PROGRESS REPORTS

2011

FISH DIVISION

Oregon Department of Fish and Wildlife

2011 Warner Sucker Investigations (Honey Creek)

ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT
OREGON

PROJECT TITLE: **2011 Warner Sucker Investigations (Honey Creek)**

CONTRACT NUMBERS: 13420-08-J814 (USFWS) and L10AC20301 (BLM)

PROJECT PERIODS: 8/28/2008-12/31/2014 and 07/28/2010-07/27/2015

Honey Creek- view from the canyon rim.

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This project was financed with funds administered by the U.S. Bureau of Land Management task order L10AC20301 and U.S. Fish and Wildlife Service contract 13420-08-J814.

CONTENTS

Page

INTRODUCTION

The Warner sucker (*Catostomus warnerensis*) is endemic to the Warner Valley, an endorheic subbasin of the Great Basin in southeastern Oregon and northwestern Nevada. Historically, this species was abundant and its range included three permanent lakes (Hart, Crump, and Pelican), several ephemeral lakes, a network of sloughs and diversion canals, and three major tributary drainages (Honey, Deep, and Twentymile Creeks) (U.S. Fish and Wildlife Service 1985). Warner sucker abundance and distribution has declined over the past century and it was federally listed as threatened in 1985 due to habitat fragmentation and threats posed by the proliferation of piscivorous non-native game fishes (U.S. Fish and Wildlife Service 1985).

The Warner sucker inhabits the lakes and low gradient stream reaches of the Warner Valley. The Warner sucker metapopulation is comprised of both lake and stream life history morphs. The lake suckers are lacustrine adfluvial or potamodromous fish that normally spawn in the streams. However, upstream migration may be blocked by low stream flows during low water years or by irrigation diversion dams. When this happens, spawning may occur in nearshore areas of the lakes (White et al. 1990). Large lake-dwelling populations of introduced fishes likely reduce recruitment by preying on young suckers (U.S. Fish and Wildlife Service 1998). The stream suckers inhabit and spawn in Honey, Deep, and Twentymile Creeks.

The Recovery Plan for the Threatened and Rare Native Fishes of the Warner Basin and Alkali Subbasin (U.S. Fish and Wildlife Service 1998) sets recovery criteria for delisting the species. These criteria require that: 1) a self-sustaining metapopulation is distributed throughout the Twentymile, Honey, and Deep Creek (below the falls) drainages, and in Pelican, Crump, and Hart Lakes, 2) passage is restored within and among the Twentymile, Honey, and Deep Creek (below the falls) drainages so that the individual populations of Warner suckers can function as a metapopulation, and 3) no threats exist that would likely threaten the survival of the species over a significant portion of its range.

To inform progress towards the first criteria, our objectives in 2011 were: 1) obtain a population estimate for suckers in the Honey Creek drainage and describe their current distribution and 2) describe the association between the distribution of suckers and habitat variables in Honey Creek. In addition, we obtained a population estimate of suckers at the Summer Lake Wildlife Management Area (WMA), where a self-sustaining population became established after a fish salvage from Hart Lake in 1991 when the lakes desiccated.

METHODS

Warner Sucker Distribution and Abundance in Honey Creek

In the summer of 2011, we surveyed approximately 26 km of the mainstem of Honey Creek (Figure 1). We used a backpack electrofisher to obtain a two-pass mark-recapture abundance estimate. The sample frame included the suspected geographical extent of suckers in the stream. We divided the sample frame into forty-eight 500 m reaches, which we measured using a hip chain. We further divided the sample reaches into 100 m stream sections for fish sampling. We electrofished each 100 m stream section in a single upstream pass and placed all captured fish in buckets. We enumerated and measured all Warner suckers and recorded the approximate abundance and distribution of all other fish

Figure 1. Study area. Areas surveyed in Honey Creek are highlighted in red. The location of the Summer Lake Wildlife Management Area is shown on the Oregon inset map.

species collected. At the upstream end of each 100 m section, we processed the fish and released them back to the approximate location from which they were captured. We anesthetized all suckers using methyl sulfonate (MS-222), measured fork length (FL), weighed to nearest 5 g, and marked with fin clips those suckers $\geq$60 mm FL. We alternated between upper and lower caudal fin clips every 1,000 m (every two sample reaches) throughout the extent of the sample frame to examine small scale movements of fish between the first and second passes. We collected fin clips from a subsample of the suckers captured and preserved them in 95% ethanol for future genetic analysis. During the initial electrofishing pass, we scanned each sucker $\geq$100 mm FL for Passive Integrated Transponder (PIT) tags and recorded detections of previously-installed PIT tags. If no tag was detected, we surgically implanted a 23 mm half-duplex PIT tag in the anterior ventral side of the body cavity of all suckers $\geq$100 mm FL. During the second electrofishing pass we recorded the number of marked and unmarked suckers, scanned each fish for an existing PIT tag, and recorded the tag number when we detected one. If no PIT tag was detected, we installed a PIT tag in all suckers $\geq$100 mm FL.

