

Type locality and conservation status of the northern plains killifish (*Fundulus kansae*: Fundulidae) in Kansas

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Fundulus kansae Garman (northern plains killifish; Fundulidae) was described in 1895 and “Kansas” was designated as the type locality. Based on the information available, a more specific locality is suggested: Big Creek near Ellis, Kansas. However, the continued presence of *F. kansae* in this region is uncertain. In several areas of western Kansas, including Big Creek, the distribution of *F. kansae* has been reduced since the late 1880s and its relative abundance has declined since the 1970s. These declines resulted primarily from habitat loss through dewatering of streams, although introduced predators, parasites, and fragmented streams also represent threats to the species. In other areas of western Kansas, especially in the upper Arkansas River basin, *F. kansae* has increased in relative abundance. However, these are probably short-term increases linked to declines in water quality, to which *F. kansae* is more tolerant than most other species of native fish. Thus, generally declining trends in distribution and relative abundance for Kansas populations of *F. kansae* suggest that the species is in need of conservation and warrants monitoring and additional study.

Key words: Fish, streams, salinity, Great Plains.

Introduction

Fundulus kansae Garman (northern plains killifish) is a member of the family Fundulidae (Topminnows). It alternately has been recognized as a distinct species and classified within the species *Fundulus zebrinus* Jordan and Gilbert (plains killifish). Poss and Miller (1983) concluded from a study of morphological characters that a north-south cline of variation occurred in a single species (*F. zebrinus*). The separation of the two species as currently recognized (Nelson et al. 2004) is based solely on genetic analyses of Kreiser, Mitton, and Woodling (2001) and Kreiser (2001). Thus, no reliable morphological or ecological attributes are known to distinguish the two taxa, but the genetic analyses indicate that only *F. kansae* occurs in Kansas (Kreiser 2001).

Fundulus kansae grows to a maximum of about 100 mm (4 inches) in total length. The species

typically inhabits shallow streams with sand substrate in areas of current or in pools, where silt accumulates, but it is most abundant in streams with high salinity or alkalinity (Cross 1967). The prevalence of the species in saline environments might be due, at least in part, to the limits that high salinity places on the presence of potential competitors, as noted for *F. zebrinus* in the Red River basin (Echelle, Echelle, and Hill 1972). The principal food of *F. kansae* is aquatic insect larvae, especially midge larvae (‘bloodworms’; Chironomidae) taken from the bottom of the stream (Minckley and Klaassen 1969). The species spawns from April through August as water temperatures warm (Minckley and Klaassen 1969).

The native distribution of *F. kansae* includes the Platte, Kansas, and Arkansas river basins (Poss and Miller 1983; Kreiser 2001). Prior to the genetic analyses of Kreiser, Mitton, and Woodling (2001) and Kreiser (2001), the Red River basin of Oklahoma and Texas was

included in the distribution of *F. kansae*, but it is now included within the distribution of *F. zebrinus*. Introduced populations of plains killifish were reported to occur in the Colorado River basin of Arizona, Colorado, New Mexico, and Utah, and in tributaries of the Missouri River in Montana, Wyoming, and South Dakota (Poss and Miller 1983); however, Hoagstrom et al. (2006) and Brown (1971) considered *F. kansae* native to South Dakota and Montana, respectively. Introduced populations in the upper Missouri River basin were assumed to be *F. kansae* from nearby basins (Miller 1955; Baxter and Simon 1970). Introduced populations in the Colorado River basin apparently came from both the Arkansas River basin (*F. kansae*) and Pecos River basin (*F. zebrinus*) (Kreiser, Mitton, and Woodling 2000).

The conservation status of *F. kansae* has become a matter of concern as native stream fishes of the Great Plains have declined during recent decades (e.g., Haslouer et al. 2005). The separation of *F. kansae* from *F. zebrinus* reduced the native range of *F. kansae* to about one-half the area occupied by the formerly combined species and removed the Red River basin from its former distribution. Recently, *F. kansae* was one of several species of potential concern that were the subjects of status reports prepared for the U.S. Forest Service (Rahel and Thel 2004), although it was not subsequently designated for special management status on Forest Service lands. This combination of factors suggests it would be prudent to assess the conservation status of the species in Kansas, which was designated as the type locality of *F. kansae*.

