Agate Fossil Beds National Monument Fish Inventory

Final Report

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2008 Survey

Introduction

The Niobrara River flows through Agate Fossil Beds National Monument (AGFO) maintaining about 18-km of riverine habitat. The lack of large-scale human alterations like impoundment and channelization to the Niobrara River within AGFO make this stretch of river an ideal location to support native fish communities. However, concern for native fishes in the Niobrara River in and around AGFO has grown because non-native brown trout *Salmo trutta* and rainbow trout *Oncorhynchus mykiss* have been actively stocked in the region. Other species like largemouth bass *Micropterus salmoides*, bluegill *Lepomis macrochirus*, and northern pike *Esox lucius* may have also established populations from stocking activities above or below the AGFO property.

There have been several fish surveys conducted over the past 100 years in and near AGFO. Surveys in the panhandle region of Nebraska during the 1940s and again in the early 1970s made no specific reference to confirm sampling was conducted in what is now AGFO making these data difficult to interpret with specific reference to AGFO. However, surveys conducted in 1979 and 1989 (Stasiak 1990) suggest there were nine species in AGFO (Table 1). Little sampling has been conducted since to assess fish species composition and their abundances. The region has experienced considerable drought events since the early 2000s making it important to determine if the fish community has remained intact. Therefore, we conducted a survey during 2008 to assess the fish population in the Niobrara River at AGFO.

Methods

Fish sampling generally followed methods used by researchers at other National Park Service sites in the Northern Great Plains (White et al. 2002) and also attempted to use methods previous implemented at AGFO. A Smith-Root pulsed-DC, backpack electrofisher (Model 15) was used to sample 10 sites along the length of the Niobrara River flowing through AGFO (Figure 1). Output voltage was set at 300-v with pulse waveform signal settings typically at70-Hz (J setting on control) and 4-ms pulses. We also sampled one site on Agate Springs Ranch property (Site A on Figure 1) located within AGFO jurisdiction. We attempted to sample a minimum of a 150-m reach at each site. Site distances were measured using global positioning units (GPS) to track the route taken by the person carrying the electrofisher. Sampling was conducted moving upstream where the shoreline and any additional underwater structures were exposed to the electric field generated by the electrofisher when engaged. Two netters were used to collect fish when stunned. Each site was sampled once in mid-June when stream flows were believed to be near base low levels to optimize fish-sampling efficiency. Bag-seine sampling was not used as had been performed in the past because stands of emergent vegetation along the shoreline prevented effective deployment and retrieval of the net.

Sample sites were primarily identified based on Stasiak's (1990) sites used in 1979 and 1989 where feasible to assist in documenting site-specific changes in fish species presence/absence (Figure 1). The National Park Service's Heartland Inventory and Monitoring Network annually samples macroinvertebrates (and physical habitat) in the Niobrara River at fixed sites within AFGO. Therefore, fish sampling locations were also co-located at the invertebrate sample sites to provide additional insight into the biological communities found in the Niobrara River. We also sampled other sites where river access was logistically feasible.

Physical characteristics associated with each site were measured, geo-referenced, and recorded for future use. Parameters included: location (GPS), stream width, water depth, water velocity, water temperature, water conductivity, turbidity, dissolved oxygen (DO) concentration, substrate composition (e.g., percent cobble, sand, silt, etc.), and riparian cover (e.g., vegetation type, overhanging bank, etc.). Water velocities were measured at the thalweg (0.6 x total depth) and reflect maximum velocity at a sample site. Habitat assessment methods followed stream sampling procedures outlined in Bain and Stevenson (1999). Upstream and downstream photographs were also taken at the midpoint of each sample site to document general site characteristics.

Fish collected during electrofishing were usually identified and released, unharmed, in the field. However, some specimens were preserved to provide voucher specimens (held at University of Nebraska-Lincoln). Biotic information gathered from each individual included: fish species, total length (millimeters), mass (grams), and signs of Disease, Erosions, Lesions, or Tumors (DELTs).

