ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT
OREGON

PROJECT TITLE: 2014 Foskett Speckled Dace Investigations

PROJECT NUMBERS: USFWS contract F13AC00622 and BLM L12AC20619

PROJECT PERIOD: 01 January 2014 - 31 December 2014

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

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INTRODUCTION

Speckled dace (*Rhinichthys osculus*) are geographically widespread throughout the western United States and occur in many isolated subbasins and interior drainages in south-central Oregon. The Foskett speckled dace (*R. osculus* ssp.) is an evolutionary significant unit (ESU) of speckled dace that is represented by a naturally-occurring population that inhabits Foskett Spring and an introduced population that inhabits Dace Spring, both 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 Pluvial period (9,000-10,000 years ago). Foskett speckled dace was listed as threatened under the federal Endangered Species Act in 1985 (U.S. Fish and Wildlife Service 1985). 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 pools excavated in a shallow spring brook.

The primary recovery objective for this species is long-term persistence through preservation of its native ecosystem (U.S. Fish and Wildlife Service 1997). 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 its habitat, conserving genetic diversity of the fish population, ensuring adequate water supplies are available, monitoring of the dace population and habitat conditions, and evaluating long-term effects of climatic trends on the health of this fish population.

These objectives have largely been met since the time of listing. Substantial progress has been made towards the conservation and long term sustainability of this species. In 1987, the 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 (RMP) (BLM 2003), which identifies Foskett speckled dace as a Special Status Species to be managed in accordance with the Recovery Plan.

In 2012-2014, BLM conducted a controlled burn in the tule and cattail marshes to reduce the vegetative biomass and hand excavated 11 pools, substantially increasing the amount of open water habitat suitable for Foskett speckled dace (Scheerer et al. 2013; this study).

In 2009, the BLM and the U.S. Fish and Wildlife Service (USFWS) completed a habitat enhancement project creating two spring-fed pools at Dace Spring. The population 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, Oregon Department of Fish and Wildlife (ODFW) introduced 124 dace from Foskett Springs into these ponds; however survival of these fish was low, due to frequent prolonged algal blooms and resultant anoxic conditions (Scheerer et al. 2012; 2013). In September 2013, BLM excavated flow-through channels to improve water circulation in the Dace Spring ponds and saw immediate improvement in water clarity (algal bloom subsided) and water quality (dissolved oxygen increased from 0.1 ppm to over 4.0 ppm) (Scheerer et al. 2013). In October 2013, ODFW transferred an additional 200 speckled dace from Foskett Spring into the Dace Spring ponds (100 fish ea.).

ODFW monitored the dace population and habitat at Foskett Spring in 1997, 2005, 2007, 2009, and in both springs from 2011-2014 and described a declining trend in open water habitat and dace abundance at Foskett Spring from 1997 through 2012 (Dambacher et al. 1997; Scheerer and Jacobs 2005; 2007; 2009; Scheerer 2011; Scheerer et al. 2012; 2013). Following BLM's recent habitat restoration activities, the dace population responded, increasing in abundance from approximately 1,800 individuals in 2011 to more than 13,000 individuals in 2013 (Scheerer et al. 2013). Also during these surveys, ODFW gained knowledge of several key demographic parameters. We documented annual recruitment (presence of young-of-the-year dace) and a broad size (presumptive age) structure. In 2013, we noted that dace spawning occurs, as evidenced by presence of larval dace, beginning in early spring (March-April) and extending into July and that young-of-the-year dace were more common in the shallow marsh habitats (unpublished data). At Dace Springs, we documented individuals/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 2013 (3-4 years old).

In addition, two genetics studies were recently completed. Ardren et al.'s (2010) genetic analysis called into question the taxonomic status of the subspecies. 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 dace from Foskett Spring, compared to other dace from the Warner Basin, were in the range typically observed between populations belonging to the same species. This study was followed up 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 Spring dace were isolated relatively recently (10,000 years vs. millions of years) and suggest that Foskett Spring 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 Spring is a genetically distinct population, and suggest, with support from their morphological analysis, that Foskett Spring dace constitute a distinct ESU and warrant continued Endangered Species Act (ESA) protection (Hoekzema and Sidlauskis 2014).

