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2016 Foskett Speckled Dace Investigations

ANNUAL PROGRESS REPORT

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Photograph of a pool in the lower spring brook at Foskett Spring.

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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 endangered 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 2016 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 2016 fish abundance and habitat conditions to those of previous years. We used a Huggins closed-capture model to estimate Foskett Speckled Dace abundance in Foskett Spring, which allowed us to vary capture probabilities for different fish sizes and habitats. We used a state-space model to estimate Foskett Speckled Dace abundance in Dace Spring. Foskett Speckled Dace abundance was 1,830 individuals in Foskett Spring during 2016, has declined steadily since 2014, and was 88% less than the median abundance from 2012 – 2015. We observed a 57% decrease in open water habitat at Foskett Spring from 2013 – 2016, which may be related to the observed decrease in Foskett Speckled Dace abundance. We found a strong, but not significant relationship between Foskett Speckled Dace abundance and open water habitat area at Foskett Spring from 2012 – 2016. We estimated 1,964 Foskett Speckled Dace at Dace Spring, which was larger than, but not significantly different from the 2015 estimate of 876 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 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 this species 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 this species 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

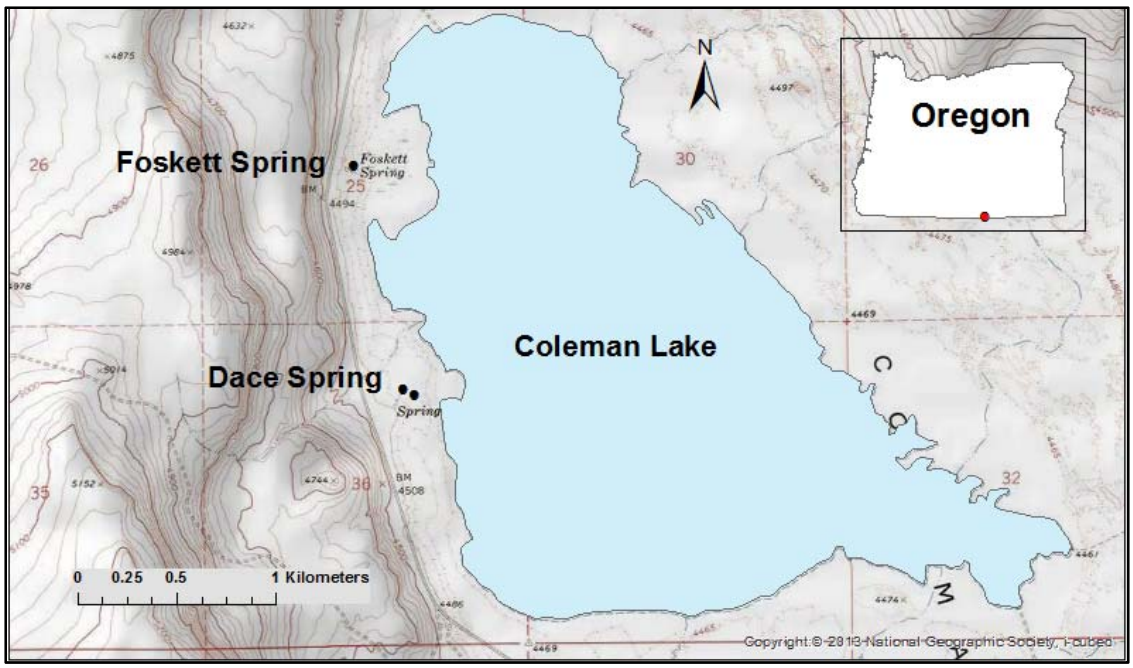

Figure 1. Map showing the locations of Foskett and Dace springs in the Coleman Lake subbasin in southeastern Oregon.

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 in 2013 – 2014, they hand excavated 11 pools, 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).