Type locality of *Fundulus kansae*. Type specimens used to describe a species, as well as their collection locality, are important when biologists consider the identity of species, which is relevant to the conservation of native species. The type locality given for the specimens used to describe *F. kansae* is vague: “Kansas” (Garman 1895), which encompasses over 200,000 km². However, it is possible to interpret

available information and suggest a more specific locality.

In the references cited by Garman (1895) with his original description of *F. kansae*, the first reference listed is a publication by Gilbert (1884). This publication has an account of *F. zebrinus*, the only one of the two species names discussed here that was recognized at the time. The account was based on three specimens (two males, one female) collected near Ellis, Kansas from Big Creek, a tributary of the Smoky Hill River (Kansas River basin). In this account, Gilbert (1884:15) stated that the specimens “are the first that have been seen since the original discovery of the species [*F. zebrinus* in New Mexico, described in 1859 (Poss and Miller 1983)]...and afford material for a full description,” which he provided. Garman (1895) also cited the summary of North American fishes by Jordan (1887:48-49), who quoted the entire description by Gilbert (1884).

In addition, Garman (1895) listed another note by Gilbert (1889) with the title “Fourth Series of Notes on the Fishes of Kansas” published in the same journal as his 1884 description. This subsequent note referred to specimens of *F. zebrinus* (now *F. kansae*) from the Republican and North Fork Solomon river basins, both of which are also in the Kansas River basin. Yet Garman (1895) omitted two intervening publications — the “Second” and “Third Series of Notes” about Kansas fishes (Gilbert 1885, 1886) — published in the same journal as the other two notes in the series he cited. The two notes Garman (1895) did not cite referred again to “Ellis” (Gilbert 1885) but provided new collection sites for the species in Kansas only from “Garden City,” “Breathing Spring, Ford Co.,” and tributaries of the Medicine Lodge River, all of which are in the Arkansas River basin. This might have been an intentional omission by Garman (1895), which would suggest that he intended to name the species *F. kansae* from “Kansas” based on specimens from the Kansas River basin, rather than the Arkansas River basin in the

state. However, he also cited publications reporting *F. zebrinus* (now *F. kansae*) from the Arkansas River basin in south-central Kansas (Evermann and Fordice 1886:412), Colorado (Jordan 1891:17), and Texas (Evermann and Kendall 1894:92), in addition to a publication recording the species from three sites in the Kansas River basin (Hay 1887). Garman (1895) cited two additional publications. Cragin (1885) simply listed species from earlier publications on Kansas fishes. The publication he listed for Jordan (1885, Report of the U.S. Fish Commissioner, page 48) apparently was an error; Jordan did not author information in the volume published that year, and Garman (1895) did not include a more complete citation in his list of literature cited.

Garman (1895:159) stated that he used “specimens in the collections at hand” and available descriptions to describe species of *Fundulus* and their relatives, so it is not clear if he saw the specimens from Ellis, Kansas housed at the U.S. National Museum. However, he was familiar with the enhanced description of *F. zebrinus* (now *F. kansae*) by Gilbert (1884) and the importance placed on these specimens from Ellis by Jordan (1887) and Evermann and Kendall (1894). Five years later, Jordan and Evermann (1900: plate 103, figure 246), in their four-volume publication, “The Fishes of North and Middle America,” published an illustration of a specimen of *F. kansae* (as *F. zebrinus*) from Ellis, Kansas. Evermann and Kendall (1894: plate 23) previously used this same illustration. The complete information provided by Jordan and Evermann (1900:3254) for the illustration is, “Drawing by H. L. Todd from No. 36610, U.S.N.M., collected at Ellis, Kansas, by F. W. Cragin.” Actually, ‘Dr. L. Watson’ sent the specimens to Cragin in Topeka, and Cragin sent them to Gilbert.

Thus, the specimens that Garman (1895) actually used for his description cannot be confirmed from the published literature. The description provided by Garman (1895)

included ranges of measurements beyond those provided by Gilbert (1884). This suggests that he relied on specimens (or descriptions of specimens) in addition to those used by Gilbert (1884), and this might be why he designated the type locality broadly as “Kansas.” However, the description by Gilbert (1884) based on specimens from Big Creek near Ellis is the first for *F. kansae* (at the time referred to as *F. zebrinus*), leaving it for Garman (1895) to distinguish the two species. The description by Gilbert (1884) and the specimens from near Ellis were referred to or illustrated by Garman’s contemporaries as typical of the then single species, *F. zebrinus*. All of this suggests that Big Creek near Ellis, Kansas is the most appropriate type locality for *F. kansae*. Unfortunately, although specimens are available in museum collections, the species probably is no longer extant in Big Creek at Ellis, as explained in the following summary.