In 2014, the Bureau of Land Management (BLM), Oregon Department of Fish and Wildlife (ODFW), and the US Fish and Wildlife Service (USFWS) developed a draft 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 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. The agencies involved all have shown support for the plan and the plan should be finalized (signed) in 2015.

The status of ESA listed species is reviewed every 5 years. The Foskett Speckled Dace 5-Year Review was initialized in 2014. 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. ODFW provided comments during this process, concluding that the recovery criteria have essentially been met and recommending the Service consider delisting of this ESU.

This report updates monitoring initiated by ODFW in 2005 (Scheerer and Jacobs 2005; 2007; 2009; Scheerer 2011; Scheerer et al. 2012; 2013) by providing results of monitoring conducted in 2014. Our objectives were to: 1) estimate the abundance of the federally listed Foskett speckled dace, and 2) document the habitat conditions at Foskett and Dace Springs to assess the effectiveness of the restoration efforts.

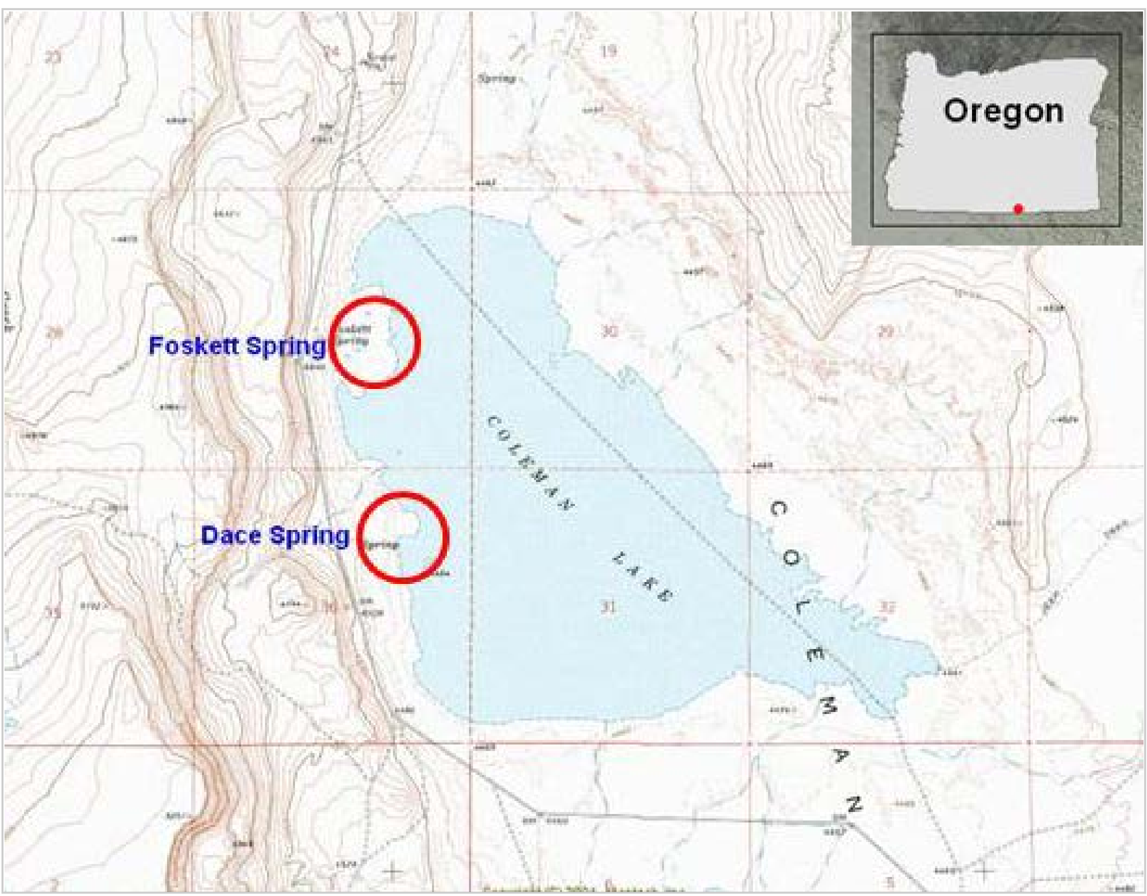

Figure 1. Map showing the locations of Foskett and Dace Springs in the Warner Valley of southeastern Oregon.

