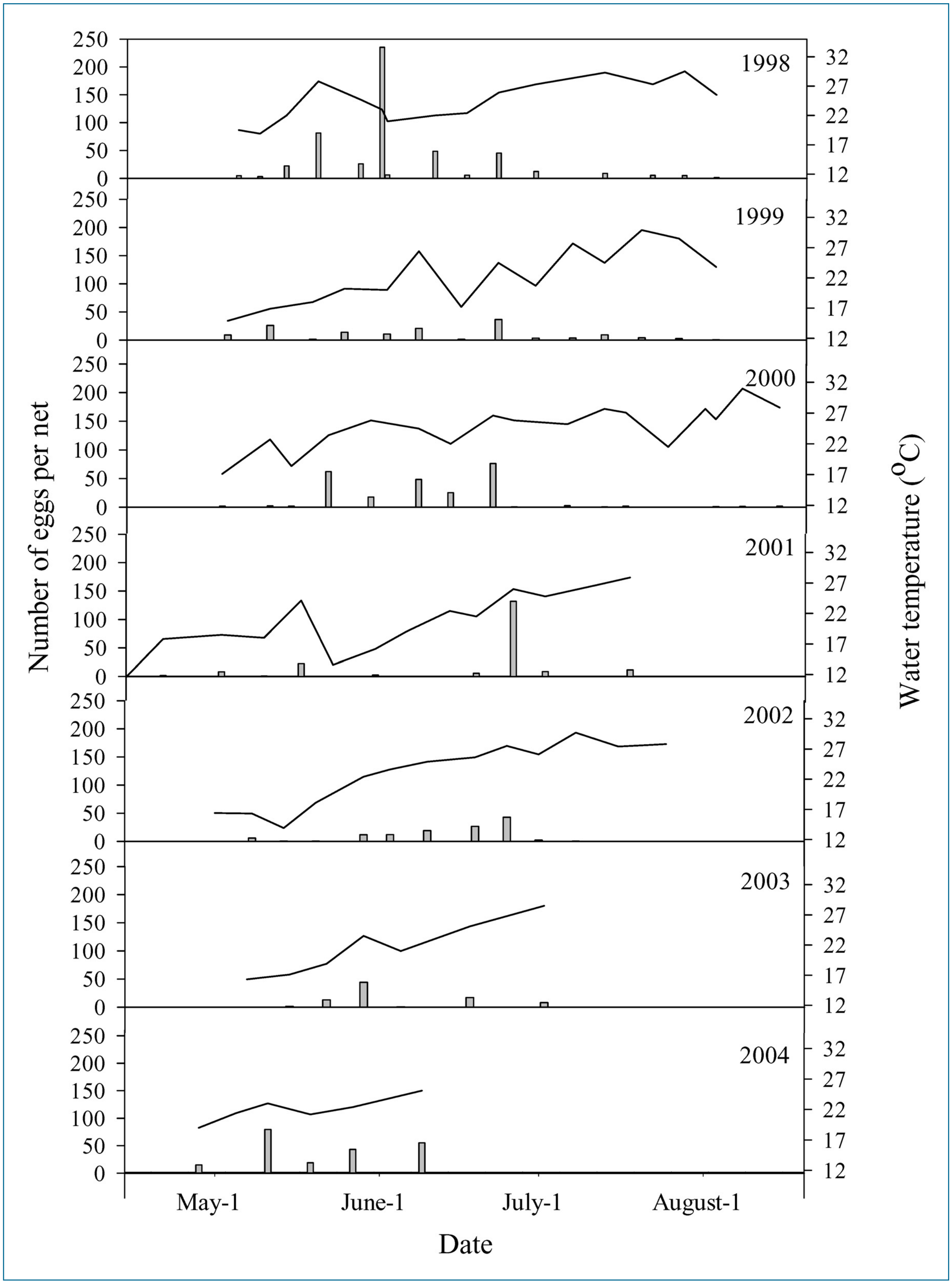

Figure 8.17. Number of eggs per net (gray bars) and water temperature (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

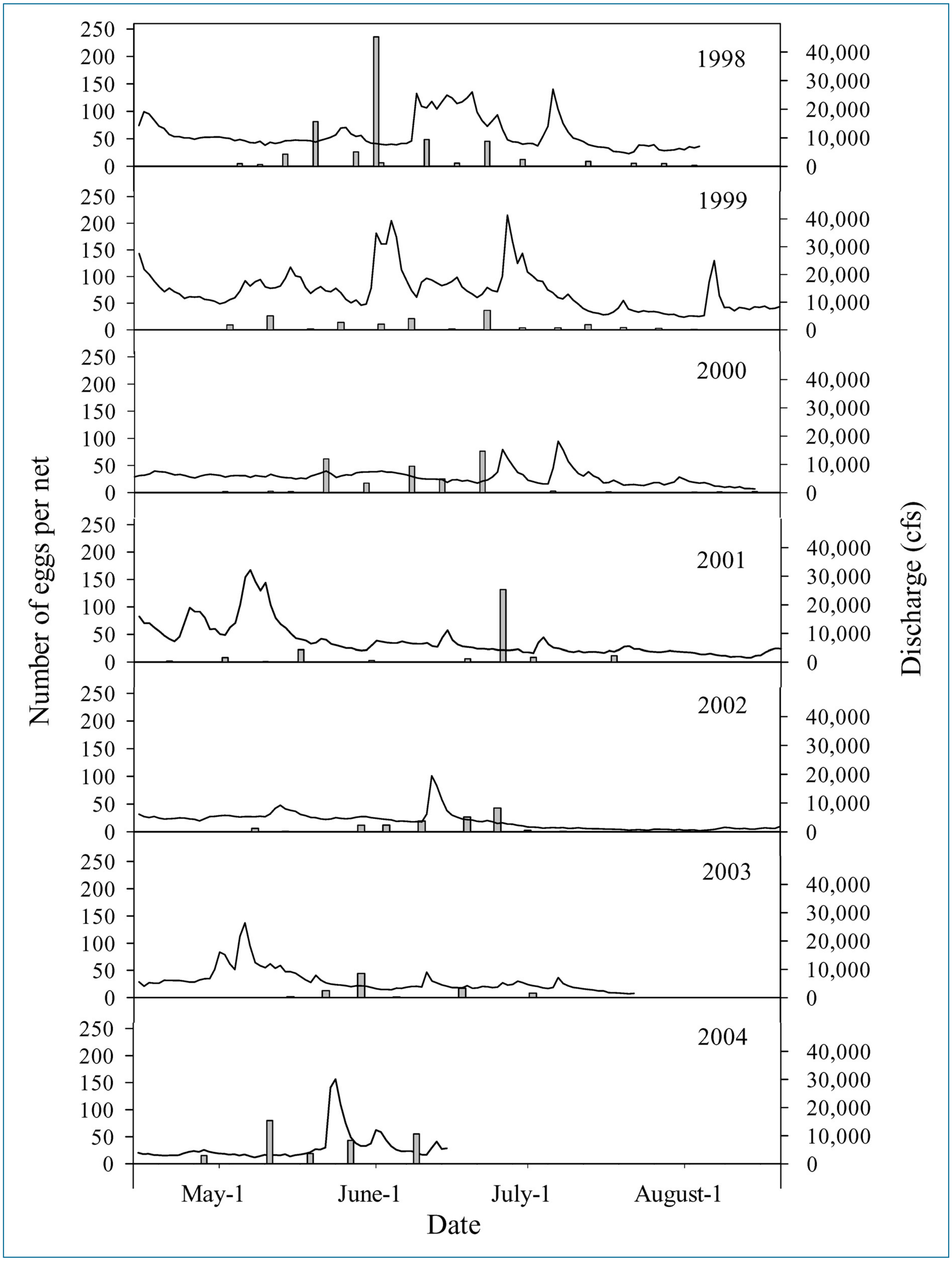

Figure 8.18. Number of eggs per net (gray bars) and mean daily discharge (lines) from 1998 through 2004 (1998 and 1999 data from Reade (2000)).

CHAPTER 9
CREEL SURVEY OF THE LOWER PLATTE RIVER

INTRODUCTION

Recreational angling for sturgeon is a small but important spring activity in the lower Platte River according to the 1992 and 1993 angler creel surveys (Holland and Peters 1994). These surveys found that most anglers fished primarily for channel catfish, but in the lower 40 km of the river and especially near the Schilling WMA, shovelnose sturgeon fishing was popular in the early spring, where they comprised 4.0 and 5.3% of the catch in 1992 and 1993, respectively. Harvest of shovelnose sturgeon was over 73% of the total sturgeon caught during both years.

Unintentional harvest of pallid sturgeon by shovelnose sturgeon anglers is a concern for conservation and recovery efforts for the pallid (USFWS 1993) and limitations on sturgeon fishing is one potential way to avoid this source of mortality. Montana, Missouri, Nebraska and Iowa allow the sport fishing harvest of shovelnose sturgeon, but North Dakota, South Dakota and Kansas prohibit the harvest of all sturgeon. Nebraska has maintained a recreational fishery for shovelnose sturgeon on the Platte River and on the Missouri River below the confluence with the Big Sioux River. In Nebraska on the Missouri River commercial fishing is allowed for rough fish only. The species that may be commercially harvested in Nebraska are: black bullhead, yellow bullhead, freshwater drum, yellow perch in addition to common carp, grass carp, silver carp, bighead carp, bigmouth buffalo, smallmouth buffalo, river carpsucker, quillback, white sucker, longnose gar, shortnose gar and gizzard shad. Missouri has allowed commercial fishing for shovelnose sturgeon in the Missouri River, but several ongoing studies continue to evaluate this harvest (Herzog et al. 2005). Studies in the Wabash River have documented differences in shovelnose sturgeon population structure which are attributed to commercial harvest (Kennedy et al. 2007), but we found no studies that have documented similar impacts by sportfishing harvest.

As part of our study, we wanted to evaluate the impact of angling on sturgeon and therefore our objective was to document the catch of sturgeon by anglers in the lower Platte River. We also wanted to evaluate the ability of anglers to distinguish pallid from shovelnose sturgeon.

METHODS

This objective was accomplished by conducting a focused creel survey in the Platte River approximately from the Ak-Sar-Ben aquarium at Schramm Park SRA (RM 22) downstream to the mouth of the Platte at the Schilling WMA (RM 0). The survey was an access point creel with standard stops along the road at Schramm Park SRA, Louisville SRA (RM 16.5) and Schilling WMA.

The creel survey followed a stratified multi-stage probability sampling regime designed using the WinFin computer program produced by the NGPC. A total goal of 10 survey days was performed each month, from 1 April through 31 May, with the number of creel days per month stratified between weekdays and weekends/holidays. Each creel day was further stratified into 4 time periods and count times were randomized within these time periods. During each count the creel clerk recorded the number of anglers present. Clerks interviewed anglers to collect information on what they were fishing for, duration of their trip and number and species of fish captured and harvested. All sturgeons in the creel were measured and barbel clips collected for DNA analysis. To estimate overall catch, the number of anglers was divided by the number of time periods sampled within the month, then multiplied by the total number of time periods within the month. This resulted in an estimated angler effort for the month. An estimate of average angler catch was calculated by dividing the total number of fish reported by the total number of anglers surveyed. The estimate of total monthly catch by anglers was calculated by multiplying the average angler catch by the estimated angler effort for the month.

To evaluate the ability of anglers to discern the differences between pallid and shovelnose sturgeon, each angler was asked to identify pallid and shovelnose sturgeon from photos (Figure 9.1). The creel survey clerks also passed out flyers to increase the awareness of local anglers about pallid sturgeon conservation efforts.

Figure 9.1. Photograph of shovelnose sturgeon (left) and pallid sturgeon (right) used to test anglers on their ability to identify species.

RESULTS AND DISCUSSION

A total of 247 anglers was surveyed during this study. In 2002, we surveyed 89 anglers over the course of 23 days, 11 days in April and 12 days in May. In 2003, we surveyed 81 anglers over 32 days, 16 each in April and May. During 2004, we surveyed 77 anglers over 20 days, 10 each in April and May. All of these anglers were fishing from the shore. The majority of anglers were fishing at the Schilling WMA (199), followed by Schramm SRA (35) and then Louisville SRA (13). Generally the highest number of anglers was counted during the late afternoon and evening hours (1700 to 2000 hrs).

The 247 anglers surveyed reported catching 84 shovelnose sturgeon during the 2002-2004 creel survey period. Of those, 72 were reported from Schilling WMA and 12 from Schramm SRA. Anglers at Schilling reported keeping 34 of the 72 sturgeon (48.6% harvest rate) that they caught and those at Schramm reported keeping only one sturgeon (8.3% harvest rate). Total shovelnose sturgeon catch by year was 26 in 2002, 18 during 2003 and 40 in 2004. Only during 2002 were more sturgeon caught during April than May (15 vs. 11). The next two most common species caught by anglers in our surveys were channel catfish (64) and freshwater drum (43). Those three species comprised over 88% of the 216 total fish reported in the creel.

Expanding the creel reports by month by year gives us an estimate of the total catch of 900 sturgeon during the period surveyed. Table 9.1 summarizes the estimated number of shovelnose sturgeon, channel catfish and freshwater drum caught by anglers during April and May 2002 to 2004. Based on the estimated total catch of 900 shovelnose sturgeon during this study and the overall estimated percent harvested of 43%, we estimate that 387 sturgeon were harvested over the three year period.

The test of angler's ability to distinguish shovelnose from pallid sturgeon showed a marked difference between anglers fishing for sturgeon and those just fishing in the lower Platte River. Sturgeon anglers were able to correctly identify shovelnose and pallid sturgeon an average of 87% of the time while other anglers were able to correctly identify the species an average of 66% of the time. However, on a year by year basis the general anglers improved their correct response rate from 55% in 2002 to 64% in 2003 and 78% in 2004. In contrast, sturgeon angler responses were 86% in 2002, 86% in 2003, and 88% in 2004.

Our collections of sturgeon in the Platte River over the past four years (2000 to 2004) have captured 15 pallid sturgeon and 1,541 shovelnose sturgeon. Assuming equal vulnerability to sampling techniques, this equals a less than 1% chance that any sturgeon caught is going to be a pallid sturgeon. The creel information indicates a probable catch of about 300 sturgeon per year by anglers in the lower Platte River. If their catch is approximately the same as ours, they could be capturing about 3 pallid sturgeon per year. The worst that anglers scored on the identification quiz was 55% correct and the best was 88%. The worst case scenario is that anglers in the Platte River may take two pallid sturgeon per year by mistake and the best case scenario is that they may take one. With the educational materials that we and the Nebraska Game and Parks Commission have distributed, it seems that most current anglers are aware of the importance of protecting pallid sturgeon.

Table 9.1. Estimated numbers of shovelnose sturgeon, channel catfish and freshwater drum caught from the lower Platte River during April and May, 2002-2004.

YEAR	Shovelnose sturgeon		Channel catfish		Freshwater drum	
2002	April 164	May 112	April 164	May 52	April 228	May 2
2003	April 36	May 100	April 172	May 48	April 76	May 8
2004	April 216	May 272	April 84	May 100	April 60	May 60
Totals All Years	416	484	420	200	364	70

Chapter 10

GIS MODELS OF HABITAT TYPE AVAILABILITY, RIVER CONNECTIVITY, AND DISCHARGE IN THE LOWER PLATTE RIVER

INTRODUCTION

As an outgrowth of the discharge records summarized in Chapter 1, the water quality sampling summarized in Chapter 3, and the habitat use and movement information for pallid and shovelnose sturgeon presented in chapters 4 and 5, respectively, this chapter introduces an analysis of the relationships among the data presented in those chapters. The goal of this chapter is to present two different models that were constructed to aid in understanding the relationships between river discharge and habitat requirements of pallid and shovelnose sturgeon. The first model, called the Lower Platte River Habitat Type Availability Model, focuses on developing a relationship between available habitat types and river discharge. After developing a relationship between the types of available habitats and discharge, we weighted the model with sturgeon habitat use to describe the changes in sturgeon habitat with respect to discharge. The second model, called the Lower Platte River Connectivity Model, focuses on developing a relationship between the connectedness of the migratory pathway and river discharge (IFC 2004). The combination of the two models provides a method to view quantity and accessibility of instream habitats in the lower Platte River with respect to changes in river discharge.

The development of the relationship between discharge and habitat availability is useful for several purposes. First, this relationship would provide a generalized model of habitat dynamics for a relatively large section (103 RM) of the Platte River. Secondly, this relationship would allow information gathered on habitat needs of the biotic community associated with the specific river habitats to be analyzed with respect to discharge. This is especially important on the lower Platte River given the occurrence of endangered and threatened species in this stretch of the river. The fish, pallid sturgeon and sturgeon chub, and the sandbar nesting birds, the least tern and the piping plover, have habitats which are potentially influenced by river discharge.

The information derived from these GIS models is used in conjunction with the habitat descriptions of the pallid and shovelnose sturgeon. We used data on the more common shovelnose sturgeon as well as data collected directly from pallid sturgeon in the lower Platte River.

The objectives of the Lower Platte River Habitat Type Availability Model were:

To develop relationships between the observed quantities of instream habitat types and river discharge.

To determine the quantity of instream habitat types throughout the lower Platte River at different discharges using aerial images.

To determine the relationships for the amount of suitable habitat for sturgeon species to river discharge.

The objectives of the Lower Platte River Connectivity Model were:

To determine the linear extent of a pathway through the river in relation to river discharge.

To compare movement rates of radio-tagged shovelnose sturgeon to river discharge conditions to see if fish movement correlates to the availability of a migratory pathway.

METHODS

Lower Platte River Habitat Type Availability Model

Digital orthoquadrangle (DOQ) images were collected for the area covering the lower Platte River for 1993, 1994 and 1999. These DOQs were from the National Aerial Photography Program (NAPP). The 1:40,000 scale aerial photographs were taken at 20,000 feet above land surface with a 6 inch focal length camera. The scanned images were rectified to orthographic projections of 1 m resolution based on the National Mapping Standards and cast on the Universal Transverse Mercator Projection (UTM) on the North American Datum of 1983 (NAD83). The images for the NAPP within each year were acquired over a number of different days as the flight lines for the images covered the segment of the state in a north-south direction. A portion of the images for the 1993 state coverage were reacquired in 1994, presumably as a result of unsatisfactory image quality. A total of 7 different dates were used to develop the 1993 (1994) images and 5 dates for the 1999 images. Since the images were acquired on different days, discharge values were not consistent across the combined image of the 103 RM river segment therefore, contiguous image groups were developed for individual dates. An additional flight on was made on 15 August 2003 to acquire images during drought conditions. The images were acquired from approximately 6,000 feet above land surface with a Nikon F4 digital camera with images taken from a port in the bottom of a small aircraft. Each contiguous image group was digitized, classified and post-processed individually. Each image group was projected into NAD83 UTM zone 14 prior to digitizing.

The first step in the process was to digitize and classify the aerial photos. All of the habitat classification was done at the 1:5,000 scale using on-screen digitizing methods in ArcGIS 8.3 (ESRI, Inc. 2004). The habitat was classified into five groups: exposed sandbars, woody islands, sandbar complexes, open water and no data. Exposed sandbars were sandbars that lacked woody vegetation and appeared to be above the surface of the water. Woody islands were exposed islands or sandbars with trees. Sandbar complexes included areas where the bottom was visible or deeper water between exposed sandbars no more than 50 m apart. Open water was defined as water too deep to see the bottom but not inside a sandbar complex. No data areas were areas of high reflectance or bridge crossings and were not used in further analyses. Images were classified by a research technician trained in the classification methods and checked for consistency and errors by a supervisor.