Results

Fish sampling was conducted 17-19 June 2008. An additional water-quality check was conducted on 16 October 2008. A total of 2,000-m of the Niobrara River were electrofished. The mean distance sampled ($\pm$ 1 S.E.) was 182-m ($\pm$ 20-m) with an average effort of 11.75-min ($\pm$ 1.4-min). A total of 13 fish, representing two species, were collected from all sites for a catch-per-minute abundance estimate of 0.14 fish per minute (Table 3). A small number of fish (< 10 individuals) were also observed during sampling but not captured. All northern pike captured were relatively small (Figure 2) as were the white suckers *Catastomus commersoni* (Figure 3).

Dissolved oxygen concentrations were often less than 5 mg/l during the fish sampling period. Therefore, we measured DO at several locations above and below AGFO to determine the extent of the low oxygen levels (Figure 4). Our results indicate that DO concentrations were low from the Nebraska-Wyoming state line to downstream of AGFO in June 2008 (Figure 5). Subsequent sampling at AGFO in October 2008 demonstrated that DO concentrations were much improved and exceeded 10 mg/l at all sites checked (Highway 29 bridge and service road bridge). No fish were observed while conducting the October water-quality check.

Discussion

Species diversity at AGFO was markedly less than previous sampling efforts (Table 1). One potential contributor to this change in community composition could be sustained, low DO concentrations during the summer months. We observed DO concentrations that were below minimum thresholds that can cause stress (<5 mg/l) and mortality (<3 mg/l) under sustained conditions (Stickney and Kohler 1990). Highly variable, diel temperatures and oxygen concentrations are normal in many prairie stream systems. However, the variability in DO concentrations described for prairie streams does not typically drop below stress and mortality thresholds for sustained periods. Published information on species-specific DO tolerance limits for species historically collected at AGFO is limited, but does suggest that the concentrations we observed during fish collection efforts were near potentially lethal limits (Table 4). Dense vegetation was observed along the shoreline throughout much of AGFO as well as at other sites where water quality was measured. Oxygen demands associated with decomposition of plant material from this vegetation could explain the low DO levels throughout the portion of Niobrara River we sampled. We observed no fish at any location outside AGFO during DO sampling except at the WY/NE state line site. The state line site did have fish present, but we were unable to collect any individuals for identification and enumeration due to lack of access to private land. Ultimately, the sustained, low oxygen levels in the Niobrara River upstream, in, and downstream of the AGFO property may limit sustainable fish populations. These limitations may also preclude immigration of fishes from source populations within the Niobrara River making re-establishment by species that were historically present difficult.

The presence of northern pike, a non-native species in this reach of the Niobrara River, could also contribute to the change in fish community composition. Northern pike are a top predator species and are known to reduce fish populations or even eliminate species where introduced (He and Kitchell 1990). Northern pike are also relatively tolerant to low DO concentrations (Table 4) likely confounding stressful environmental conditions, like we observed in 2008, for fishes that could be eaten by northern pike.

The fish community has changed considerably in the past two decades since the last study at AGFO based on this sampling event. The potential negative effects of predation by northern pike and low DO concentrations seem likely candidates for at least accentuating changes that have occurred to the abiotic and biotic characteristics of AGFO and the surrounding region. The water quality aspect of these concerns is seemingly more widespread than a single-source problem so there are likely other mechanisms for unsuitable conditions at play. We recorded low DO concentrations for over 40-km and at locations both upstream and downstream of AGFO. Low DO concentrations at a regional scale could likely hinder immigration and establishment of fish populations from refugia up- or down-stream if this phenomenon occurs on a regular basis.

Other factors could have also contributed to fish community changes as well. For example, yellow iris (*Iris pseudacorus*), an invasive plant species is now established in the upper Niobrara River. Presence of this plant in high densities, like those observed along the Niobrara River, could have also altered riparian and in-stream habitat types and availability to aquatic organisms. Therefore, watershed management approaches may be required to improve water quality or other systemic problems along the Niobrara River in western Nebraska to provide conditions suitable for a diverse fish community.