We estimated population abundance for Warner suckers in Honey Creek using a Bayesian logistic regression capture-recapture model implemented in WinBUGS, software version 1.4 (Spiegelhalter et al. 2006). We divided the stream into four segments based on channel gradient and percent pool habitat. We incorporated prior information of the effects of habitat covariates on sucker capture probabilities using the parameter estimates and their variances from Price and Peterson (2010) and modeled capture probabilities based on fish length. We added predictors representing site level covariates (cross-sectional stream area, electrofishing pass, percent pool habitat, turbidity, stream discharge, and water temperature) averaged over these segments. We obtained abundance estimates for all suckers, suckers $\geq$59 mm FL, adult suckers $\geq$159 mm FL (Scheerer et al. 2008), and for all suckers in each of the four stream segments. Abundance and 95% credible intervals (equivalent to confidence limits) were estimated using the unknown denominator approach (Spiegelhalter et al. 2006). In addition, we estimated population abundance using a single-sample mark-recapture procedure and calculated 95% confidence intervals using a Poisson approximation (Ricker 1975). This method, which we used in Twentymile Creek drainage in 2009, assumes homogeneous capture probabilities. We included this method to examine the magnitude of the bias compared to the Bayesian model. We did not deploy block nets during the survey; however, we installed a PIT-tag antenna at the downstream boundary of our surveys to estimate the magnitude of downstream movement of fish out of the sample reach during our study. We tested the antenna weekly and verified that it functioned continuously during the sampling period.

Note: we were denied access to sample Snyder creek, the main tributary to Honey Creek, by the private landowners who own most of the drainage. We did not survey Twelvemile Creek (tributary to Honey Creek), because stream flow was puddled.

Habitat Assessment in Honey Creek

Following the second pass of the survey, we measured habitat parameters in each 500 m sample reach including: wetted width (m), average depth (m), wetted surface area (m^2) and maximum depth (m) of backwater pools, maximum depth (m), water temperature (^oC), aquatic vegetation (as a percentage of total surface area), dominant substrate type, dominant riparian cover type, percent pools, and number of pools. Width, depth, substrate and aquatic vegetation measurements were taken at transects located every 100 m, starting approximately 50 m from the downstream boundary of each reach. We calculated average depth by summing depth measurements collected at 25%, 50% and 75% of the wetted width and dividing by four, to account for zero depth at the stream margins. Maximum depth was the single deepest water depth measured in each reach. We measured the length, width, and maximum depth of backwater habitats when they occurred. We determined the dominant substrate from seven equally-spaced points along each transect. At each point (100 mm circle), we recorded whether the majority of the substrate was fines (<1/16th mm), sand (1/16th-2 mm), gravel (3-64 mm), cobble (65-256 mm), boulder (>256 mm), bedrock (native consolidated rock), or embedded. We identified dominant riparian cover categorically (conifer, deciduous, grasses and shrubs, and limited vegetation). We recorded stream temperature at the beginning and end of each 500 m reach and recorded Universal Transverse Mercator (UTM) coordinates, stream elevation, and took photographs at the beginning of each reach. We installed a Hobo® temperature monitor at the downstream extent of the survey that recorded temperature every 5 hours for the duration of the survey.

Association between Sucker Distribution and Habitat in Honey Creek

We explored relationships between habitat variables and total fish captured (sum of catch from the electrofishing passes per reach) using multiple regression (zero inflated quasi-Poisson model with a logit link) in the statistical program R (Zeileis et al. 2008; Jackman 2011). The quasi-Poisson model incorporates overdispersion parameters to address the reality that variance is not equal to, but often much larger than the mean in count data, whereas a Poisson model assumes homogeneous variances (O'Hara and Kotze 2010). We removed habitat variables which had high degrees of co-linearity from the analysis. The variables that we included in the model were: maximum temperature recorded per reach, reach area, number of pools, average depth, percent fine substrates, and mean percentage of aquatic vegetative cover per reach. We also calculated the percent gradient and percent undercut banks for each reach from an ODFW Aquatic Inventories stream survey conducted in 2007 (P. Kavanagh, personal communication). We selected the most parsimonious final model based on the Akaike Information Criteria (AIC) score. We calculated an approximate R^2 value for the model relative to the model without any predictor variables (intercept only), as R^2 is only well defined for ordinary least squares regression (M. Falcy, ODFW, personal communication). Our model did not exceed one independent variable for every ten sample sites.

Warner Sucker Abundance in the Summer Lake Wildlife Management Area

On 28 July 2011, we obtained a mark-recapture abundance estimate of the population of Warner suckers located in the artesian well-fed ditch on the Summer Lake Wildlife Management Area (WMA). We estimated population abundance using the Bayesian modeling approach described above for Honey Creek and using a single-sample mark-recapture procedure (Ricker 1975).

RESULTS

Warner Sucker Abundance and Distribution in Honey Creek

We divided Honey Creek into four segments, based on gradient and habitat characteristics (Table 1). We captured the majority of the suckers upstream of the Honey Creek canyon and the Twelvemile Creek confluence (Figure 2; segment 3), a low gradient stream segment that was dominated by pool habitat. We captured substantially fewer small suckers (<70 mm FL) during the second electrofishing pass, compared to the first pass (Figure 3), and the proportion of tagged suckers that we recaptured was substantially lower for fin clipped suckers (60-99 mm, 1.3%) compared to PIT tagged suckers (>99 mm, 11%). Consequently, we based our population model solely on PIT-tagged suckers and expanded the estimate using catch probabilities modeled for suckers smaller than 100 mm.

Table 1. Length, average unit gradient, average percent pool habitat, and Warner sucker catch, by pass, for distinct segments of Honey Creek.