METHODS

We used baited minnow traps (1/16" mesh) to obtain mark-recapture population estimates of Foskett speckled dace at Foskett and Dace Springs from 3-5 June 2014. On Day 1, we distributed the traps haphazardly throughout the spring pool (n=6), spring brook (n=11), tule marsh (n=11), and cattail marsh (n=4) at Foskett Spring and in the two pools (9 traps ea.) and spring brook (3 traps) at Dace Spring and left them in place for 3-4 h.

At Foskett Spring, we marked all fish that we captured in the spring brook with a partial upper caudal fin clip and recorded the number of fish in each of three size categories (small <35 mm TL, medium 35-59 mm TL, and large $\geq$60 mm TL). After we marked the fish, we returned them to the water near the location of capture. The following morning (day 2), we set the traps at approximately the same locations, left them in place for 3-4 h to capture fish, recovered the traps, recorded the number of marked and unmarked fish in each size category, marked all fish with a partial lower caudal fin clip, and released them near the location of capture. On day 3, we pulled the traps, and recorded the total number of unmarked and marked fish (upper caudal, lower caudal, and both) in each size category. At Dace Spring, we followed the same procedure as described above. In the spring pool and marsh habitats of Foskett Spring, we only recorded the number of fish in each of three size categories (no marking) and trapped on two occasions (days 1 and 2).

Using the capture-recapture data, we estimated abundance at the spring brook habitat at Foskett Springs and Dace Spring using the Huggins closed-capture model in program MARK (White and Burnham 1999) with three consecutive encounter occasions and three attribute groups (small <35 mm, medium 35-59 mm, and large fish >59 mm). This model requires a minimum of three sampling occasions to estimate capture probabilities and can include covariates that are known to affect capture probabilities (e.g., fish size and habitat characteristics) (Peterson and Paukert 2009). The Huggins model does not directly estimate abundance, but rather abundance (N) is derived using the following formula:

$$N = M_t / (1 - [(1-p_1)(1-p_2)(1-p_3)]),$$

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 calculated abundance estimates separately for the spring pool, spring brook, tule marsh, and cattail marsh. In the spring pool and marsh habitats, where we sampled on only two occasions and did not mark fish, we estimated abundance using the numbers of fish in each size category on each occasion and the capture probabilities calculated in 2012-2013 (Scheerer et al. 2012; 2013). We calculated 95 percent confidence intervals for the estimates according to Chao (1987).

To evaluate which of the independent variables in our Huggins closed-capture model (sampling occasion, fish size, or habitat location) had a greater effect on the dependent variable (capture probability), we examined the parameter estimates for the best approximating capture probability model. The parameter estimates were on a logit scale, so to facilitate interpretation of the parameters we calculated the odds ratios by exponentiating the parameter estimates (Hosmer and Lemeshow 2000). Odds ratios are an estimate of the odds of an event occurring (e.g., capture of a fish) in response to increasing the predictor variable one unit, or the relative differences between two groups. An odds ratio of 1 is interpreted as no effect on the response or no differences between groups. An odds ratio estimate >1 is interpreted as a positive effect. For example, if the odds ratio is 1.24 for small vs. large fish, then small fish are 24% more likely to be captured than large fish. An odds ratio estimate of <1 is interpreted as a negative effect. For example, if the odds ratio is 0.333 for sampling occasion 1 versus 2, then fish are approximately 3 times (1/0.333) less likely to be captured on occasion 2, compared to occasion 1. We calculated 95% confidence limits for the odds ratios by exponentiating the 95% confidence limits for the beta estimates

We evaluated the effect of these variables by systematically fitting alternative capture probability models with and without predictors (e.g., body size) and selected the best model using Akaike's Information Criteria with a small sample bias adjustment (AICc; Burnham and Anderson 2002).