After the digitization process was completed and all of the polygons for the various habitat classes were created, the polygons were converted into a grid format that was based on the maximum extent of the river polygons with a cell size of 3 m^2. After each of the grids was developed, all grids were combined into a single continuous grid for the group of images from a single date. From this continuous grid we were able to determine total area for each habitat type within the classified section of the river. All cells outside of the river were not classified and were set to no data to eliminate them from further analysis. To rectify the classified images from the 2003 flight, the images were fitted to the 1999 images as the base map. This was accomplished using the warp function in ArcGIS with a minimum of 18 control points spaced along the shoreline of the river at identifiable landmarks. Unfortunately, many of the images of the 2003 flight had insufficient overlap with the adjacent images to create useful river sections, so only 3 segments were able to be used in the effort. Figures 10.1 and 10.2 show examples of how the classification looks, although to provide better visualization the sections are much smaller than those used in the analysis.

The quantities of each habitat type within each section were recorded from the attribute table within the GIS. These quantities were converted into percent coverage by removing no data cells and dividing each habitat type into the total of all habitat types within the river section.

Mean daily discharge was recorded from the USGS gage sites chosen with respect to distance and the locations of major tributaries. In locations where gaged tributaries entered downstream of an upstream main river gage, discharge readings from more than one gage were combined. The percentages for each habitat class were then plotted against the mean daily discharge for the nearest gage site on the Platte River.

To develop the relationships between habitat quantity and discharge, the curve of best fit was solved for the data using Table Curve 2D 5.01(Systat 2002). Selection of the most appropriate curve followed methods outlined in the curve-fitting software. This process generally followed the criteria simultaneously increasing adjusted r^2 values, reducing parameterization, eliminating of the unstable or undefined regions, and examining the curve ends with the goal of choosing the simplest equation that describes the curve. Once each curve for the habitat type vs. discharge was determined independently, all the equations were adjusted together in a spreadsheet by requiring that the sum of all equations total 100% at all discharge rates.

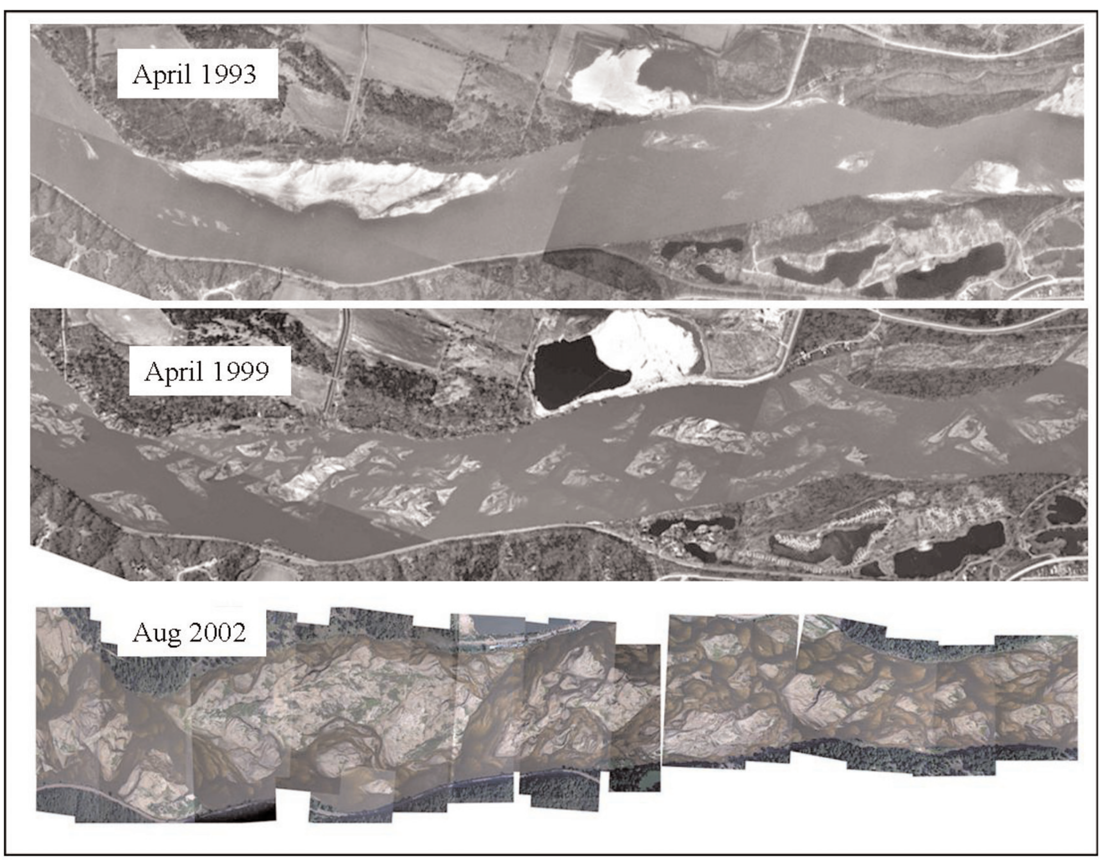

Figure 10.1. Examples of aerial images used in the analysis. The images are from the region around South Bend on the Platte River, NE.

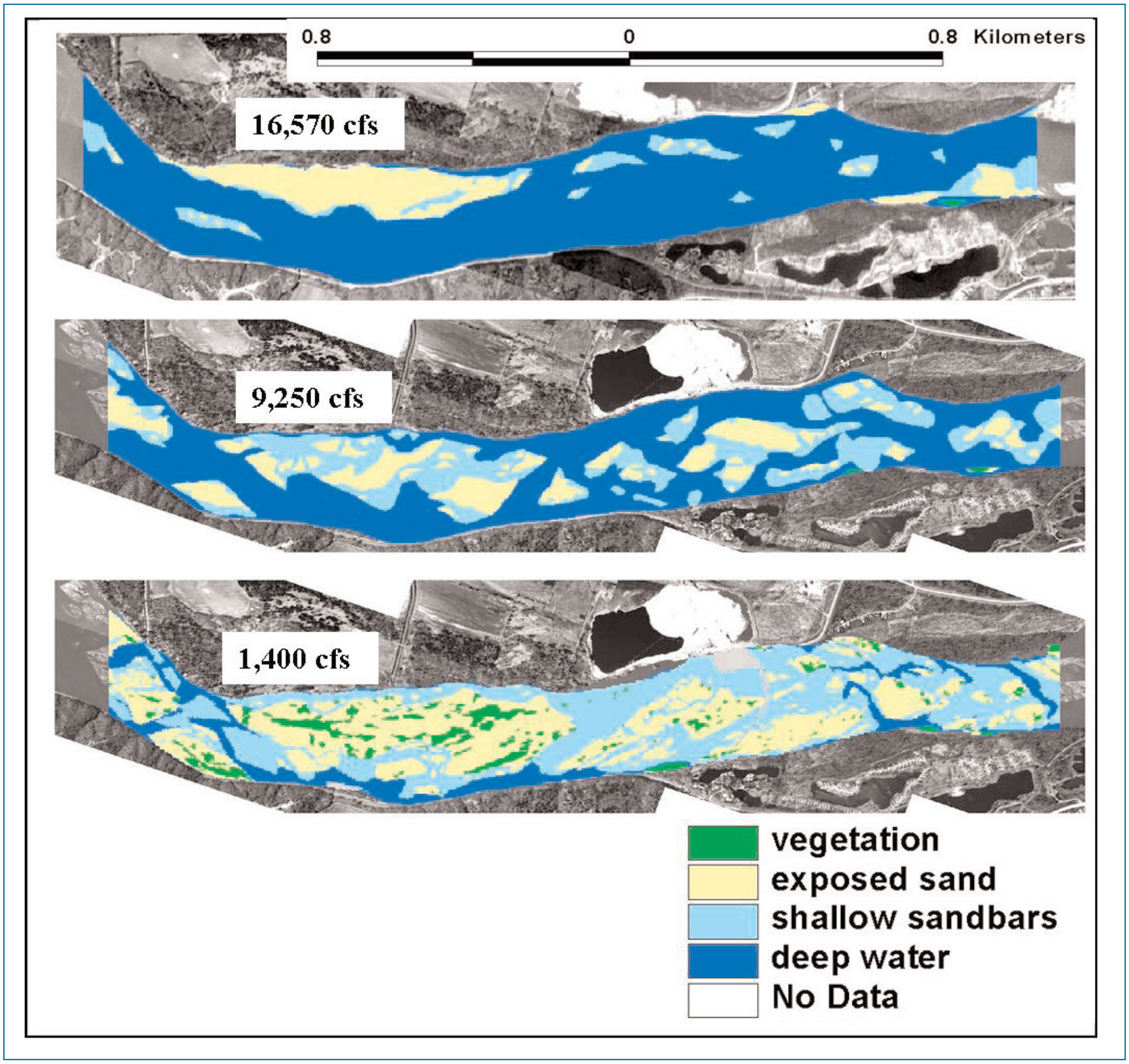

Figure 10.2. Examples of habitat type classification of the aerial images with associated discharge rates. The bottom image shows the resultant rectification for the 2002 data (1,400 cfs) to the 1999 base-map.

Determination of habitat quality of the instream habitat types: To determine the quality of the habitat types classified in the aerial image data transect data from the Nebraska Game and Parks Commission IFIM (NGPC 1993a, b.) were used. These data were collected in the 1980s and were taken over a range of flows from 1,181 to 6,767 cfs. The data collected along each transect included bed elevation (depth), mean column velocity, substrate, and cover. The bed elevation of each transect was plotted and sections of transects were classified as exposed sandbars (points above the water line), open water (points deeper than 0.5 m for sections greater than 50 m) and shallow sandbar complexes (points not in other categories). Each point was then classified as a specific habitat type to go along with its physical habitat measurements. The four habitat variables of depth, mean column velocity, substrate, and cover were compared using a T-test between the two water covered habitat types (open water and shallow sandbar complexes). Variables that were statistically different were used in the subsequent habitat selection analysis. Figures 10.3 and 10.4 show an example of this process. Overall, this provided an estimate of the proportions of depth and mean column velocities within each habitat type classified in the aerial images.

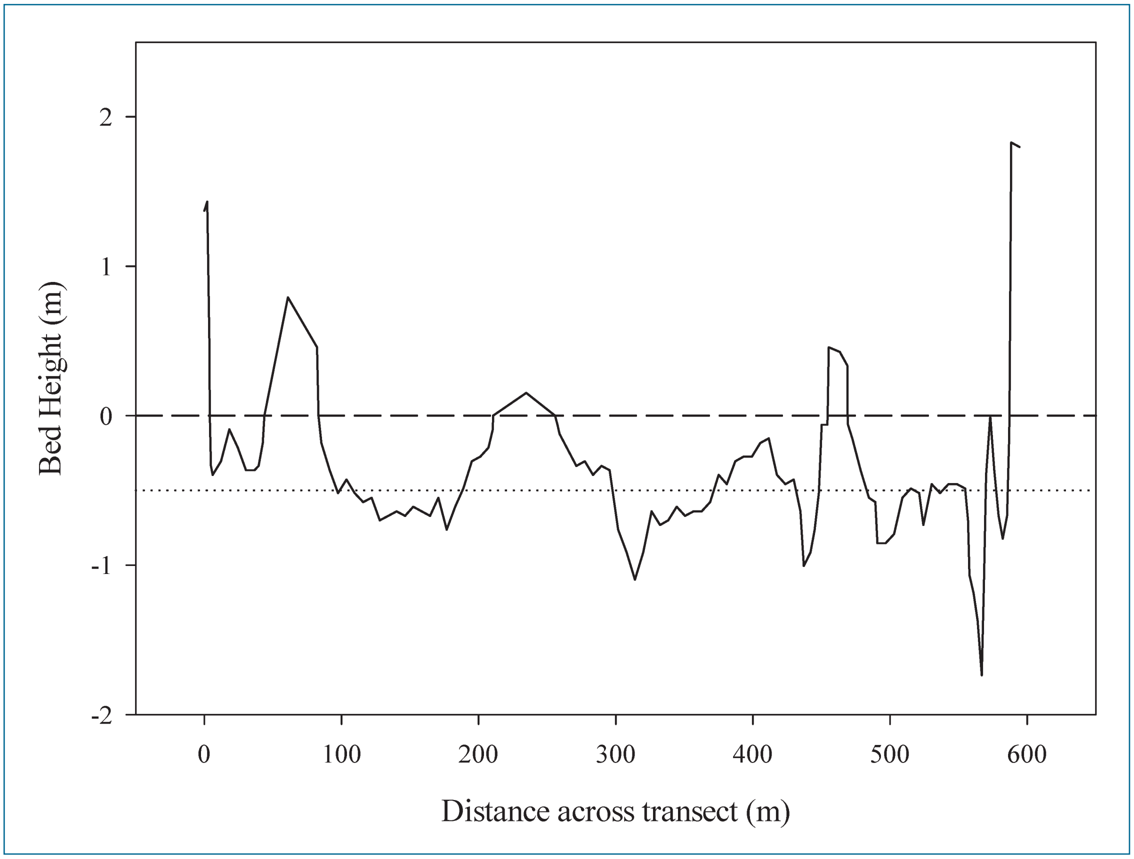

Figure 10.3. River bed heights (solid line) along and example transect from the 1985 survey of the Platte River at Cedar Creek, NE when discharge was 5,116 cfs. The water surface (0 m) is represented by the dashed line and the dotted line indicates the estimated limit of visibility into the water

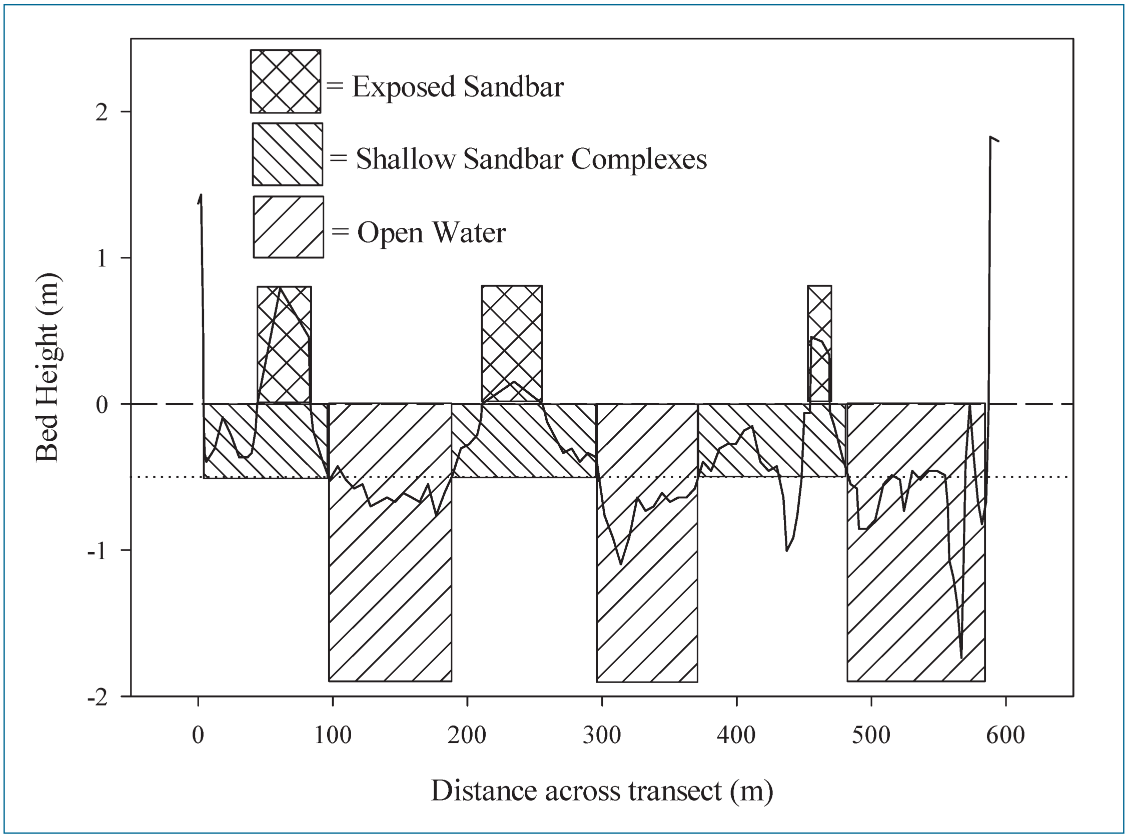

Figure 10.4. Classification of the habitat types for the points along the Cedar Creek transect (Figure 10.3) as defined in the aerial image section. The boxes indicate the habitat type into which the points were classified.

To integrate the extent of the habitat with the quality of the habitat for sturgeon, a chi-squared test was used to compare the availability of each habitat variable with the observed use of these habitat variables. Data for shovelnose sturgeon is from the telemetry section of this study and the data for pallid sturgeon is a combination of the telemetry data from this study and the telemetry data on stocked pallid sturgeon in the lower Platte River (Snook 2001, Snook et al. 2002). The results of sturgeon habitat selection for depth and velocity were used to weight each habitat category. The suitability for each habitat type was assumed to be equal to the average of the amount of suitable depths and velocities within the category. To develop the relationship between suitable habitat for shovelnose and pallid sturgeon and discharge, the sum of the proportion of suitable habitat at each discharge level was determined and the resultant curve was solved with Table Curve 2D 5.01(Systat 2002) following the criteria described previously.

Lower Platte River Connectivity Model

After the digitized classification was developed (as described in previous section), an additional 25m buffer was placed around sandbar complexes that extended into the open water. The buffer was set to 25 m, which is less than 5% of the average river width. The buffer was used to approximate the edge habitat near sandbar complexes in deeper water that may have been misclassified due to the gradual transition from one habitat type to the other. The assumption in the buffering strategy was if 5% or more of the width of the river was open water habitat fish, could find a way to swim through the river section. The corollary assumption to this is that if less than 5% of the width of the river was open water the fish were likely to not move through the shallow sandbar complexes. In the Platte River the main channel frequently shifts and twists down the channel bed. For readers unfamiliar with the shallow, sandbed rivers like the Platte River in Nebraska, the deeper sections could roughly be construed as the run and pool habitats of a typical riffle-run-pool river sequence. Connectivity for open water fishes would be the extent of these habitats between shallow riffles. Figure 10.5 shows the shallow sandbar complexes characteristic of the lower Platte River and the lack of a defined deepwater channel at low discharge rates.

