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2017 Foskett Speckled Dace Investigations

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Photograph of minnow traps in the spring pool at Foskett Spring, Coleman Valley.

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Abstract— Foskett Speckled Dace *Rhinichthys osculus* are small minnows endemic to the Coleman Lake subbasin in southeastern Oregon. Foskett Speckled Dace was listed as threatened by the U.S. Fish and Wildlife Service in 1985 because of their limited range and threats to their habitat from cattle grazing. Over the past three decades, focused recovery actions have addressed the threats to Foskett Speckled Dace that were identified at the time of listing. Our 2017 study objectives were to: 1) obtain a population estimate of Foskett Speckled Dace in Foskett and Dace springs, 2) describe the habitat conditions at Foskett Spring to assess the effectiveness of habitat enhancement efforts, and 3) compare 2017 fish abundance and habitat conditions to those of previous years. We used a state-space model, which included fish length- and habitat-specific capture probabilities obtained from previous surveys, to estimate Foskett Speckled Dace abundance in Foskett and Dace springs. Foskett Speckled Dace abundance was 4,279 individuals in Foskett Spring in 2017. This was a significant increase from the 2016 abundance estimate of 1,830 fish, but was 51% less than the median abundance from 2012 – 2017. We observed a 62% decrease in open water habitat at Foskett Spring from 2013 – 2017. We observed a significant relationship between Foskett Speckled Dace abundance and open water habitat area at Foskett Spring from 2012 – 2017 ($F = 9.68$; df = 4,1; $P = 0.036$). We estimated 15,729 Foskett Speckled Dace at Dace Spring (introduction site), which was significantly greater than the 2016 estimate of 1,964 fish.

INTRODUCTION

Speckled Dace *Rhinichthys osculus* are geographically widespread throughout the western United States and in southeastern Oregon, and they occur in many isolated subbasins and interior drainages. The Foskett Speckled Dace *R. osculus* is represented by a naturally-occurring population that inhabits Foskett Spring and an introduced population that inhabits Dace Spring. Both springs are located on the west side of Coleman Lake in Lake County, Oregon (Figure 1). The Foskett Speckled Dace became isolated in Foskett Spring at the end of the most recent pluvial period (9,000 – 10,000 years ago). Foskett Spring is a natural spring that rises from a springhead pool, flows through a narrow spring brook into a series of shallow marshes, and then disappears into the soil of the normally dry Coleman Lake (Figure 1). Dace Spring consists of two ponds excavated in a shallow spring brook. Foskett Speckled Dace were listed as threatened under the federal Endangered Species Act (ESA) in 1985 because of their limited range and threats to their habitat from cattle grazing (U.S. Fish and Wildlife Service 1985).

The primary recovery objective for Foskett Speckled Dace is long-term persistence through preservation of its native ecosystem (U.S. Fish and Wildlife Service 1998). The recovery plan further states that the conservation and long-term sustainability of Foskett Speckled Dace will be met when: (1) long-term protection of its habitat, including spring source aquifers, spring pools and outflow channels, and surrounding lands is assured; (2) long-term habitat management guidelines are developed and implemented to ensure the continued persistence of important habitat features and guidelines will include monitoring of current habitat and investigation for and evaluation of new spring habitats; and (3) research into life-history, genetics, population trends, habitat use and preference, and other important parameters is conducted to assist in further developing or refining criteria (1) and (2), above. Actions needed to meet these criteria include protecting the fish population and

