The Prairie Naturalist
Great Plains Natural Science Society

12-2010

Current Distribution of Rare Fishes in Eastern Wyoming Prairie Streams

Christina E. Barrineau

Elizabeth A. Bear

Anna C. Senecal

The Prairie Naturalist 42(3/4):80–88; 2010

Current Distribution of Rare Fishes in Eastern Wyoming Prairie Streams

CHRISTINA E. BARRINEAU[1], ELIZABETH A. BEAR, AND ANNA C. SENECAL

Wyoming Game and Fish Department, Laramie, WY 82070, USA (CEB, EAB, ACS)

ABSTRACT Distributions of native fishes have declined throughout the Great Plains region. Over 50% of native fishes within the Missouri River drainage in Wyoming have experienced declines in distributions. Thus, the primary goal of our study was to assess current distribution of rare native fishes in eastern Wyoming prairie streams. Of the 10 rare fishes sampled, goldeye (*Hiodon alosoides*), western silvery minnow (*Hybognathus argyritis*), plains minnow (*H. hankinsoni*), and Iowa darter (*Etheostoma exile*) have experienced declines in distribution over the last decade. Plains topminnow (*Fundulus sciadicus*) appears to be expanding to areas outside their historical distribution, while pearl dace (*Margariscus margarita*), hornyhead chub (*Nocomis biguttatus*), suckermouth minnow (*Phenacobius mirabilis*), finescale dace (*Phoxinus neogaeus*), and orangethroat darter (*Etheostoma spectabile*) distributions appear stable. Our study has increased knowledge of current distribution and status of rare fishes in eastern Wyoming prairie streams.

KEY WORDS fish distributions, Missouri River drainage, prairie fishes, Wyoming

Freshwater systems are among the most imperiled ecosystems worldwide (Leidy and Moyle 1998). As sentinels for these fragile aquatic ecosystems, North American freshwater fish populations have been in decline since the early 20th century (Williams et al. 1989, Moyle and Leidy 1992). Over the past 30 years, the number of imperiled freshwater fish taxa has increased 179 fold (Jelks et al. 2008).

Similar declines are apparent in prairie stream systems within the Great Plains region (Patton 1997, Hoagstrom et al. 2006*b*, Fischer and Paukert 2008). North American prairie ecosystems are among the most threatened biomes in North America (Samson and Knopf 1994). As most of the remaining fragments of the Great Plains ecosystem are not large enough to support naturally-functioning watersheds (Dodds et al. 2004), those that persist require dedicated conservation efforts to support viable aquatic resources for future generations.

Prairie streams have been described as harsh and fluctuating systems due to their variable hydrologic regimes and physicochemical conditions (Matthews 1988, Fausch and Bestgen 1997). Prairie stream fishes have evolved adaptations to these natural processes and environmental extremes. Prairie streams are of ecological importance due, in part, to their highly-adapted native fish assemblages (Cross et al. 1986, Rabeni 1996).

Considerable changes to prairie stream systems have occurred throughout the Great Plains. Water development activities, irrigation practices, and livestock grazing have altered these systems and impacted native fish communities (Rabeni 1996, Fausch and Bestgen 1997, Nesler et al. 1997). In Wyoming, Patton et al. (1998) found that over 50% of the native fish species in prairie streams of the Missouri River drainage had experienced reduced distributions.

Little is known about the current distribution, ecology, and status of prairie fishes as these fish have historically been considered species of low conservation and management need by managers and researchers (Fausch and Bestgen 1997). The Wyoming Game and Fish Department (WGFD) is charged with conserving and managing all fish species throughout the state. However, funding in the state has historically been lacking for nongame fish management and conservation. In 2000, the United States Congress established the Federal State Wildlife Grants Program, which created funding sources for states to support projects that focus on the management of all fish and wildlife species (WGFD 2005). With this new program, the WGFD identified native fish species with conservation need. Declines in native fish distributions combined with the inception of the Federal State Wildlife Grants Program have led to increased efforts by resource managers to expand fisheries evaluations, particularly throughout Wyoming prairie streams (Barrineau et al. 2007, Bear and Barrineau 2007). Thus, the primary goal of our study was to assess the status of rare native fishes in eastern Wyoming prairie streams in accordance with the goals of the WGFD conservation strategy (WGFD 2005). Our specific objective was to document the current distribution of rare native fishes in eastern Wyoming prairie streams.