The ODFW monitored the Foskett Speckled Dace population and habitat at Foskett Spring in 1997, 2005, 2007, 2009, in Foskett and Dace springs from 2011 – 2015, 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. 2015). Following the BLM's recent habitat enhancement activities, the Foskett Speckled Dace population responded, increasing 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 were recently completed. Ardren et al. (2010) questioned 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. This study was followed by a more extensive geographic, taxonomic, and phylogenetic analysis of Speckled Dace from Foskett Spring and adjacent basins (Hoekzema and Sidlauskas 2012). Their findings confirmed the conclusion of Ardren et al. (2010) that Foskett Speckled Dace were isolated relatively recently (10,000 years vs. millions of years) and suggested that Foskett Speckled Dace do not constitute a distinct subspecies under a phylogenetic species concept. Using microsatellites, which evolve more quickly than mitochondrial genes, they found evidence for no 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 (ESA) (Hoekzema and Sidlauskis 2014).

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 to remove 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. 2015) by providing results of monitoring conducted in 2016. 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 2016 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 27 through 29 June 2016. Minnow traps were distributed haphazardly throughout the spring pools (n = 6), spring brook (n = 11), tule marsh (n = 11), and cattail marsh (n = 4) 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 2016 as we did in 2012 – 2015.

At Foskett Spring, minnow traps were distributed on day one and left in place for 3 – 4 h. After 3 – 4 hours, minnow traps were collected and captured Foskett Speckled Dace were marked with a partial upper caudal fin clip, the number of individuals per size group was recorded (small < 35 mm total length (TL), medium 35 – 59 mm TL, and large ≥ 60 mm TL), and Foskett Speckled Dace were returned to the water near the location of capture. This procedure was repeated on day two with the exceptions that: 1) we noted whether Foskett Speckled Dace had been previously captured on day one based on the presence of an upper caudal fin clip, and 2) we marked all fish with a partial lower caudal fin clip. On day three, minnow traps were distributed and left in place for 3 – 4 h. After 3 – 4 hours, minnow traps were collected, the number of Foskett Speckled Dace per size group was recorded, capture histories for individuals were noted based on caudal fin clip pattern (see Appendix A), and Foskett Speckled Dace were returned to the water.

We used capture history data to estimate abundance using the Huggins closed-capture model. For this model we used the program MARK (White and Burnham 1999) with three consecutive encounter occasions and three fish size groups. This model requires a minimum of three sampling occasions to estimate capture and recapture probabilities, and can include covariates that may affect capture probabilities (e.g., fish size and habitat characteristics) (Peterson and Paukert 2009). For the Huggins model, abundance ($\widehat{N}$) is derived using the following formula:

$$\widehat{N} = M_t / (1 - [(1-p_1)(1-p_2)(1-p_3)]),$$

where M_t is the total number of marks in the populations, p_1 is the probability of capture for occasion one, p_2 is the probability of capture for occasion two, and p_3 is the probability of capture for occasion 3.

We estimated abundance separately for the spring pool, spring brook, tule marsh, and cattail 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.

At Dace Spring, 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 per size group 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 at Dace Spring 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 2016 compared to the three or four sampling occasions used in 2012 – 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 calculated 95% confidence intervals for the estimates according to Chao (1987).

We measured the open water habitat area and average depth at Foskett Spring in 2016. We examined the relationship between open water habitat area and Foskett Speckled Dace abundance using linear regression. Note, the pools in the tule marsh were re-excavated by hand in April 2016; however, substantial regrowth of vegetation occurred during the 2.5 months prior to our late-June sampling visit.

RESULTS

In Foskett Spring, we estimated the Foskett Speckled Dace abundance at 1,830 fish (95% CI: 1,694 – 2,144). Foskett Speckled Dace abundance has declined steadily since 2014 (Figure 2). The 2016 abundance estimate was 88% lower than the median (n=14,741) for the previous four 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 2016, we noted significant declines in fish abundance in the spring pool, spring brook, and tule marsh (Table 1). In 2015, we noted large numbers of young-of-the-year fish at Foskett Spring, but saw little evidence of successful recruitment of small-sized fish in 2016. The abundance of small-

Table 1. Estimates of Foskett Speckled Dace abundance by habitat type, 2012 – 2016. Numbers in parentheses are 95% confidence intervals.