We estimated the abundance of dace in the spring pool and marsh habitats of Foskett Spring using a state space model (Bolker 2008), which allows us to vary capture probabilities for different sized fish and habitats. Here the capture of fish 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, *p* is the estimated capture probability, and 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. (2013). 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 (MCMC) 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 assessed the effects of BLM's habitat restoration at Foskett spring by mapping the aquatic vegetation in 2013 and 2014 and comparing these results to similar mapping done in 2012, prior to the habitat restoration.

RESULTS

We estimated the 2014 Foskett speckled dace abundance at 24,888 fish (95% CI: 19,250-31,510), which was nearly double, and significantly larger than, the 2013 estimate of 13,142 fish (10,665-16,616), and more than a 13 fold increase over the 2012 estimate of 1,848 fish (1,489-2,503) (Table 1). To obtain our estimate, we modeled capture probabilities based on fish size, year, sampling occasion, and habitat location. We observed heterogeneity in capture probabilities among fish of different size classes, among habitat locations, and among capture occasions (Table 2). Results from 2014 were similar to those from 2012 and 2013 (Scheerer et al. 2012; 2013). We found that small fish (<35 mm TL) were 12 times less likely to be captured than medium sized fish (35-59 mm) and that marked fish were 3 times more likely to be captured than unmarked fish ("trap happy") (Table 3). We also found that unmarked and marked fish were much more likely to be captured at Dace Spring (likely due to the higher trap density) than at Foskett Spring. In 2013, we observed heterogeneity in capture probabilities among locations in the spring complex, for example fish were three times more likely to be captured in the spring brook, four times more likely to be captured in the spring pool, and ten times more likely to be captured in the cattail marsh, than in the tule marsh (Scheerer et al. 2013). Details regarding the best model beta estimates, odds ratios, and their interpretations are shown in Table 3. All abundance estimates that we obtained from 2005 through 2012 at Foskett Spring were significantly lower than the 1997 estimate of 27,787 dace (Dambacher et al. 1997); the 2013 and 2014 estimates were not significantly different from the 1997 estimate (Figure 2).

In Dace Spring, we estimated the dace abundance at 552 fish (95% CI: 527-694), which was a significant increase over the 2013 estimate of 34 fish (95% CI: 17-62). Note that we transferred an additional 200 dace to Dace Spring after the 2013 estimate was obtained. Not only did we see substantial recruitment in 2014, but these recruits also grew rapidly and most (66%) were in the medium size category.

Table 1. Estimates of Foskett speckled dace abundance obtained using the Lincoln-Petersen model, 1997-2012, and the Huggins closed-capture model, 2011-2014. Abundance estimates were not calculated by habitat type using the Huggins model in 2011, because length-frequency data was not available for each habitat location.

	Lincoln-Petersen model						Huggins model			
Location	1997	2005	2007	2009	2011	2012	2011	2012	2013	2014
Spring pool	204	1,627	1,418	247	322	404	-	633	2,579	2,843
	(90 - 317)	(1,157 - 2,281)	(1,003 - 1,997)	(122 - 463)	(260 - 399)	(354-472)	-	(509-912)	(1,985-3,340)	2,010-3,243)
Spring brook	702	755	719	1,111	262	409	-	589	638	7,514
	(321 - 1,082	(514 - 1,102)	(486 - 1,057)	(774 - 1,587)	(148 - 449)	(357-481)	-	(498-1024)	(566-747)	(2,422-13,892)
Tule marsh	not sampled	425	273	1,062	301	220	-	625	6,891	11,594
		(283- 636)	(146 - 488)	(649 - 1,707)	(142 - 579)	(159 - 357)	-	(442-933)	(5,845-8,302)	(7,891-12,682)
Cattail marsh	26,881	353	422	158	0	0	0	0	3,033	2,935
	(13,158 - 40,605)	(156-695)	(275 - 641)	(57 - 310)					(2,500-3,777)	(1,175-7,002)
Entire site	27,787	3,147	2,984	2,830	751	988	1,728	1,848	13,142	24,888
	(14,057 - 41,516)	(2,535 - 3,905)	(2,403 - 3,702)	(2,202-3,633)	(616 - 915)	(898-1,098)	(1.269-2,475)	(1,489-2,503)	(10,665-16,616)	(19,250-31,510)

Table 2. Foskett speckled dace capture probabilities, listed by habitat location, fish size, and capture occasion. Note, capture probabilities for the spring pool, tule marsh, and cattail marsh are from 2012-2013 sampling (Scheerer et al. 2012; 2013).

