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STATUS OF THE PRESTON WHITE RIVER SPRINGFISH (*CRENICHTHYS BAILEYI ALBIVALLIS*)

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ABSTRACT.—We determined the distribution and estimated population number of Preston White River springfish (*Crenichthys baileyi albivallis*) in summer 1998 and winter 1999. The total population was <5000 fish persisting in only 4 of 6 spring systems from which it had been previously captured. To improve its status, we recommend conservation measures.

Key words: Crenichthys, *Goodeidae, Empetrichthyidae, springfish, warm springs, White River, Colorado River, population estimate.*

Preston White River springfish (*Crenichthys baileyi albivallis*) is endemic to the White River system, White Pine County, Nevada. It is 1 of 5 subspecies of White River springfish (*Crenichthys baileyi*) inhabiting warm water springs extending from east central Nevada to the Colorado River system (Williams and Wilde 1981). The subspecies' distribution has been used as zoogeographic evidence that a prehistoric tributary (pluvial White River) flowed from east central Nevada south to the Virgin River and then to the Colorado River (Hubbs and Miller 1948, Minckley et al. 1986). Of the White River springfish subspecies, the Preston White River springfish is located farthest north.

Crenichthys baileyi is a member of an unusual taxonomic group (Empetrichthyidae) comprising the genera *Crenichthys* and *Empetrichthys*, both endemic to Nevada. Its closest relatives are of the family Goodeidae, found more than 1500 km to the south in central Mexico. Parenti (1981) identified the Nevada group as belonging to the family Goodeidae by virtue of its osteology, but considered it primitive because it is oviparous while all other goodeids are viviparous. Miller and Smith (1986), in agreement with Jordan et al. (1930), argued that oviparity and isolation of these genera distinguish them as the family Empetrichthyidae. All members of *Crenichthys* and *Empetrichthys* have been impacted by habitat alteration and introduction of nonnative species leading to population declines and extinctions. Three taxa of *Empetrichthys* are extinct (*E. merriami, E. latos concavus,* and *E. latos pahrump*), and another (*E. latos latos*) has been extirpated from its native habitat and exists only in refuges (U.S. Fish and Wildlife Service 1980). Of the 2 extant *Crenichthys* species (*C. baileyi* and *C. nevadensis*), *C. nevadensis* is federally listed as threatened and the 5 subspecies of *C. baileyi* are federally listed as endangered (*C. b. baileyi* and *C. b. grandis;* U.S. Fish and Wildlife Service 1985) or have been considered for listing (*C. b. albivallis, C. b. thermophis,* and *C. b. moapae;* U.S. Fish and Wildlife Service 1994).

When described in 1981, *C. b. albivallis* was reported from 6 spring systems (Williams and Wilde 1981), but numbers were sufficiently low that there was concern for its persistence (Courtenay et al. 1985, Williams et al. 1985). In 1991 *C. b. albivallis* was found in only 4 spring systems (Scoppettone and Rissler unpublished); this decline stimulated the U.S. Fish and Wildlife Service to review its status. However, except for an early estimate of the *C. b. albivallis* population in 1 spring system (Deacon et al. 1980), there has not been a published account of *C. b. albivallis* population size. In this study we estimated the population size, demographics, and distribution of Preston White River springfish in springs where it was last known to occur. This information is intended to aid regulatory agencies in monitoring the status of *C. b. albivallis* to ensure against further decline or extinction.

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Description of Area

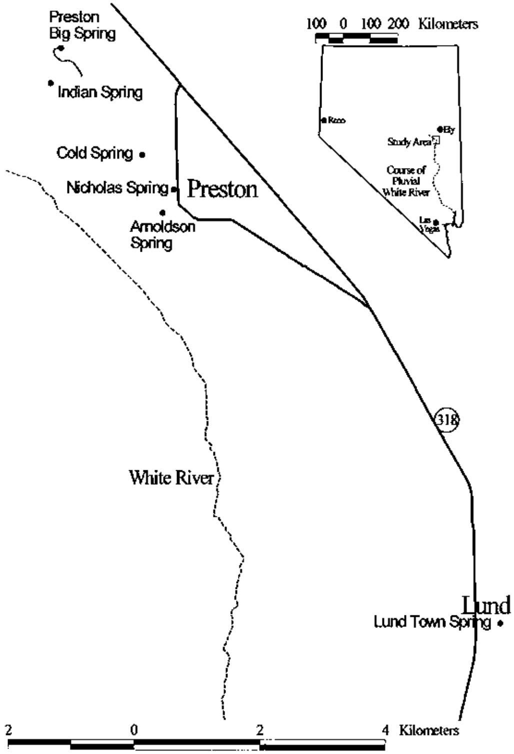

Fig. 1. Map showing study area in relationship to the course of the pluvial White River and springs in which *Crenichthys baileyi albivallis* was known to occur.