The objective of this study was to inventory fish species present within AGFO. Our findings identify a general decline in diversity of fish compared to historical data. The inference to measuring this change is limited in scope because sample design specified a single sample at each of 10 sites. Nonetheless, previous fish collections at AGFO (Stasiak 1990) used similar or less effort, providing initial evidence species declines may have in fact occurred. We commented on two prominent aspects (low dissolved oxygen concentrations and presence of a non-native predator) of the potential decline in fish diversity within AGFO. In no way were these comments intended to be comprehensive or conclusive; rather, our intent was to document prevalent factors on the landscape at the time of sampling that were of concern. Future assessments of the fish community within AGFO and the upper Niobrara River should include temporal and spatial aspects of the biotic community as well as abiotic factors that may influence species distributions and population dynamics.

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Table 1. Fish species collected from the Niobrara River at Agate Fossil Beds National Monument in 1979 and 1989 by Stasiak (1990) and during 2008. An "X" in the year columns indicate at least one individual representing each species was collected. Asterisks indicate species that are not native to the upper Niobrara River drainage.

			Year	
Species (common name)	**Species (scientific name)**	**1979**	**1989**	**2008**
Brassy Minnow	*Hybognathus hankinsoni*	X	X	
Brown Trout*	*Salmo trutta*	X	X	
Central Stoneroller	*Campostoma anomalum*	X	X	
Creek Chub	*Semotilus atromaculatus*	X	X	
Fathead Minnow	*Pimephales promelas*	X	X	
Iowa Darter	*Etheostoma exile*	X		
Longnose Dace	*Rhinichthys cataractae*		X	
Northern Pike*	*Esox lucius*			X
Plains Topminnow	*Fundulus sciadicus*		X	
White Sucker	*Catastomus commersoni*	X	X	X

Table 2. Site location, sample date, and distance sampled at each site using a backpack electrofisher along the Niobrara River in Agate Fossil Beds National Monument. Site numbers correspond to sites identified on Figure 1.

Site	Alias	Date	Distance (m)	Zone	Easting	Northing
1	East Boundary	6/17/2008	180	13	604600	4697816
2	Walking bridge near visitor center	6/19/2008	150	13	604561	4697506
3	East side of service road	6/18/2008	225	13	603263	4696996
4	West side of service road	6/18/2008	169	13	603234	4697088
5	Fishing access	6/18/2008	225	13	602451	4697054
6	East of lone tree on south river road	6/18/2008	206	13	602395	4696657
7	Lone tree on south river road	6/18/2008	287	13	602196	4696607
8	West of lone tree on south river road	6/19/2008	142	13	602129	4696652
9	East of bluff and west of site 8	6/19/2008	103	13	601992	4696655
10	Highway 29 culvert (west boundary)	6/17/2008	61	13	599537	4697227
A	Agate Springs Ranch property	6/18/2008	252	13	600437	4697193

Table 3. Catch results from Agate Fossil Beds National Monument during June 2008 sampling. Numbers below each site label represent the total catch for each species at a given site.

	Site											
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**A**	**Total**
Northern Pike, *Esox lucius*	--	--	--	--	1	--	--	3	2	--	--	6
White Sucker, *Catastomus commersoni*	--	--	--	2	--	--	--	2	--	1	1	6

Table 4. Minimum dissolved oxygen (DO) concentrations for each species historically and currently found in the Niobrara River at Agate Fossil Beds National Monument. The lower lethal limit is the published DO concentration at which each species cannot survive for an indefinite period of time.