STUDY AREA

Our study sites were located within the Missouri River drainage, east of the Continental Divide in Wyoming, USA. We selected study watersheds identified as priority areas for aquatic species within the eastern Wyoming short-grass prairie ecosystem (Patton 1997, WGFD 2001). Surveyed watersheds included the Little Powder, Little Missouri, Cheyenne, Niobrara, North Platte, and South Platte rivers

[1] Corresponding author email address: christina.barrineau@wgf.state.wy.us

(Fig. 1). Study area streams typically originated as high-gradient, headwater systems before transitioning to intermittent, prairie streams. Detailed descriptions of these watersheds have previously been described (Snigg 1999, Barrineau et al. 2007, Bear and Barrineau 2007). While native cyprinids and catostomids dominated fish communities, rare fishes in our study area include goldeye (*Hiodon alosoides*), western silvery minnow (*Hybognathus argyritis*), plains minnow (*H. hankinsoni*), pearl dace (*Margariscus margarita*), hornyhead chub (*Nocomis biguttatus*), suckermouth minnow (*Phenacobius mirabilis*), finescale dace (*Phoxinus neogaeus*), plains topminnow (*Fundulus sciadicus*), Iowa darter (*Etheostoma exile*), and orangethroat darter (*E. spectabile*; Table 1).

METHODS

We conducted fish surveys from April through October 2004–2007 following the collection methods used by Patton (1997), with the exception that electrofishing and seining were seldom used at the same site. Our sample site selection criteria targeted (1) larger mainstem streams located upstream and downstream of major tributary confluences, (2) tributary streams near the mainstem confluence, (3) sites where rare fishes were previously found, (4) sites surveyed by Patton (1997) and sites upstream and downstream of these sites, and (5) site accessibility. At each site, we selected a sampling reach and marked the upstream and downstream boundaries. Sampling reaches measured at least 200 m (Patton et al. 2000) and encompassed multiple habitat units (pools, riffles, runs, backwaters, and side channels) to capture all species present.

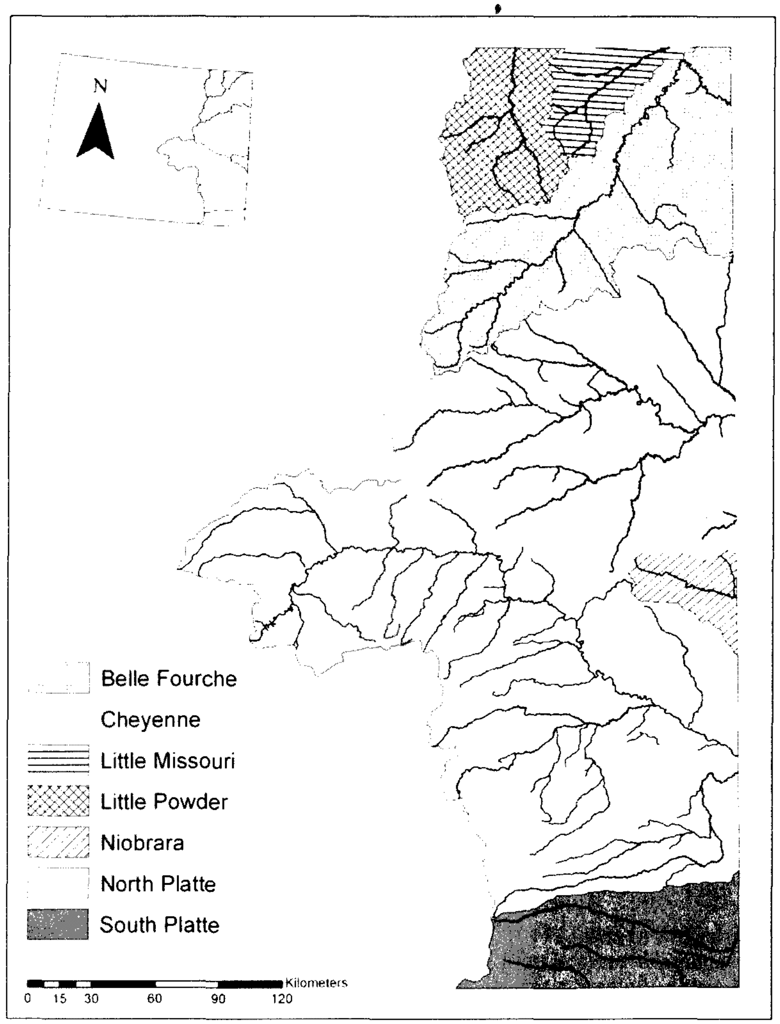

Figure 1. Location of watersheds surveyed within the Missouri River drainage in eastern Wyoming, 2004–2007. No surveys were conducted in the Belle Fourche watershed.

Given the inefficiency of electrofishing in turbid, high conductivity water, our sampling efforts consisted largely of seining (6, 4.6, or 7.6 m long with a 1.2 × 1.2 m bag and 4.8-mm mesh). In addition to seining, we used a pulsed DC backpack electrofishing unit (Smith-Root LR 24 or Coffelt Model Mark-10) to collect fish in low conductivity waters. Captured fish were identified to species, counted, and returned to the stream. We preserved unidentified fish in 10% formalin for later identification by personnel at the Larval Fish Laboratory at Colorado State University in Fort Collins.