	Foskett Spring spring brook				Foskett Spring spring pool				Foskett Spring tule marsh				Foskett Spring cattail marsh				Dace Spring ponds			
Parameter	Estimate	SE	Lower 95%	Upper 95%	Estimate	SE	Lower 95%	Upper 95%	Estimate	SE	Lower 95%	Upper 95%	Estimate	SE	Lower 95%	Upper 95%	Estimate	SE	Lower 95%	Upper 95%
Small fish																				
Capture occasion 1	0.010	0.010	0.001	0.071	0.229	0.029	0.177	0.291	0.234	0.021	0.195	0.278	0.319	0.035	0.255	0.392	0.254	0.179	0.051	0.685
Capture occasion 2	0.006	0.006	0.001	0.045	0.229	0.029	0.177	0.291	0.234	0.021	0.195	0.278	0.319	0.035	0.255	0.392	0.174	0.136	0.032	0.572
Capture occasion 3	0.010	0.010	0.001	0.071													0.254	0.179	0.051	0.685
Recapture occasion 2	0.211	0.036	0.149	0.290													0.502	0.055	0.396	0.609
Recapture occasion 3	0.211	0.036	0.149	0.290													0.502	0.055	0.396	0.609
Medium fish																				
Capture occasion 1	0.110	0.052	0.042	0.258	0.358	0.032	0.298	0.421	0.224	0.023	0.182	0.273	0.129	0.048	0.060	0.254	0.809	0.022	0.762	0.848
Capture occasion 2	0.071	0.035	0.027	0.177	0.358	0.032	0.298	0.421	0.224	0.023	0.182	0.273	0.129	0.048	0.060	0.254	0.724	0.033	0.654	0.784
Capture occasion 3	0.110	0.052	0.042	0.258													0.809	0.022	0.762	0.848
Recapture occasion 2	0.280	0.019	0.244	0.320													0.595	0.019	0.556	0.632
Recapture occasion 3	0.280	0.019	0.244	0.320													0.595	0.019	0.556	0.632
Large fish																				
Capture occasion 1	0.238	0.112	0.085	0.511	0.096	0.027	0.054	0.161	0.035	0.010	0.020	0.063	na	na			0.914	0.023	0.858	0.949
Capture occasion 2	0.162	0.084	0.054	0.393	0.096	0.027	0.054	0.161	0.035	0.010	0.020	0.063	na	na			0.868	0.034	0.785	0.922
Capture occasion 3	0.238	0.112	0.085	0.511													0.914	0.023	0.858	0.949
Recapture occasion 2	0.190	0.025	0.146	0.243													0.469	0.029	0.413	0.525
Recapture occasion 3	0.190	0.025	0.146	0.243													0.469	0.029	0.413	0.525

Table 3. Huggins closed-capture best model beta coefficients, odds ratios, and their interpretations. See "Methods" for a description of these descriptive statistics. Parameters listed with asterisks represent interactions among the two parameters.

Parameter	Estimate	SE	Lower 95%	Upper 95%	Odds Ratio	Interpretation
Intercept	-2.088	0.525	-3.117	-1.059		
Dace Springs	3.530	0.542	2.467	4.593	34.12	Dace were 34.1 times more likely (95% CI: 11.8-98.8) to be captured in Dace Spring ponds that in the Foskett Spring spring brook
Small	-2.520	0.951	-4.385	-0.656	0.08	Small fish were 12.4 times (1/0.08) less likely (95% CI: 1.9-80.2) to be captured than medium fish
Large	0.923	0.322	0.292	1.554	2.52	Large fish were 2.5 times more likely (95% CI: 1.3-4.7) to be captured than medium fish
Occasion 2	-0.480	0.093	-0.662	-0.297	0.62	Marked and unmarked fish were 1.6 times (1/0.62) less likely (95% CI: 1.3-1.9) to be captured on occasion 2 than on occasion 1
Recapture	1.144	0.534	0.098	2.190	3.14	Marked fish were 3.1 times more likely (95% CI: 1.1-8.9) to be captured than unmarked fish
Recapture*Dace Springs	-2.203	0.555	-3.291	-1.114	0.11	Marked fish were 9.1 times (1/0.11) less likely (3.0-26.9) to be recaptured in Dace Spring compared to marked fish from Foskett
Recapture*Small	2.147	0.976	0.233	4.061	8.56	Marked small-sized fish were 8.6 times more likely (95% CI: 1.3-58.0) to be captured than marked medium-sized fish
Recapture*Large	-1.432	0.350	-2.119	-0.745	0.24	Marked large-sized fish were 4.2 times (1/0.24) less likely (95% CI: 2.1-8.3) to be recaptured than marked medium-sized fish

