



Vulnerability of Fish Communities to Climate and Land Use Change at Tallgrass Prairie National Preserve (TAPR)

Biotic communities are useful indicators of aquatic ecosystem health because a high quality, diverse, and functioning community reflects a high quality and functioning ecosystem. Stream habitats and communities are dynamic. Therefore, it is important to understand the natural variability of communities through time, such that changes from that natural variability may be used to make inferences of instability and the susceptibility to future climate and land use change. In addition, alterations in environmental conditions due to climate and land use change are major contributors to stream variability and degradation, but the extent that these impacts have on various regions and streams likely differ. Determining a stream's susceptibility to change from human caused impacts is necessary to determine stream communities that are most likely to experience a decrease in diversity, abundance, and function in the future. Data collected through monitoring equips park managers with the ability to understand the natural fluctuations in communities over time and among locations such that changes in future settings may be used to infer instability and, thus, vulnerability. Identifying locations where species are more vulnerable to degradation and determining the types of degradation that increases a community's vulnerability allows for an efficient science-based prioritization to manage and protect aquatic resources.

Methods:

For details on methods of site selection, fish sampling, habitat, and water quality data collection, and data analysis see Dodd et al. (2008) and Schwoerer (2016).

- Sites at Tallgrass Prairie National Preserve were sampled annually for fish community data from 2001 to 2009 (Figure 1). Number of sites sampled depended on availability of water for sampling and ranged from 6 to 18 sites sampled in any given year.
- Fish were sampled using a seine and were identified to species and measured for length and weight.
- The fish Index of Biotic Integrity (IBI; Fausch et al. 1984) was used to assess stream health based on fish community data and ranges from 0-100 with higher values indicating higher health. This index uses 12 metrics for scoring which includes six metrics describing species richness and composition, three metrics describing trophic composition, and three metrics describing fish abundance and condition.

- Community variability was assessed by calculating the range in the IBI (quantitative measure of stream health) at each site over each of the years it was sampled.
- Fish community vulnerability was calculated using methods found in Table 1. Fish vulnerable to habitat degradation (rock or gravel spawners or stream bed invertivores), warming temperatures (cool and cold-water species), altered flow regime (species requiring steady or variable yet predictable flow), or were a poor disperser (members in the topminnow, sculpin, and darter families) received a score of 1 in that category and all others received a 0. Scores range from 0 to 5. Fish species vulnerability scores can be found in Appendix 1.

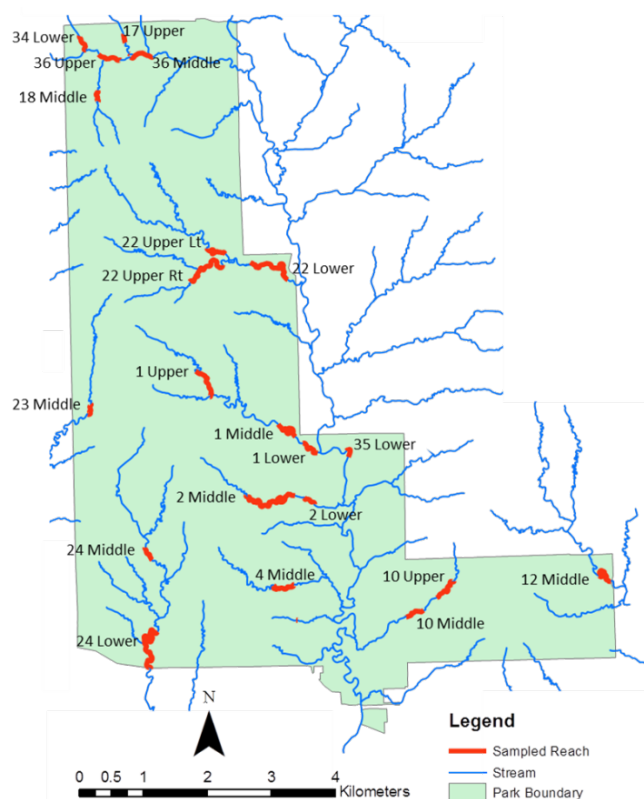


Figure 1. Location of sites sampled within Tallgrass Prairie National Preserve.

Table 1. Framework for developing species/taxa vulnerability scores (Sievert et al. 2016) that was used to calculate the community vulnerability score (mean of species/taxa vulnerability scores). Aquatic invertebrate vulnerability did not take into account dispersal ability or persistence. See above for vulnerability classifications.