Species (common name)	**Species (scientific name)**	**Lower lethal limit (mg/l)**	**Source**
Brassy Minnow	*Hybognathus hankinsoni*	2.1*	Ostrand & Wilde 2001
Brown Trout	*Salmo trutta*	3.0	Doudoroff & Shumway 1970
Central Stoneroller	*Campostoma anomalum*	2.3	Hlohowskyj & Chagnon 1991
Creek Chub	*Semotilus atromaculatus*	2.4	Starrett 1950
Fathead Minnow	*Pimephales promelas*	1.0	Bennett et al. 1995
Iowa Darter	*Etheostoma exile*	1.7*	Hancock & Sublette 1958
Longnose Dace	*Rhinichthys cataractae*		
Northern Pike	*Esox lucius*	1.5	Casselman 1978
Plains Topminnow	*Fundulus sciadicus*	<1.6	Smale & Rabeni 1995
White Sucker	*Catastomus commersoni*	2.4	Dence 1948

*information from species in same genus.

Figure 1. Sample site locations for fish survey in the Niobrara River. Numeric symbols indicate samples conducted within Agate Fossil Beds National Monument, whereas letters indicate sampling on Agate Springs Ranch property (permission to sample granted 6/17/08). Site 1 is the eastern property boundary and Site 10 is located at the western boundary at Highway 29. Aerial map provided by Google Earth.

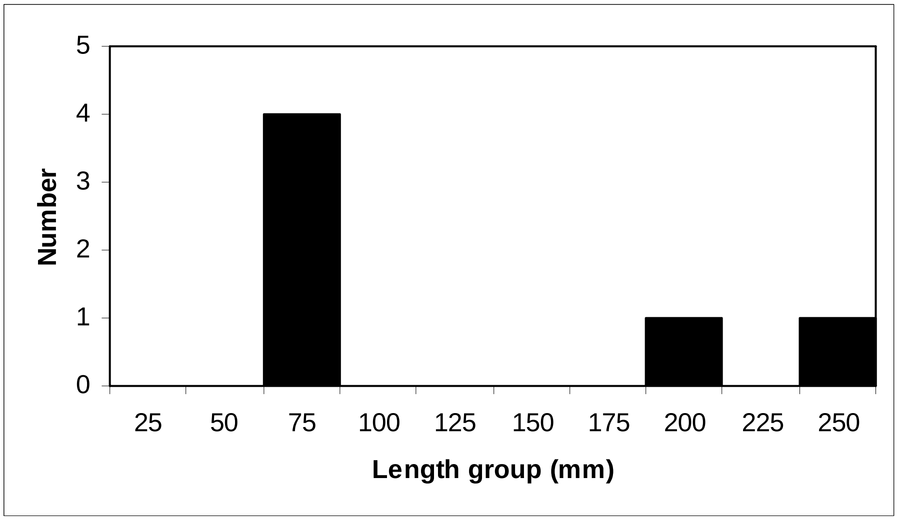

Figure 2. Length-frequency histogram for northern pike collected at Agate Fossil Beds National Monument during June 2008.