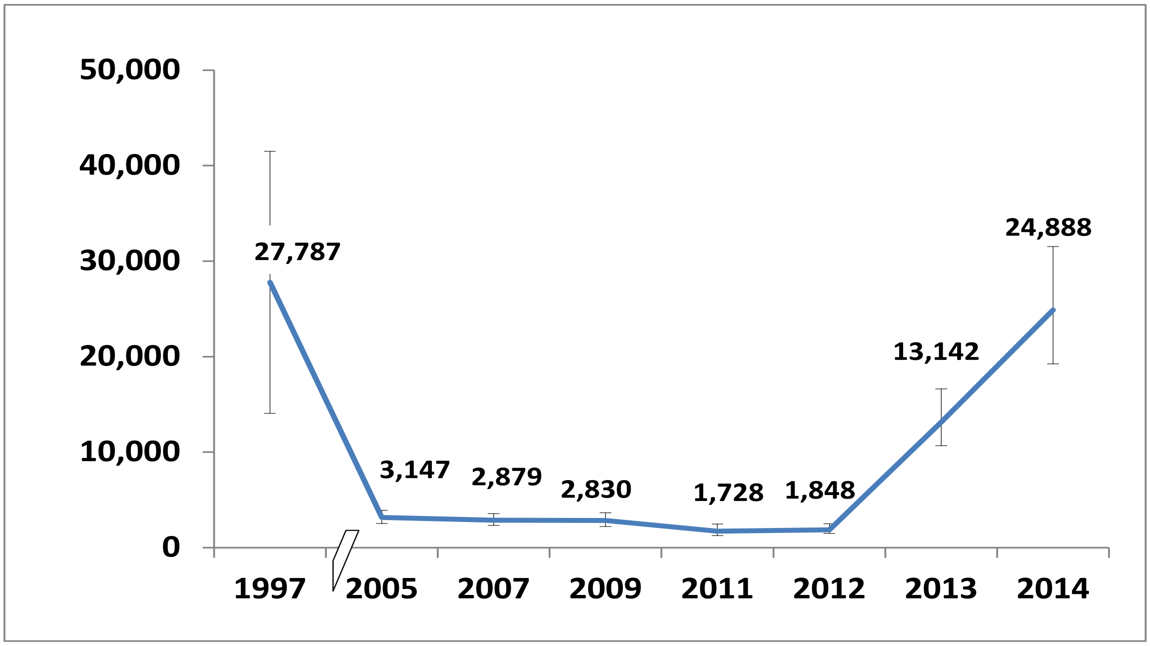

Figure 2. Population estimates for Foskett speckled dace, 1997-2014. Vertical bars represent 95% confidence limits for each estimate. Prior to 2011, the estimates were obtained using a Lincoln-Petersen model, which underestimated abundance by approximately 50 percent, compared to the Huggins closed-capture model used in 2011-2014 (Scheerer et al. 2012).

DISCUSSION

The ODFW Native Fish Investigations Program has been monitoring the status of the federally listed Foskett speckled dace and its habitat since 2005. We found the abundance of Foskett speckled dace declined substantially from 1997 through 2012 (Dambacher et al. 1997; Scheerer and Jacobs 2005, 2007, 2009; Scheerer et al. 2011, 2012). Encroachment by aquatic macrophytes since the habitat was fenced by BLM in 1987 substantially reduced the open-water habitat, with a subsequent decline in the dace population. This is not uncommon in desert spring ecosystems, when springs are fenced and livestock removed, these ecosystems often experience increases in aquatic vegetation, reduction of open-water habitat, and reduction of fish populations (Kodric-Brown and Brown 2007).