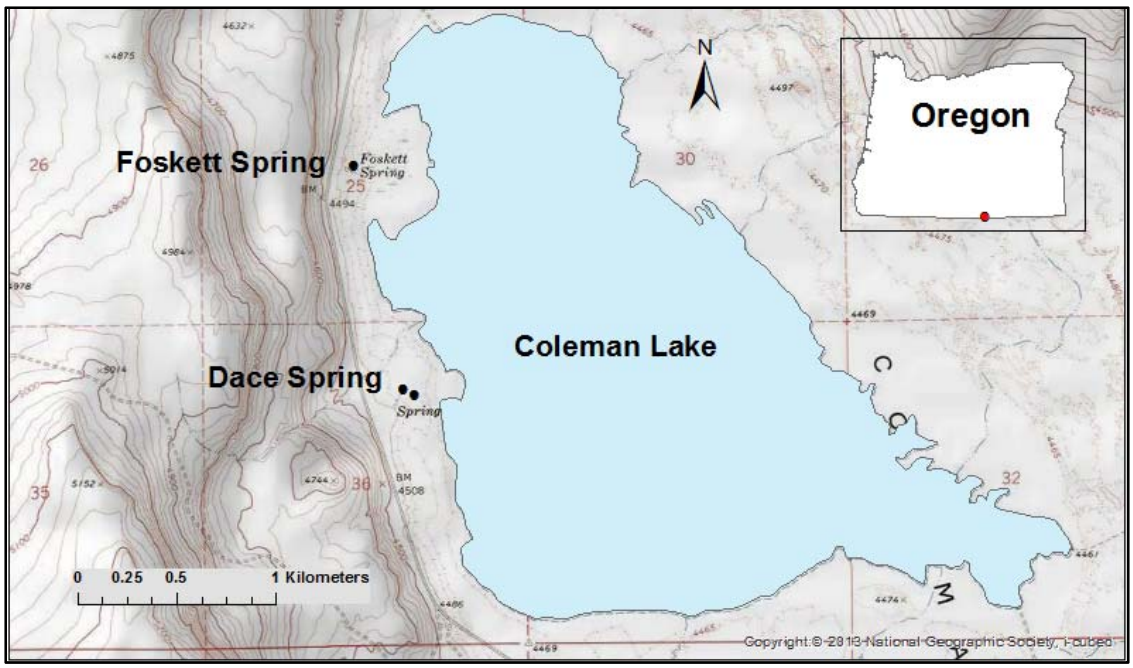

Figure 1. Map showing the locations of Foskett and Dace springs in the Coleman Lake subbasin in southeastern Oregon.

its habitat, conserving genetic diversity of the fish population, ensuring adequate water supplies are available, monitoring of the fish population and habitat conditions, and evaluating long-term effects of climatic trends on the health of this fish population.

Substantial progress has been made towards the conservation and long-term sustainability of Foskett Speckled Dace. In 1987, the Bureau of Land Management (BLM) acquired the 65 hectare parcel of land containing Foskett and Dace springs and fenced 28 hectares to exclude cattle from the springs. Currently, the BLM manages the lands surrounding the springs consistent with the Lakeview Resource Management Plan (Bureau of Land Management 2003), which identifies Foskett Speckled Dace as a Special Status Species to be managed in accordance with the Recovery Plan (U.S. Fish and Wildlife Service 1998). In 2012, the BLM conducted a controlled burn in the tule and cattail marshes to reduce the vegetative biomass and handed-excavated 11 pools in 2013 – 2014, which substantially increased the amount of open water habitat suitable for Foskett Speckled Dace (Scheerer et al. 2014).

In 2009, the BLM and the U.S. Fish and Wildlife Service (USFWS) completed a habitat enhancement project creating two spring-fed ponds at Dace Spring. A population of Foskett Speckled Dace in Dace Spring was initially established from an introduction of 100 fish from Foskett Spring in 1979 – 1980 (Williams et al. 1990); however, this population failed due to habitat loss (vegetative succession) and lack of successful recruitment. In 2010 – 2011, the Oregon Department of Fish and Wildlife (ODFW) introduced 124 Foskett Speckled Dace from Foskett Spring into these ponds; however, survival of these fish was low due to frequent prolonged algal blooms and resultant anoxic conditions (Scheerer et al. 2013). In 2013, the BLM excavated flow-through channels to improve water circulation in the Dace Spring ponds and observed

an immediate improvement in water clarity (algal bloom subsided) and water quality (Scheerer et al. 2013). In October 2013, the ODFW transferred an additional 200 Foskett Speckled Dace from Foskett Spring into the Dace Spring ponds (100 fish each).