Table 1. Fish fauna of eastern Wyoming prairie streams by watershed, 2004–2007.

			Watershed[a]					
Family	Scientific name	Common name	LP	LM	C	N	NP	SP
Hiodontidae	*Hiodon alosoides*[b]	Goldeye	x	x				
Cyprinidae	*Campostoma anomalum*	Central stoneroller				x	x	x
	Cyprinella lutrensis	Red shiner					x	
	Cyprinus carpio	Common carp	x[c]	x[c]	x[c]		x[c]	
	Hybognathus argyritis[b]	Western silvery minnow		x				
	Hybognathus hankinsoni	Brassy minnow				x	x	x
	Hybognathus placitus[b]	Plains minnow			x			
	Luxilus cornutus	Common shiner					x	x
	Margariscus margarita[b]	Pearl dace				x		
	Nocomis biguttatus[b]	Hornyhead chub					x	
	Notropis atherinoides	Emerald shiner					x[c]	
	Notropis dorsalis	Bigmouth shiner					x	
	Notropis stramineus	Sand shiner	x	x	x	x	x	
	Phenacobius mirabilis[b]	Suckermouth minnow					x	
	Phoxinus neogaeus[b]	Finescale dace				x		
	Pimephales promelas	Fathead minnow	x	x	x	x	x	x
	Platygobio gracilis	Flathead chub	x		x			
	Rhinichthys cataractae	Longnose dace	x		x		x	x
	Semotilis atromaculatus	Creek chub	x	x		x	x	x
Catostomidae	*Carpiodes carpio*	River carpsucker		x	x			
	Carpiodes cyprinus	Quillback					x	
	Catostomus catostomus	Longnose sucker					x	
	Catostomus commersoni	White sucker	x	x	x	x	x	x
	Catostmus platyrhynchus	Mountain sucker			x			
	Moxostoma macrolepidotum	Shorthead redhorse	x		x			

Table 1. Continued.

			Watershed[a]					
Family	Scientific name	Common name	LP	LM	C	N	NP	SP
Ictaluridae	*Ameiurus melas*	Black bullhead	x[c]	x[c]	x[c]		x	
	Ictalurus punctatus	Channel catfish		x	x		x	
	Noturus flavus	Stonecat	x				x	
Fundulidae	*Fundulus sciadicus*[b]	Plains topminnow			x[c]	x	x	x
	Fundulus kansae	Northern plains killifish			x[c]	x[d]	x	x
Gasterosteidae	*Culaea inconstans*	Brood stickleback			x[c]		x[c]	
Centrarchidae	*Lepomis cyanellus*	Green sunfish	x[c]	x[c]	x[c]		x[c]	x[c]
	Micropterus dolomieu	Smallmouth bass					x[c]	
	Micropterus salmoides	Largemouth bass			x[c]			
	Pomoxis annularis	White crappie					x[c]	
	Pomoxis nigromaculatus	Black crappie			x[c]		x[c]	
Percidae	*Etheostoma exile*[b]	Iowa darter				x	x	x
	Etheostoma nigrum	Johnny darter					x	
	Etheostoma spectabile[b]	Orangethroat darter						x
	Perca flavescens	Yellow perch			x[c]		x[c]	
Clupeidae	*Dorosoma cepedianum*	Gizzard shad					x[c]	
Salmonidae	*Oncorhynchus mykiss*	Rainbow trout					x[c]	
	Salmo trutta	Brown trout					x[c]	

[a] Watersheds LP, LM, C, N, NP, SP refer to the Little Powder, Little Missouri, Cheyenne, Niobrara, North Platte, and South Platte River drainages, respectively; [b] rare species; [c] introduced species; [d] the native status of Northern plains killifish in these watersheds is questionable (Hoagstrom et al. 2009).

We determined percent relative abundance for each rare species within a watershed by dividing the number of each rare species by the total number of fish captured in that watershed. We calculated watershed-specific percent occurrence for rare fish by dividing the number of sites at which a species was collected by the total number of sites sampled within a given watershed.