Location	2012	2013	2014	2015	2016
Spring pool	633 (509-912)	2,579 (1,985-3,340)	2,843 (2,010-3,243)	698 (520-954)	138 (122-226)
Spring brook	589 (498-1024)	638 (566-747)	7,514 (2,422-13,892)	11,941 (5,465-15,632)	656 (609-1,240)
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)
Cattail marsh	0	3,033 (2,500-3,777)	2,935 (1,175-7,002)	38 (8-111)	14 (12-19)
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)

sized fish declined by 92% from 2015 to 2016. However, we also noted similarly large reductions in the abundance of medium and large-sized fish (88% and 74%, respectively), which suggests that factors affecting recruitment may have also affected survival.

Since 2014, we have seen a substantial reduction in open water habitat at Foskett Spring (Figure 3; Appendix B), which may have reduced this habitat's carrying capacity for Foskett Speckled Dace. There is a strong, but not significant relationship between Foskett Speckled Dace abundance and open water habitat area at Foskett Spring ($F = 6.30$; df = 3,1; $P = 0.087$), 2012 – 2016 (Figure 4).

In Dace Spring, we estimated the Foskett Speckled Dace abundance at 1,964 fish (95% CI: 1,333 – 4,256), which was greater than, but not significantly different from the 2015 estimate of 876 fish (95% CI: 692 – 1,637) (Figure 5). This introduced population has increased substantially in abundance (~10 fold) since 2013.