Segment	Length (km)	Percent gradient	Percent pools	Sucker catch Pass 0	Sucker catch Pass 1
1	2.2	0.5	47.6	60	18
2	8.5	1.8	15.9	89	25
3	10.5	0.7	55.9	331	320
4	4.4	1.4	5.0	0	0
All	25.6	1.2	32.0	480	363

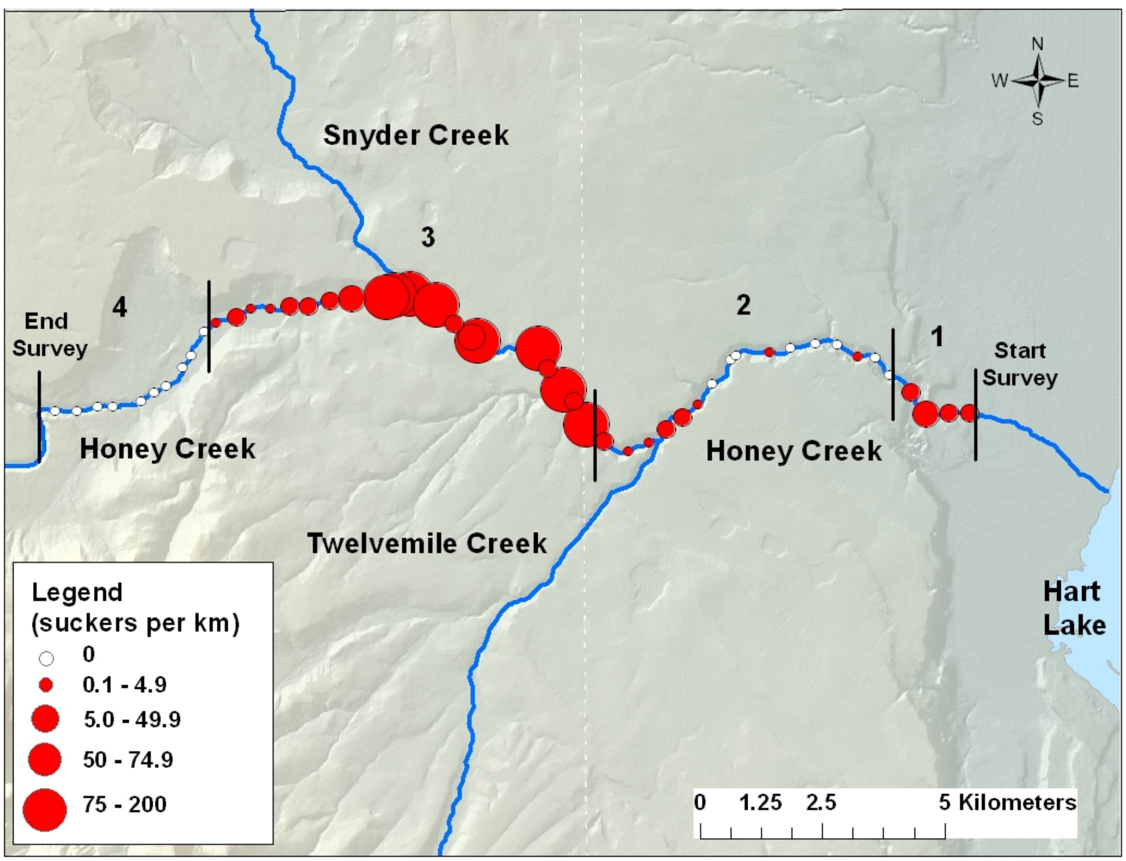


Figure 2. Distribution of Warner suckers in Honey Creek in 2011. Values represent the total number of suckers captured during two electrofishing passes in each sample reach. Vertical lines mark the limits of the numbered stream segments.

Using the Bayesian modeling approach, we estimated 4,718 Warner suckers (95% CI: 3,868-5,683) in Honey Creek in September 2011 (all sizes), 4,495 suckers larger than 59 mm (95% CI: 3,668-5,448), and 2,511 adult suckers (95% CI: 1,719-3,429). Note: adult sucker abundance is included in the estimate for suckers larger than 59 mm. Warner suckers were most abundant in segment 3 (3,317; 95% CI: 2,713-4,002) (Table 2). We noted a 16% decline in abundance between the first (5,622; 95% CI: 4,728-6,633) and second (4,718: 95% CI: 3,868-5,683) electrofishing passes (Table 2), notably in segments 1 and 2. The 2011 estimate was substantially, but not significantly larger than our 2007 estimate (2,202; 95% CI: 418-3,986) (Scheerer et al. 2007); precision was dramatically improved in 2011. Using the single-sample mark-recapture approach (Ricker 1975), we could only estimate the abundance of PIT-tagged fish (>99 mm); the estimate was 2,105 suckers (95% CI: 1,372-3,201).

Table 2. Warner sucker abundance, estimated by stream segment and pass, for Honey Creek, summer 2011.

	Pass 0			Pass 1		
	Estimate	Lower	Upper	Estimate	Lower	Upper
Segment 1	1,039	651	1,555	570	275	1,038
Segment 2	1,296	841	1,885	644	318	1,148
Segment 3	3,100	2,561	3,736	3,317	2,713	4,002
Segment 4	187	55	549	187	55	548
	5,622	4,728	6,633	4,718	3,868	5,683

We noted three apparent peaks in the length-frequency histogram for suckers captured during the surveys, which may represent distinct age-classes (Figure 3). Compared to 2007, the 2011 Warner sucker length-frequency distribution was characterized by a lower proportion of small suckers (<100 mm) (Figure 4). We found a strong relationship between body weight and fork lengths in 2011 (Figure 5); we did not weigh suckers captured in 2007. We adjusted the sucker length frequencies, based on size-specific capture probabilities and resultant estimated abundance by size-class from the Bayesian model (Figure 6).

Spatially, we also noted substantial differences in the distribution of suckers between electrofishing passes, with notable reductions in sucker numbers in the lower half of segment 3 (Figures 7 and 8). In this stream segment during the second pass, we observed high turbidity coming from Snyder Creek and a reduction in amount of submergent aquatic vegetation downstream of the Snyder Creek confluence.

In addition to Warner suckers, we also collected native redband trout (*Oncorhynchus mykiss* ssp.), speckled dace (*Rhinichthys osculus* ssp.), and tui chub (*Gila bicolor)* from Honey Creek; no nonnative fish were collected.