RESULTS

We collected 58,350 fish from 100 sites across 6 watersheds. We surveyed 3 sites and collected 4,218 fish within the Little Powder River drainage. Within the Little Missouri River drainage, we sampled 8 sites and collected 1,603 fish. Within the Cheyenne River drainage, we sampled 28 sites and collected 20,669 fish. We surveyed 5 sites and collected 5,768 fish within the Niobrara River drainage. We sampled 51 sites and collected 25,673 fish in the North Platte River drainage. Lastly, in the South Platte River drainage we surveyed 5 sites and collected 419 fish. Rare species represented 8% of the total catch and were collected from 25 sites across 5 watersheds. We collected no rare species from the Little Powder River drainage. The Niobrara and North Platte River drainages each yielded 4 rare species, the most of any watershed surveyed. Rare species relative abundance was generally less than 10% of the total catch from each watershed. Only 1 rare species, goldeye, was not documented during our survey.

Fish Species Collections

We collected western silvery minnow from the Little Missouri River drainage. Relative abundance of western silvery minnow in the Little Missouri River was <1% and the species was documented at 13% of sampled sites. We collected plains minnow in the Cheyenne River drainage. Relative abundance of plains minnow in the Cheyenne River drainage was 1% and the species was collected at 36% of sites surveyed in the drainage. We collected pearl dace from the Niobrara River drainage. Relative abundance of pearl dace in the Niobrara River was 8%. Pearl dace were collected from 60% of sampled sites in the Niobrara River drainage. We collected hornyhead chub from the North Platte River drainage. Hornyhead chub relative abundance was 2%, and we sampled the species at 8% of surveyed sites in the North Platte River drainage. We collected suckermouth minnow from the North Platte River drainage. Relative abundance of suckermouth minnow in the North Platte River drainage was <1%. Six percent of the sites we surveyed in the North Platte River drainage had suckermouth minnow. We collected finescale dace from the Niobrara River drainage. The relative abundance of finescale dace was 1% in the Niobrara River drainage, and we documented the species at 40% of our sampled sites. We collected plains topminnow from the Cheyenne, Niobrara, North Platte, and South Platte drainages. Relative abundance of plains topminnow in the Cheyenne River drainage was 9%, and we collected the species at 36% of our sites sampled. Within the Niobrara River drainage, plains topminnow relative abundance was 7%, and we collected the species at 100% of sites sampled. Relative abundance of plains topminnow in the North Platte River drainage was 4%, and we collected the species at 18% of sites sampled. Within the South Platte drainage, plains topminnow relative abundance was 15%, and we collected the species at 40% of our sites sampled. We collected Iowa darters in the Niobrara, North Platte, and South Platte drainages. Relative abundance of the species in the Niobrara River drainage was 3% and we documented them at 20% of our sites sampled. Iowa darter relative abundance in the North Platte River drainage during this survey was <1% and we documented them at 4% of our sites. Relative abundance of Iowa darters in the South Platte River drainage was 4%, and we documented them at 20% of our sites sampled. We collected orangethroat darters in the South Platte River drainage. Relative abundance of the species was 13%, and we collected orangethroat darters at 22% of our sites sampled in the South Platte River drainage.

DISCUSSION

Of the rare fish species documented, 4 were noted to have declined and 6 were stable or increasing since previous surveys were conducted in the mid-1990s survey (Patton 1997). Rare species which appear to have declined include goldeye, western silvery minnow, plains minnow, and Iowa darter. In contrast, the observed range of plains topminnow has expanded. Species with minimal changes in distribution over the last decade include: pearl dace, hornyhead chub, suckermouth minnow, finescale dace, and orangethroat darter. Changes in the distribution of these rare fishes can be attributed to habitat degradation, introduced species, range expansions, and in the case of goldeye, variable sampling efficiency.

Goldeye

While Patton (1997) found goldeye distributions had increased since the 1960s, we observed a decreasing distribution trend for this species. We expected to collect goldeye in the Little Powder and Little Missouri drainages based on the findings of Baxter and Simon (1970) and Patton (1997). However, it is possible that putative declines are artifacts of ineffective sampling. We used seining to capture fish in the Little Powder and Little Missouri drainages and others have found this method to be ineffective at capturing goldeye (Hoagstrom et al. 2006*a*, WGFD 2007). In addition, adult goldeye are thought only to enter the Little Powder and Little Missouri rivers in Wyoming for spawning (Barrineau et al. 2007). These watersheds were sampled in late-July and August, after goldeye had likely completed spawning migrations (Pflieger 1997). Given the need to sample many species across multiple drainages, sampling efforts were not tailored around the unique life-history characteristics of goldeye. As a result, observed declines may be related to the sampling gear used and timing of the survey.