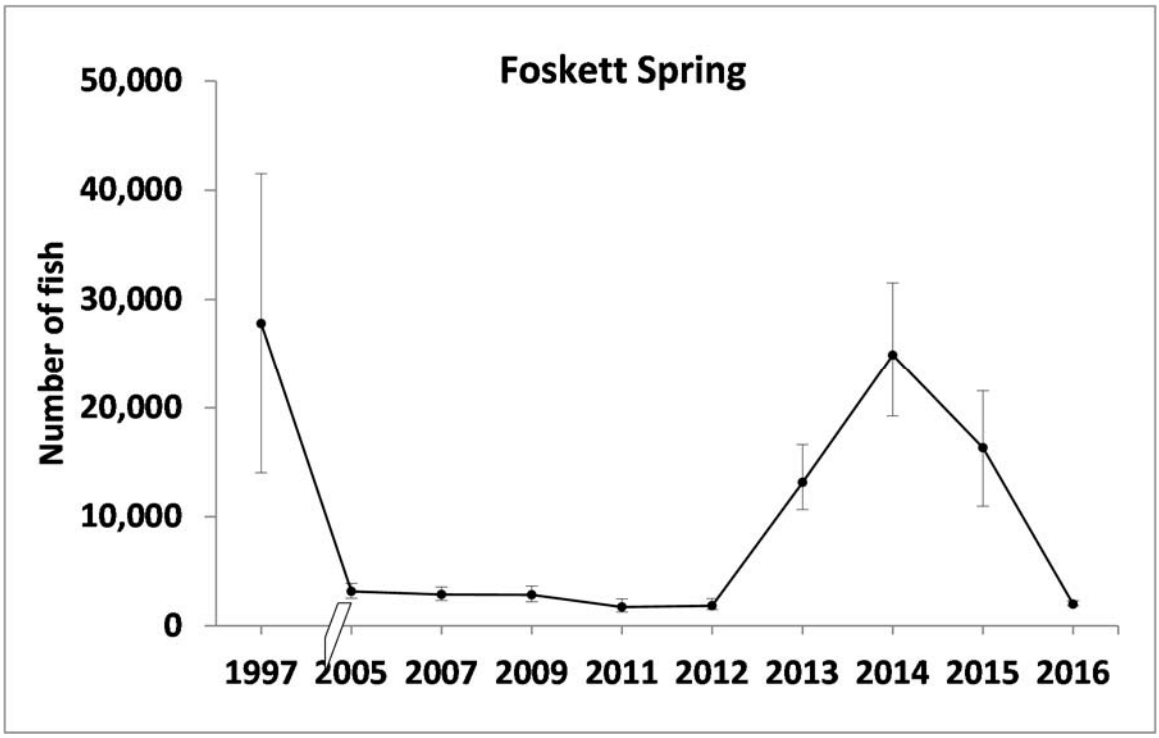

Figure 2. Population abundance estimates for Foskett Speckled Dace at Foskett Spring, 1997 – 2016. Vertical bars represent 95% confidence intervals for each estimate.

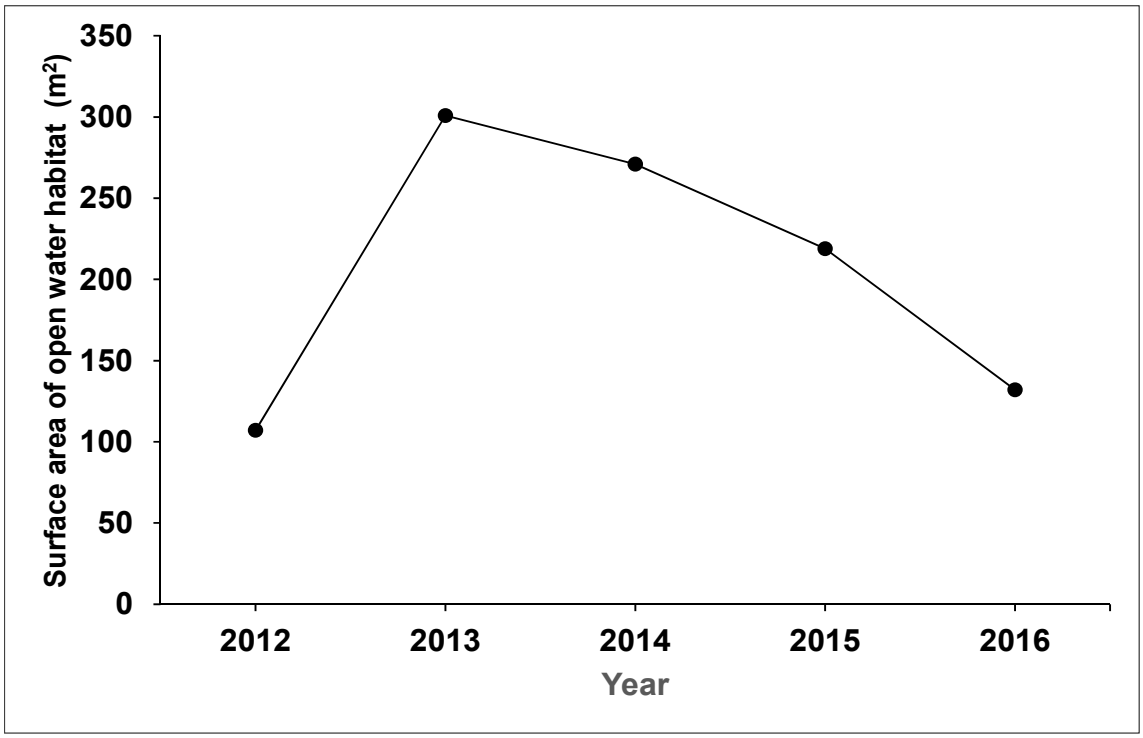

Figure 3. Surface area (m^2) of open water habitat at Foskett Spring, 2012 – 2016.