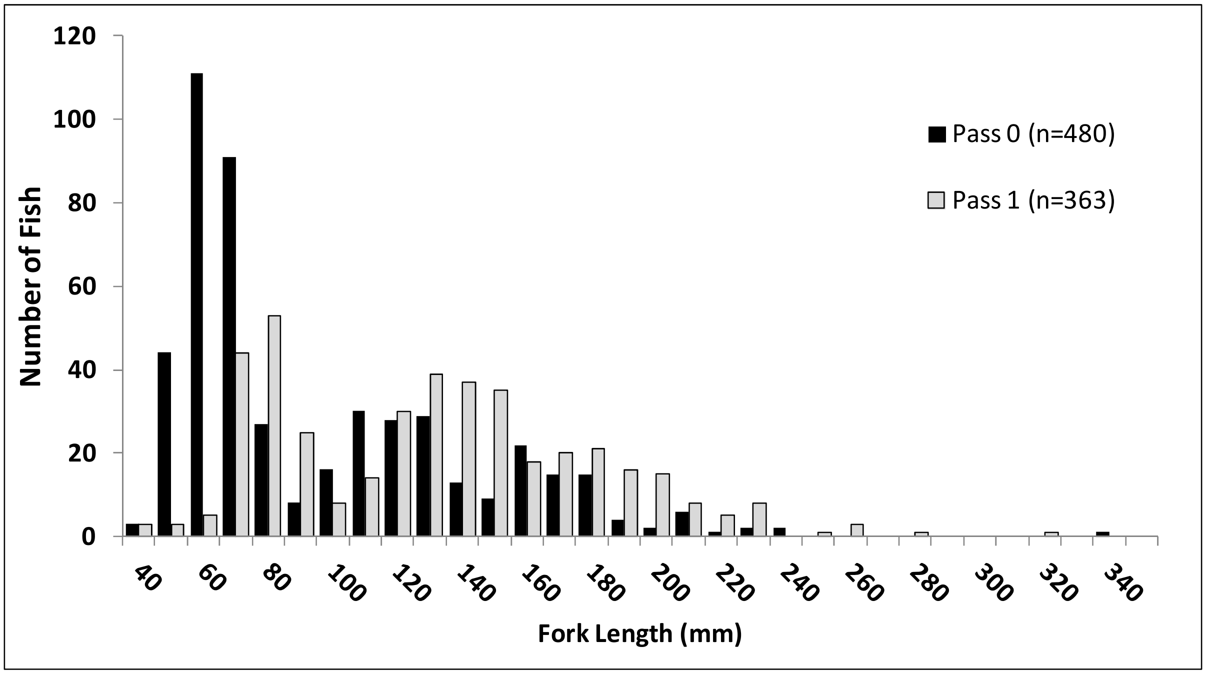


Figure 3. Length-frequency distribution for suckers collected during two electrofishing passes in Honey Creek, summer 2011.

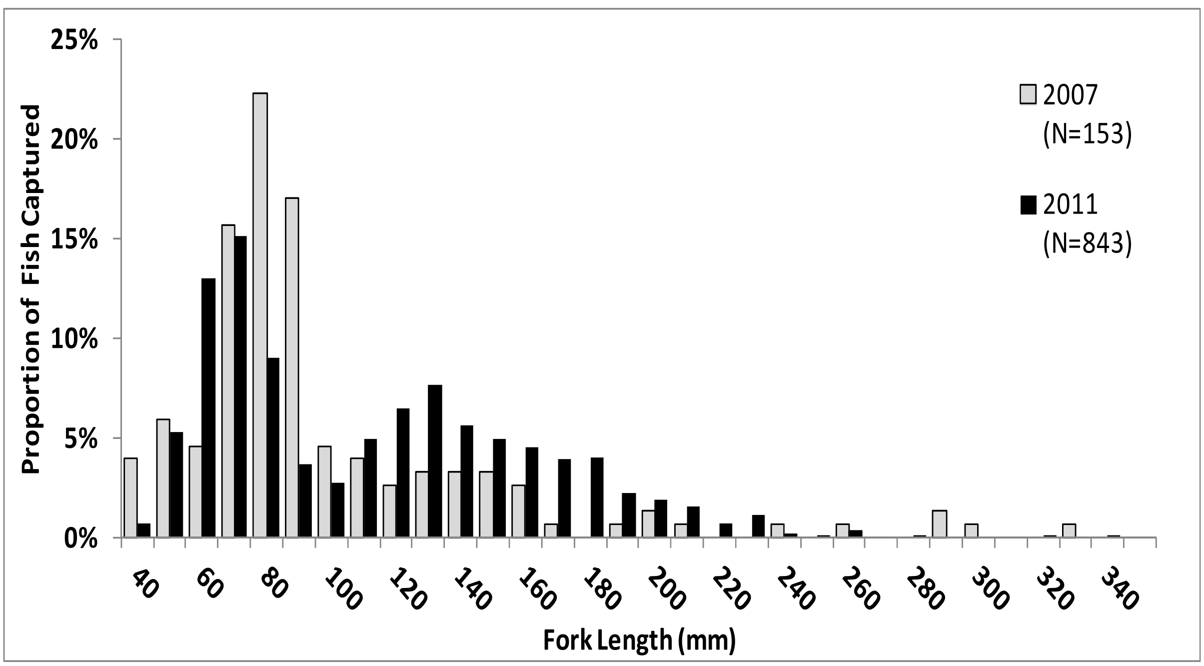


Figure 4. Length-frequency distributions for Warner suckers captured in 2007 and 2011.