Western Silvery Minnow

Since the 1960s, Patton (1997) reported that western silvery minnow distributions had declined. Our survey results point to further distributional declines for this species. Patton (1997) sampled western silvery minnow from both the Little Missouri and Little Powder River drainages. We sampled the species from the Little Missouri River drainage alone. Declines in western silvery minnow in eastern Wyoming prairie streams can be attributed to changes in habitat conditions, introductions of non-native, piscivorous fishes, and natural drought cycles (Quist et al. 2004, Hoagstrom et al. 2006*a*, Bear and Barrineau 2007). Western silvery minnow are often found in the backwaters and pools of large prairie rivers (Baxter and Stone 1995, Pflieger 1997). This species is associated with silt and sand substrates and is tolerant of high turbidity (Baxter and Stone

1995, Pflieger 1997). Impoundments and reservoirs on prairie streams have altered river morphology, thus have affected water depth, substrate, and turbidity levels (Patton and Hubert 1993, Quist et al. 2004). Additionally, presence of introduced, piscivorous fishes in these reservoirs is inversely related to native fish abundances, suggesting the potential for predation and competition to reshape native fish assemblages (Quist et al. 2004, Hoagstrom et al. 2006*b*). Compounding these factors, recent drought conditions have likely exacerbated the apparent range constriction of the western silvery minnow (Hoagstrom et al. 2006*a*).

Plains Minnow

Patton (1997) indicated that plains minnow had declined since the 1960s and our findings suggest that this trend is continuing. Patton (1997) sampled plains minnow from the Cheyenne and Little Powder River drainages. However, we were only able to sample the species from the Cheyenne River drainage. Similar to the western silvery minnow, plains minnow is associated with slow water, pool habitats in turbid streams (Baxter and Stone 1995, Pflieger 1997, Hoagstrom et al. 2006*a*). Given the two species' overlap in habitat, the mechanisms driving plains minnow declines are likely the same as those which have caused range reductions in western silvery minnow (Hoagstrom et al. 2006*b*).

Pearl Dace

Currently, the distribution of pearl dace in Wyoming is stable. Pearl dace were documented in the Niobrara River drainage both in our survey and by Patton (1997). This species is commonly found in clear, cool streams (Baxter and Simon 1995). Habitat in the Niobrara River consists of clear, deep-pools with an abundance of aquatic vegetation (Bear and Barrineau 2007). If current habitat conditions persist throughout this watershed, the Niobrara River will likely remain a stronghold for pearl dace in Wyoming.

However, several potential threats to pearl dace persistence exist. If aquifer recharge requirements are not factored into current water withdrawal practices, available habitat for Niobrara River pearl dace may be limited in the future (Cunningham 2006). Another potential threat to pearl dace in the Niobrara River is the introduction of non-native piscivores (Weitzel 2002*a*, Cunningham 2006). While we did not collect any non-native piscivores from the Niobrara River drainage during our survey, brown trout (*Salmo trutta*) and green sunfish (*Lepomis cyanellus*) have been documented in the past (Mueller and Rockett 1966, Baxter and Simon 1970).

Hornyhead Chub

Patton (1997) found that hornyhead chub distributions had declined since the 1960s. Our survey indicates that no further declines have occurred since the 1960s and that the species is stable. We collected hornyhead chub from two locations in the North Platte River drainage not previously sampled by Patton (1997). Hornyhead chub are found in clear, small streams with persistent flow and coarse substrate (Pflieger 1997, Weitzel 2002*b*, Bear and Barrineau 2007). Preferred streams throughout the species' Wyoming range are influenced primarily by water development activities including local and transbasin diversions, reservoir construction, and groundwater withdrawals (Bear and Barrineau 2007). These activities likely threaten the persistence of hornyhead chub throughout the North Platte River drainage by fragmenting habitats and creating physical barriers to movement (Miller et al. 2005).

Suckermouth minnow

Although sampled, changes in distribution of suckermouth minnow in the North Platte River drainage were not assessed by Patton (1997) due to differences between his and the previous (Baxter and Simon 1970) survey. Like Patton (1997), we also documented suckermouth minnow in Horse Creek, a tributary to the North Platte River. While the number of individuals collected was low compared to other rare species, suckermouth minnow appears stable throughout the North Platte River drainage. Suckermouth minnow prefer clear streams with riffle habitats and substrates composed of sand, gravel, or rubble (Baxter and Stone 1995). Future persistence of suckermouth minnow in the North Platte drainage may be limited by water development and introductions of non-native piscivores (Quist et al. 2003). Many small impoundments and diversion structures occur along Horse Creek. Water development activities such as these impede movements of suckermouth minnow and reduce available habitat through periodic stream channel dewatering. Additionally, introduced piscivores, including green sunfish, yellow perch (*Perca flavescens*), and largemouth bass (*Micropterus salmoides*) have been collected from Horse Creek in reaches not occupied by suckermouth minnow (Quist et al. 2003).