The White River is situated in White Pine and Nye counties in east central Nevada. The source of the White River is warm and cool water springs as well as seasonal snowmelt from the White Pine Mountains (Eakin 1966). Spring systems have been altered to irrigate pastures and hay crops.

Springs with *C. b. albivallis* (Preston Big, Indian, Arnoldson, and Nicholas) are within a 2-km radius (Fig. 1) and have a constant water temperature of about 21°C. Of those, Preston Big Spring is the northernmost and has the greatest discharge, 0.11 $m^3 \cdot s^{-1}$ (Garside and Schilling 1979). It flows south 524 m in an earthen ditch before entering a pipe. The upstream reach is slow and wide, the downstream shallow and fast. The banks are lined with big sage (*Artemesia tridentata*).

Indian Spring, about 0.6 km southwest of Preston Big Spring, issues at 0.02 $m^3 \cdot s^{-1}$. It flows more than 500 m southeast in an excavated channel before discharging into a shallow reservoir. The channel is choked with bulrush (*Scirpus* sp.) along most of its course.

The outflow of Arnoldson Spring travels 128 m southeast before entering a pipe. Its discharge is about 0.04 $m^3 \cdot s^{-1}$, and several cottonwoods (*Populus* sp.) border the channel.

Nicholas Spring has the least amount of habitat available to *C. b. albivallis;* it flows only 10 m before entering a pipe. Its flow is frequently manipulated, and its character fluctuates from pool to riffle. A large willow tree (*Salix* sp.) shades much of this reach, and discharge from the spring source is about 0.03 $m^3 \cdot s^{-1}$.

Cold and Lund Town springs are 2 systems from which *C. b. albivallis* has recently been extirpated. Cold Spring flows at 0.02 $m^3 \cdot s^{-1}$. Lund Town Spring, which flows at 0.15 $m^3 \cdot s^{-1}$, is the southernmost and coolest (18.9°C; Maxey and Eakin 1949) of the springs *C. b. albivallis* has been documented to inhabit. Except for Lund Town Spring, springs that support or have supported *C. b. albivallis* have water temperatures ranging from 21°C to 22°C.

Hubbs and Miller (1948) reported 4 native fish species from the White River system: *C. baileyi*, *Lepidomeda albivallis*, *Rhinichthys osculus*, and *Catostomus clarki*. In the White species (*C. b. albivallis* and *C.b. thermophilus;* Williams and Wilde 1981). *Crenichthys baileyi thermophilus* inhabits springs with water temperatures of approximately 33–37°C in the southern end of the White River, and *C. b. albivallis* inhabits springs of 21–22°C in the northern valley. There are no cohabiting native fish species with *C. b. thermophilis*, presumably because the water that it inhabits is too warm. When surveyed by Hubbs and Miller (1948), *C. b. albivallis* co-occurred with *L. albivallis, R. osculus,* and *C. clarki*. Now it co-occurs only with *R. osculus* (Preston Big, Indian, and Arnoldson springs). Several nonnative fishes have been introduced into the White River system, but only *Poecilia reticulata* (guppy) co-occurs with *C. b. albivallis* in Arnoldson and Nicholas springs (Scoppettone and Rissler unpublished). *Poecilia reticulata* also inhabits Lund Town and Cold springs, systems from

Materials and Methods

In summer 1998 we used mark and recapture and snorkel counts to estimate the extant populations of *C. b. albivallis,* and in winter 1999 only mark and recapture was used. The snorkel count method was used only in the outflow of Preston Big Spring. Because of sufficient cover, fish were difficult to enumerate and the method was abandoned during the winter sampling. Baited minnow traps lined with 1-mm-mesh screen were used for mark and recapture. We fished them overnight for 12–16 hours. Captured fish were measured, given an upper caudal fin clip, and released midway between traps. Traps were reset and fished overnight; marked and unmarked fish were enumerated. Using a modified Petersen estimator, we estimated population size, and 95% confidence intervals were calculated from the standard error of the estimate (Begon 1979). Summing the estimated population for each of the 4 springs gave us the total number of *C. b. albivallis,* while summing the variance of the estimated population of each of the 4 springs gave us the total variance. From these we calculated standard error and then 95% confidence interval (Bart et al. 1998).

The number of *R. osculus* and *P. reticulata* co-occurring with *C. b. albivallis* was not estimated because there were too few recaptures to establish confidence intervals. However, we noted whether they were abundant, common, or rare.