Species Vulnerability Template		
Scoring	Habitat Degradation	0 or 1
	Warming Temperature	0 or 1
	Altered Flow Regime	0 or 1
	Dispersal Ability	0 or 1
	Species Persistence	1- (# Years Species Present/Total # Years Sampled)
Calculating	Environmental Tolerance	Habitat + Temperature + Flow
	Sensitivity	Dispersal Ability + Species Persistence
	Vulnerability	Environmental Tolerance + Sensitivity

Summary of Findings:

- A total of 36 fish species have been sampled at this park. Site 24 Lower and 35 Lower had highest fish richness (25 species) and site 17 Upper had lowest fish richness among mainstem sites (2 species).
- 39% of fish species were present in the park each time it was sampled while 64% of fish species were present in more than half of the years it was sampled.
- Site 1 Lower had the highest mean IBI score and ranged from 52 to 40 while 17 Upper had the lowest mean IBI and ranged from 0 to 36 (Figure 2).

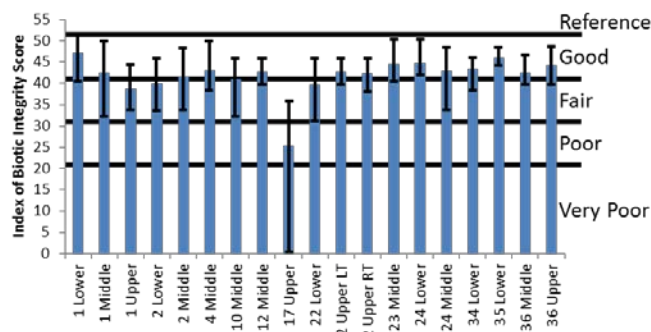


Figure 2. Mean Index of Biotic Integrity scores for fish communities at 19 sites within Tallgrass Prairie National Preserve. Bars represent ranges in scores during the nine sampling events in 2001 to 2009. Horizontal lines indicate stream integrity categories based on IBI scores.

- For fish species found within this park, 42% were vulnerable to habitat degradation, 19% were vulnerable to warming temperature, 42% were vulnerable to a change in flow regime, and 11% were poor dispersers (Table 2).
- Site 1 Upper had the highest fish community vulnerability while site 22 Upper Right had the lowest fish community vulnerability (Table 3).

- Of the seven parks analyzed in the Heartland I&M network Tallgrass Prairie National Preserve had the 6th most vulnerable fish community.

Table 2. Percent of fish at seven National Park Service units within the central United States vulnerable to habitat degradation, warming temperatures altered flow regime or being a poor disperser as well as overall park vulnerability score. Pipestone National Monument (PIPE), Tallgrass Prairie National Preserve (TAPR), Homestead National Monument of America (HOME), George Washington Carver National Monument (GWCA), Wilsons Creek National Battlefield (WICR), Ozark National Scenic Riverways (OZAR), and Buffalo National River (BUFF).

Park	Habitat	Temperature	Flow	Dispersal	Vulnerability (5)
HOME	27	27	53	0	1.45
TAPR	42	19	42	11	1.47
OZAR	56	39	50	19	1.85
BUFF	64	47	45	25	1.95
PIPE	50	50	33	17	2.00
WICR	66	51	46	29	2.17
GWCA	69	63	44	38	2.31

Table 3. Percent of fish species at Tallgrass Prairie National Preserve vulnerable to habitat degradation, temperature increase, flow modification, and dispersal ability (fish only) and the overall site vulnerability score.

Site	Habitat	Temperature	Flow	Dispersal	Vulnerability (5)
1 Lower	40	25	45	5	1.63
1 Middle	50	36	36	7	1.72
1 Upper	63	25	25	13	1.73
2 Lower	44	19	44	6	1.63
2 Middle	46	38	23	8	1.58
4 Middle	44	22	33	11	1.62
10 Middle	46	23	23	15	1.61
12 Middle	41	24	47	12	1.63
17 Upper	29	14	43	14	1.66
22 Lower	35	24	41	6	1.53
22 Upper LT	43	36	29	7	1.56
22 Upper RT	40	30	20	10	1.30
23 Middle	35	25	40	5	1.56
24 Lower	36	16	48	8	1.48
24 Middle	37	16	42	11	1.52
34 Lower	55	36	27	9	1.73
35 Lower	44	20	36	12	1.46
36 Middle	44	25	38	6	1.51
36 Upper	40	33	40	7	1.53

Appendix 1. Fish species vulnerable (1) to habitat degradation, temperature increase, altered flow, and poor dispersal ability for species sampled in Tallgrass Prairie National Preserve from 2001 to 2009. Sensitivity score does not account for species persistence through time and is the sum of habitat, temperature, flow, and dispersal scores for a species (out of 5).