Finescale Dace

Patton's (1997) surveys documented declines in finescale dace. However, our findings do not support these trends. Although few individuals were collected, our survey suggests that the species is stable throughout the Niobrara River drainage. Finescale dace inhabit small, cool, spring-fed streams with aquatic vegetation (Baxter and Stone 1995, Stasiak and Cunningham 2006). If current habitat conditions continue, the Niobrara River should remain an important stronghold in the persistence of finescale dace in Wyoming. However, as with pearl dace, the introduction of non-native piscivores is a potential threat (Weitzel 2002*a*, Stasiak and Cunningham 2006).

Plains topminnow

Patton (1997) found that plains topminnow distributions had declined since the 1960s. Based on our survey, its distribution has remained stable over the last decade in the Niobrara, North Platte, and South Platte drainages. However, we believe the species has expanded its range within the Cheyenne River drainage. While we found plains topminnow to be widely distributed throughout the Cheyenne drainage, Patton (1997) collected no individuals from this area. Previous to Patton's (1997) sampling, Baxter and Simon (1970) found the species at one site in the watershed and suggested that it was likely introduced. Plains topminnows have been incidentally released when stocking waters with non-native warmwater game species in the past (Simon 1946).

Habitat degradation and competition with nonnative species likely limit plains topminnow distribution within its native range. Plains topminnows inhabit pool habitats in clear streams with aquatic vegetation (Baxter and Stone 1995, Pflieger 1997). Many of the stream systems the species occupies in Wyoming are influenced by natural and anthropogenic dewatering (Weitzel 2002*a*). For instance, several of the streams within the Cheyenne River drainage follow natural cycles of periodic intermittency (Barrineau et al. 2007), while streams within the North Platte River drainage have intermittent reaches due to irrigation water withdrawals (Bear and Barrineau 2007). Stream dewatering limits the amount of available pool habitat for plains topminnow (Weitzel 2002*a*). Additionally, introductions of western mosquitofish (*Gambusia affinis*) have been implicated in restricted distributions of plains topminnow in Nebraska and also may be affecting Wyoming populations (Rahel and Thel 2004).

Iowa Darter

Patton (1997) found that Iowa darter distributions had been stable since the 1960s. Based on our survey, Iowa darter distributions appear to have declined in the North Platte River drainage, but remain stable in the Niobrara and South Platte drainages. Iowa darters are found in clear, cool streams with aquatic vegetation (Baxter and Stone 1995). Declines in this species can be attributed to habitat degradation and interspecific competition (Baxter and Stone 1995). Increasing turbidities have degraded Iowa darter habitat and may have contributed to range retractions in Wyoming. Range expansions of Johnny darter (*E. nigrum*) are implicated in Iowa darter declines. Increases in spatial overlap between the two darter species may result in greater competition for resources and consequently may contribute to localized reductions in native darter abundances (Baxter and Stone 1995).

Orangethroat Darter

As with suckermouth minnow, changes in distribution of orangethroat darter in the South Platte drainage were not assessed by Patton (1997). Nevertheless, our results are consistent with previous findings by Patton (1997), indicating that orangethroat darter continue to persist in Lodgepole Creek, a tributary to the South Platte River. We found no evidence for distributional changes in orangethroat darter; the species appears to be stable. Orangethroat darter are typically associated with small, clear streams with sand or gravel substrates (Baxter and Stone 1995, Pflieger 1997). Habitat in the tributary stream where orangethroat darter were collected consisted of clear pools with abundant aquatic vegetation. Drought and habitat degradation associated with water withdrawals and land use practices are threats to the persistence of orangethroat darter in the South Platte watershed (Weitzel 2002*b*).

MANAGEMENT IMPLICATIONS

Our survey has increased the knowledge of the current distribution of rare fishes in eastern Wyoming prairie streams. In light of current rare species' distribution information, streams previously identified as high conservation priorities for native Wyoming fishes should remain as such. Implementing conservation efforts and monitoring programs for rare fishes in eastern Wyoming prairie streams is warranted. Additionally, sampling methods to target large-bodied, migratory fishes, such as drifting trammel nets to capture goldeye should be incorporated with other sampling techniques to monitor prairie stream assemblages (WGFD 2007).

ACKNOWLEDGMENTS

A United States Fish and Wildlife Service (USFWS) State Wildlife Grant provided funding to survey warmwater streams in eastern Wyoming. Surveys were conducted in cooperation with Wyoming Game and Fish Department personnel including Aquatic Habitat Biologists, the statewide Aquatic Assessment Crew, the Sheridan, Casper and Laramie Region Fish Management Crews, and the United States Forest Service. The Wyoming Game and Fish Department also acknowledges the Colorado State University Larval Fish Lab for identification of age-0 fish and the private landowners who allowed access to their property for stream surveys.

LITERATURE CITED

Barrineau, C., B. Bear, and L. Tooker. 2007. Status of habitat and native species in northeast Wyoming prairie streams. Wyoming Game and Fish

Department Administrative Report. Cheyenne, Wyoming, USA.