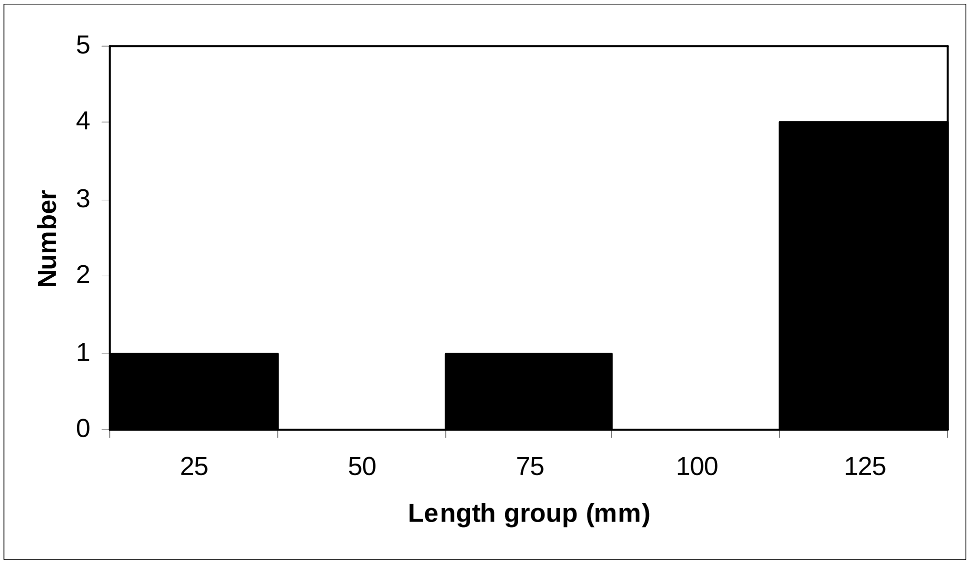

Figure 3. Length-frequency histogram for white suckers collected at Agate Fossil Beds National Monument during June 2008.

Figure 4. Locations of additional temperature and dissolved oxygen sampling along the Niobrara River on 17 June 2008. Aerial map provided by Google Earth.