ODFW monitored the Foskett Speckled Dace population and habitat at Foskett Spring in 1997, 2005, 2007, 2009, in Foskett and Dace springs from 2011 – 2016, and described a declining trend in open water habitat and Foskett Speckled Dace abundance at Foskett Spring from 1997 – 2012 (Dambacher et al. 1997; Scheerer et al. 2016). Following the BLM's recent habitat enhancement activities, the Foskett Speckled Dace population increased in abundance from 1,728 individuals in 2011 to 24,888 individuals in 2014 (Scheerer et al. 2014). Also during these surveys, we gained knowledge of several key demographic parameters. We documented annual recruitment (presence of young-of-the-year fish) and a broad size range; indicative of multiple age groups. In 2013, we noted that Foskett Speckled Dace spawning occurs, as evidenced by presence of larval fish, beginning in late-March and extends into July and that young-of-the-year fish were more common in the shallow marsh habitats (unpublished data). At Dace Springs, we documented individual recruits that grew to adult size and matured in a single year and gained insight into species longevity by noting individuals from 2010 – 2011 translocations that were present and alive in 2014 (4 – 5 years old).

Two genetics studies of Foskett Speckled Dace have been completed. Ardren et al. (2010) evaluated the taxonomic status of the Foskett Speckled Dace, which were considered a distinct subspecies at the time of the study. Speckled Dace from the Warner Basin, including those from Foskett Spring, were found to be closely related, but showed signs of recent isolation from each other. Levels of genetic divergence observed between Speckled Dace from Foskett Spring and other locations within the Warner Basin were in the range typically observed between populations belonging to the same species. Hoekzema and Sidlauskas (2012) conducted a more extensive geographic, taxonomic, and phylogenetic analysis of Speckled Dace from Foskett Spring and adjacent basins. Similar to Ardren et al. (2010), Hoekzema and Sidlauskas (2012) found that Foskett Speckled Dace were isolated relatively recently (10,000 years vs. millions of years) and they suggest that Foskett Speckled Dace do not constitute a distinct subspecies based on the phylogenetic species concept. Using microsatellite DNA loci, which evolve more quickly than mitochondrial genes, Hoekzema and Sidlauskas (2012) found no evidence for recent gene flow, that Foskett Speckled Dace is a genetically distinct population, and suggested, with support from morphological analysis, that Foskett Speckled Dace constitute a distinct Evolutionarily Significant Unit under the Endangered Species Act.

In 2015, the BLM, the ODFW, and the USFWS completed a Cooperative Management Plan for Foskett Speckled Dace to ensure the continued persistence of important habitat features in these spring areas including actions to: (1) protect and manage these habitats, (2) enhance the habitat, when appropriate, (3) monitor the Foskett Speckled Dace populations and habitats, (4) develop a regular maintenance schedule to increase and maintain suitable open water habitat, and (5) develop an emergency contingency plan to address potential threats from pollutants or the introduction of nonnative species (USFWS 2015a).

The status of ESA listed species is reviewed every five years. This process reviews available data gathered and activities undertaken since the time of listing to determine if recovery actions have progressed, and reviews any new information

regarding the status of the threats to the species and Recovery Plan criteria to make recommendations regarding potential changes to the species' listing status. The Foskett Speckled Dace 5-Year Review was completed in 2015, with a recommendation proposing the removal of the species from the ESA list of threatened and endangered species (U.S. Fish and Wildlife Service 2015b).

This report updates monitoring initiated by the ODFW in 2005 (Scheerer et al. 2016) by providing results of monitoring conducted in 2017. Our objectives were to: (1) obtain a population estimate of Foskett Speckled Dace in Foskett and Dace springs, (2) describe the habitat conditions at Foskett Spring to assess the effectiveness of habitat enhancement efforts, and (3) compare 2017 fish abundance and habitat conditions to those of previous years.