Sampling was conducted from 28 July to 12 August 1998 and from 5 to 12 January 1999. In the wider springhead region of Indian and Preston Big springs and the entire 10-m length of Nicholas Spring, we spaced minnow traps approximately 4 m apart in length and width. In the outflows of Indian, Preston Big, and Arnoldson springs, traps were set at 4-m intervals along the length. In summer 1998, using mask and snorkel, we counted fish in the 524-m-long outflow of Preston Big Spring; inasmuch as the upstream-most 64 m was a broad spring pool, mark and recapture was employed.

Lund Town Spring was sampled to further confirm *C. b. albivallis* extirpation from that system, but we were unable to contact the landowner to further confirm its extirpation from Cold Springs. Twenty minnow traps were set approximately equidistance apart around the Lund Town spring pool. Minnow traps were fished 28–31 July 1998 and checked at 8- to 10-hour intervals. Also, the spring pool and outflow were snorkeled on 31 July 1998.

Results

We estimated that <5000 *C. b. albivallis* exist in known habitats (Table 1). Indian Spring had the greatest number, followed by Preston Big, Arnoldson, and then Nicholas springs. There was not a substantial difference in abundance between summer and winter. There was a greater number of fish during the summer in Arnoldson, but more in winter in Indian and Nicholas. We could not contrast the difference in numbers between the 2 seasons for Preston Big Spring because of the different counting methods (snorkel and mark/recapture) used.

The range and mean size of fish were fairly consistent between seasons. Fish were generally smallest in Arnoldson Spring, with a mean

Table 1. *Crenichthys baileyi albivallis* population estimates in 4 White River valley spring systems. Confidence interval is 95%. Values in parentheses incorporate estimates from mark and recapture of Preston Big Spring pool and snorkel count of outflow.

Spring name	July–August 1998	Confidence interval	January 1999	Confidence interval
Nicholas Spring	91	±40	162	±52
Arnoldson Spring	1175	±99	901	±98
Preston Big Spring	1096[a] (1205)	±80	1668	±177
Indian Spring	1736	±73	2128	±107
Total	4098[b] (4207)	±152	4858	±235

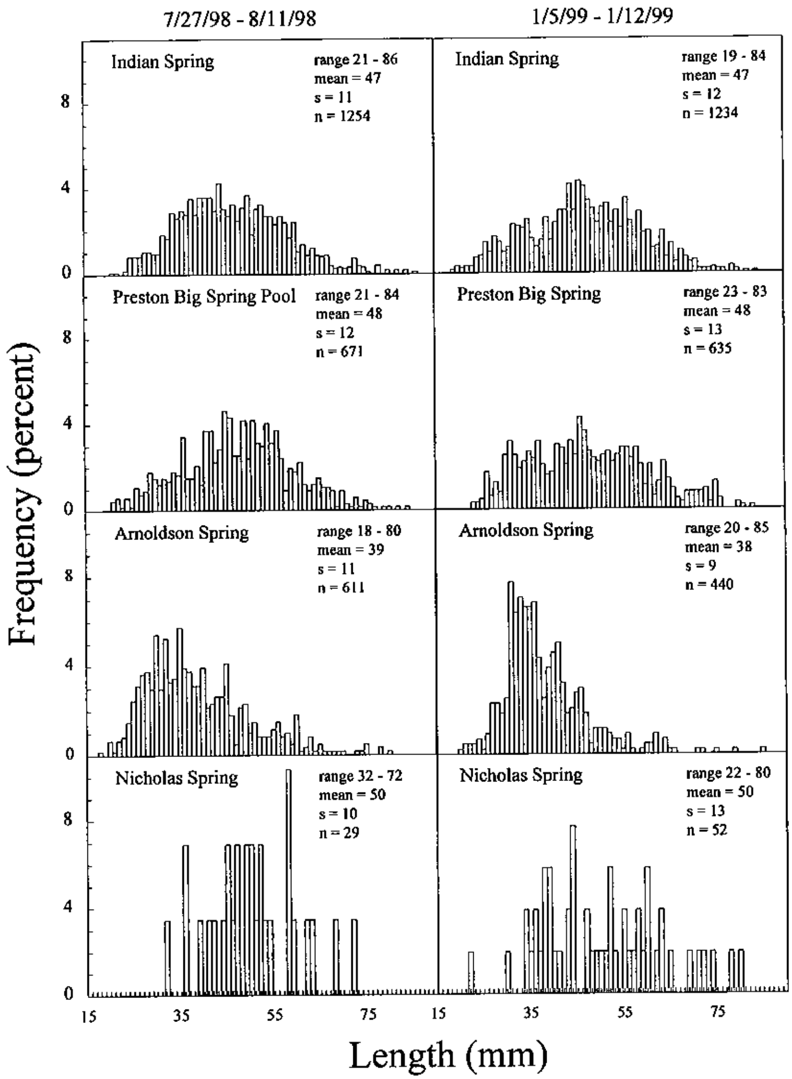

Fig. 2. Length frequency distribution of *Crenichthys bailyei albivallis* for summer 1998 and winter 1999 at 4 spring systems.

size of 39 mm FL in the summer and 38 mm FL in the winter (Fig. 2). Nicholas Spring had the largest mean size (50 mm FL in summer and winter) with few subadults (≤35 mm FL) captured. Range and mean size of fish were most similar for Indian and Preston Big springs.