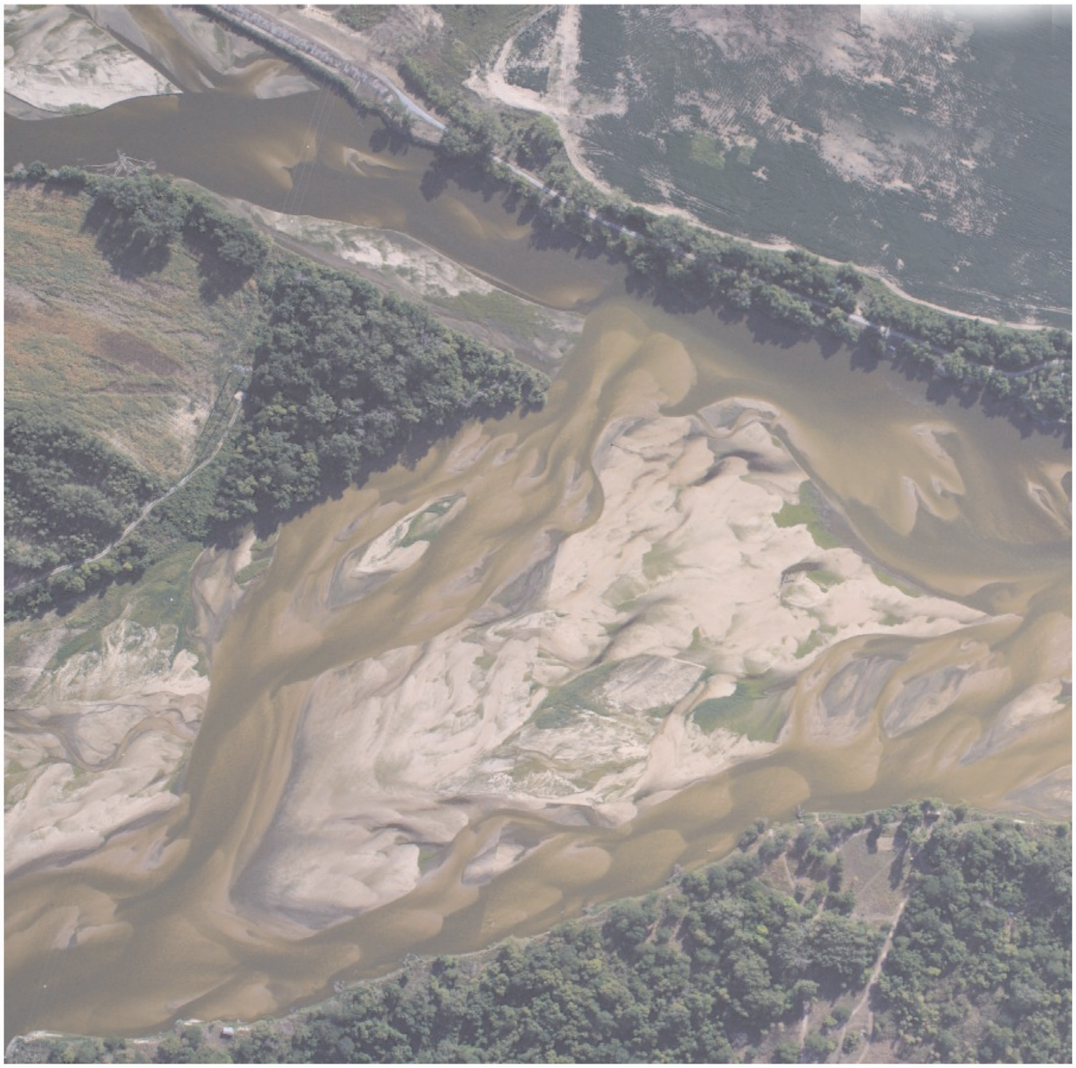

Figure 10.5. Confluence of the Platte River (bottom left) and Elkhorn River (top left) showing the characteristic shallow sandbar complexes and the lack of a defined channel which allow for passage of open water fishes. Note the increased discharge provided by the Elkhorn River creates a channel along the north bank of the Platte River. Also note that deep water is available within the sandbar complexes although it is not continuous channel. This image is a composite of two images from the flight on 15 August 2003 at a discharge of 1,400 cfs below the confluence.

After the buffers were placed on the habitat, the maximum linear extent of open water was measured for each image group. The measurement was converted to a percentage by dividing the maximum linear extent of open water by the total linear extent of the river section. Results of the proportion of the river connected were plotted against river discharge and the curve of best fit was solved using Table Curve 2D 5.01 (Systat 2002) following the similar criteria as described in first section. Figure 10.6 shows an example of the determination of maximum linear extent for the aerial images show in Figure 10.1.

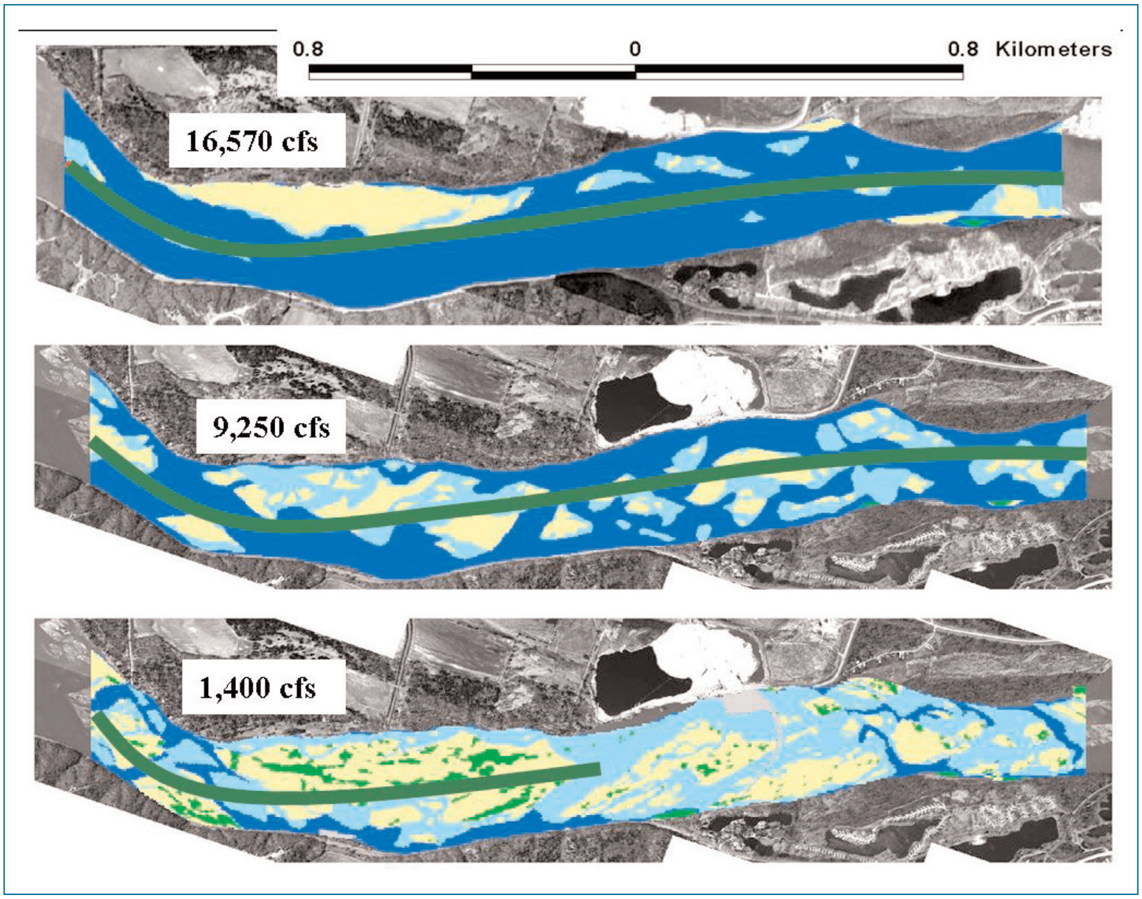

Figure 10.6. An example of aerial images (Figure 10.1) classified at three discharge levels. The green lines represent the maximum linear extent of the open water habitat type (blue color) for the classified images at the various discharge rates.

RESULTS

A description of the 26 image groups containing the date images were acquired, gage location, discharge, section length, and GPS bounding coordinates are provided in Table 10.1. On average the sections were about 11.9 km long (range 2.8 to 31.3 km) and the discharge varied from 0 to 21,000 cfs. The zero discharge was from August 2002 in the vicinity of Columbus, NE when the river bed of the Platte River was completely dry.

Lower Platte River Habitat Suitability Model:

The process classified 219,122,848 m^2 of instream habitat for the 26 sections into the four categories: open water, shallow sandbar complexes, exposed sandbars, and woody islands. The amount and percentage of the habitat types varied considerably with discharge (Table 10.2).

Determining the relationships between each habitat type and discharge resulted in four different response curves. For woody islands, no relationship was detected (adjusted r^2 = 0.0, Figure 10.7). The distribution and amount of woody islands was not a function of discharge over the range of flows in the analysis. For exposed sandbars, the amount peaked at no flow and decreased rapidly to 2,500 cfs and then flattened out (Figure 10.8). The curve that best fit the exposed sandbar data (adjusted r^2 = 0.89) was described as a Lorentzian Cumulative Curve (Equation 10.1)

Equation 10.1. The function of exposed sandbars (y) at a given discharge (x) in the lower Platte River (where: a = 0.09976, b = 1.08377, c = 29.38736, d = -17.43732).

$$y = \frac{a}{\pi}\left[\arctan\left(\frac{x-b}{c}\right)+\frac{\pi}{2}\right]+d$$

For shallow sandbar complexes, the amount peaked around 2,000 cfs and decreased rapidly to around 7,000 cfs and then flattened out (Figure 10.9). The curve that best fit the data (adjusted r^2 = 0.87) was described as a natural logarithm of x rationals (Equation 10.2).

Equation 10.2. The function of shallow sandbar complexes(y) at a given discharge (x) in the lower Platte River (where: a = 0.00749, b = -0.47214, c = 0.00283, d = 0.05705).

$$y = \frac{a + c\ln x}{1 + b\ln x + d(\ln x)^2}$$

For open water, the amount reached its maximum around 7,000 cfs from lower quantities at lower discharge rates (Figure 10.10). The curve that best fit the data (adjusted $r^2 = 0.87$) was described as a logistic dose response peak (Equation 10.3)

Equation 10.3. Equation for the function of open water(y) at a given discharge (x) in the lower Platte River (where: a = 0.79317, b = 133.85995, c = -3.65680).

$$y = \frac{a}{1+\left(\frac{x}{b}\right)^{c}}$$

The simultaneously corrected curves for the habitat types vs. discharge result in a pattern where the river starts as all exposed sand at no discharge, and rapidly changes to shallow sandbar complexes at low to moderate discharges and then moves to an open water system at higher discharge rates (Figure 10.11). Even at the highest discharge rates, some exposed sandbars and shallow sandbar complexes were still visible.

To determine the habitat quality of the different habitat classes, the Nebraska Game and Parks transect data were classified into similar types as the aerial photos. The data for the transects were collected between 1983 and 1987 from North Bend, Louisville, and Cedar Creek along the lower Platte River. Discharge rates during the times that data were collected ranged from 1,181 to 6,767 cfs. There was a significant difference between open water categories for depth ($p < 0.001$ and velocity ($p < 0.001$) when compared with shallow sandbar complexes. There was no difference for substrate ($p = 0.82$) or cover ($p = 0.69$) categories between open water and shallow sandbar complexes, so these were dropped from further analysis. This process provided a description of the distribution of depths and mean column velocities typically found within the habitat categories over a range of discharges.

To compare this to sturgeon habitat suitability, the proportion of records from the radio-tracking studies on shovelnose and pallid sturgeon were grouped into even sized bins and compared to the habitat availability in the transect data. Chi-square selectivity analysis determined areas of selection, neutral use, or avoidance for shovelnose and pallid sturgeon vs. habitat availability. For depth use, wild pallid sturgeon neutrally use or select waters deeper than 0.8 m in the lower Platte River, and shovelnose sturgeon neutrally use or select waters deeper than 0.6 m (Figure 10.12). For mean column velocities, pallid sturgeon neutrally use or select waters faster than 0.7 m/s in the lower Platte River, and shovelnose sturgeon neutrally use or select waters faster than 0.5 m/s (Figure 10.13). We applied these as criteria for depth and velocity conditions favorable to sturgeon use.

Combining the depth and velocity criteria to the proportions of depths and velocities in the habitat types resulted in an estimate of suitable habitat for pallid sturgeon and shovelnose sturgeon, equations 10.4 and 10.5 respectively, at a given discharge. By solving this over a range of discharges and determining the curve of best fit, we found that the relationship for both sturgeon species followed the same general shape. There was little to no suitable habitat at low discharge rates to 2,000 cfs. Percent suitable habitat rapidly increased through 6,000 cfs and reached an asymptote near 9,000 cfs (Figure 10.14). The pallid sturgeon curve always showed lower percent suitable habitat than the shovelnose sturgeon curve because of their habitat selection for deeper and swifter waters.

Equation 10.4. The curve for pallid sturgeon habitat suitability (y) vs. discharge (x) in the lower Platte River (where: a = -6.455, b = 39.275, c = 115.637, d = 55.158).

$$y = \frac{a}{\pi}\left[\arctan\left(\frac{x-b}{c}\right)+\frac{\pi}{2}\right]+d$$

Equation 10.5. The curve for shovelnose sturgeon habitat suitability (y) vs. discharge(x) in the lower Platte River (where: a = 65.252, b = 111.030, c = 63.300).

$$y = a\exp\left[-\exp\left(-\frac{x-\ln(\ln 2)-b}{c}\right)\right]$$

These equations for sturgeon habitat suitability vs. discharge can be used in many ways, since a value of x (discharge) computes a value for y (percent suitable habitat) for that species in the lower Platte River. Two examples (Figures 10.15 and 10.16), were obtained using the average daily discharge values for 1 January through 31 December from the gages at Louisville, North Bend and Duncan on the Platte River. The resultant graphs show average daily percent suitable habitat for pallid sturgeon (Figure 10.15) and shovelnose sturgeon (Figure 10.16). These graphs suggest that more habitat is available during the spring and fall of the year than during the summer for shovelnose sturgeon. Over the last 50 to 70 years of record, from these gage records, it appears that there has been little suitable habitat for pallid sturgeon in lower Platte River during the summer season.

Lower Platte River Connectivity Model

The classified images of the lower Platte River were broken up into 29 contiguous sections. The sections average 8.2 km in length and a total of 237.4 km of river segments covering all of the 163 km of river in the lower Platte at least once over multiple discharge rates were used for this analysis. Some of the 26 image groups used in the previous analysis had areas of "no data" that restricted the use of these sections for connectivity estimates. In some cases the single image group was broken into two groups on each side of the "no data" region. The locations, lengths, and connectivity are shown for each section in Table 10.3.

The percent connected value was plotted against the discharge value and the curve of best fit was calculated for the distribution of data points (Equation 10.6). The curve (Figure 10.17) was highly informative (adjusted $r^2 = 0.86$) and reflected a pattern where the river was generally unconnected at low discharge levels, then rapidly increased in connectivity between 3,200 and 5,600 cfs, and appeared to be almost completely connected by 8,000 cfs. These discharge levels generally correspond to the flows where the lower Platte River converts from primarily shallow sandbar habitat to open water habitat as seen in the habitat relationships developed in the Lower Platte River Habitat Suitability Model.

Equation 10.6. The relationship for the curve of river connectivity (y) vs. discharge (x) in the lower Platte River (where: a = 100.083, b = 124.107, c = 38.099).

$$y = \frac{a}{1 + \exp\left(-\frac{x-b}{c}\right)}$$

From the river connectivity relationship, we calculated the average monthly connectedness for sections of the lower Platte River by determining the percent connected between USGS gage site from the average month discharges over the period of record. By showing river connectivity, average monthly water temperature, and average monthly shovelnose sturgeon movement in the same graphic, it is apparent that the shovelnose sturgeon's migratory movements coincide with conditions of river connectivity and appear to be triggered by changes in water temperature. The annual monthly cycle of river connectivity, temperature and shovelnose sturgeon movement are displayed in Figures 10.18 to 10.29 for January to December, respectively.

CONCLUSIONS

The results of the Lower Platte River Habitat Type Availability Model support the conclusion that the habitat to discharge relationship is most accurately modeled with non-linear curves. The habitat to discharge relationship changes more rapidly at low discharge rates than at high discharge rates. There are two transitional phases as discharge increases. First, as water floods the dry river bed at low discharges, there is rapid transition of habitat from exposed sandbars to shallow sandbar complexes. This transition is also characterized by a lateral increase in the wetted area of the river bed. The second transition phase occurs at moderate discharges, where the transition from shallow sandbar complexes to open water habitats happens. This second transition is also characterized by a decrease in lateral expansion as the river bed is fully inundated and an increase in vertical expansion as the river fills up constrained by its banks. Given the non-linear relationship between habitat and discharge, small changes in discharge can result in large changes in suitable habitat if the discharge is near a transition phase.

The selection of deep and swift water by sturgeon in the Platte River support the findings that open water habitats are the primary habitats for sturgeon. Pallid sturgeon are found in deeper and swifter waters than shovelnose sturgeon, and the much lower overall percentages of useable habitat for the habitat categories (2% of shallow sandbar complexes and 16% of open water habitats) than for shovelnose sturgeon (39% of shallow sandbar complexes and 81% of open water habitats). This suggests that shovelnose sturgeon have always been more common in the Platte River, based on a larger area of suitable habitat. But this difference in habitat doesn't account for the difference in population size (1.25 pallid sturgeon to 1,000 shovelnose sturgeon; our estimate, Chapter 5). Considering habitat suitability alone, shovelnose sturgeon were likely to be 5 to 20 times more common than pallid sturgeon in the Platte River. Although not estimated for the Platte River, Forbes and Richardson (1905) estimated that pallid sturgeon comprised 1 in 5 river sturgeon collected in the lower Missouri River supporting the contention that habitat requirements only account for a portion of the current differences in population sizes.

The Lower Platte River Habitat Type Availability Model was developed over a wide range of discharge conditions reflecting conditions found in the lower Platte River from no flow to bank full flow conditions. There are no overbank flood flows modeled in this analysis, and the importance of such flows is not able to be effectively addressed. The development of the equations relating habitat types to discharge is important as it allows the development of habitat suitability relationships for any species of concern that uses exposed sandbars, shallow sandbar complexes or open waters in the Platte River. Obvious extensions of the results of this model are for predicting suitable habitat for the sandbar nesting birds, such as piping plovers or least terns or for shallow water forage fishes, such as sand shiners and river shiners. The model may prove transferable to other shifting, sandbed rivers with adjustments for bed slope, sediment size, and river width and may aid in the conservation of native species in those systems.

The Lower Platte River Connectivity Model suggests a physically based relationship between river connectivity and discharge. The river connectivity relationship is associated with the vertical expansion of water during the second transition phase described previously. As the discharge increases and the river transitions to mostly open water habitats, the connectivity among habitat rapidly increased and, ultimately, most of the river is connected at higher discharges. The results of the river connectivity model do not relate to the quantity of habitat available locally within any section of river, but only describes whether or not a pathway between the habitat patches exists.

In comparisons of river connectivity to shovelnose sturgeon movements, the movement of the fish seems to correlate to periods of high river connectivity. Temperature appears to be the cue to initiate upstream movement in the spring, but most long distance movements, both upstream and downstream, are completed prior to the low summer discharges and therefore times of low connectivity. This may hold evolutionary significance as the sturgeon may time their spawning migration in the Platte River to coincide with the times of naturally high flows. In addition to the evolutionary significance, this movement pattern related to river connectivity has significance to water managers. Continued development of surface waters of the Platte River Basin and the retention of spring flow behind dams is likely to decrease average spring discharge rates in the lower Platte River, with a corresponding decrease in river connectivity. If the lower Platte River is consistently unconnected in the spring of the year, sturgeon may not be able to access the habitats available to them in the river and may decrease the likelihood of the fish completing a successful spawning run.

Sturgeon, in the lower Platte River, require water flows sufficient to provide habitat and to allow movement to and from spawning localities. Specifically, discharge criteria, for both pallid sturgeon and shovelnose sturgeon, which maintain the connectivity in the lower Platte River are most important during the spring. During the rest of the year, discharge rates for suitable habitat conditions are the priority.

River connectivity is important for sturgeon migration up and down the river. These migrations, suspected spawning runs, occur during spring and early summer with peak movements upstream during April and May followed by downstream movements in June and July. Average discharge greater than 8,000 cfs during these months would likely provide migratory pathways, since at this level connectivity approaches 100% (Table 10.4). This table also indicates that average monthly discharge less than 6,000 cfs would be ineffective at assuring connectivity within this reach of the Platte River.