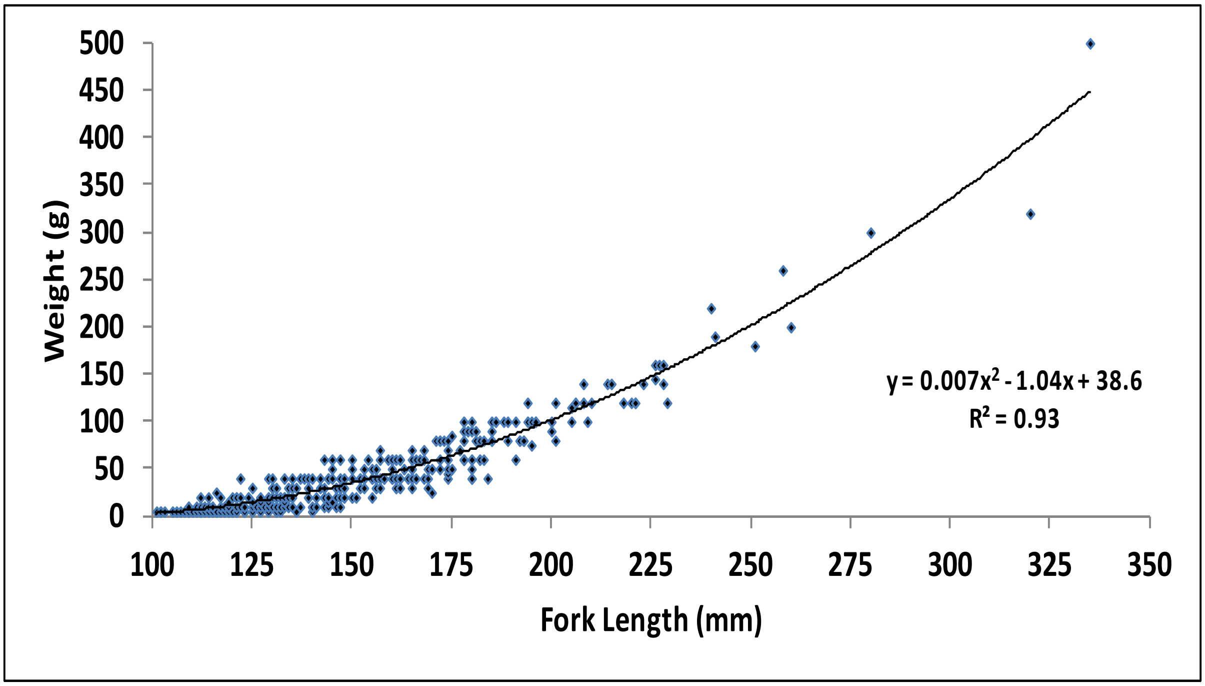


Figure 5. Weight-length power relationship for Warner suckers from Honey Creek, summer 2011.

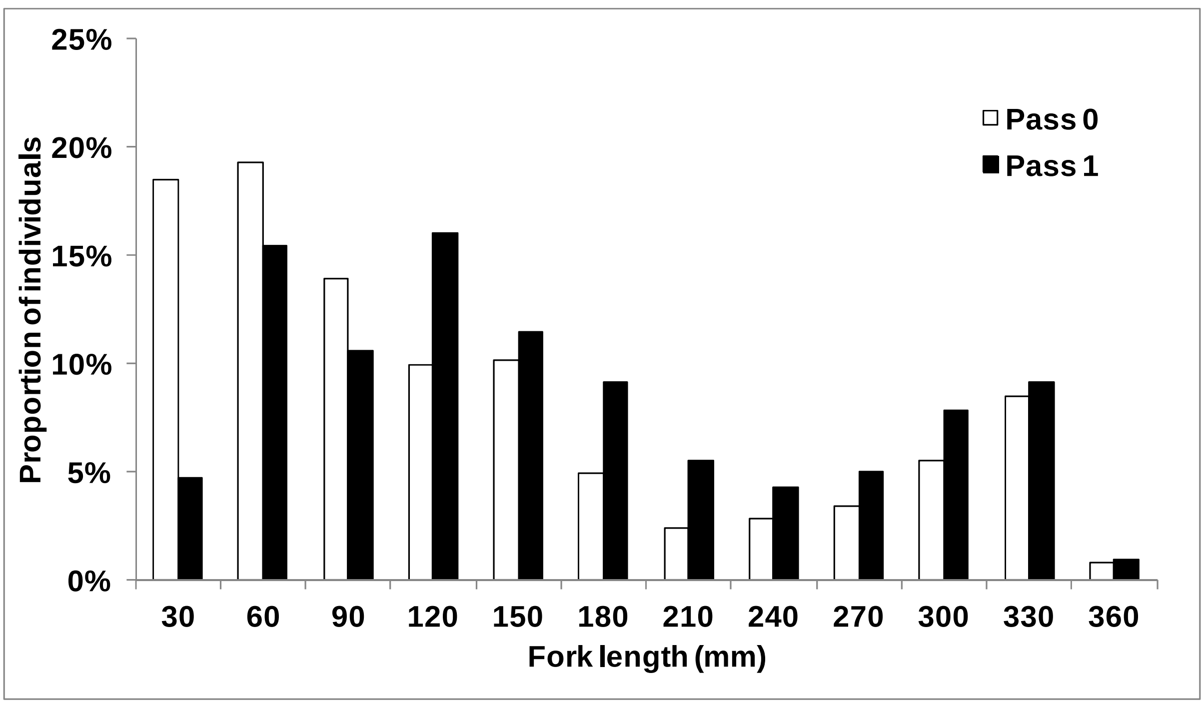
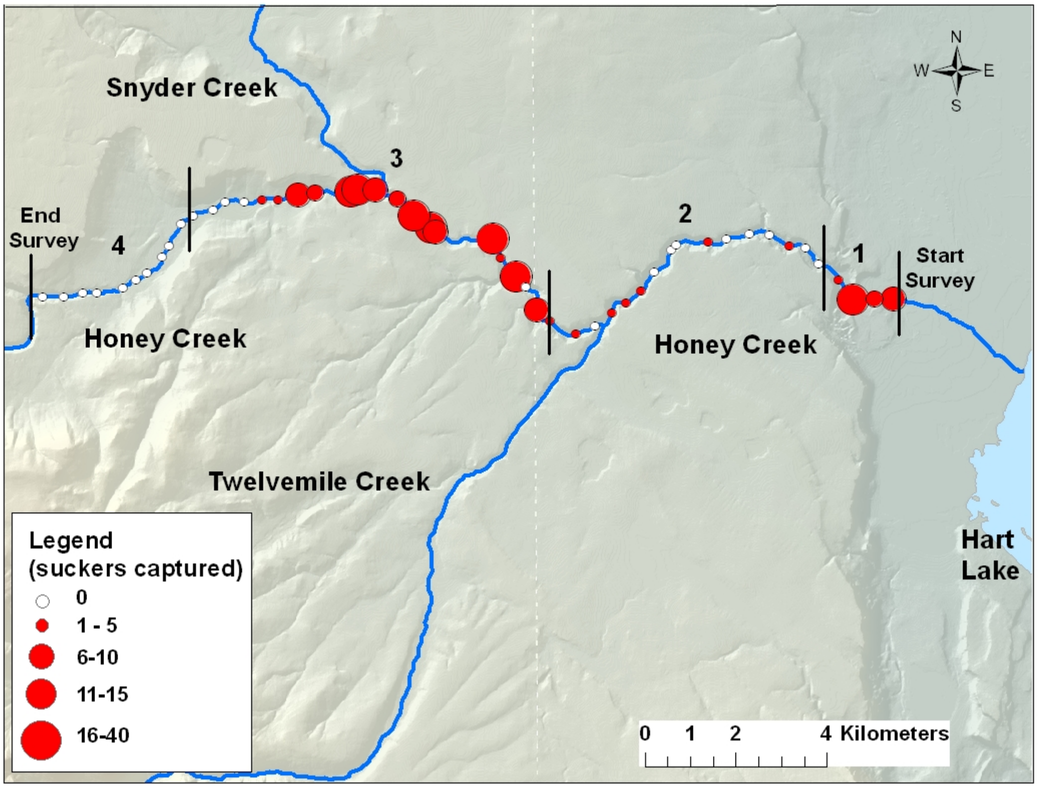