Conservation Status of *Fundulus kansae* in Kansas. In Kansas, *F. kansae* occurred at sites in much of the Kansas and Arkansas river basins generally west of 97°W longitude — west of Junction City and Arkansas City (Cross 1967; Fig. 1). In northwestern Kansas, the species occurred primarily in the western sections of the Smoky Hill River basin and two of its major tributaries, the Saline and Solomon river basins, which together drain most of the region (Cross 1967). A few records also exist from the Republican River basin in northwestern Kansas and in the Blue River basin and Kansas River in northeastern Kansas (Cross 1967). In southwestern Kansas, the species occurred in the Arkansas River basin, including the Cimarron and Walnut river basins (Cross 1967).

To assess the conservation status of *F. kansae* in western Kansas, where the species was most abundant, I compiled museum and written records from 1885 through 2007 and made temporal and spatial comparisons. I considered three measures: distribution, prevalence (number of sites where the species was present

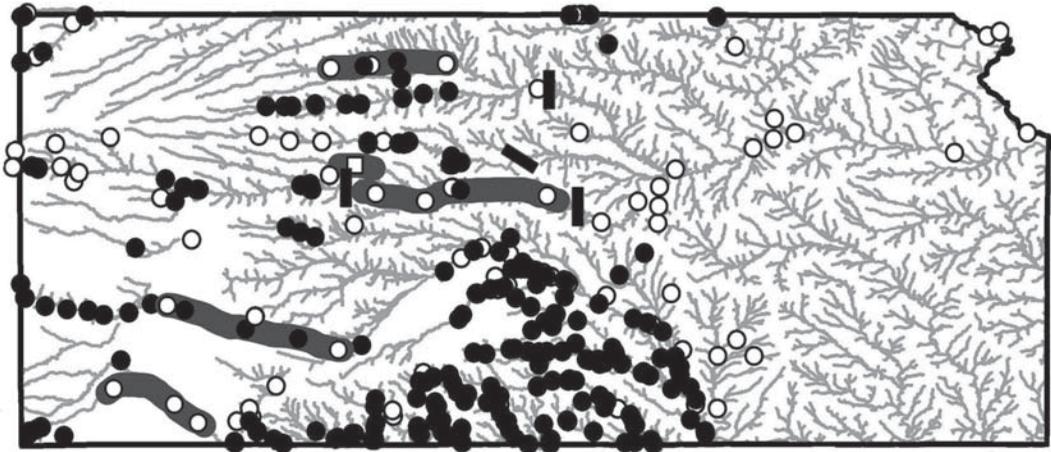


Figure 1. Illustration of the reported distribution of *Fundulus kansae* (northern plains killfish) in Kansas. Streams shown in light gray. Solid circles represent collections during 1994-2006. Open circles represent collections prior to 1994. The single, open square represents the potential type locality in Big Creek described in the text. Shaded dark gray streams represent stream segments where substantial reductions have occurred as described in the text; listed north to south, these streams are the North Fork Solomon River, Big Creek, Smoky Hill River, Arkansas River, and Cimarron River. Solid bars represent four federal reservoirs (US Corps of Engineers or US Bureau of Reclamation) mentioned in text; listed north to south, west to east, these are Waconda Reservoir (Solomon River), Wilson Reservoir (Saline River), and Cedar Bluff and Kanopolis reservoirs (Smoky Hill River). Data obtained from Kansas Gap Project at Kansas State University; Kansas Department of Wildlife and Parks, Pratt; and Cross (1967). (Horizontal scale exaggerated for clarity)

relative to the number of sites sampled), and relative abundance.