Specific discharge rates to protect instream habitat for sturgeon show that more water equals more habitat, although the amount of habitat begins reaching an asymptote around 8,000 cfs. This upper inflection point for the curve suggests a diminishing rate of habitat creation for each additional 1,000 cfs above that discharge (Table 10.5). Approximately 50% of the maximal amount of habitat is available around 4,500 cfs for pallid sturgeon and 4,100 cfs for shovelnose sturgeon (Table 10.5).

These two GIS based models of sturgeon habitat and river connectivity highlight the importance of and the challenges facing the sturgeon in the lower Platte River. The lower Platte River's relatively natural active channel, that still contains the meandering channels, shifting sandbars, and scour holes, provides areas of suitable habitat for shovelnose and pallid sturgeon throughout much of the year. The natural spring rise in discharge provided by the waters of the Loup and Elkhorn Rivers allows migratory sturgeon to move through the river to find and return from suitable spawning areas. Clearly, with the large shovelnose sturgeon population and the use of the river by the endangered pallid sturgeon, the lower Platte River is one of the last remnants of semi-natural, high quality habitat in the mid Great Plains area. The challenge facing the sturgeon in the lower Platte River comes from their habitat requirements of deep, swift waters. If the discharge levels of the lower Platte are decreased, the amount and interconnectedness of these suitable habitats for sturgeons are likely to decrease.

The analysis presented summarizes the habitat needs for the pallid and shovelnose sturgeon in the lower Platte River and their need for connectivity within the system for migration and potentially for reproduction. A missing component (and there are surely others) is their need for food resources which habitats in the Platte River must provide to support a sustainable biotic community. Hesse (1993, 1994) and others have documented the demise of the forage fish community in the Missouri River caused by channelization and flow alterations. Taken to its extreme, the flow recommendations for sturgeon habitat and channel connectivity could be interpreted to fo ster a similar fate for the Platte River. However, examination of the needs for chub species and the diverse assemblage of fishes which require the shallow water conditions in the Platte River (Peters et al. 1989, Peters and Holland 1994) indicate the need for maintaining a balance between the amount of deepwater and shallow water habitats.

Table 10.4. Discharge, percent connectivity, and the 95% confidence interval range for river connectivity in the lower Platte River, Nebraska.

Discharge	% Connectivity	Range
1000	8	0-15
2000	15	2-26
3000	26	13-40
4000	43	30-55
5000	61	52-71
6000	77	69-85
7000	88	81-94
8000	94	88-99
9000	97	91-100
10000	99	93-100

Table 10.5. Discharge, percent shovelnose sturgeon habitat and percent pallid sturgeon habitat in the lower Platte River, Nebraska.

Discharge	% Shovelnose habitat	% Pallid habitat
1000	5	1
2000	14	3
3000	21	6
4000	33	13
5000	44	19
6000	51	23
7000	55	25
8000	58	27
9000	60	28
10000	61	29

Table 10.1. Descriptive information for the aerial images used for habitat classification from the lower Platte River, NE. The gage site represents the nearest USGS gage for classified image. In some cases, discharge was determined from a combination of USGS gages. Gage sites are as follows: LSV = Platte River at Louisville, NE; ASH = Platte River at Ashland, NE; LES = Platte River at Leshara; ELK = Elkhorn River at Waterloo, NBD = Platte River at North Bend, NE; LPC = Loup Power Canal at Genoa, NE; LPR = Loup River at Genoa, NE; DCN = Platte River at Duncan, NE. GPS coordinates are in decimal degrees and are located approximately mid-channel at the upstream and downstream ends of the river section. UPGPSW = upstream GPS west, UPGPSN = upstream GPS north, DGPSW = downstream GPS west, DGPSN = downstream GPS north.

Site ID	Date	Gage Site	Discharge (cfs)	Length (km)	UPGPSW	UPGPSN	DGPSW	DGPSN
1	15-Aug-2002	DCN	0	5.7	-97.3801	41.3962	-97.3218	41.3970
2	15-Aug-2002	LES	958	4.5	-96.3578	41.2468	-96.3605	41.2191
3	15-Aug-2002	LSV	1,400	4.7	-96.2254	40.9979	-96.1718	41.0079
4	1-Apr-1999	DCN	2,450	5.1	-97.3801	41.3962	-97.3218	41.3970
5	22-Apr-1993	DCN	2,840	11.0	-97.4431	41.3748	-97.3211	41.3965
6	1-Apr-1999	DCN+LPR	4,080	3.3	-97.3218	41.3970	-97.2836	41.3965
7	21-Mar-1994	DCN+LPR+LPC	4,690	2.8	-97.3175	41.3985	-97.2833	41.3996
8	18-Apr-1994	NBD	5,610	5.0	-96.8182	41.4497	-96.7599	41.4526
9	4-Apr-1999	LES	5,680	16.4	-96.3534	41.2537	-96.3130	41.1209
10	4-Apr-1999	LES	5,680	13.9	-96.5665	41.4357	-96.4318	41.3664
11	1-Apr-1999	DCN+LPR+LPC	5,820	3.5	-97.2836	41.3965	-97.2459	41.3845
12	16-Apr-1993	NBD	6,350	38.3	-97.2419	41.3833	-96.8235	41.4487
13	6-Apr-1999	NBD	6,570	15.8	-97.1304	41.3859	-96.9672	41.4408
14	21-Mar-1994	DCN+LPR	6,580	3.7	-97.2833	41.3996	-97.2462	41.3838
15	4-Apr-1999	ASH	7,760	11.8	-96.3182	41.1281	-96.3072	41.0368
16	14-Apr-1993	ASH-ELK	7,830	12.1	-96.3532	41.2536	-96.3203	41.1581
17	4-Apr-1999	LSV	8,480	31.3	-96.2557	41.0172	-95.9338	41.0586
18	6-Apr-1999	LES	8,800	8.3	-96.4417	41.3713	-96.3985	41.3089
19	22-Apr-1993	NBD	10,400	24.4	-96.7555	41.4525	-96.4903	41.3992
20	2-Apr-1993	ASH-ELK	10,740	6.5	-96.3794	41.2995	-96.3562	41.2469
21	6-Apr-1999	LSV	10,800	4.5	-96.2343	41.0041	-96.1850	41.0030
22	14-Apr-1999	ASH	14,400	7.2	-96.3172	41.0463	-96.2488	41.0157
23	16-Apr-1993	ASH	15,000	21.0	-96.3187	41.1279	-96.1837	41.0048
24	26-Mar-1993	LSV	15,500	29.4	-96.1940	41.0010	-95.8810	41.0532
25	22-Apr-1993	ASH-ELK	18,920	12.7	-96.4547	41.3782	-96.3698	41.2911
26	19-Apr-1999	LSV	21,000	5.6	-95.9438	41.0579	-95.8808	41.0531

Table 10.2. Area and percent for the habitat types classified from the aerial images of the lower Platte River, NE. Site ID's correspond to location information in Table 10.1. OWTR = open water, SSBC = shallow sandbar complexes, EXSB = exposed sandbars, WDIL = woody islands. Percentages are calculated as a proportion of the Total Area – WDIL.

Site ID	Discharge (cfs)	OWTR (m^2)	OWTR (%)	SSBC (m^2)	SSBC (%)	EXSB (m^2)	EXSB (%)	WDIL (m^2)	Total Area (m^2)
1	0	0	0	0	0	2,750,598	100	416,331	3,166,929
2	958	0	0	785,016	32	1,638,342	68	693,198	3,116,556
3	1,400	152,271	5	1,456,947	46	1,553,022	49	0	3,162,240
4	2,450	22,086	1	2,096,109	88	265,437	11	458,982	2,842,614
5	2,840	807,939	13	4,243,563	68	1,211,832	19	383,535	6,646,869
6	4,080	312,795	21	860,202	57	338,337	22	821,160	2,332,494
7	4,690	472,167	37	464,850	36	339,165	27	131,751	1,407,933
8	5,610	1,789,488	65	581,247	21	378,585	14	337,005	3,086,325
9	5,680	6,575,418	71	1,993,383	22	701,640	8	1,731,609	11,002,050
10	5,680	4,414,248	55	2,265,021	28	1,373,319	17	1,676,934	9,729,522
11	5,820	999,324	44	724,878	32	523,854	23	726,696	2,974,752
12	6,350	13,801,968	71	2,817,054	14	2,877,984	15	5,755,185	25,252,191
13	6,570	4,363,668	45	3,482,262	36	1,912,086	20	1,081,017	10,839,033
14	6,580	1,175,427	54	631,026	29	384,408	18	56,754	2,247,615
15	7,760	4,522,914	67	1,441,071	21	783,180	12	1,190,196	7,937,361
16	7,830	5,926,383	82	578,457	8	720,765	10	1,749,105	8,974,710
17	8,480	11,682,639	62	4,388,157	23	2,694,276	14	3,761,748	22,526,820
18	8,800	3,881,376	75	1,174,779	23	125,010	2	1,990,818	7,171,983
19	10,400	10,541,880	73	1,851,552	13	2,110,644	15	5,573,349	20,077,425
20	10,740	2,431,188	57	838,089	20	990,036	23	547,029	4,806,342
21	10,800	1,750,491	59	746,001	25	470,160	16	0	2,966,652
22	14,400	4,353,462	95	202,968	4	48,924	1	816,525	5,421,879
23	15,000	11,280,402	86	806,436	6	1,085,751	8	2,436,984	15,609,573
24	15,500	12,296,934	68	3,104,397	17	2,761,308	15	3,917,322	22,079,961
25	18,920	6,157,746	79	1,001,970	13	665,658	9	2,590,200	10,415,574
26	21,000	2,851,551	95	121,527	4	33,957	1	319,410	3,326,445

Table 10.3. Date, discharge, location, section length, longest connected segment, and percent connected within the segment for the classified aerial images. GPS location area at the approximate midstream point of the river.

Date	Discharge (cfs)	Upstream GPS W	Upstream GPS N	Downstream GPS W	Downstream GPS N	Section Length (m)	Longest connected segment (m)	Percent Connected
8/15/2002	0	-97.372724	41.397715	-97.320979	41.396877	4,629	0	0.0
8/15/2002	1,440	-95.943929	41.057734	-95.880847	41.05313	5,665	781	13.8
4/1/1999	2,450	-97.320687	41.397708	-97.282103	41.399205	3,277	632	19.3
4/22/1993	2,840	-97.443057	41.374605	-97.320309	41.396375	11,034	1,487	13.5
4/1/1999	4,080	-97.282103	41.399205	-97.246196	41.384091	3,581	1,118	31.2
4/18/1994	5,610	-96.818211	41.449519	-96.759852	41.452479	5,024	5,024	100.0
4/4/1999	5,680	-96.353339	41.253634	-96.329839	41.19317	8,043	8,043	100.0
4/4/1999	5,680	-96.329839	41.19317	-96.316788	41.120951	8,375	6,059	72.3
4/16/1993	6,350	-96.879212	41.457384	-96.823455	41.448584	4,809	4,809	100.0
4/16/1993	6,350	-97.092429	41.392642	-96.965535	41.446522	12,934	12,934	100.0
4/16/1993	6,350	-97.241841	41.383514	-97.183778	41.379117	5,172	5,172	100.0
4/6/1999	6,570	-97.130484	41.385838	-97.059774	41.412016	6,889	6,889	100.0
3/21/1994	6,580	-97.282259	41.399263	-97.246134	41.383851	3,599	3,599	100.0
4/4/1999	7,760	-96.313046	41.121732	-96.309919	41.038654	10,673	10,673	100.0
4/14/1993	7,830	-96.353445	41.253612	-96.320133	41.158152	12,059	12,059	100.0
4/4/1999	8,480	-96.088864	41.054706	-95.935115	41.058673	13,611	13,611	100.0
4/4/1999	8,480	-96.199711	40.998149	-96.088864	41.054706	11,611	10,761	92.7
4/22/1993	10,700	-96.454643	41.378231	-96.369482	41.291046	13,020	13,020	100.0
4/22/1993	10,700	-96.631066	41.439423	-96.490571	41.399328	13,103	13,103	100.0
4/22/1993	10,700	-96.755691	41.451736	-96.643403	41.439455	10,410	10,058	96.6
4/6/1999	10,800	-96.234066	41.003989	-96.18809	41.002829	4,503	4,503	100.0
4/2/1993	11,740	-96.379451	41.298393	-96.357539	41.246914	6,569	5,982	91.1
4/16/1993	15,000	-96.308599	41.037664	-96.245979	41.013809	6,112	6,112	100.0
4/16/1993	15,000	-96.313032	41.122609	-96.308599	41.037664	10,998	10,998	100.0
4/12/1999	15,300	-96.316938	41.048161	-96.248773	41.01537	7,101	7,101	100.0
3/26/1993	15,500	-95.960875	41.059001	-95.880996	41.053369	6,961	6,961	100.0
3/26/1993	15,500	-96.077288	41.057738	-95.960875	41.059001	10,374	10,374	100.0
3/26/1993	15,500	-96.190194	41.001303	-96.077288	41.057738	11,639	11,639	100.0
4/19/1999	21,000	-95.943929	41.057734	-95.880847	41.05313	5,665	5,665	100.0

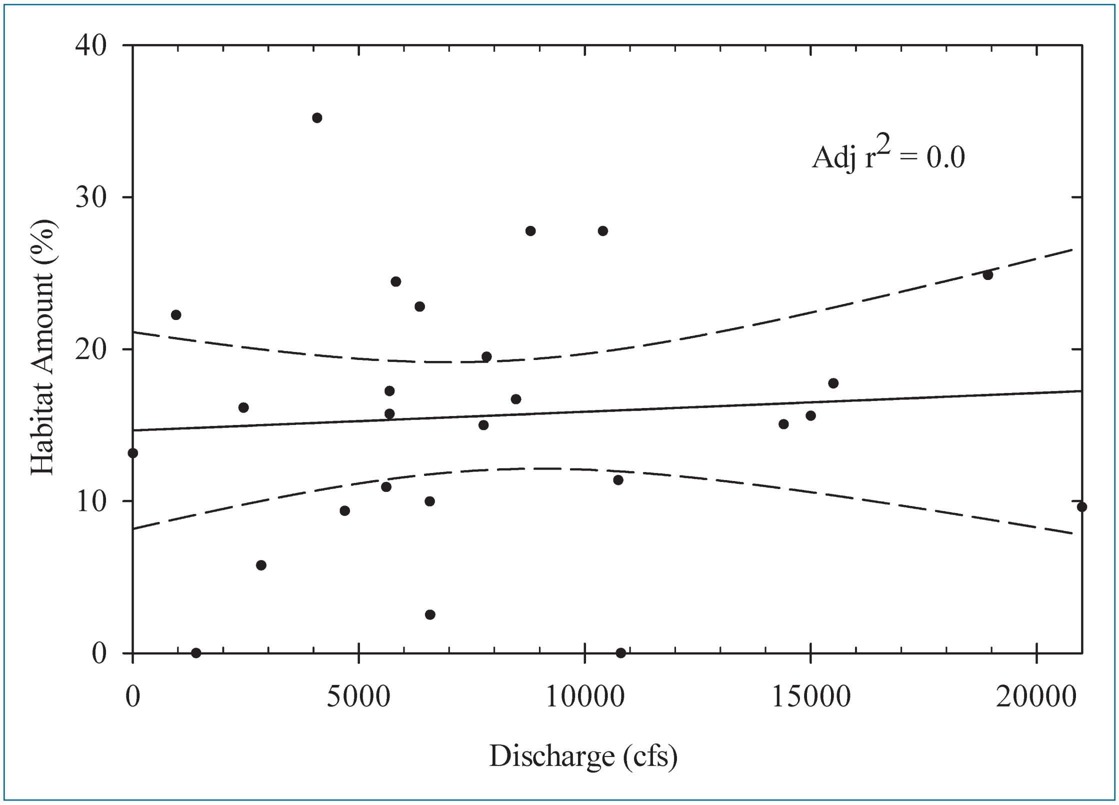

Figure 10.7. Regression line of best fit for woody islands from the aerial photo classification. The solid line represents the fitted line, the dashed lines are the 95% confidence intervals about the line, and the dots are the observations.

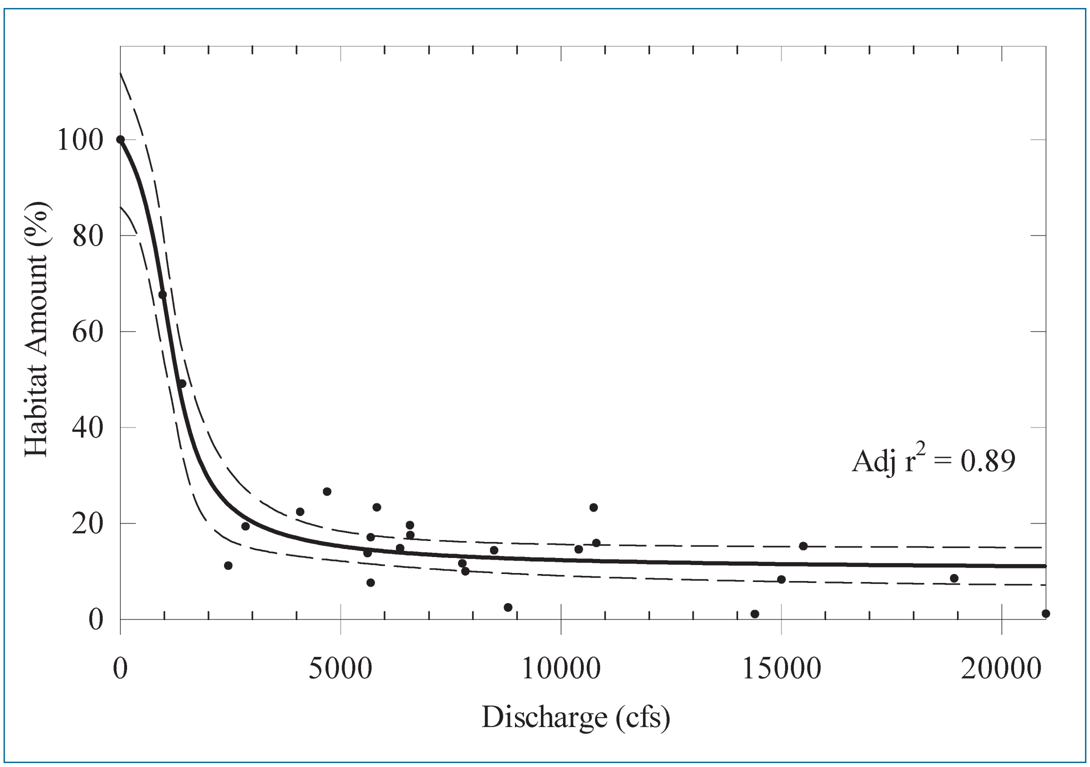

Figure 10.8. Regression line of best fit for exposed sandbars (Equation 10.1) from the aerial photo classification. The solid line represents the fitted line, the dashed lines are the 95% confidence intervals about the line, and the dots are the observations.