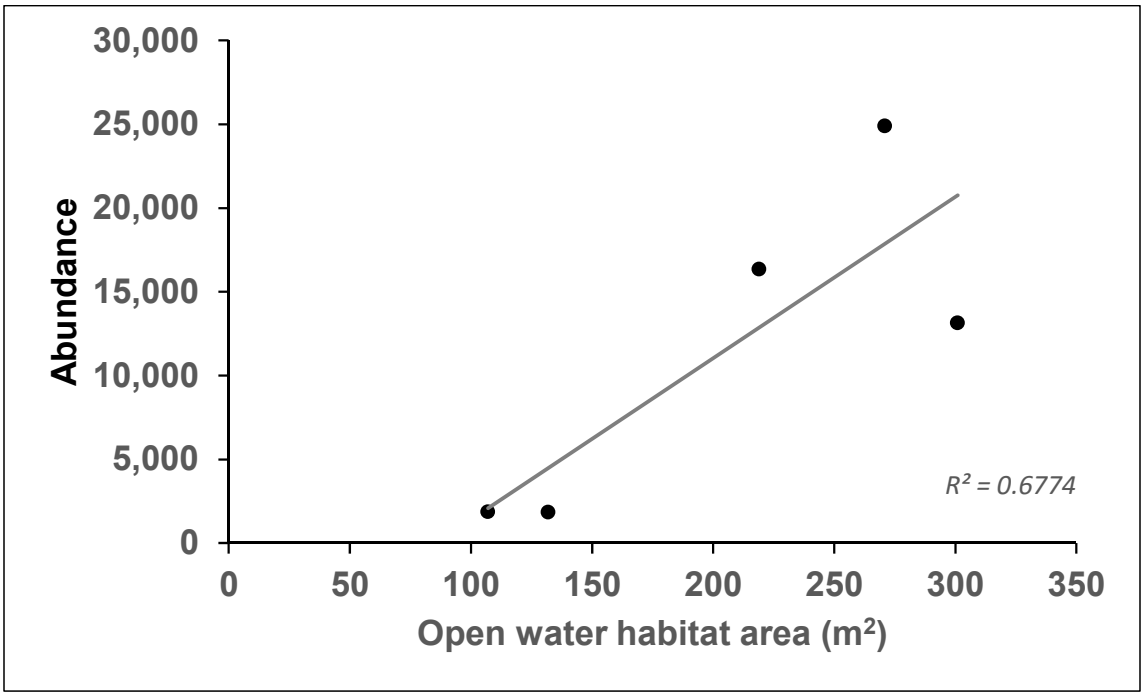

Figure 4. The relationship between Foskett Speckled Dace abundance and open water habitat area at Foskett Spring, 2012 – 2016.