Baxter, G. T., and J. R. Simon. 1970. Wyoming Fishes. Wyoming Game and Fish Department Bulletin Number 4. Cheyenne, Wyoming, USA.

Baxter, G. T., and M. D. Stone. 1995. Fishes of Wyoming. Wyoming Game and Fish Department Bulletin Number 4. Cheyenne, Wyoming, USA.

Bear, B., and C. Barrineau. 2007. Status of habitat and native species in southeast Wyoming prairie streams. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming, USA.

Cross, F.B., R.L. Mayden, and J.D. Stewart. 1986. Fishes in the western Mississippi drainage. Pages 363–412 *in* C.H. Hocutt and E.O. Wiley, editors. The zoogeography of North American freshwater fishes. John Wiley and Sons, New York, New York, USA.

Cunningham, G. R. 2006. Pearl dace (*Margariscus margarita*): a technical conservation assessment. United States Department of Agriculture Forest Service, Rocky Mountain Region. <http://fs.fed.us/r2/projects/scp/assessments/pearl dace.pdf>. Accessed 1 November 2008.

Dodds, W.K., K. Gido, M.R. Whiles, K.M. Fritz, and W.J. Matthews. 2004. Life on the edge: the ecology of Great Plains prairie streams. BioScience 54:205–216.

Fausch, K.D., and K.R. Bestgen. 1997. Ecology of fishes indigenous to the central and southwestern Great Plains. Pages 131–166 *in* F.L. Knopf and F.B. Samson, editors. Ecology and conservation of Great Plains vertebrates. Springer-Verlag, New York, New York, USA.

Fischer, J. R., and C. P. Paukert. 2008. Historical and current environmental influences on an endemic Great Plains fish. American Midland Naturalist 159:364–377.

Hoagstrom, A. C. DeWitte, N. J. C. Gosch, and C. R. Berry Jr. 2006*a*. Perennial-warmwater fish communities of the Cheyenne River drainage: a seasonal assessment. Proceedings of the South Dakota Academy of Science 85:213–245.

Hoagstrom, C. W., C. A. Hayer, J. G. Kral, S. S. Wall, and C. R. Berry Jr. 2006*b*. Rare and declining fishes of South Dakota: a river drainage scale perspective. Proceedings of the South Dakota Academy of Science 85:171–211.

Hoagstrom, C. W., C. Hayer, and C. R. Berry Jr. 2009. Criteria for determining native distributions of biota: the case of the northern plains killifish in the Cheyenne River drainage, North America. Aquatic conservation: Marine and Freshwater Ecosystems 19:88–95.

Jelks, H. L., S. J. Walsh, N. M. Burkhead, S. Contreras-Balderas, E. Diaz-Pardo, D. A. Hendrickson, J. Lyons, N. E. Mandrak, F. McCormick, J. S. Nelson, S. P. Plantania, B. A. Porter, C. B. Renaud, J. J. Schmitter-Sotto, E. B. Taylor, and M. L. Warren, Jr. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. Fisheries 33:372–407.

Leidy, R. A., and P. B. Moyle. 1998. Conservation status of the world's fish fauna: an overview. Pages 187–227 *in* P. L. Fiedler and P. M. Kareiva, editors. Conservation biology: for the coming decade. Chapman and Hall, New York, New York, USA.

Matthews, W.J. 1998. Patterns in freshwater fish ecology. Chapman and Hall, New York, New York, USA.
Miller, W. J., D. E. Rees, R. J. Carr, and D. S. Berube. 2005. Hornyhead chub (*Nocomis biguttatus*): a technical conservation assessment. United States Department of Agriculture Forest Service, Rocky Mountain Region. http://www.fs .fed.us/r2/projects/scp/assessments/hornyheadchub .pdf>. Accessed 1 November 2008.

Miller, W. J., D. E. Rees, R. J. Carr, and D. S. Berube. 2005. Hornyhead chub (*Nocomis biguttatus*): a technical conservation assessment. United States Department of Agriculture Forest Service, Rocky Mountain Region. <http://www.fs.fed.us/r2 <http://www.fs.fed.us/r2/projects/scp/assessments /honryheadchub.pdf>. Accessed 1 November 2008.

Moyle, P. B., and R. A. Leidy. 1992. Loss of biodiversity in aquatic ecosystems: evidence from fish faunas. Pages 127–169 *in* P.L. Fielder and S.K. Jain, editors. Conservation biology: the theory and practice of nature conservation, preservation, and management. Chapman and Hall, New York, New York, USA.