For relative abundance, I relied on median values rather than means, because *F. kansae* can dominate a fish assemblage, occasionally being the only species present. Thus, mean relative abundance can be skewed to a misleadingly higher value by a few sites. For example, this occurred in a comparison of two datasets from general stream surveys by personnel from the Kansas Department of Wildlife and Parks in northwestern Kansas. *Fundulus kansae* was present at 25 sites during 1974-1976 and 26 sites during 1994-2006. Between these two periods, the mean relative abundance of the species increased from $10.0 \pm 0.5\%$ SE to $19.5 \pm 1.4\%$ SE, yet its median relative abundance decreased from 4.9% to 2.5%. This apparent contradiction in trends was caused by four sites sampled during 1994-2006, where the species comprised 98.5 to 100% of the fish. At the other 22 sites

sampled during 1994-2006, the range of relative abundances of *F. kansae* (0.1 to 39.2%) was similar to the range during 1974-1976 (0.1 to 44.1%), and the mean and median relative abundances both decreased to $5.0 \pm 0.4\%$ SE and 1.6%, respectively. In a dataset such as this, with an asymmetric distribution, the median is preferred over the mean (Sokal and Rohlf 1995).

In the Kansas River basin of northwestern Kansas, *F. kansae* was most widespread in the Smoky Hill River upstream from Cedar Bluff Reservoir, Saline River upstream from Wilson Reservoir, and Solomon River basin upstream from Waconda Reservoir (Fig. 1). In this area, *F. kansae* was almost twice as likely to be present at a river main-stem site as at a tributary site in samples collected from 1885 through 1987 (Table 1), probably because larger streams referred to as rivers in western Kansas were more likely to provide the shallow, sandy habitat typically inhabited by the species.

Table 1. *Fundulus kansae* (northern plains killifish) prevalence (number of sites where the species was present/number of sites sampled) in river main-stems and in tributary streams in western Kansas and adjacent southwestern Nebraska. Data compiled from museum records, literature records, and unpublished records of the Kansas Department of Wildlife and Parks (data from 1994-2006) and Nebraska Department of Environmental Quality (data from 2007).

Period	Republican River Basin ^a		Smoky Hill River Basin		Arkansas River Basin	
	Main-stems	Tributaries	Main-stems	Tributaries	Main-stems	Tributaries
1885-1987			55.8% (29/52)	28.6% (20/70)		
1994-2007	60.0% (12/20)	0.0% (0/29)	50.0% (11/22)	27.3% (15/55)	73.7% (146/198)	47.5% (123/259)

^a = Includes sites from the Republican River and tributaries flowing into the river in Nebraska and Kansas, including and upstream from the river main-stem in Jewell County in north-central Kansas.

This higher prevalence of *F. kansae* at river main-stem sites persisted in samples collected during 1994-2006 (Table 1).

Prevalence of *F. kansae* at all sites in the upper Smoky Hill, Solomon, and Saline river basins was 40.2% (49 of 122 sites) during 1885-1987. Stream surveys in this area conducted from 1994 to 1996 by personnel from Fort Hays State University (Hays, Kansas) and the Kansas Department of Wildlife and Parks (Pratt) documented *F. kansae* at 43.2% (19/44) of sites. Thus, the overall prevalence of *F. kansae* in this region remained relatively stable. However, declines occurred in some streams. In the North Fork Solomon River basin, *F. kansae* was present at 7 of 19 sites from 1885 to 1978, but was present at only 1 of 10 sites during 1994-1996. In Big Creek, the potential type locality for the species, *F. kansae* was absent during 1975-1976 (0 of 11 sites; unpublished stream survey report, Kansas Department of Wildlife and Parks), and its prevalence was low during a 1983-1985 survey (1 of 9 sites sampled multiple times; this site was at the confluence of Big Creek with the Smoky Hill River; Eberle, Ernsting, and Tomelleri 1986). Similar declines occurred elsewhere in the middle Smoky Hill River basin (between Cedar Bluff and Kanopolis reservoirs), where *F. kansae* was collected at 5 of 22 sites during 1974-1976 but was not collected at any of the 14 sites sampled during 1994-2001. Additional details on prevalence are presented in Table 2.

It is difficult to assess changes in abundance over the long term. Early reports sometimes referred to *F. kansae* as “abundant” or “very abundant” at sites in northwestern Kansas, but quantifiable data are limited. However, a comparison is possible between two datasets from general stream surveys by personnel from the Kansas Department of Wildlife and Parks conducted in the Smoky Hill River basin upstream from Kanopolis Reservoir, Solomon River basin upstream from Waconda Reservoir, and Saline River basin upstream from Wilson Reservoir (Fig. 1). From 1974-1976 to 1994-2006, the median relative abundance of *F. kansae* at sites where it was present decreased from 4.9 to 2.5%. Additional details on relative abundance are presented in Table 2. Thus, although the overall prevalence of *F. kansae* remained relatively stable in the upper Smoky Hill, Solomon, and Saline river basins since the late 1800s, relative abundance has decreased since the 1970s, and there have been local declines in both prevalence and distribution.