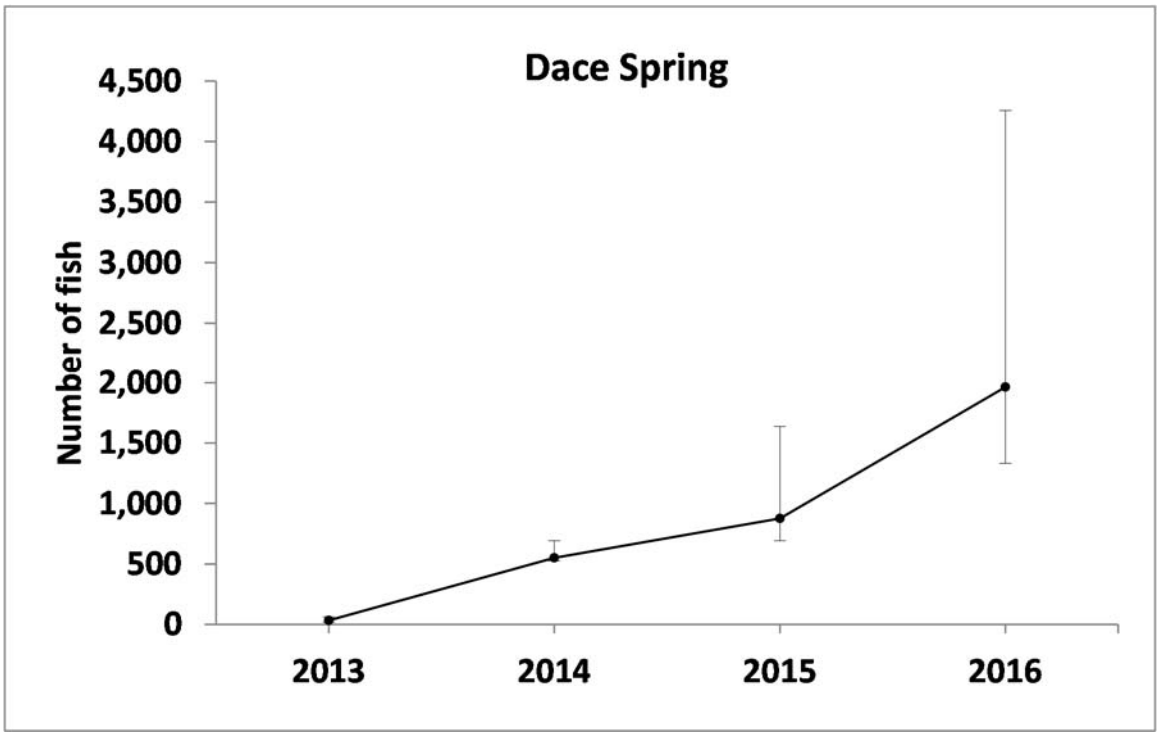

Figure 5. Population abundance estimates for Foskett Speckled Dace at Dace Spring, 2013 – 2016. Vertical bars represent 95% confidence intervals for each estimate.

DISCUSSION

The 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 plans to use a mechanical excavator to deepen the open water pools in 2017.

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Appendix A. Capture histories for Foskett Speckled Dace in Foskett Spring, 2016. Capture histories are expressed as a series of ones (captured on the sampling occasion) and zeros (not captured on the sampling occasion). UC=upper caudal fin clip (day 1), LC=lower caudal fin clip (day 2), and UC/LC=both fin clips.

Location/ history	Description	Small (<35 mm)	Medium (35-59 mm)	Large (>59 mm)
Spring pool				
100	UC not captured again	2	18	1
110	UC/LC not captured on day 3	1	15	3
101	UC captured on day 3, not day 2	2	16	1
111	UC/LC captured on day 3	0	6	0
001	unmarked fish captured on day 3 only	8	20	1
011	LC captured on day 3	1	5	0
010	LC not captured on day 3	2	11	5
Spring brook				
100	UC not captured again	15	152	13
110	UC/LC not captured on day 3	9	71	3
101	UC captured on day 3, not day 2	4	92	7
111	UC/LC captured on day 3	1	59	0
001	unmarked fish captured on day 3 only	12	47	3
011	LC captured on day 3	0	33	0
010	LC not captured on day 3	13	67	4
Tule marsh				
100	UC not captured again	18	165	46
110	UC/LC not captured on day 3	3	118	15
101	UC captured on day 3, not day 2	5	120	14
111	UC/LC captured on day 3	0	24	0
001	unmarked fish captured on day 3 only	74	51	4
011	LC captured on day 3	4	15	0
010	LC not captured on day 3	27	140	14
Cattail marsh				
100	UC not captured again	3	0	0
110	UC/LC not captured on day 3	0	0	0
101	UC captured on day 3, not day 2	0	0	0
111	UC/LC captured on day 3	0	0	0
001	unmarked fish captured on day 3 only	1	0	0
011	LC captured on day 3	0	0	0
010	LC not captured on day 3	5	0	0

Appendix B. Wetted and open water habitat area (m^2) by habitat type at Foskett Spring, 2012 – 2016.

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

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