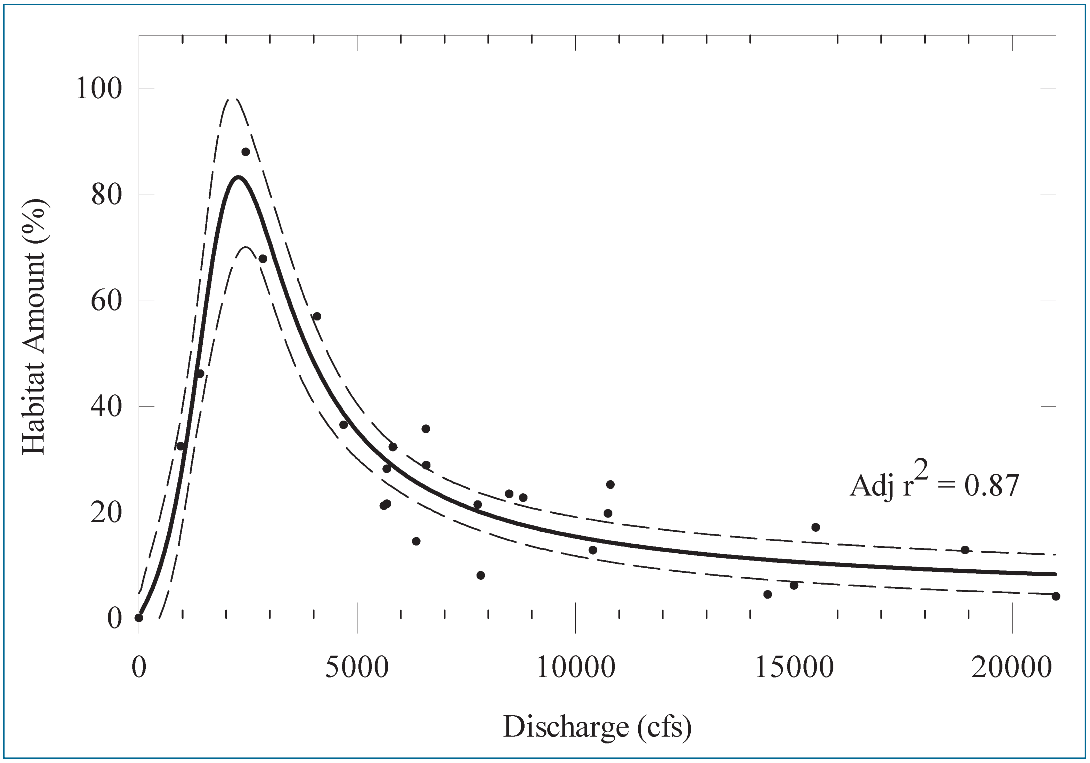

Figure 10.9. Regression line of best fit for shallow sandbar complexes (Equation 10.2) from the aerial photo classification. The solid line represents the fitted line, the dashed lines are the 95% confidence intervals about the line, and the dots are the observations.

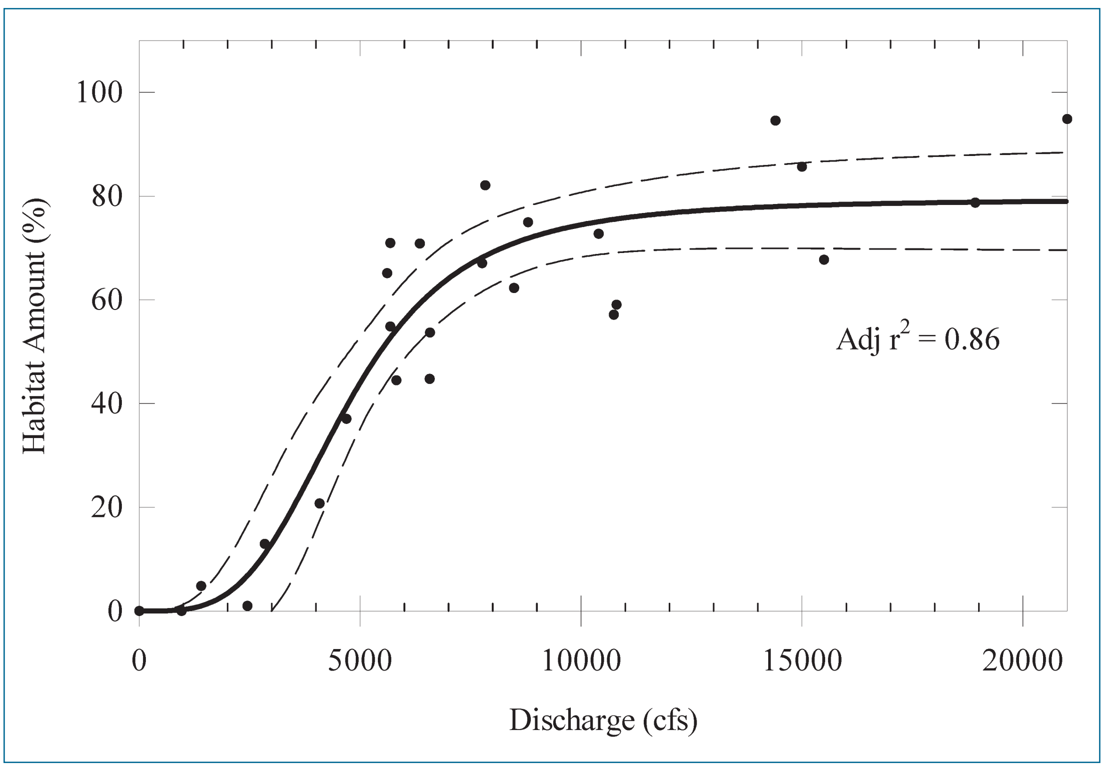

Figure 10.10. Regression line of best fit for open water (Equation 10.3) from the aerial photo classification. The solid line represents the fitted line, the dashed lines are the 95% confidence intervals about the line, and the dots are the observations.

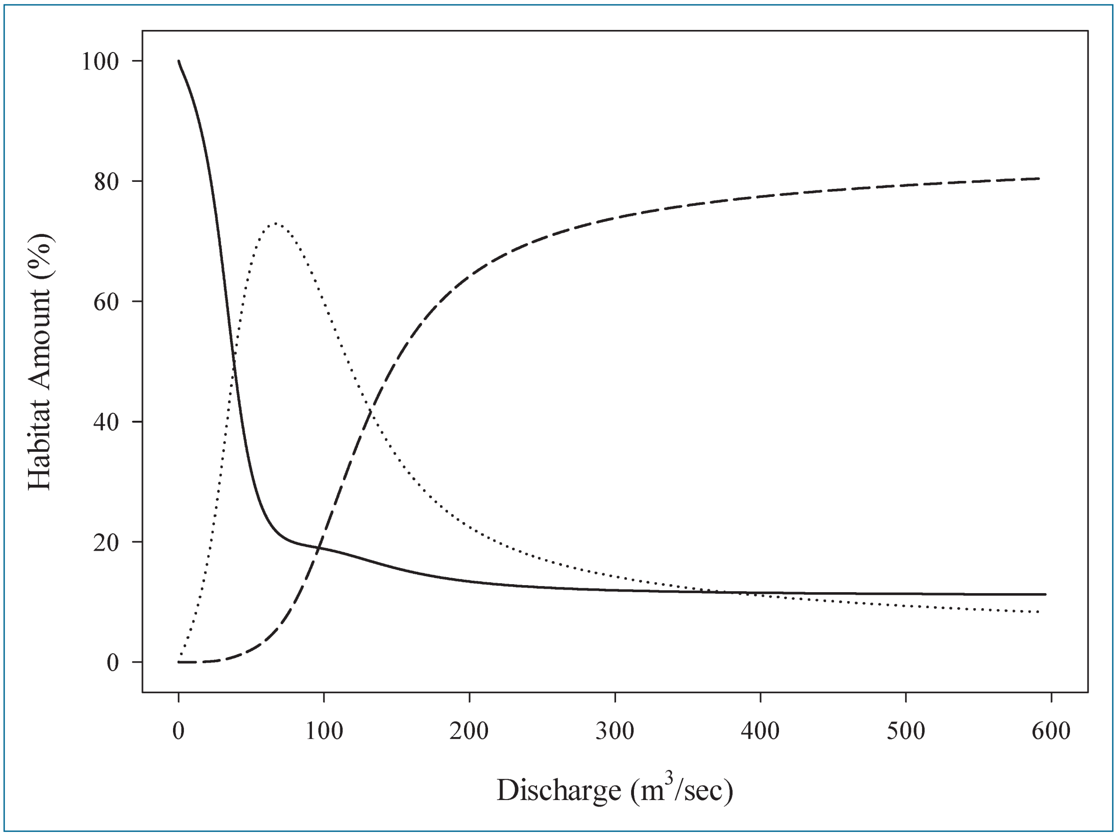

Figure 10.11 The simultaneously adjusted curves for the habitat type vs. river discharge. The solid line represents exposed sandbars, the dotted line is shallow sandbar complexes, and the dashed line represents open water.

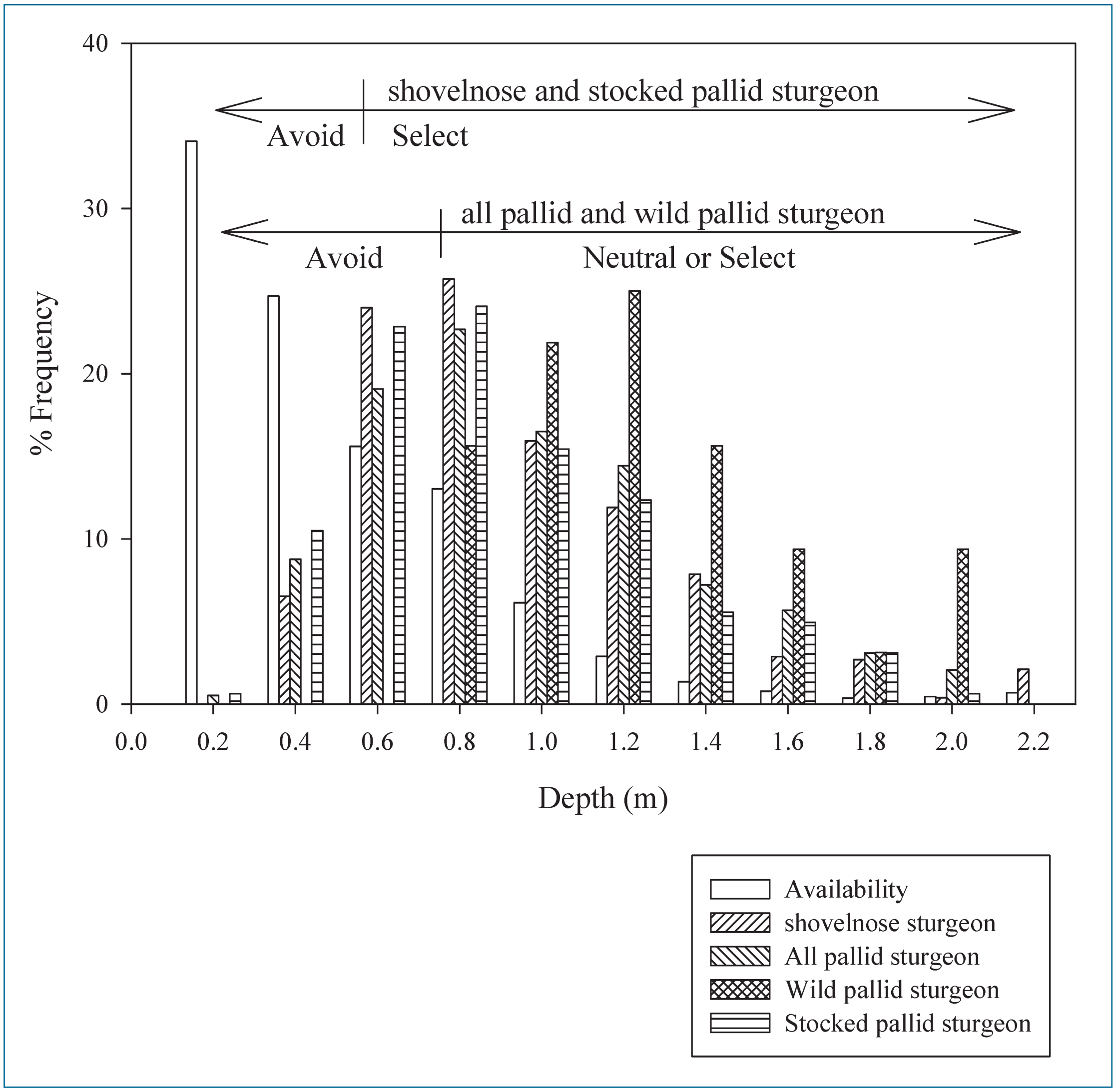

Figure 10.12. Sturgeon habitat use vs. depth availability in the lower Platte River. Selectivity determined with Chi-Square selectivity Index.

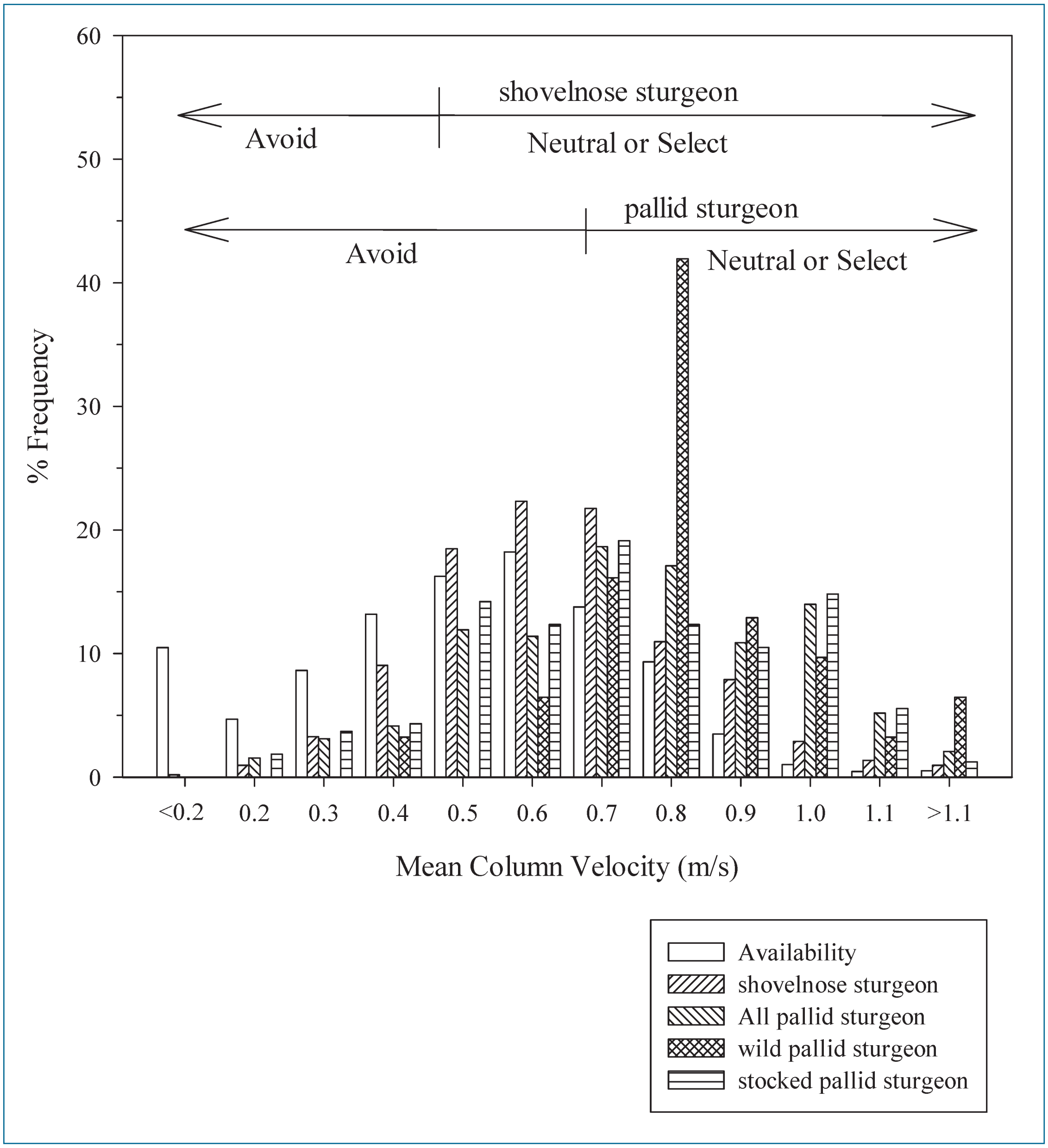

Figure 10.13. Sturgeon habitat use vs. mean column velocity availability in the lower Platte River. Selectivity determined with Chi-Square selectivity Index.

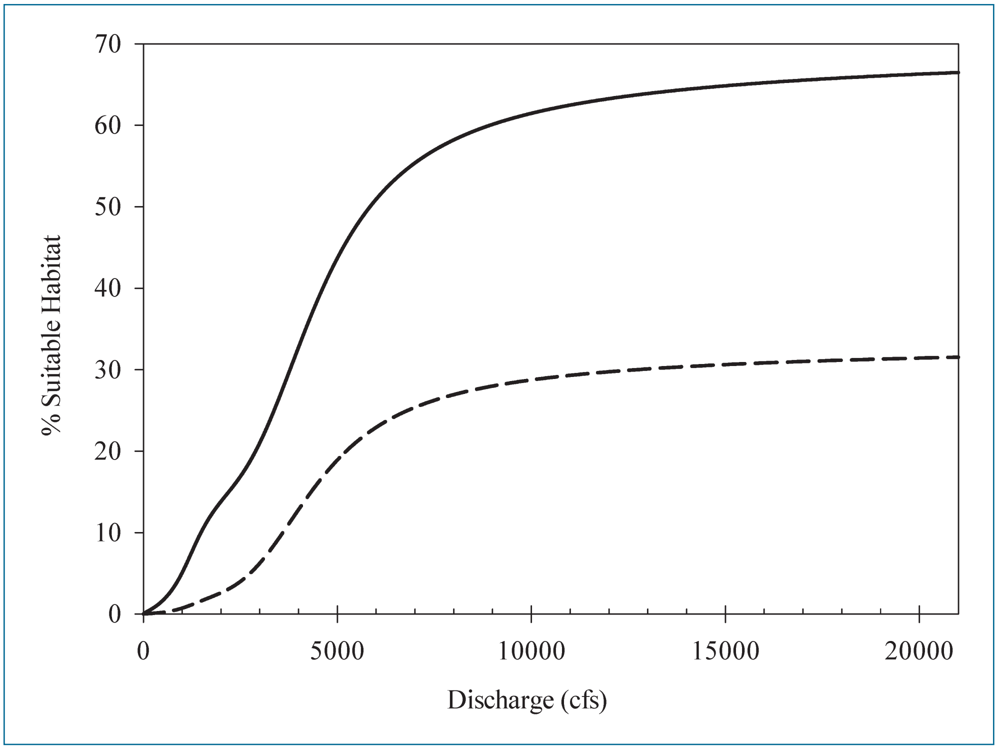

Figure 10.14. Suitable habitat vs. discharge for sturgeon in the lower Platte River. The dashed line represents pallid sturgeon (Equation 10.4) and the solid line represents shovelnose sturgeon (Equation 10.5).