METHODS

We used baited minnow traps (1.6 mm mesh) to sample Foskett Speckled Dace over a three-day period from 12–14 June 2017. Minnow traps were distributed haphazardly throughout the spring pools (n = 6), spring brook (n = 11), and tule marsh (n = 11) at Foskett Spring, and in the two ponds (n = 9 traps per pond) and the spring brook (n = 3) at Dace Spring. We placed the same number of minnow traps at the same approximate locations in 2017 as we did in 2012 – 2016, except that no traps were set in the cattail marsh in 2017 (too shallow to trap).

At both springs, minnow traps were distributed on day one and left in place for 3 – 4 h. After 3 – 4 h, minnow traps were collected, the number of Foskett Speckled Dace in each size group (small < 35 mm total length (TL), medium 35 – 59 mm TL, and large ≥ 60 mm TL) was recorded, and fish were returned to the water near the location of capture. This procedure was repeated on day two.

We estimated the abundance of Foskett Speckled Dace using a state space model (Bolker 2008), which allowed us to vary capture probabilities for different sized fish and habitats. Here the capture of fish (c) was assumed to follow a binomial distribution:

$$c_{i,j,k} \sim bin\left(\hat{p}_{i,j,k}, \widehat{N}_{i,j}\right),$$

where c is the number of fish captured, $\hat{p}$ is the estimated capture probability, and $\widehat{N}$ is the estimated abundance for size class i in habitat j on sampling occasion k. Capture probabilities were estimated using the best approximating Huggins capture-recapture models from Scheerer et al. (2012; 2013), which allowed us to reduce fish handling to two sampling occasions in 2017 compared to the three or four sampling occasions used in 2012 and 2013, and required no marking of the fish. Variability in the estimated capture probabilities was incorporated using a beta distribution with parameters that corresponded to the mean estimated capture probability and associated standard errors. The state space model was fit using Markov Chain Monte Carlo as implemented in WinBUGS software, version 1.4 (Lunn et al., 2000) with 10,000 iterations, 20,000 burn in and diffuse priors. These values were determined by fitting the model with 10,000 iterations and evaluating the output with the Raftery and Lewis (1995) diagnostic, as implemented in the R package Coda (Plummer et al. 2006). We estimated abundance

separately for the spring pool, spring brook, and tule marsh using the estimated capture probabilities for each location and fish size group, and we estimated abundance for all Foskett Spring habitats combined. We calculated 95% confidence intervals according to Chao (1987) for all abundance estimates.

We measured the open water habitat area and average depth at Foskett Spring in 2017 along previously established transects (*n*=17), which crossed each hand-excavated pool. Additional open water habitat area in the spring brook and tule marsh was estimated by multiplying the length of each habitat (less the length of the excavated pool) by the mean width, which was obtained from transects (*n*=2 each) in the channel portion of these habitats. Habitat was considered open water if the water depth exceeded 0.025 m, regardless of the density of macrophytes. We examined the relationship between open water habitat area and Foskett Speckled Dace abundance using linear regression.

RESULTS

In Foskett Spring, we estimated the Foskett Speckled Dace abundance at 4,279 fish (95% CI: 3,878 – 4,782), which was significantly higher than the 2016 estimate of 1,830 fish (95% CI: 1,694 – 2,144) (Table 1; Figure 2). However, the 2017 abundance estimate was 67% lower than the median (*n*=13,142) for the previous five years. Note, in 2012 we changed our abundance estimator from a Lincoln-Petersen estimator to a Huggins closed-capture estimator. Prior to 2012, abundance was underestimated and thus is not directly comparable to abundance estimated since 2012 (Scheerer et al. 2012). In 2017, we noted significant increases in fish abundance in the spring pool and tule marsh (Table 1). The abundance of small-sized fish increased significantly from 375 fish (95% CI: 272 – 650) in 2016 to 2,102 fish (95% CI; 1,712 – 2,598) in 2017. The 2017 abundance of medium-sized (1,941; 95% CI: 1,841 – 2,043) and large-sized fish (235; 95% CI: 208 – 267) was not significantly different from 2016 estimates (1,307; 95% CI: 1,249 – 2,326 and 148; 95% CI: 135 – 296, respectively).