Figure 6. Adjusted length-frequency distribution for suckers in Honey Creek, summer 2011, based on abundances obtained by size category using the Bayesian capture-recapture model.



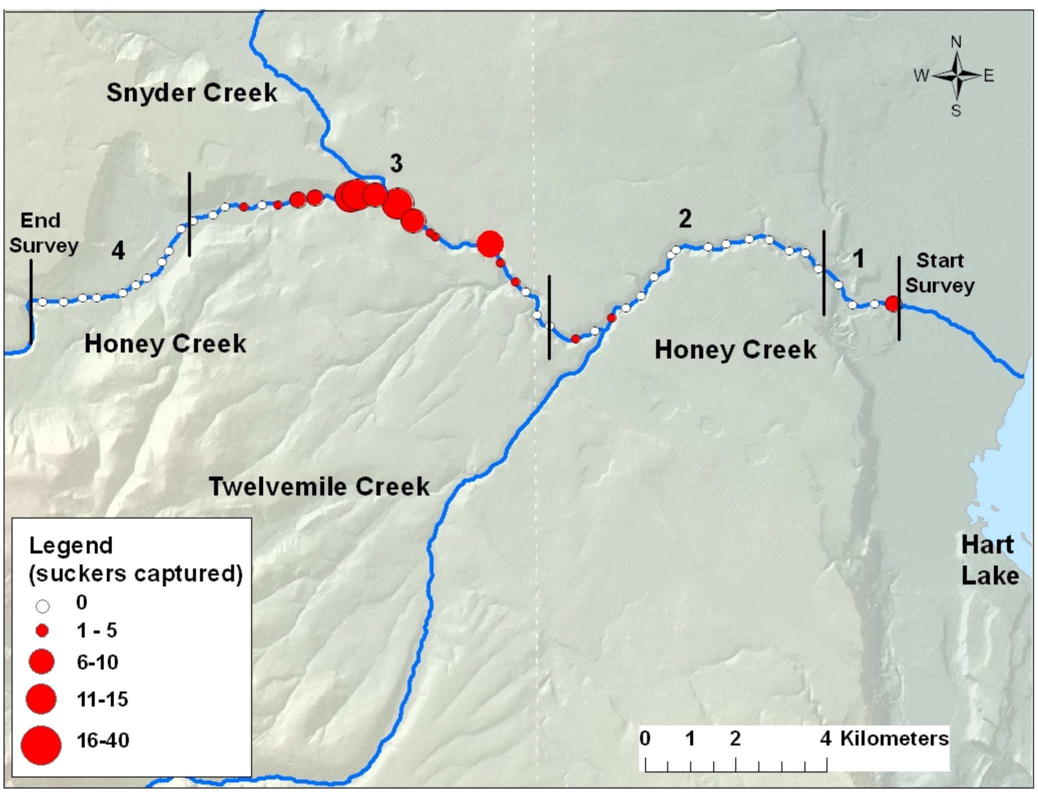


Figure 7. Distribution of Warner suckers (<100 mm) during the first (top) and second (bottom) electrofishing passes in Honey Creek, summer 2011. Passes were separated by an average of 31 days (range: 21-56 days).