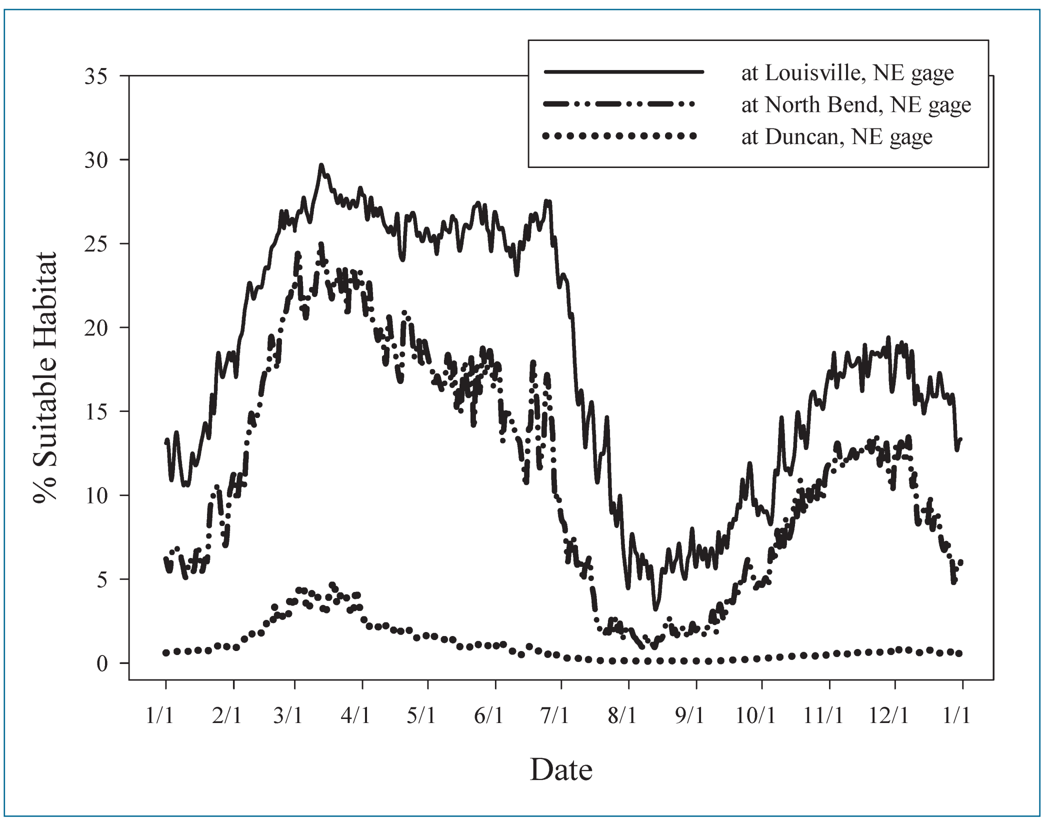

Figure 10.15. Mean suitable habitat for pallid sturgeon in relation to average daily discharge recorded at three gage locations in the lower Platte River. Average daily discharge is based on the complete published record from the USGS for each gage site.

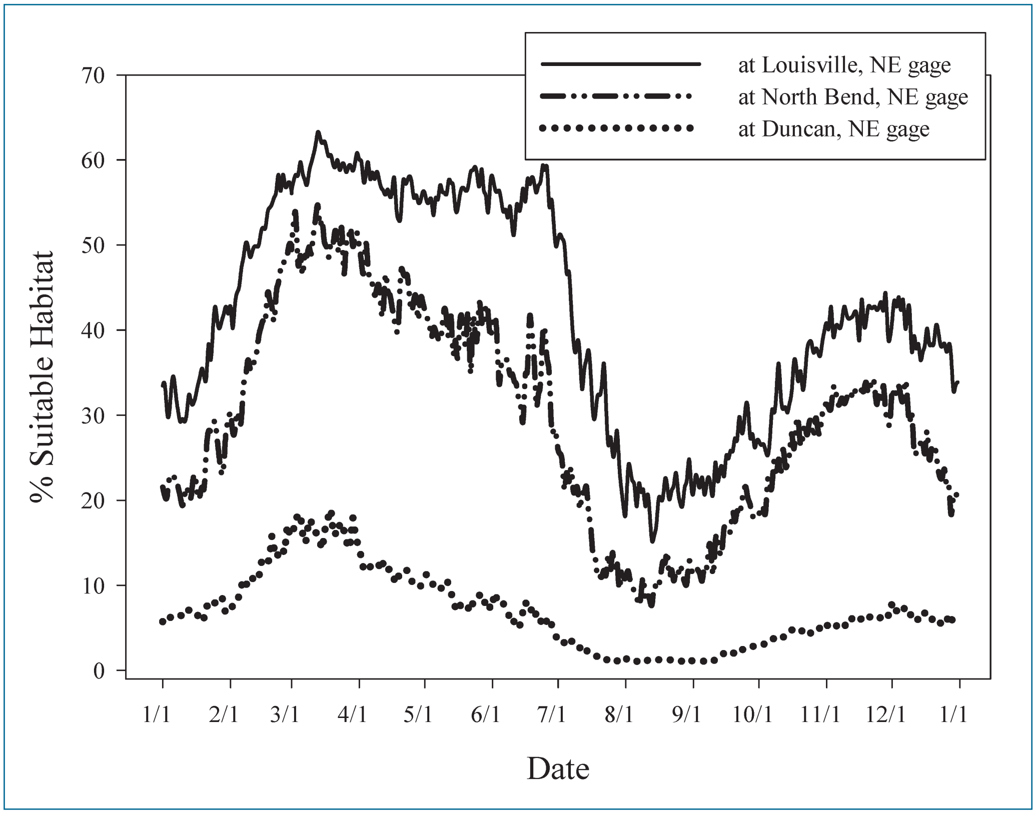

Figure 10.16. Mean suitable habitat for shovelnose sturgeon in relation to average daily discharge recorded at three gage locations in the lower Platte River. Average daily discharge is based on the complete published record from the USGS for each gage site.

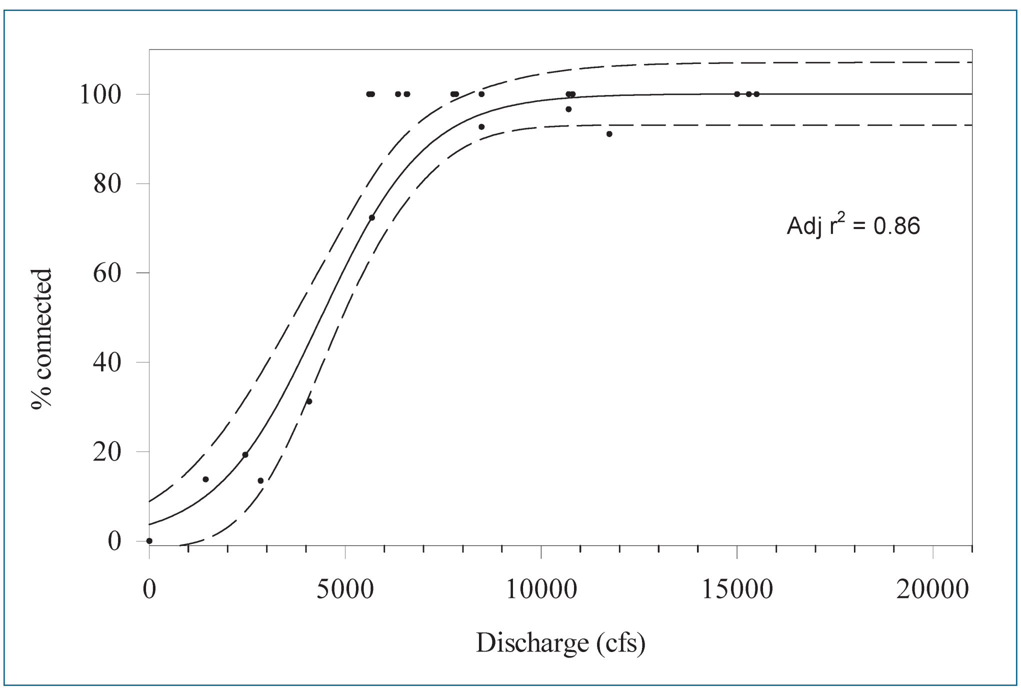

Figure 10.17. Curve of best fit for river connectivity vs. discharge (Equation 10.6) for the lower Platte River. The solid line represents the fitted line, the dashed lines are the 95% confidence intervals about the line, and the dots are the observations.

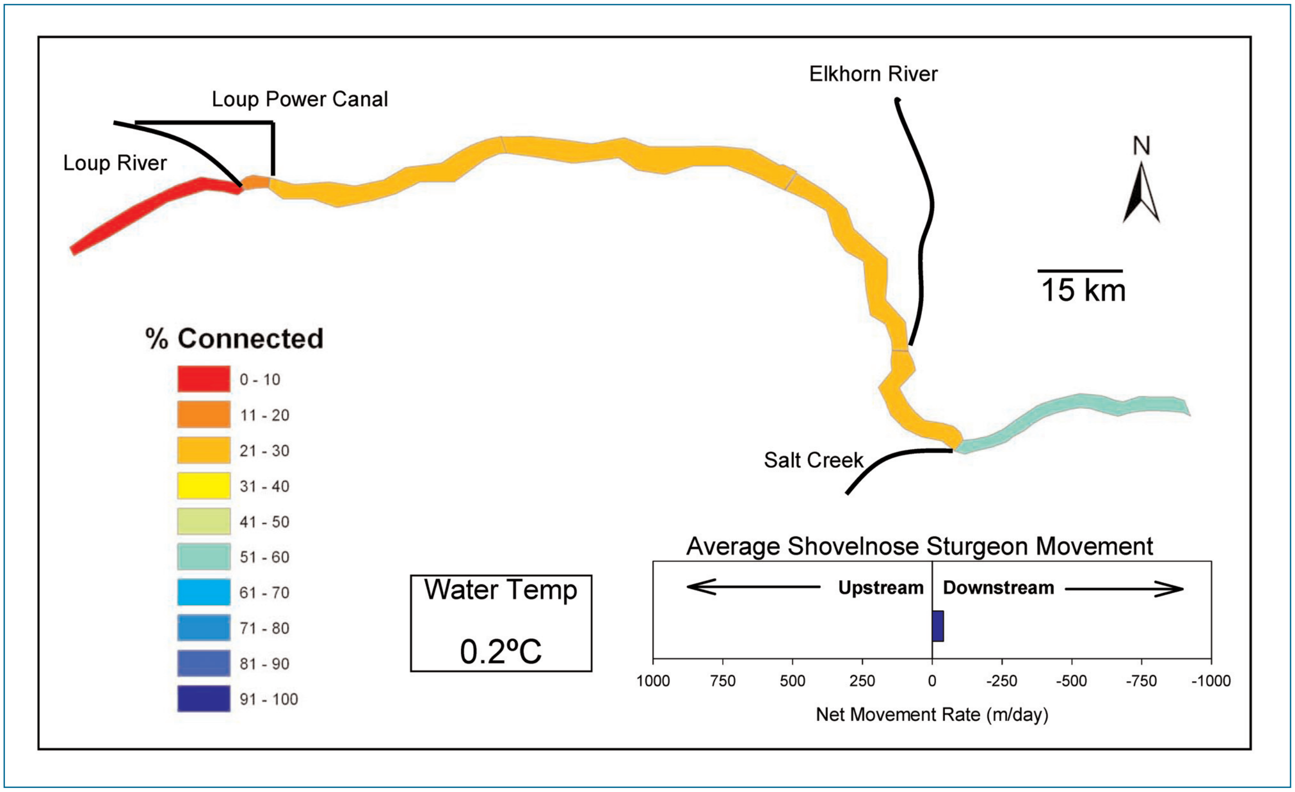

Figure 10.18. River connectivity for average monthly conditions in January for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

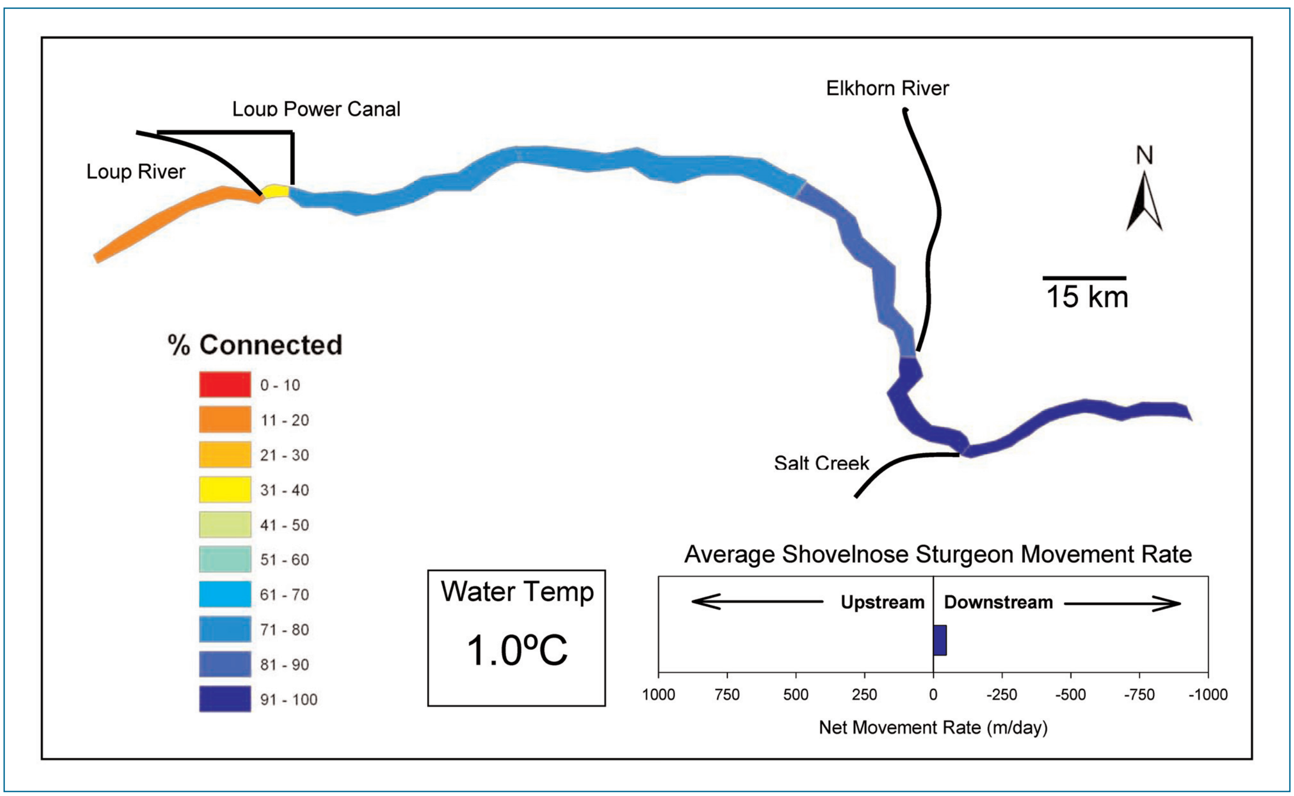

Figure 10.19. River connectivity for average monthly conditions in February for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

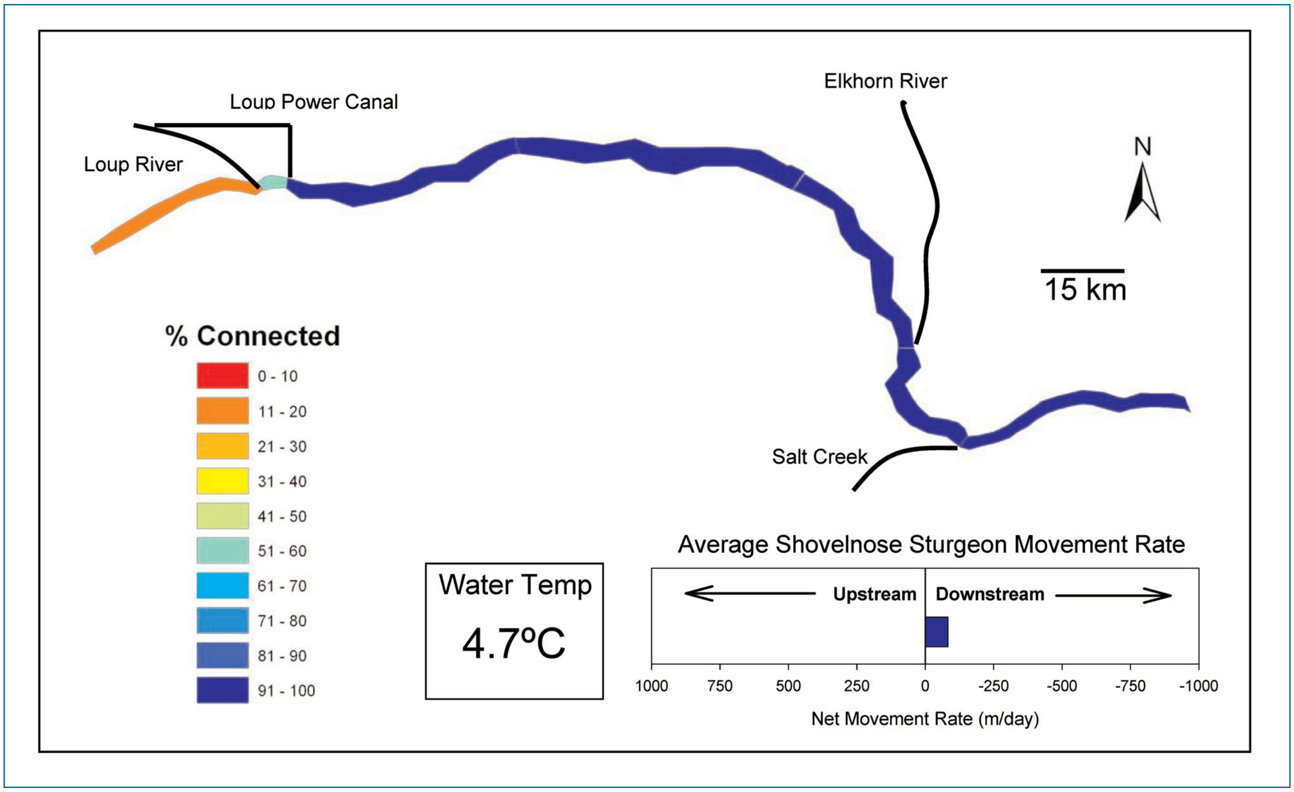

Figure 10.20. River connectivity for average monthly conditions in March for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