Table 1. Estimates of Foskett Speckled Dace abundance by habitat type, 2012 – 2017. Numbers in parentheses are 95% confidence intervals. Sampling was not conducted in the cattail marsh in 2012 or 2017 (N/A).

Location	2012	2013	2014	2015	2016	2017
Spring pool	633 (509-912)	2,579 (1,985-3,340)	2,843 (2,010-3,243)	698 (520-954)	138 (122-226)	925 (781-1,117)
Spring brook	589 (498-1024)	638 (566-747)	7,514 (2,422-13,892)	11,941 (5,465-15,632)	656 (609-1,240)	1,032 (933-1,154)
Tule marsh	625 (442-933)	6,891 (5,845-8,302)	11,594 (7,891-12,682)	3,662 (2,158-6,565)	1,021 (926-1,245)	2,322 (1,964-2,789)
Cattail marsh	N/A	3,033 (2,500-3,777)	2,935 (1,175-7,002)	38 (8-111)	14 (12-19)	N/A
Entire site	1,848 (1,489-2,503)	13,142 (10,665-16,616)	24,888 (19,250-31,510)	16,340 (10,980-21,577)	1,830 (1,694-2,144)	4,279 (3,878-4,782)

Since 2014, we have observed a substantial reduction in open water habitat at Foskett Spring (Figure 3; Table 2), which may have reduced the carrying capacity for Foskett Speckled Dace. We observed a 62% decrease in open water habitat at Foskett Spring from 2013 to 2017 and an 11% from 2016 to 2017. We observed a significant relationship between Foskett Speckled Dace abundance and open water habitat area at Foskett Spring from 2012 through 2017 ($F = 9.68$; df = 4,1; $P = 0.036$) (Figure 4).

In Dace Spring, we estimated the Foskett Speckled Dace abundance at 15,729 fish (95% CI: 12,259 – 58,479), which was significantly larger than the 2016 estimate of 1,964 fish (95% CI: 1,333 – 4,256). The broad confidence limits on this estimate are due to high variability of the capture probability for small-sized fish. The total number of small-, medium-, and large-sized fish was 14,037 (95% CI; 1,782 – 72,505), 1,547 (95% CI: 1,467 – 1,641) and 145 (95% CI: 139 – 154); respectively.