Mueller, J.W., and L.C. Rockett. 1966. A fisheries survey of streams and reservoirs in the Belle Fourche, Cheyenne, Little Missouri, Little Powder, and Niobrara drainages. Wyoming Game and Fish Commission Fish Division Fisheries Technical Report No. 15. Project No. 163-3-10. Cheyenne, Wyoming, USA.

Nesler, T.P., R. VanBuren, J.A. Stafford, and M. Jones. 1997. Inventory and status of South Platte River native fishes in Colorado. Colorado Division of Wildlife, Aquatic Wildlife Section Final Report. Ft. Collins, Colorado, USA.

Patton, T. M. and W. A. Hubert. 1993. Reservoirs on a Great Plains stream affect downstream habitat and fish assemblages. Journal of Freshwater Ecology 8:279–286.

Patton, T. M. 1997. Distribution and status of fishes in the Missouri River drainage in Wyoming: implications for identifying conservation areas. Dissertation. University of Wyoming, Laramie, USA.

Patton, T.M., F.J. Rahel, and W.A. Hubert. 1998. Using historical data to assess changes in Wyoming's fish fauna. Conservation Biology 12:1120–1128.

Patton, T.M., W.A. Hubert, F.J. Rahel, and K.G. Gerow. 2000. Effort needed to estimate species richness in small streams on the Great Plains in Wyoming. North American Journal of Fisheries Management 20:394–398.

Pflieger, W.L. 1997. The fishes of Missouri, revised edition. Missouri Department of Conservation, Jefferson City, USA.

Quist, M. C., W. A. Hubert, and F. J. Rahel. 2003. Exotic piscivorous fishes and reduced intermittence affect suckermouth minnows in a southeastern Wyoming stream. Intermountain Journal of Sciences 9:62–65.

Quist, M.C., W.A. Hubert, and F.J. Rahel. 2004. Relations among habitat characteristics, exotic species, and turbid-river cyprinids in the Missouri River drainage of Wyoming. Transactions of the American Fisheries Society 133:727–742.

Rabeni, C.F. 1996. Prairie legacies – fish and aquatic resources. Pages 115–124 *in* F.B. Samson, F.L. Knopf,editors. Prairie conservation: preserving North America's most endangered ecosystem. Island Press, Covelo, California, USA.

Rahel, F. J., and L. A. Thel. 2004. Plains topminnow (*Fundulus sciadicus*): a technical conservation assessment. United States Department of Agriculture Forest Service, Rocky Mountain Region. <http://www.fs.fed.us/r2/projects/scp/assessments/plainstopminnow.pdf>. Accessed 1 November 2008.

Samson F.B., and F.L. Knopf. 1994. Prairie conservation in North America. BioScience 44:418–421.

Simon, J.R. 1946. Wyoming Fishes. Wyoming Game and Fish Department Bulletin Number 4. Cheyenne, Wyoming, USA.

Snigg, M. 1999. A fisheries inventory of the South Platte River drainage located within Laramie and Albany Counties, Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming, USA.

Stasiak, R., and G. R. Cunningham. 2006. Finescale dace (*Phoxinus neogaeus*): a technical conservation assessment. United States Department of Agriculture Forest Service, Rocky Mountain Region. <http://www.fs.fed.us/r2/projects/scp/assessments/finescaledace.pdf>. Accessed 1 November 2008.

Weitzel, D. L. 2002*a*. Conservation and status assessments for the finescale dace (*Phoxinus neogaeus*), pearl dace (*Margariscus margarita*), and plains topminnow (*Fundulus sciadicus*): rare native fish species of the Niobrara and Platte River basins, Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming, USA.

Weitzel, D. L. 2002*b*. Conservation and status assessments for the hornyhead chub (*Nocomis biguttatus*), suckermouth minnow (*Phenacobius* mirabilis), and orangethroat darter (*Etheostoma spectabile*): rare stream fish species of Platte River drainages, Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming, USA.

WGFD (Wyoming Game and Fish Department). 2001. Strategic Habitat Plan. Wyoming Game and Fish Department, Cheyenne, Wyoming, USA.

WGFD (Wyoming Game and Fish Department). 2005. A comprehensive wildlife conservation strategy for Wyoming. Wyoming Game and Fish Department Report. Cheyenne, Wyoming, USA.

WGFD (Wyoming Game and Fish Department). 2007. Fisheries division progress report on the 2006 work year. Wyoming Game and Fish Department. Cheyenne, Wyoming, USA.

Williams, J. E., J. E. Johnson, D. A. Hendrickson, S. Contreras-Balderas, J. D. Williams, M. Navarro-Mendoza, D. E. McAllister, and J. E. Deacon. 1989. Fishes of North America endangered, threatened, or of special concern: 1989. Fisheries 14:2–20.

Submitted 5 February 2009. Accepted 1 June 2010. Associated Editor was Brian G. Blackwell.