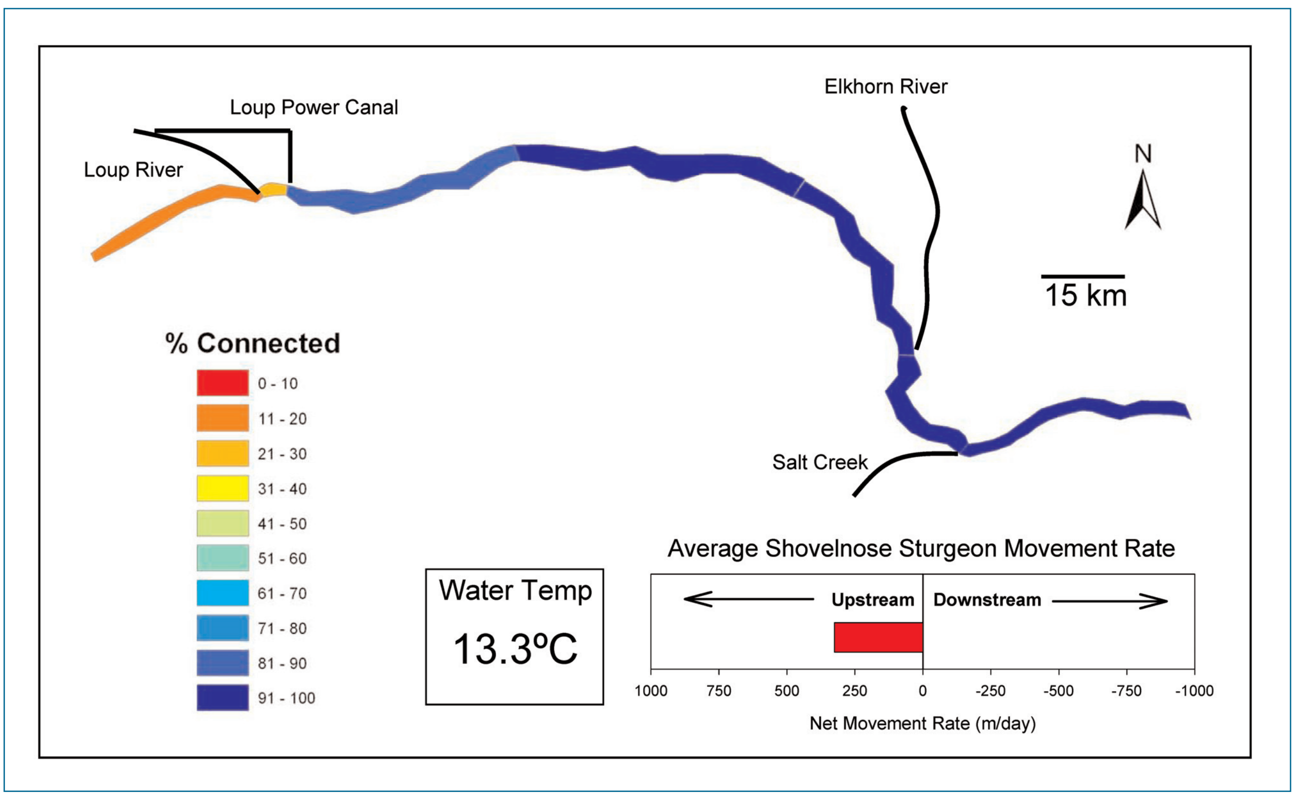

Figure 10.21. River connectivity for average monthly conditions in April for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

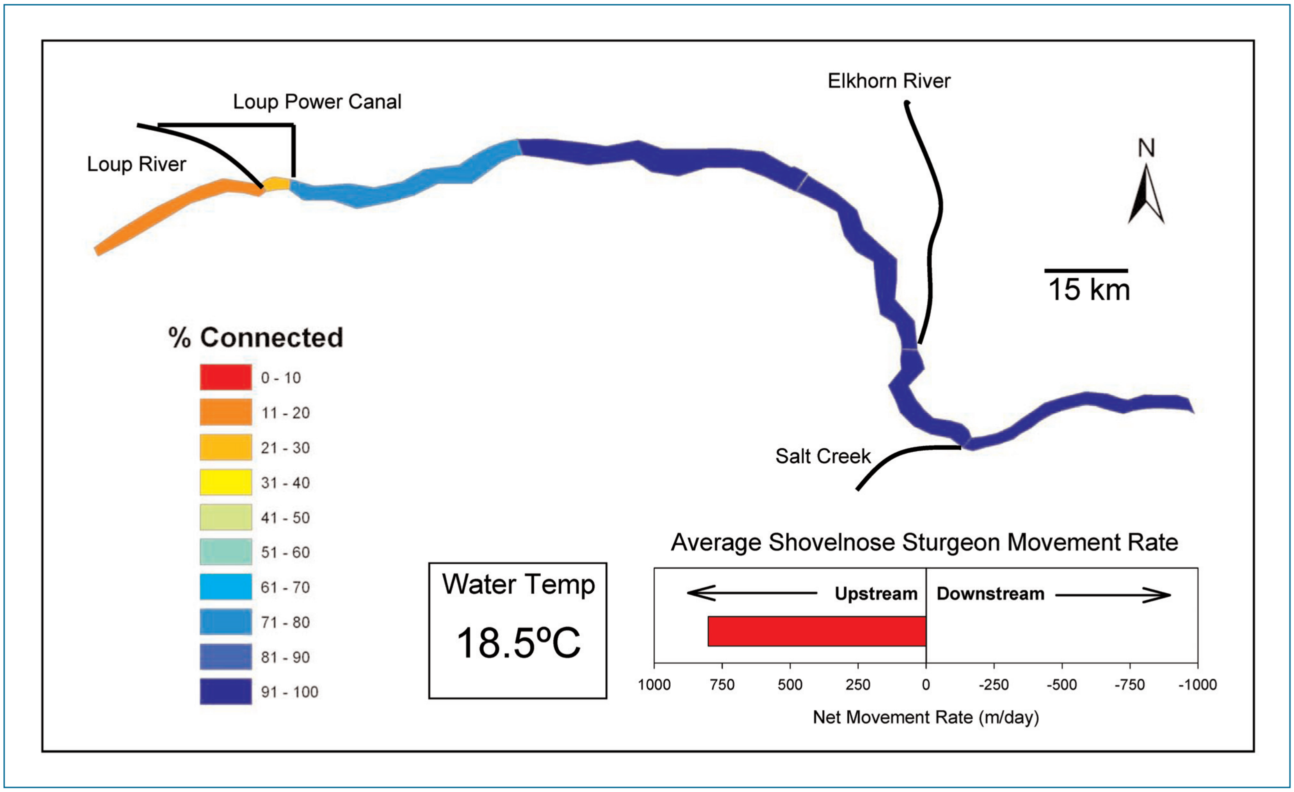

Figure 10.22. River connectivity for average monthly conditions in May for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

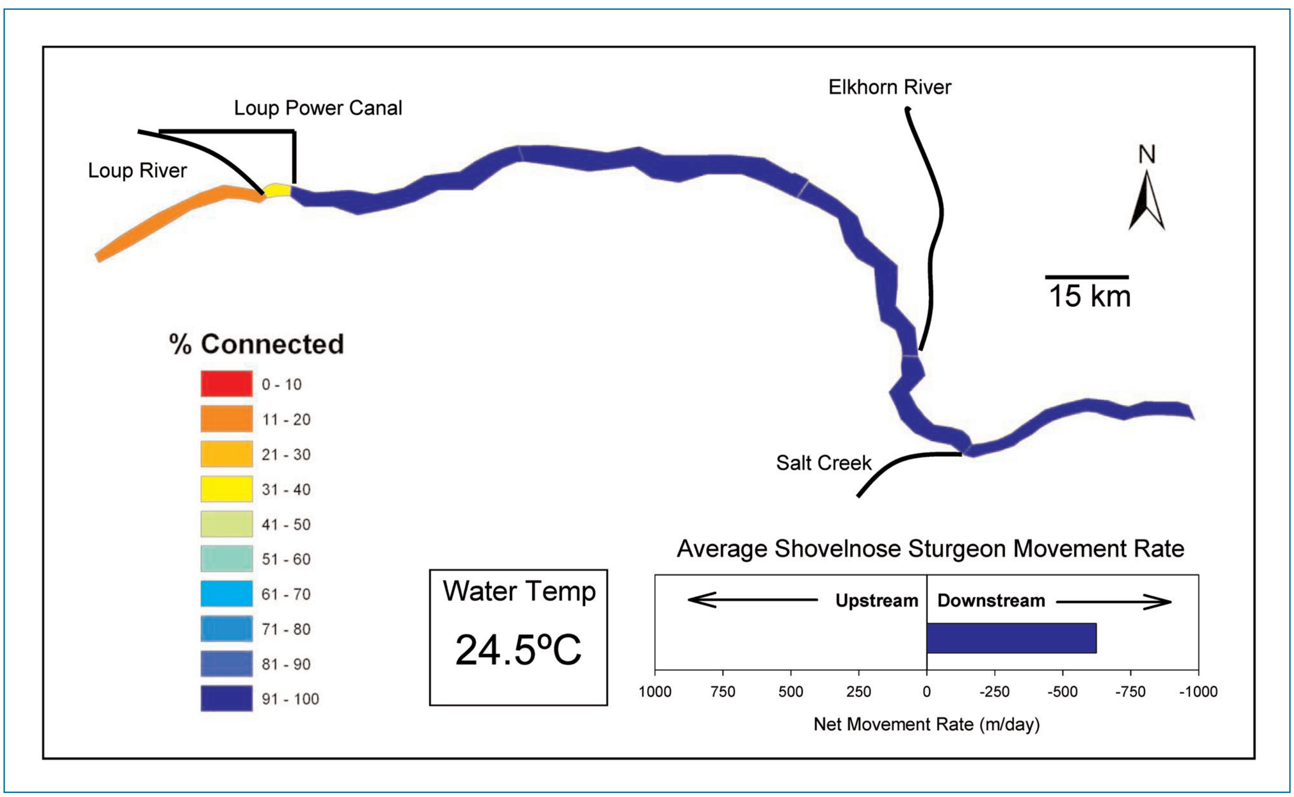

Figure 10.23. River connectivity for average monthly conditions in June for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

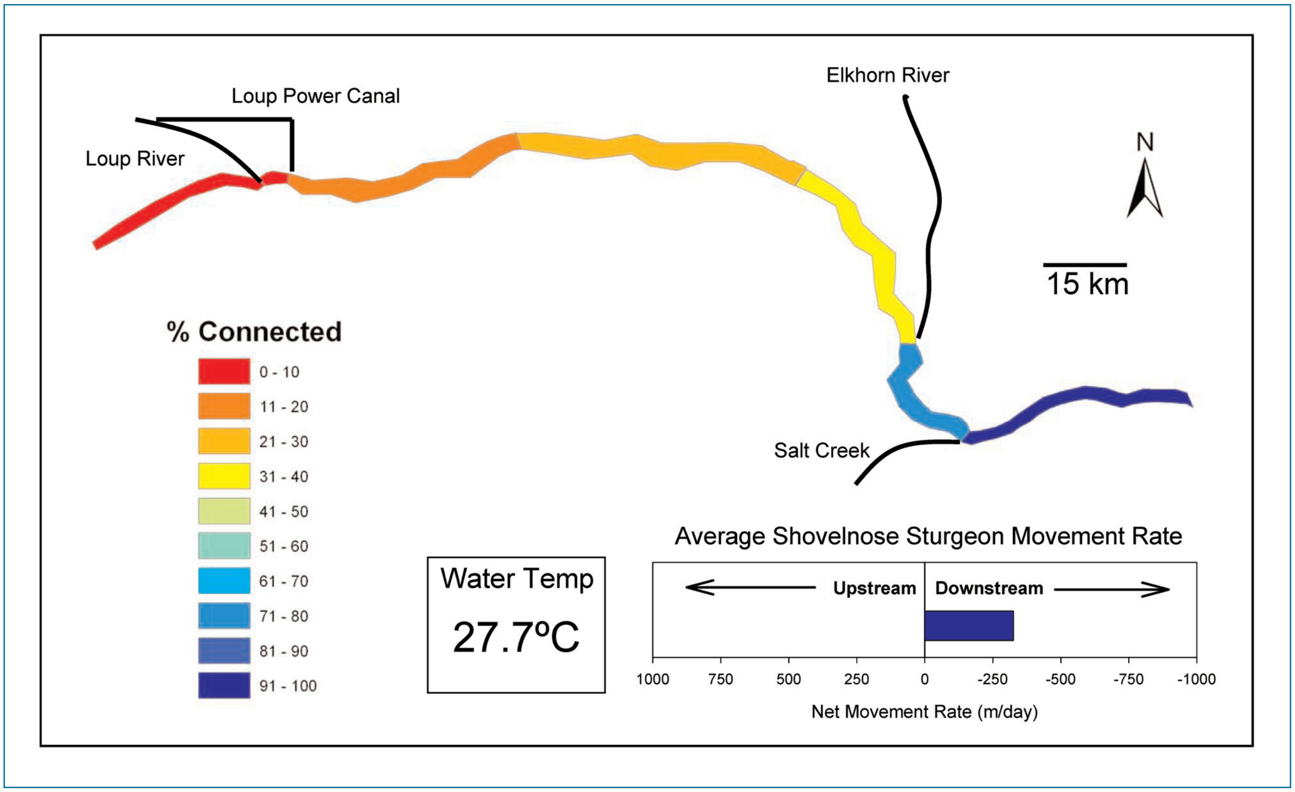

Figure 10.24. River connectivity for average monthly conditions in July for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

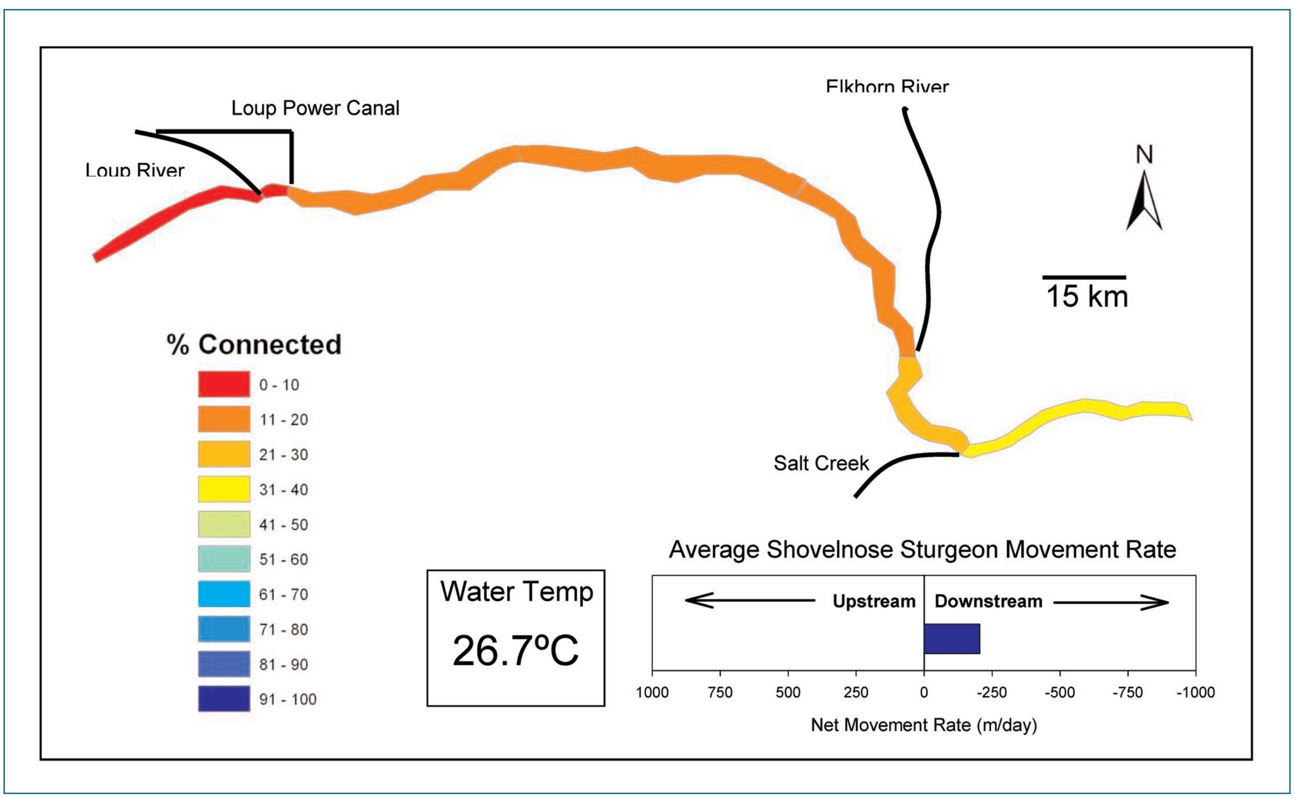

Figure 10.25. River connectivity for average monthly conditions in August for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

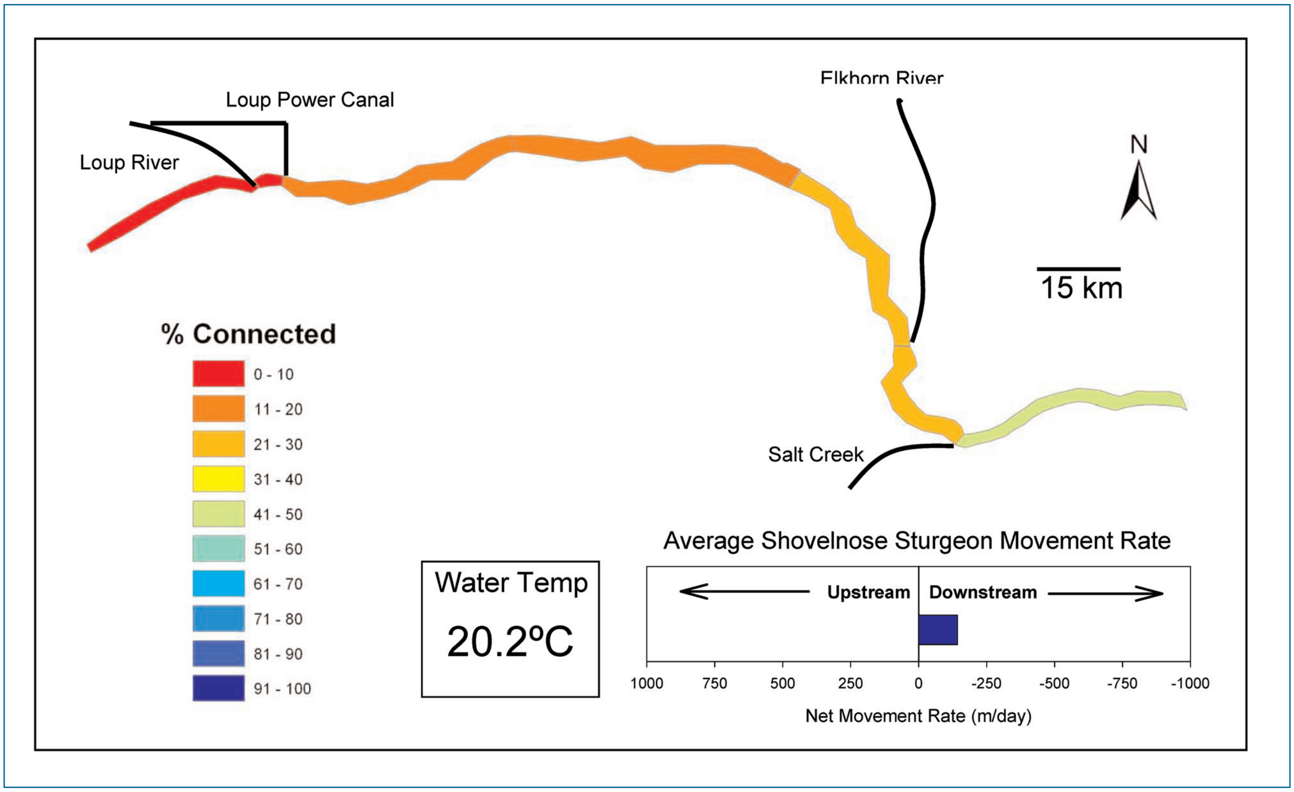

Figure 10.26. River connectivity for average monthly conditions in September for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