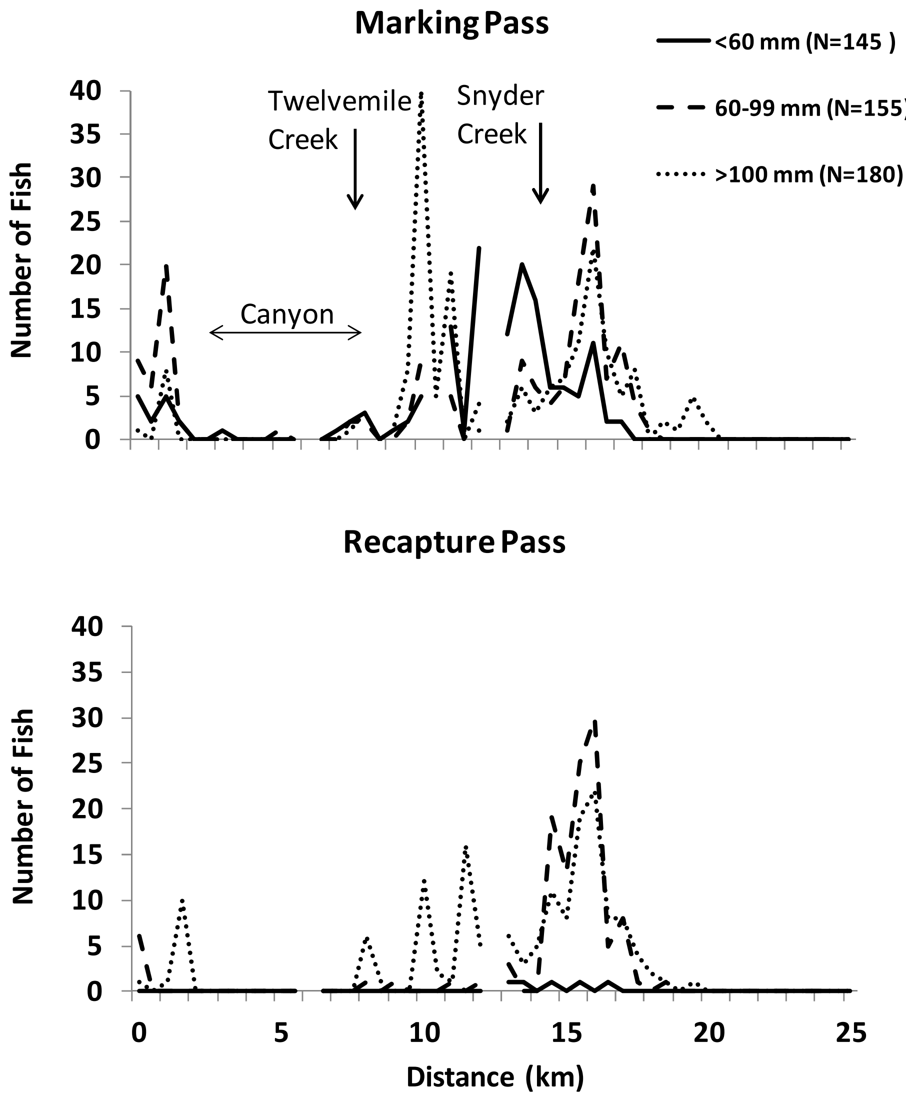


Figure 8. Distribution of Warner suckers in Honey Creek during the marking pass and the recapture pass, summer 2011. Gaps in the plots represent stream segments that were not surveyed because access was denied on private lands.

Association between Sucker Distribution and Habitat in Honey Creek

Warner suckers were most abundant upstream of the canyon in Honey Creek. These habitats were characterized by low gradients and abundant pools, including beaver pools, some of which were difficult to sample due to their depth and size. The stream in these areas was characterized by low water velocity, abundant macrophytes, undercut banks, and was dominated by fine substrates (Figure 9). Larger suckers were typically associated with large patches of aquatic buttercup (*Ranunculus* sp.) or milfoil (*Myriophyllum* sp.), whereas smaller suckers were typically associated with rushes (*Juncas* sp.) along the margins of the stream channel. There were no apparent relationships between sucker numbers and stream temperatures or maximum stream depth.