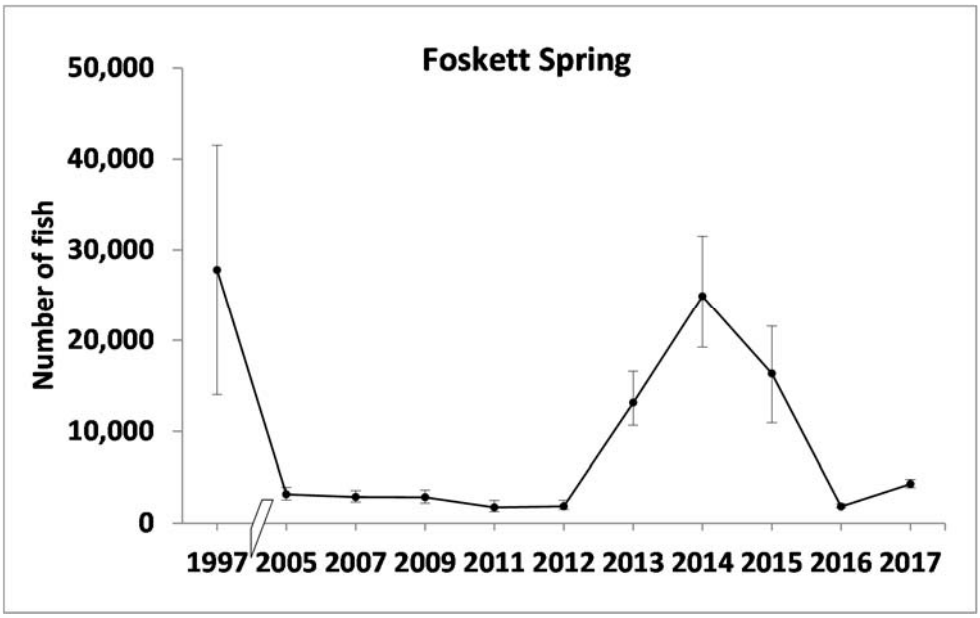

Figure 2. Population abundance estimates for Foskett Speckled Dace at Foskett Spring, 1997 – 2017. Vertical bars represent 95% confidence intervals for each estimate.

Table 2. Wetted and open water habitat area (m^2) by habitat type at Foskett Spring, 2012 – 2017.

		Wetted	Open water area (m^2)					
Habitat type	Length (m)	area (m^2)	2012	2013	2014	2015	2016	2017
Spring pool	4.7	57	4	4	21	19	4	6
Spring brook	71.0	74	25	31	68	71	61	40
Tule marsh	98.3	2,022	43	86	88	55	48	59
Cattail marsh	96.0	2,013	35	181	93	74	17	10
total	270.0	4,166	107	301	271	219	130	116

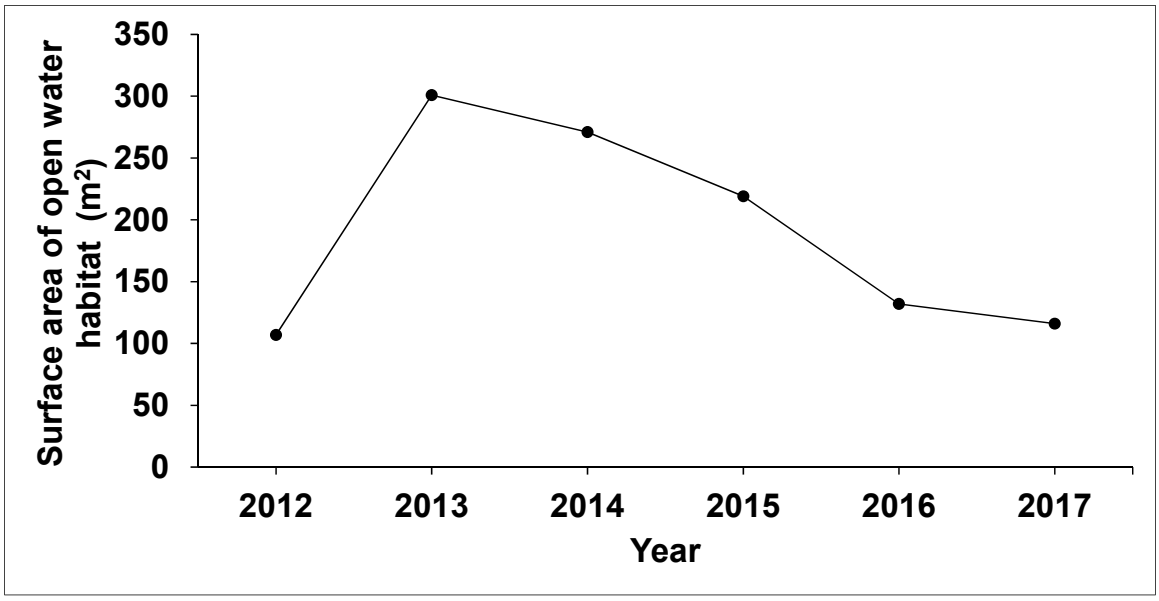

Figure 3. Surface area (m^2) of open water habitat at Foskett Spring, 2012 – 2017.