When the U.S. Fish and Wildlife Service completed the initial Foskett Speckled Dace Five-Year Review in 2009 (U.S. Fish and Wildlife Service 2009), they 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). The second 5-Year Review is in progress, with expected completion and recommendations in 2015.

To assess 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, restore 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%) (APPENDIX A). The response of speckled dace to this habitat restoration has been remarkable. In 2014, we estimated there were nearly 25,000 dace at Foskett Spring, with the majority of these (over 19,000) in the restored tule and cattail marshes. We also found the marsh habitats were dominated by native aquatic plants, as they were prior to the burn. However, it should be noted that the increase in open water habitat in the spring pool and spring brook in 2014 (~60 m^2) was offset by a similar reduction of open water habitat in the tule and cattail marshes (~86 m^2). This illustrates the need for frequent maintenance to maintain open water habitat at Foskett Spring. The benefits of these restoration/maintenance activities could be extended, if in the future the open water pools are excavated to a greater depth (>1 m) using an excavator.

The draft Cooperative Management Plan for Foskett Speckled Dace addresses the second recommendation in the 5-Year Review by developing a restoration plan and regular maintenance schedule to increase and maintain suitable open-water habitat.

To address the restoration potential at Dace Spring and feasibility of a dace transplant effort, the BLM and USFWS created two spring-fed pools at Dace Spring in 2009. In 2010-2011, ODFW introduced 124 dace from Foskett Springs into these ponds. In 2011-2013, we documented evidence of recent recruitment at Dace Springs, but also documented substantial algal blooms, periods of low dissolved oxygen, trapping related mortalities, and low survival. In 2013, BLM modified the fresh water delivery from the spring source so that it passes through the ponds; previously, only a single channel existed. We noted an immediate response with improved water clarity and quality in the ponds. In October 2013, we introduced 200 dace from Foskett Spring into the ponds (100 ea.). In 2014, we documented successful recruitment and an associated increase in abundance (estimate = 552 fish) at Dace Spring. We plan to transfer 10% of the Foskett Springs population of speckled dace into Dace Springs per year until a total of 500 have been transferred, to minimize impacts to the donor population and potential genetic consequences resulting from drift or founders effect in the recipient population. To date, 324 dace have been translocated from Foskett to Dace Spring.

ODFW provided comments for the current 5-Year Review and recommended the Service consider delisting Foskett speckled dace. We based this recommendation on the following: 1) Foskett and Dace Springs are owned and managed by the BLM, 2) both sites have been fenced to exclude grazing (with the exception of the cattail marsh), 3) habitat restoration has occurred at both springs, 4) the declining abundance trend at Foskett Spring has been reversed, 5) the introduced population at Dace Spring totals >500 fish, and 6) a Cooperative Management Plan has been drafted, has multi-agency support, and includes a regular maintenance schedule to increase and maintain suitable open-water habitat and a monitoring schedule to assess the effects of recent habitat restoration and to ensure the population remains stable.

ACKNOWLEDGEMENTS

Thanks to J. Leal, J. Shen, and J. Sleasman for assistance with the field work. This work was funded by the U.S. Fish and Wildlife Service and the Bureau of Land Management.

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APPENDIX A. Habitat dimensions, by location, at Foskett Spring in 2014. Also included are measurements from 2012 (pre-restoration) and the changes in open water habitat from 2012 to 2014. We defined open water habitat as habitat which is suitable for speckled dace. Wetted water habitat includes both the open water habitat and emergent wetland habitat, which is typically unsuitable for dace.

Habitat type	Length (m)	Wetted width (m)	Open water width (m)	Average depth (m)	Wetted area (m^2)	2014 open water area (m^2)	2012 open water area (m^2)	Increase in open water area
Spring pool	4.7	12.2	4.5	0.26	57	21	4	430%
Spring brook	71.0	2.7	1.0	0.05	192	68	25	175%
Tule marsh	98.3	18.7	0.9	0.21	1840	88	43	106%
Cattail marsh	96.0	21.0	1.0	0.19	2019	93	35	165%
total	270.0				4109	271	107	153%