No *C. b. albivallis* was captured or sighted in Lund Town Spring, but *Catostomus clarki* (desert sucker) was rare, *R. osculus* common, and *P. reticulata* abundant. *Rhinichthys osculus* was abundant in Preston Big Spring and Spring. *Poecilia reticulata* was abundant in Arnoldson and Nicholas springs.

Discussion

Crenichthys baileyi albivallis persisted in 4 spring systems, but it was not numerous in any one of them. This subspecies has been known to stay near spring sources where water temperatures remain nearly constant (Sumner and Sargent 1940, La Rivers 1962). The fact that *C. b. albivallis* persisted in the outflows of just prior to entering pipes suggests that water temperature was constant, but that useable habitat is currently less than historical conditions.

In Nicholas and Arnoldson springs, *C. b. albivallis* was subjected to habitat alteration and the nonnative *P. reticulata*. *Poecilia reticulata* is an effective larvae predator (Courtenay and Meffe 1989), and such larvorous species have been documented to replace natives (Meffe 1985).

The cause of extirpation of *C. b. albivallis* from Lund Town and Cold springs can only be speculated. Lund Town Spring is the coldest spring (18.9°C; Maxey and Eakin 1949) that *C. b. albivallis* is known to have inhabited, which may have contributed to the rarity noted by Williams and Wilde (1981) and Courtenay et al. (1985). Of the 5 subspecies, *C. b. albivallis* inhabits the coolest springs (21.0–22.0°C); the others inhabit warmer waters (26.0–37.0°C); Sumner and Sargent 1940, La Rivers 1962, Williams and Wilde 1981). The Lund Town Spring population was extirpated after the system was disconnected (outflow had been diverted into pipe) from other *C. b. albivallis* springs, possibly from chronic exposure to cooler water temperature (James Deacon, University of Nevada, Las Vegas, personal communication). *Crenichthys baileyi albivallis* was reportedly abundant in Cold Spring in 1979 (Williams and Wilde 1981), but by 1991 it had been reported extirpated (Scoppettone and Rissler unpublished), with only *P. reticulata* remaining. The spring system had been greatly altered with only 10 m of outflow remaining before entering a pipe.

Our winter 1999 estimate for the Preston outflow is probably more reliable than that from summer 1998. Data for the latter survey were gathered by snorkeling, and habitat complexity made it difficult to see the fish. Consequently, our snorkel counts were lower than numbers actually present. Because the Preston outflow consists primarily of fast water that *C. baileyi* generally avoids, we would not expect it to accommodate more adults than were present in the winter estimate (about 500 adults). The actual number of *C. b. albivallis* was probably similar for both seasons. Our reliable estimate (1668 ± 177) was close to Deacon et al.'s (1980) estimate (1674 ± 240), suggesting no decline in the Preston Big Spring population

Freshwater fish tend to scale in size to the water volume inhabited (Smith 1981). Preston Big and Indian springs had the greatest depth and breadth of the 4 remaining spring habitats, and *C. b. albivallis* individuals were generally longer than the fish in Arnoldson (Fig. 2). Although Nicholas Spring had a low water volume, its *C. b. albivallis* had the greatest mean size. The population was skewed toward large adults, indicating little recruitment. During the irrigation season the spring outflow is manipulated, changing habitat from a spring pool to a shallow stream, and this may lead to drying of eggs.

Survival of *C. b. albivallis* depends, at a minimum, on maintaining existing habitat, and conservation will require enhancing native fish habitats. Locally, this will require cooperation by management agencies, farmers, and the local irrigation district. For example, the excavated channel of Indian Spring is clogged with bulrush, causing water to overflow and the channel to lose its efficacy as a means of water conveyance. Conservation will require designing and improving a stream channel that will convey water for irrigation while protecting habitat for native fishes. This must be done by averting the need for intermittent channel dredging or resorting to piping the water. Habitat improvement should also be studied and implemented for Preston Big, Arnoldson, Nicholas, and Cold springs. Because springfish thrive in spring pools and slow water habitat (La Rivers 1962), especially those free of nonnative fishes, a proactive effort to improve and create this habitat type could lead to an increase in population range and abundance and thus secure the future of *C. b. albivallis*. The population should be monitored annually to gauge success.

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