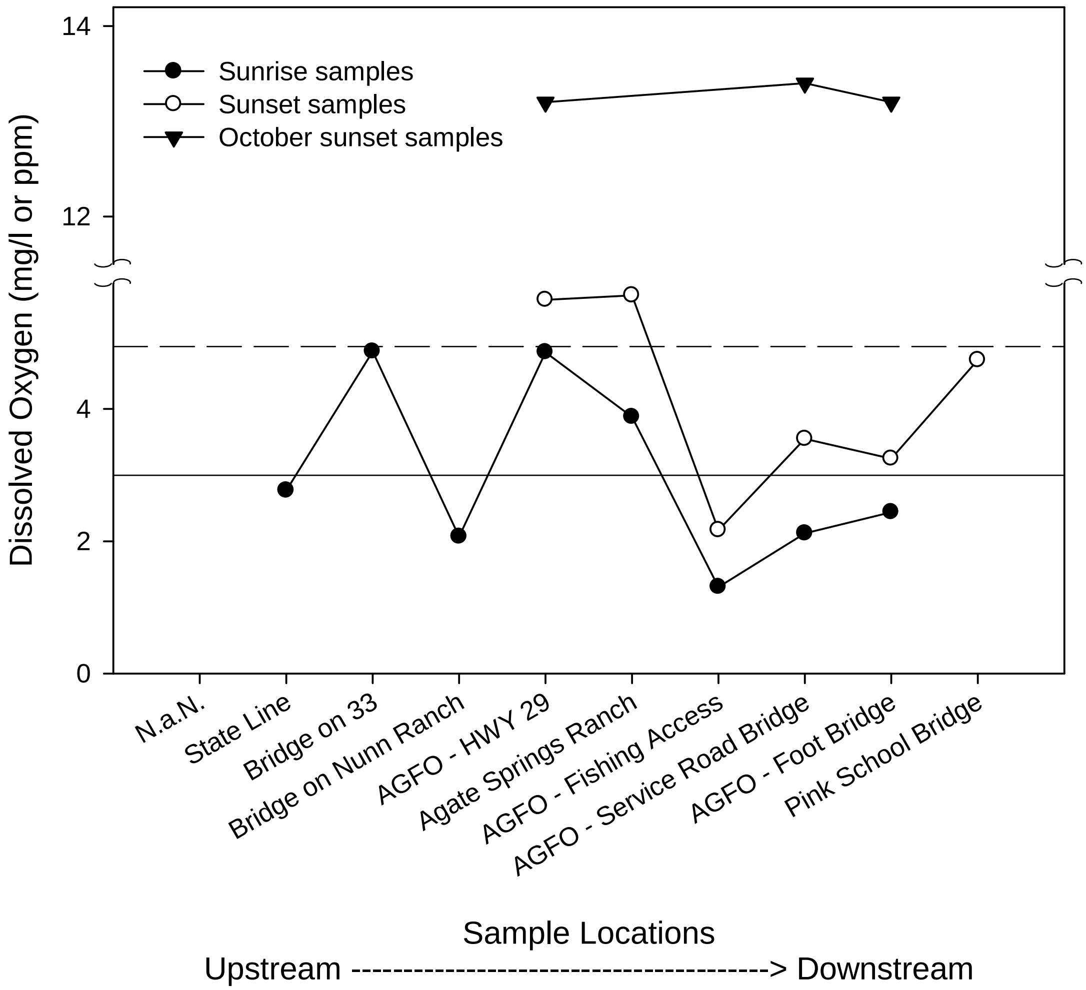

Figure 5. Longitudinal dissolved oxygen (DO) measures for the Niobrara River from the Wyoming-Nebraska state line (upstream most site) to the Pink School Road bridge (downstream most site) on 17 June 2008. Sunrise and sunset samples were collected during fish collection efforts in June. October sunset samples were collected 16 October 2008. Sunrise samples reflect the lowest DO values over a 24-hour period. Sunset samples should reflect the greatest DO values over a 24-hour period. The horizontal lines represent DO thresholds where fish start to become stressed (dashed line) and mortality begins (solid line) for most fish.

Appendix A: Habitat Information

Table A.1. Summary of Niobrara River substrate composition during fish collection at AGFO during June 2008.

	Substrate (%)			
Site	**Silt**	**Sand**	**Gravel**	**Cobble**
1	90	10	0	0
2	20	80	0	0
3	0	60	40	0
4	40	60	0	0
5	95	5	0	0
6	90	10	0	0
7	0	85	10	5
8	80	15	5	0
9	10	85	5	0
10	30	70	0	0
A	100	0	0	0

Table A.2. Summary the composition of structure present in the Niobrara River during fish collection at AGFO during June 2008.

	In water structure (%)		
Site	**Wood**	**Vegetation**	**None**
1	0	35	65
2	5	10	85
3	0	5	95
4	0	5	95
5	0	5	95
6	0	10	90
7	0	15	85
8	0	15	85
9	0	5	95
10	0	10	90
A	0	10	90

Table A.3. Summary the riparian structure present along the Niobrara River during fish collection at AGFO during June 2008.

	Riparian structure (%)		
Site	**Overbank**	**Wooded**	**Grass**
1	0	0	100
2	0	10	90
3	5	0	95
4	0	0	100
5	0	0	100
6	0	0	100
7	0	0	100
8	0	0	100
9	0	0	100
10	0	0	100
A	0	0	100

Table A.4. Summary the water quality measures taken along the Niobrara River during fish collection at AGFO during June 2008.

Site	Temperature (^oC)	Dissolved Oxygen (mg/l)	Conductivity (uS/cm)	Velocity (m/s)	Depth (cm)	Turbidity (NTU)	Channel Width (m)
1	20.6	4.7	402	0.32	56	1.80	2.0
2	18.1	3.484	377	0.3	56	3.13	2.5
3	17.7	3.28	374	0.34	43	3.11	3.1
4	18	2.87	375	0.26	71	1.49	2.2
5	18.7	3.17	373	0.03	41	1.14	3.1
6	21.3	5.47	394	0.16	56	1.78	4.3
7	21.3	5.71	396	0.36	66	2.00	2.0
8	20.4	5.16	383	0.25	56	2.37	1.8
9	19.1	4.32	373	0.25	69	2.16	2.3
10	21.8	6.7	389	0.31	61	10.4	3.8
A	21.1	9.55	385	0.22	43	8.13	---

Figure A.1. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 1 at AGFO.

Figure A.2. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 2 at AGFO.

Figure A.3. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 3 at AGFO.

Figure A.4. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 4 at AGFO.

Figure A.5. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 5 at AGFO.

Figure A.6. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 6 at AGFO.

Figure A.7. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 7 at AGFO.

Figure A.8. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 8 at AGFO.

Figure A.9. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 9 at AGFO.

Figure A.10. Upstream (top) and downstream (bottom) photograph from the midpoint of Site 10 at AGFO.

Figure A.11. Upstream (top) and downstream (bottom) photograph from the midpoint of Site A at Agate Springs Ranch.