In the Republican River basin of Kansas and Nebraska, *F. kansae* occurred from the headwaters region near the junction of Colorado, Kansas, and Nebraska to the point where the Republican River enters north-central Kansas in Jewell County (Johnson 1942; Metcalf 1966; Cross 1967; Fig. 1). However, the species was absent from the large tributary systems in northwestern Kansas (Beaver, Sappa, and Prairie Dog creeks; Cross 1967) and two major tributaries in south-central Nebraska (Red Willow and Medicine creeks; Johnson 1942). Unpublished collection data

Table 2. *Fundulus kansae* (northern plains killifish) prevalence (number of sites where the species was present/number of sites sampled) and relative abundance (at sites where the species was present) from stream samples in western Kansas collected by personnel from the Kansas Department of Wildlife and Parks during two periods. The number of sites where the species was present in the 1974-1976 samples differs for prevalence (first number) and relative abundance (number in parentheses) because specific data necessary to calculate relative abundance were unavailable for some sites where the species was recorded as present.

Basin	1974-1976					1994-2006				
	Number of sites		Prevalence (%)	Abundance (%)		Number of sites		Prevalence (%)	Abundance (%)	
	sampled	present		median	range	sampled	present		median	range
Kansas ^a	97	29 (25)	29.9	4.9	0.1-44.1	77	26	33.8	2.5	0.1-100.0
Upper and Middle Smoky Hill	49	12	32.7	5.7	0.3-41.3	45	16	35.6	1.9	0.1-100.0
Upper Saline	13	4	30.8	0.6	0.1- 5.3	12	4	33.3	0.9	0.4- 5.2
Upper Solomon	35	9	25.7	8.0	0.1-44.1	20	6	30.0	4.4	1.3- 22.2
Arkansas ^b	65	29 (27)	44.6	1.9	0.1-28.1	457	268	58.6	4.2	<0.1- 84.7
Cimarron	9	4	44.4	10.6	1.8-28.1	84	56	65.9	13.8	0.2- 75.3
Upper Arkansas	16	3	18.8	3.0	0.3-17.0	99	30	30.3	14.8	0.1- 84.7
Lower Arkansas	40	20	55.0	1.6	0.1-20.4	274	182	66.4	2.6	<0.1- 52.8
Western Kansas total	162	58 (52)	35.8	2.5	0.1-44.1	534	294	55.1	4.1	<0.1-100.0

^a = Data are from the three sub-basins upstream from Kanopolis, Wilson, and Waconda reservoirs, respectively. Cedar Bluff Reservoir separates the upper and middle sections of the Smoky Hill River.

^b = The break between the upper and lower Arkansas River basins is immediately downstream from the mouth of Walnut Creek, near Great Bend, Kansas.

from the Kansas Department of Wildlife and Parks during 1974-1975 included *F. kansae* at only 1 of 22 sites in northwestern Kansas. However, Eberle et al. (1989) reported the species from four of six sites in Cheyenne County in northwestern Kansas sampled during 1986-1987. In samples collected during 1994-2007 in the Republican River basin in Kansas and Nebraska upstream from Jewell County, Kansas, *F. kansae* was collected at 60.0% of river main-stem sites, but none of the 29 sites on tributary streams (Table 1). Its relative abundance at the 12 sites where it occurred was low (median = 1.7%; range = 0.2 to 20.0%).

In the Arkansas River basin, as in the Smoky Hill and Republican river basins, *F. kansae* was collected more frequently at river main-stem sites than tributary sites during 1994-2006 (Table 1). However, the prevalence of the species in tributary streams was substantially higher in the Arkansas River basin (47.5%) than in the Smoky Hill (27.3%) or Republican (0.0%) river basins.