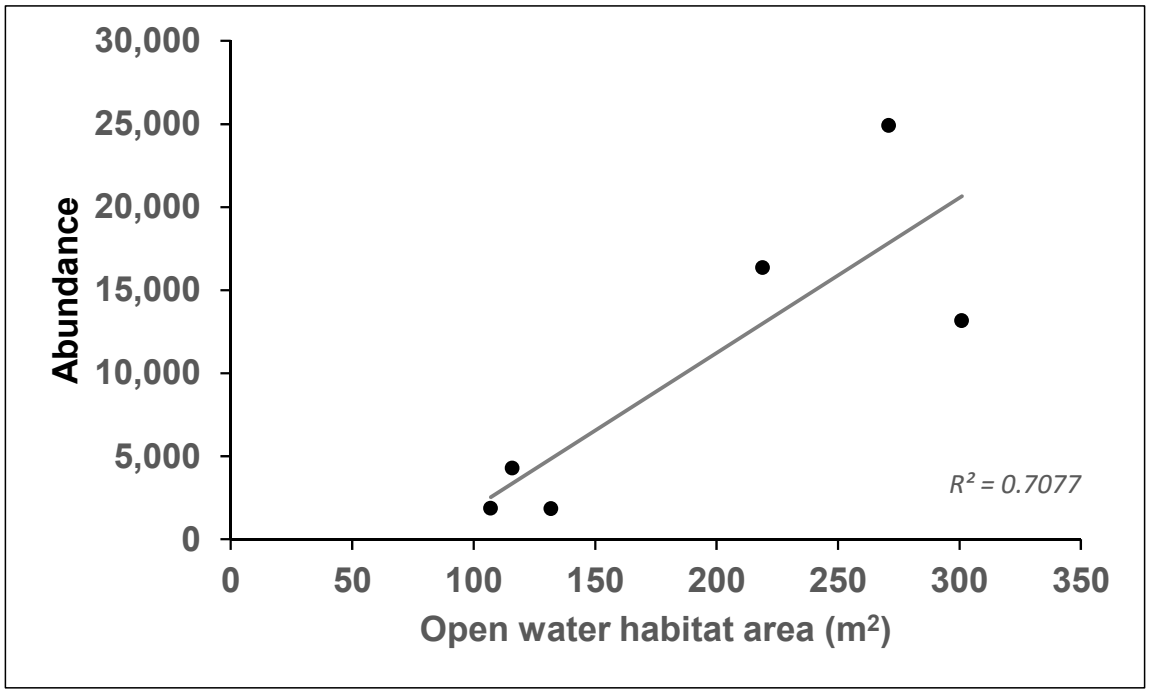

Figure 4. The relationship between Foskett Speckled Dace abundance and open water habitat area at Foskett Spring, 2012 – 2017.