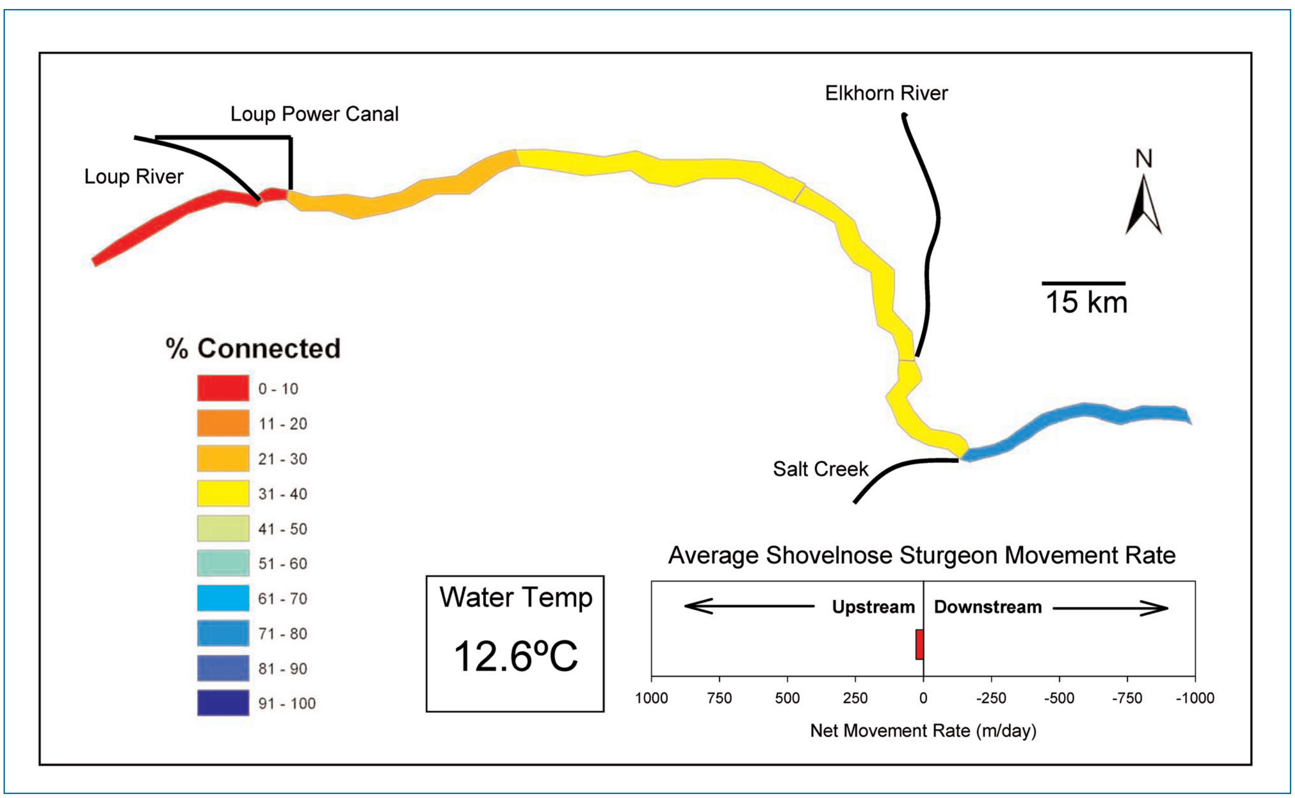

Figure 10.27. River connectivity for average monthly conditions in October for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

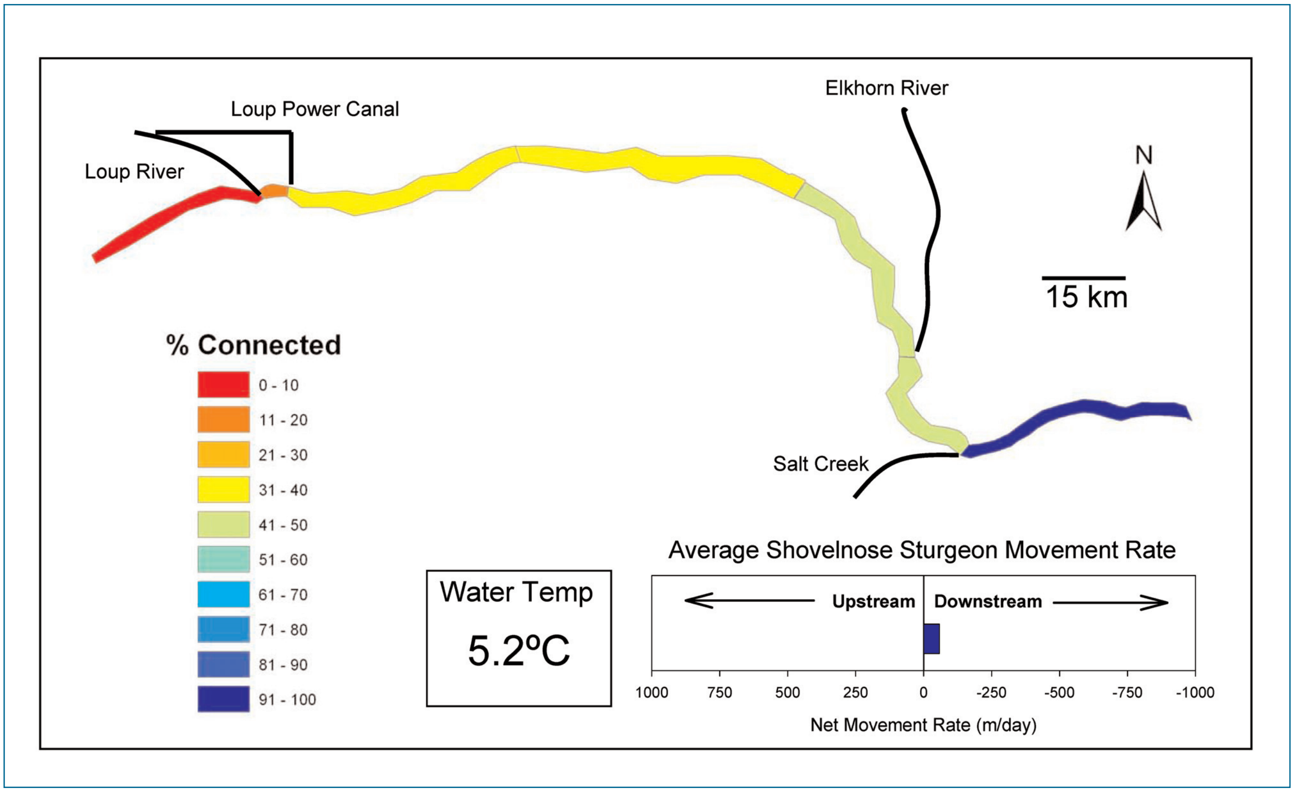

Figure 10.28. River connectivity for average monthly conditions in November for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

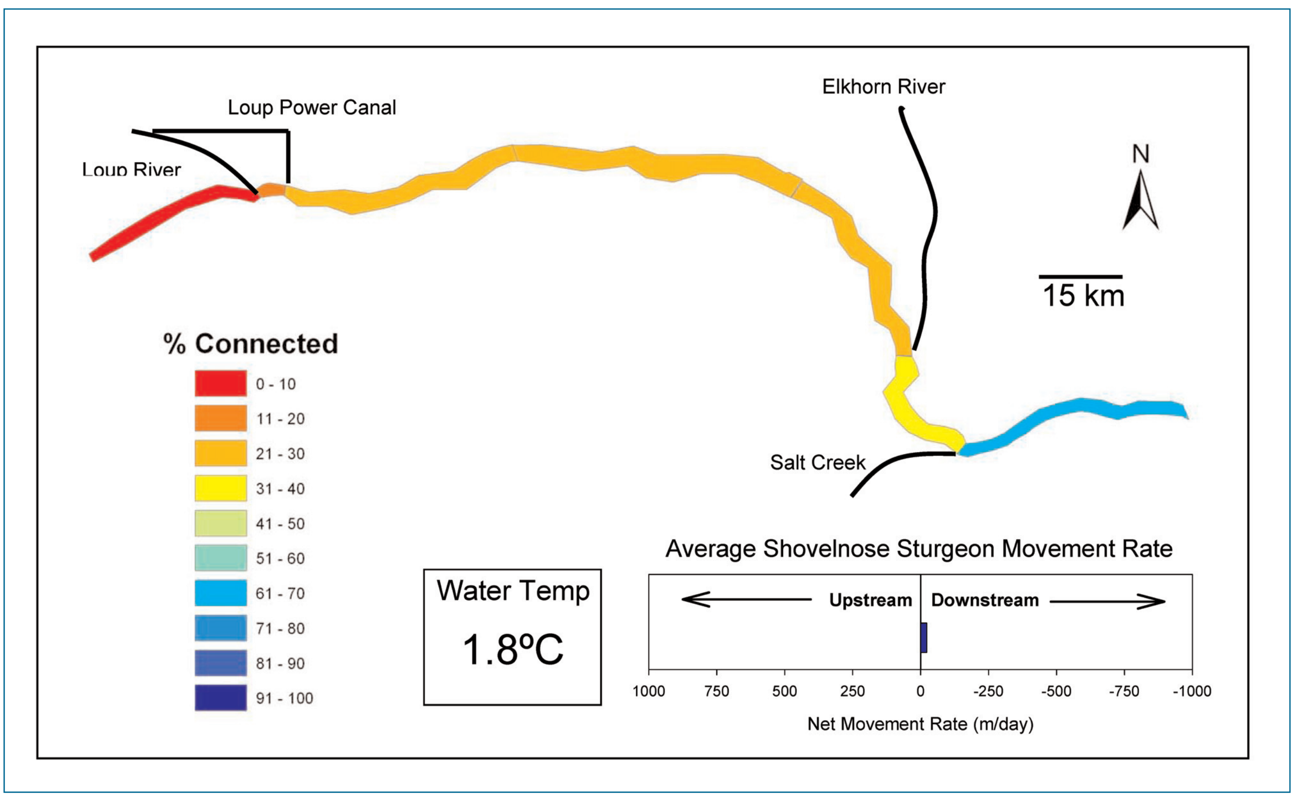

Figure 10.29. River connectivity for average monthly conditions in December for sections of the lower Platte River associated with USGS gage sites. Additional information includes average monthly water temperature and average shovelnose sturgeon movement.

CHAPTER 11

MANAGEMENT RECOMMENDATIONS FOR STURGEON AND CHUB POPULATIONS, IN THE LOWER PLATTE RIVER

INTRODUCTION

The final objectives for the Pallid Sturgeon / Sturgeon Chub Task Force and the Nebraska Game and Parks Commission in funding this research were to develop management recommendations for sturgeons and chubs. In addition, we proposed to facilitate appropriate recovery efforts for pallid sturgeon and sturgeon chub in the lower Platte River. At the time when this research was initiated there was a proposal to list the sturgeon chub as a federally endangered species. Subsequent to the initiation of this project, additional information about sturgeon chub populations resulted in the withdrawal of this proposal at the federal level, but sturgeon chub is still a Nebraska state listed endangered fish species.

Management recommendations:

The following ideas represent our considered opinions about how management can foster the continued existence of the sturgeon species and the chub species of the lower Platte River and the ecosystem upon which they depend.

Chapter 1 Recommendations:

The existence of this ecosystem depends upon a continuing reliable flow of water in the Platte River at a magnitude and timing of discharge that maintain the shifting sand bar habitat and scour channels that allow for production of food organisms, creation of suitable habitats and enable passage of sturgeon adults and fry.

1. We recommend that historical flow volumes and discharge patterns are used as a guide to the management of future flow recommendations for the lower Platte River.

Chapter 2 Recommendations:

It is obvious from the analysis in this report and other publications that no single type of collection gear is sufficient to sample all life stages of fish species like sturgeons and chubs. In fact, it is increasingly apparent that one sampling gear will not perform equally in different bodies of water. This means that in order to document the benefit (or detriment) of any management action, future sampling in the Platte River will require a multi-gear approach, such as we have used.

2. We recommend using a combination of drifted trammel nets, trawls and trotlines to monitor the long term trends in sturgeon populations and habitat use. This monitoring should also be coordinated with ongoing efforts in the Missouri River (Quist et al. 2005), since it is also apparent that Platte River sturgeon populations are virtually continuous with those in the Missouri River system.

3. We recommend continuation of telemetry efforts for pallid sturgeon in the lower Platte River to be a very prudent emphasis of continuing research. Any future studies in the Platte River should be coordinated with the efforts of USGS researchers that are using telemetry technology that allows depth and water temperature to be monitored during critical phases of the sturgeon's life cycle. Work in the Platte River could provide excellent opportunities to locate spawning sites for pallid sturgeon and then to monitor the fate of larval and juvenile life stages. It will also allow the evaluation of sturgeon stocking programs as these fish develop into adults.

4. To monitor the health of chub populations we recommend that a combination of trawls and seines would be the most effective protocol. The addition of electrofishing grids may be useful to further define chub habitat use in specific areas.

Chapter 3 Recommendations:

Overall the water quality appeared to be relatively good in the lower Platte River during this study. However, we observed an apparent reaction of pallid sturgeon to a treated water discharge. Several radio-tagged pallid sturgeon were staging upstream from the mouth of the Platte River in an apparent beginning to their upstream spawning run. All of the fish moved out of the Platte River when the water became milky from a discharge from the Omaha Metropolitan Utilities District water supply treatment plant. What are the materials in the discharge that could cause the pallid sturgeon's reaction and how can future events be avoided? These are important unanswered questions related to the current operation and future development of water treatment facilities and their Clean Water Act permitted discharges.

An additional area of water quality that appears to be an emerging threat to long-lived animals like sturgeons and humans is the role of endocrine disruptors in the environment. The contaminants are not, in general, the traditional nutrients and oxygen demanding wastes, but rather materials that include breakdown products of herbicides, surfactants and other products that act as endocrine disrupters. These materials have effects on reproductive cycles and development at very low concentrations and are just now being investigated in water supplies of the world. We are fortunate that studies in our area by other researchers in Nebraska (M. Schwarz: personal communication and A. Kolok: personal communication) are elucidating some effects of these materials in the Platte River basin. The magnitude of this affect on the reproductive capabilities of sturgeon and other species is currently unknown.

5. We recommend that the reactions of pallid sturgeon to water discharges from a variety of sources, especially those related to water treatment facilities, be developed to evaluate the effects on pallid sturgeon populations and life histories.

How will management of the Platte River influence the survival of the pallid sturgeon as a species? The primary driving forces in the creation and maintenance of the habitats in any river are river discharge, sediment supply and channel morphology (Leopold 1994). In the Platte River, without discharges sufficient to move the substrate on a regular basis, the sand bars will become stabilized and channel habitats will fill in. The loss of channel habitats would restrict the ability of sturgeon to access upstream habitats, and sturgeon will be confined to ever smaller portions of the Platte River. Concurrently, the availability of sandy sediments is also important to the functioning of a braided river like the Platte River. Without a source of sediment (sand) rich water, the lower Platte River could turn into the narrow, sediment "hungry" stream typified by the Platte River west of Kearney, NE (NRC 2005). Finally, the restriction of channel width or the armoring of the river bank may change the dynamic equilibrium that results in the shifting sandbar nature of the lower Platte River into a ditch-like system similar to the lower Missouri River. To ensure the continuance of the characteristic habitats of the lower Platte River, protection of habitat forming peak flows, sediment sources and natural channel morphology are vital to the long term health of the Platte River ecosystem.

6. We recommend additional geomorphological studies be instituted for the lower Platte River to answer questions of how river bank armoring and restrictions on the supply of sediment and water will influence the structure of the river (Quist et al. 2005).

An additional flow related issue for the overall health of the lower Platte River is the occurrence of power peaking fluctuations in discharge. How these fluctuations affect the reproduction, recruitment and growth of fishes and invertebrates in the lower Platte River is currently unknown.

7. We also recommend that future studies be designed to address potential impact of power peaking on the lower Platte River ecosystem.

Chapter 4 Recommendations:

Pallid sturgeon were found to use habitats in the Platte River which are similar to those in the Missouri River, except they tend to be on the shallower end of the depth range for most studies. These shallow conditions may require adjustments in the way certain types of sampling gear are commonly deployed in mainstream Missouri River habitats.

8. We recommend that future studies in the Platte River be designed to be comparable to those underway in the Missouri River so that the relative importance of the lower Platte River to the overall recovery effort of the pallid sturgeon can be better evaluated.

Chapter 5 Recommendations:

Shovelnose sturgeon populations in the Platte River have been found to use the river up to and beyond the mouth of the Loup River, depending on discharge levels. The habitats used by shovelnose sturgeon in the Platte River tend to be slightly shallower with slightly slower velocities that those used by pallid sturgeon.

9. We recommend that studies on shovelnose sturgeon populations be continued to evaluate the health of the lower Platte River ecosystem.

Chapter 6 Recommendations:

The habitats used by pallid sturgeon are also used by other fish species upon which they may depend for food resources. We found that several chub species, especially shoal chub, occur more frequently in the vicinity of sturgeon than in other areas. Now that gastric lavage and colonic flushing are available as tools for evaluating food consumption by sturgeons in general, and pallid sturgeon in particular, the significance of this observation can be evaluated. This could lead to studies to determine potential energy budgets in different river habitats. If appropriate food is limited for pallid sturgeon in the Missouri River system, then this may aid in understanding the importance of the lower Platte River to the recovery of pallid sturgeon.

10. We recommend that studies be initiated to evaluate pallid sturgeon food habits in the lower Platte River to coordinate with similar studies on the Missouri River.

Chapter 7 Recommendations:

Sturgeon chubs, shoal chubs, flathead chubs and silver chubs are characteristic turbid water fish species of Great Plains rivers. Both sturgeon chubs and shoal chubs have been identified from pallid sturgeon digestive tracts and their habitat requirements are similar to those of both pallid sturgeon and shovelnose sturgeon.

11. We recommend that chub populations on the lower Platte River be monitored as indicators of habitat changes that may be linked to the habitats needed by sturgeon species.

Chapter 8 Recommendations:

A critical aspect of the life history of pallid sturgeon and shovelnose sturgeon that is generally unknown throughout the Missouri – Mississippi Rivers is the location, timing and success of spawning and larval recruitment. We captured Scaphirhynchus larvae less than one day old in the Platte River in every year of our study. This confirms that Scaphirhynchus spawning is taking place in the Platte River. Larval chubs were also collected in the Platte River and these may be important food resources for pallid sturgeon.

12. We recommend a continuation of larval and juvenile fish sampling in coordination with the ongoing efforts on the Missouri River. A potential benefit from this coordinated effort would be the ability to compare sturgeon spawning success in the relatively natural instream habitats of the Platte River with that of the highly modified Missouri River. This comparison may aid in understanding the early life history dynamics limiting the overall recovery efforts for pallid sturgeon (Quist et al. 2005).

Chapter 9 Recommendations:

At this time, it appears that recreational anglers are not substantially harming the shovelnose sturgeon population in the Platte River. On the other hand any take of an endangered species like the pallid sturgeon is reason for concern.

13. We recommend that State and Federal officials employ a combination of coordinated educational and legal approaches to ensure that anglers can accurately identify pallid sturgeon to avoid unintentional take and minimize angling threats to this species.

14. We further recommend that angling regulations in all States along the Missouri River be reviewed to evaluate ways to protect pallid sturgeon populations.

Chapter 10 Recommendations:

Discharge is one of the primary factors which influence habitat quality and habitat connectivity in the Platte River. In addition, the timing of discharge fluctuations and the occurrence of flooding flows shapes and maintains the habitat in this braided river.

15. We recommend that Platte River instream flow allocations be adjusted to protect the habitat and river connectivity needed to support healthy populations of pallid and shovelnose sturgeons.

16. We further recommend that the mosaic of shallow water and deep water habitats be protected to support the production of food resources for the sturgeon species in the lower Platte River.

Overall conclusions:

The lower Platte River is one of the last shifting sandbar rivers characteristic of the Great Plains. The lower Platte River is also the only shifting sandbar river that is connected to a free flowing section of the Missouri River. As a result, the lower Platte River retains a relatively intact native biota making it a unique but stressed ecosystem. We recommend protection for and enhancement of the habitats in the Platte River ecosystem by managing its discharge, sediment supply and instream habitats. This management is critical to the recovery of pallid sturgeon, other threatened and endangered species and the rest of the biota, so that more species do not become imperiled.

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