Cross (1967) mapped a wide distribution for *F. kansae* in streams south of the Arkansas River in southwestern Kansas (Fig. 1). Cross, Moss,

and Collins (1985) and Eberle et al. (1989) also reported that the species was widespread in this region in the 1980s, but its relative abundance at sites where it occurred varied widely (<1 to 65%), perhaps related to stream salinities. For example, in a study of Rattlesnake Creek, an Arkansas River tributary in central Kansas, *F. kansae* was absent or rare (0.0-0.5% relative abundance) in the upstream segment of the creek, where salinity was lower (chloride ≤520 mg/L). In contrast, it was abundant (81-83% relative abundance) in the lower segment of the creek, where salinity was higher (chloride >3000 mg/L) (Eberle, Welker, and Welker 1996). Although *F. kansae* remained widely distributed in the Arkansas River basin (Fig. 1) and its prevalence increased (Table 2), declines in distribution within this area have occurred. A comparison of distributional information mapped by Cross (1967) and data collected since 1994 by personnel from Kansas Department of Wildlife and Parks and Fort Hays State University suggested that the species was extirpated from sections of the Cimarron River and the Arkansas River (Fig. 1). These stream segments became ephemeral, with surface water limited to isolated pools or short sections of stream channels (Cross, Moss, and Collins 1985;

Cross and Moss 1987; Eberle et al. 1989). *Fundulus kansae* can persist in some of these pools.

As with early surveys in northwestern Kansas, *F. kansae* was referred to as “abundant” at sites in the Arkansas River basin of southwestern Kansas, but quantifiable data are limited. Thus, I again compared two sets of samples from the Arkansas and Cimarron river basins (excluding the Walnut River and Grouse Creek basins in south-central Kansas) collected by personnel from the Kansas Department of Wildlife and Parks (Table 2). In samples collected during 1974-1975 and 1994-2006, the median relative abundance of *F. kansae* increased from 1.9 to 4.2%, with the largest increase in the upper Arkansas River basin (upstream from Great Bend).

Thus, despite a stable prevalence of the species since 1885 and recent increases in relative abundance in parts of southwestern Kansas, *F. kansae* declined in both distribution and relative abundance in large parts of western Kansas. These declines probably resulted from combinations of several factors.

Threats to *Fundulus kansae*. The principal threat to *F. kansae* is habitat loss. Because the species is most widespread and abundant in streams on the western Great Plains, dewatering of streams by surface diversions or by lowered water tables resulting from groundwater mining is a major threat that has eliminated substantial segments of stream habitat in both the Kansas and Arkansas river basins (Cross and Moss 1987; Eberle 2007). In addition to the loss of habitat at the scale of entire stream segments, reductions in available habitat at sites that retain surface water have occurred. Alterations of discharge patterns, especially reductions in peak discharges resulting from operation of impoundments and groundwater mining, have narrowed the active widths of sandy rivers that formerly had broad, shallow streamflows (Cross and Moss 1987; Eberle 2007). Summerfelt

(1967: figure 2) provided a photograph of this type of habitat in southwestern Trego County, Kansas, the site where he collected the highest number of *F. kansae* in a study encompassing virtually the entire length of the Smoky Hill River. Eberle et al. (2002) described substantial habitat loss of this type for rivers in the Solomon River basin, where reductions in the distribution and abundance of *F. kansae* have occurred. Thus, consideration of the stable, broader range of *F. kansae* is of limited value in the assessment of its conservation status because this broad scale approach can mask reductions in distribution and abundance at finer scales that result from habitat loss in dry and reduced stream channels.

Micropterus salmoides (largemouth bass), which is not native to western Kansas, might pose a threat to *F. kansae*, just as it decimated assemblages of other small, native fishes (Eberle 2007). *Fundulus kansae* inhabits shallow water, which could limit its exposure to large, piscivorous fish species, but the distribution of *M. salmoides* has expanded into streams throughout western Kansas (Eberle 2007) following its introduction into the many ponds and reservoirs constructed in the state (Falke and Gido 2006). *Lepomis cyanellus* (green sunfish) is native to streams of the western plains, and it is a smaller predator than *M. salmoides*, yet it can reduce or eliminate populations of *F. kansae* in isolated pools (Lohr and Fausch 1996).

Parasites are a natural part of the stream environment inhabited by *F. kansae*, but heavy parasite infestations can reduce host survival. For *F. kansae* in the South Platte River of Nebraska, individual fish heavily infested with any one of five parasite species studied had a lower survival rate over winter than fish with lighter infestations; a sixth parasite species, the protozoan *Trichodina*, did not affect over-winter survival rates (Janovy, Snyder, and Clopton 1997). Individuals of *F. kansae* in the Smoky Hill River of western

Kansas that had three embedded individuals of the copepod parasite *Lernaea* ('anchor worm') seemed emaciated compared to individuals with fewer or no parasites (Minckley and Klaassen 1969). In 1983, at sites sampled in the Smoky Hill and Saline rivers, *F. kansae* was absent or uncommon, and the individuals collected were heavily infested with abdominal parasites (Brown 1986). In areas where *F. kansae* is in decline, parasites could exacerbate the situation.