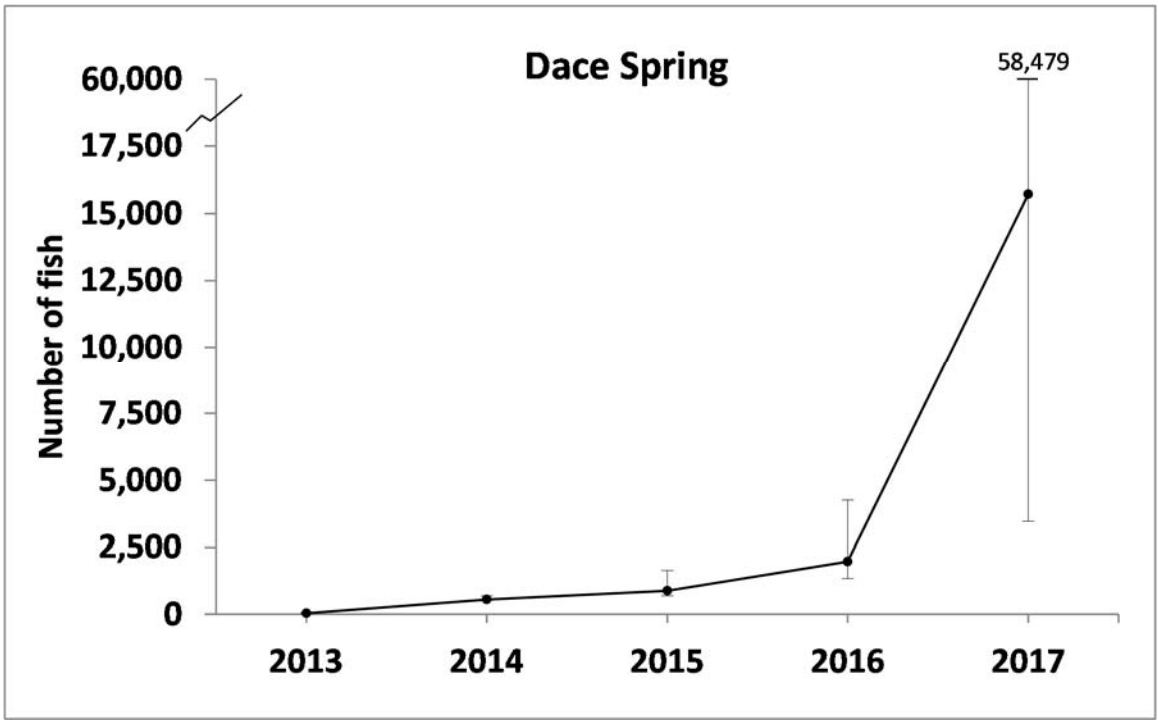

Figure 5. Population abundance estimates for Foskett Speckled Dace at Dace Spring, 2013 – 2017. Vertical bars represent 95% confidence intervals for each estimate.

DISCUSSION

ODFW's Native Fish Investigations Program has been monitoring the status of the federally listed Foskett Speckled Dace and its habitat since 2005. The abundance of Foskett Speckled Dace declined substantially from 1997 through 2012 (Dambacher et al. 1997; Scheerer et al. 2012). Encroachment by aquatic macrophytes since the habitat was fenced by the BLM in 1987 substantially reduced the open water habitat, with a subsequent decline in the Foskett Speckled Dace population. This is common in desert spring ecosystems. When springs are fenced and livestock is removed, these ecosystems often experience increases in aquatic vegetation, reduction of open water habitat, and reduction of fish populations (Kodric-Brown and Brown 2007).

The USFWS completed the Foskett Speckled Dace Five-Year Review in 2009 (U.S. Fish and Wildlife Service 2009) and specifically recommended: 1) assessing encroachment by aquatic vegetation at Foskett Spring, 2) developing a restoration plan and regular maintenance schedule to increase and maintain suitable open water habitat, 3) assessing the restoration potential at Dace Spring, and 4) evaluating the feasibility of a Foskett Speckled Dace transplant effort (U.S. Fish and Wildlife Service 2009).

To address the encroachment by aquatic vegetation at Foskett Spring, the BLM implemented a controlled burn in 2013 in the tule and cattail marshes at Foskett Spring to reduce the biomass of aquatic vegetation. Controlled burns can be an effective management tool to reduce vegetative biomass, maintain open water, and increase

plant diversity in desert spring habitats (Kodric-Brown et al. 2007). In 2013 and 2014, the BLM hand-excavated 11 pools and increased the open water habitat by 164 m^2 (>150%) (Scheerer et al. 2014). The response of Foskett Speckled Dace to this habitat enhancement was substantial. In 2014, we estimated there were 24,888 Foskett Speckled Dace at Foskett Spring, with the majority of these (*n*=22,043) in the maintained spring brook, tule marsh, and cattail marsh. However, we have observed a reduction of open water habitat since 2013 and a concomitant reduction in Foskett Speckled Dace abundance. Due to the substantial effort needed to maintain open water habitat by hand, the BLM used a mechanical excavator to deepen the open water pools and channels in 2017.

ACKNOWLEDGEMENTS

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