Scientific Name	Common Name	Habitat	Temp	Flow	Dispersal	Reoccurrence	Vulnerability
<i>Ictiobus cyprinellus</i>	Bigmouth buffalo			1		0.89	1.89
<i>Cyprinus carpio</i>	Common carp				1	0.89	1.89
<i>Luxilus cornutus</i>	Common shiner	1				0.89	1.89
<i>Pimephales tenellus</i>	Slim minnow	1				0.89	1.89
<i>Catostomus commersoni</i>	White sucker		1	1		0.89	2.89
<i>Etheostoma nigrum</i>	Johnny darter	1			1	0.78	2.78
<i>Phenacobius mirabilis</i>	Suckermouth minnow	1				0.78	1.78
<i>Notropis percabromus</i>	Carmine shiner					0.67	0.67
<i>Notropis volucellus</i>	Mimic shiner					0.67	0.67
<i>Micropterus punctulatus</i>	Spotted bass				1	0.67	1.67
<i>Noturus flavus</i>	Stonecat	1	1	1		0.67	3.67
<i>Ictalurus punctatus</i>	Channel catfish				1	0.56	1.56
<i>Percina caprodes</i>	Logperch	1			1	0.56	2.56
<i>Labidesthes sicculus</i>	Brook silverside					0.44	0.44
<i>Ameiurus melas</i>	Black bullhead	1			1	0.33	2.33
<i>Notropis stramineus</i>	Sand shiner					0.33	0.33
<i>Minytrema melanops</i>	Spotted sucker	1		1		0.33	2.33
<i>Ameiurus natalis</i>	Yellow bullhead				1	0.22	1.22
<i>Moxostoma erythrurum</i>	Golden redbreast	1		1		0.11	2.11
<i>Notemigonus crysoleucas</i>	Golden shiner				1	0.11	1.11
<i>Gambusia affinis</i>	Mosquitofish					0.11	0.11
<i>Notropis topeka</i>	Topeka shiner	1	1			0.11	2.11
<i>Fundulus notatus</i>	Blackstripe topminnow				1	0	1
<i>Lepomis macrochirus</i>	Bluegill			1		0	1
<i>Pimephales notatus</i>	Bluntnose minnow		1			0	1
<i>Luxilus cardinalis</i>	Cardinal shiner	1				0	1
<i>Camptostoma anomalum</i>	Central stoneroller	1				0	1
<i>Semotilus atromaculatus</i>	Creek chub	1	1			0	2
<i>Pimephales promelas</i>	Fathead minnow					0	0
<i>Lepomis cyanellus</i>	Green sunfish			1		0	1
<i>Micropterus salmoides</i>	Largemouth bass			1		0	1
<i>Lepomis megalotis</i>	Longear sunfish		1	1		0	2
<i>Lepomis humilis</i>	Orangespotted sunfish	1				0	1
<i>Etheostoma spectabile</i>	Orangethroat darter	1	1		1	0	3
<i>Cyprinella lutrensis</i>	Red shiner					0	0
<i>Lythrurus umbratilis</i>	Redfin shiner					0	0

For More Information Contact:

Jacob Schwoerer
University of Missouri-
Missouri Cooperative Fish and Wildlife Research Unit
302 ABNR
Columbia, MO 65211
jmsh33@mail.missouri.edu

Or

Hope Dodd, Fisheries Biologist
Heartland I & M Network
National Park Service
6424 W Farm Road 182
Republic, MO 65738
Hope_Dodd@nps.gov

Citations:

- Dodd, H. R., D. G. Peitz, G. A. Rowell, D. E. Bowles, and L. W. Morrison. 2008. Protocol for monitoring fish communities in small streams in the heartland inventory and monitoring network. Natural Resource Report NPS/HTLN/NRR – 2008/052. National Park Service, Fort Collins, Colorado.
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Heartland Inventory and Monitoring Network of the National Park Service. Visit <http://www.nps.gov/im/units/htln/index.htm>

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