Dams can fragment populations of stream fishes, blocking recolonization of depopulated stream segments (e.g., Luttrell et al. 1999) and preventing gene flow (Brown 1986). For example, an irrigation diversion dam apparently segregated populations of *F. kansae* in the Platte River basin. Knight, Janovy, and Current (1980) reported the mean prevalence of the protozoan *Myxosoma funduli*, which infests the gills of *F. kansae*, was substantially higher at sites upstream from the Tri-County Diversion Dam (59.1%) on the Platte River near North Platte, Nebraska than at downstream sites (5.4%).

Fundulus kansae is sometimes used as bait, and this was blamed for introductions of the species outside its native range (Miller 1955; Baxter and Simon 1970). Such use is not likely to be widespread in western Kansas and is probably limited to individual anglers seining their own bait. This use would probably only threaten the species in areas where it has substantially declined through other causes.

CONCLUSIONS

Fundulus kansae was collected more frequently in river main-stems than in tributary streams throughout western Kansas. The species retained the overall extent of its distribution across western Kansas, and its prevalence remained relatively stable in the upper Kansas River basin and increased in the Arkansas River basin, suggesting a species that is stable or increasing. However, substantial segments of streams formerly

inhabited by *F. kansae* became ephemeral in both basins and, therefore, are no longer sampled or presumably inhabited by the species. Thus, stable or increasing prevalence trends mask declines in distribution at local scales in both basins, making this an unreliable indicator of the status of a species - an indicator that is not equivalent to persistence of a species at the same sites sampled across time.

When considering median relative abundances from surveys conducted since 1994, *F. kansae* was generally more abundant at sites in the Arkansas River basin, especially the upper Arkansas River basin, than in the Kansas River basin, where it declined in the Solomon and Smoky Hill river basins since the 1970s. In addition to its low median relative abundance at sites where it was present in the upper Kansas River basin, *F. kansae* was absent from 66% of sampled sites in the upper Smoky Hill, Solomon, and Saline river basins. During this same period, substantial segments of streams formerly inhabited by the species in both the Kansas and Arkansas river basins were dewatered completely or to the extent that suitable available habitat was reduced. These changes in distribution, abundance, and available habitat suggest a species in decline and vulnerable in a large portion of its former range within the state.

In the six basins in western Kansas summarized in Table 2, the highest relative abundance reported for *F. kansae* during the 1970s was 44.1%. In samples collected since 1994, the highest relative abundances exceeded 50% in four of the six basins and exceeded this value at multiple sites within parts of southwestern Kansas and the westernmost tributaries of the Smoky Hill River. Although *F. kansae* might be increasing in relative abundance within its native range in parts of western Kansas, this is probably a temporary response to generally degrading environmental conditions of streams on the western Great Plains. *Fundulus*

kansae is more tolerant of physical and chemical extremes, especially high salinity, than most other species of native fish, and when it dominates a site, this is often because other species are excluded by the stressful environmental conditions. Increases in dissolved solids were reported in the Arkansas River and Republican River alluvial aquifers, probably resulting from higher concentrations in irrigation return flows (Litke 2001). Ironically, the increased abundance of *F. kansae* might be positive for the species in the short term but ultimately have a negative outcome, because this change could be symptomatic of ongoing degradation of habitat quality in western Kansas (Cross and Moss 1987; Eberle 2007). Continued declines in habitat quality and quantity could eventually lead to broader declines of *F. kansae* in the state. Thus, the status of the species should be monitored in these areas.

Rather than considering the conservation status of *F. kansae* as a legitimate but isolated conservation question, its status should be assessed in the context of the broader conservation of stream ecosystems in Kansas and elsewhere on the western Great Plains. Decisions about conserving *F. kansae* and its habitat should not be based on enhanced abundance where anthropogenic changes have degraded habitat features in ways detrimental to other native riverine species, such as *Hybognathus placitus* (plains minnow) and *Platygobio gracilis* (flathead chub) (Eberle 2007), just as these decisions should not rely on expanded distribution where the species is not native. The declining trends in distribution and relative abundance for Kansas populations of *F. kansae* suggest that the species is in need of conservation and warrants monitoring and additional study.

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