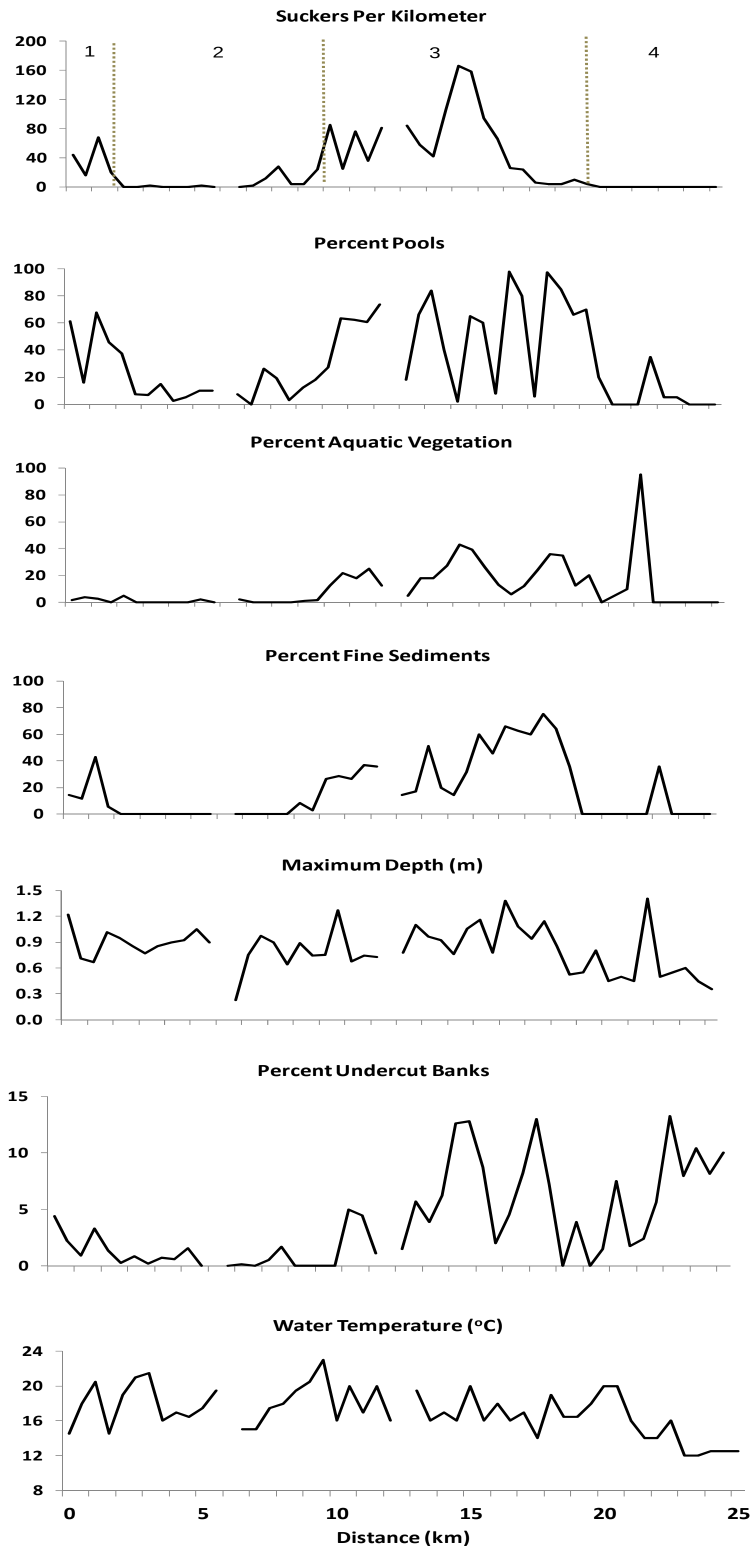


Figure 9. Relationships between the numbers of suckers captured per kilometer and percent pool habitat, percent aquatic vegetation, percent fine sediments, maximum depth, percent undercut banks, and water temperatures. Gaps in the plots represent stream segments where access was denied. Dotted lines and numbers on the top graph show the boundaries of the four stream segments.

Fish-Habitat Association Model

Using a multiple regression, we had two models with essentially identical AIC scores. One four-variable model accounted for 29% of observed variation in the total number of fish captured per reach (DF=8, 47). Significant variables included the number of pools and the percent aquatic vegetation ($P<0.05$). The final model was fish abundance = 7.16 - 0.55 (number of pools) - 23.81 (percent aquatic vegetation) - 0.31 (maximum water temperature) + 15.08 (percent undercut banks). A second four-variable model accounted for 30% of the observed variation (DF=10, 47). The only significant variable in this model was the number of pools ($P<0.05$). The final model was fish abundance = 6.561 - 0.515 (number of pools) + 73.72 (percent aquatic vegetation) - 0.27 (maximum water temperature) - 6.06 (temperature X vegetation interaction).

Movement and Growth of Recaptured PIT-tagged Suckers in Honey Creek

During the 2011 survey, we observed little net movement of the recaptured PIT-tagged fish. Eighty-six percent of the PIT-tagged suckers that we recaptured came from the same reach where they were tagged. The remaining suckers were recaptured from a reach adjacent to the one where they were tagged. We observed minimal growth of the recaptured suckers (mean: 5.1 mm, range: -3 to 17 mm). No PIT-tagged suckers crossed the fixed PIT antenna located at the downstream extent of our survey. Too few fin clipped suckers were recaptured (n=2) to assess small scale movements of suckers <100 mm.

Sucker Health

During the 2011 stream surveys, 31% of all of the suckers we handled had parasites and 11% had lesions. We noted infected fish throughout the subbasin and higher levels of infections as the summer progressed. The proportion of suckers with lesions and parasites increased from 7% and 11%, respectively, in the first pass to 15% and 53%, respectively, in the second pass. The most common parasites were fish lice (*Lernaea* sp.) and an unidentified trematode (black spots). Many lesions also had secondary fungal infections.

Warner Sucker Abundance in the Summer Lake Wildlife Management Area

The population of Warner suckers at the Summer Lake Wildlife Management Area was derived from natural production of adult suckers that were moved to the refuge when the Warner Lakes desiccated during the 1991 drought. The 2011 estimate using the Ricker (1975) single-sample procedures was 955 fish (95% CI: 713-1,277). This estimate was larger than, but not significantly different from the 2009 estimate of 660 fish (95% CI: 421-1,024) and both were significantly larger than the 2007 estimate of 142 fish (95% CI: 91-218). We also obtained abundance estimates using the Bayesian capture-recapture model for 2007 (342; 95% CI: 208-585), 2009 (851; 95% CI: 575-1,264), and 2011 (674: 95% CI: 459-985). We have minimal confidence in these latter estimates because of suspected annual differences in capture probabilities, probabilities that we were unable to quantify using the available data. The size distribution for suckers collected in 2009 and 2011 was broader and contained smaller fish than in 2007 (Figure 10), indicating recent successful recruitment at this location. We also noted larger numbers of 70 to 90 mm suckers in 2011 than in previous years. We did not observe any change in the quantity or quality of available habitat from 2007 to 2011.

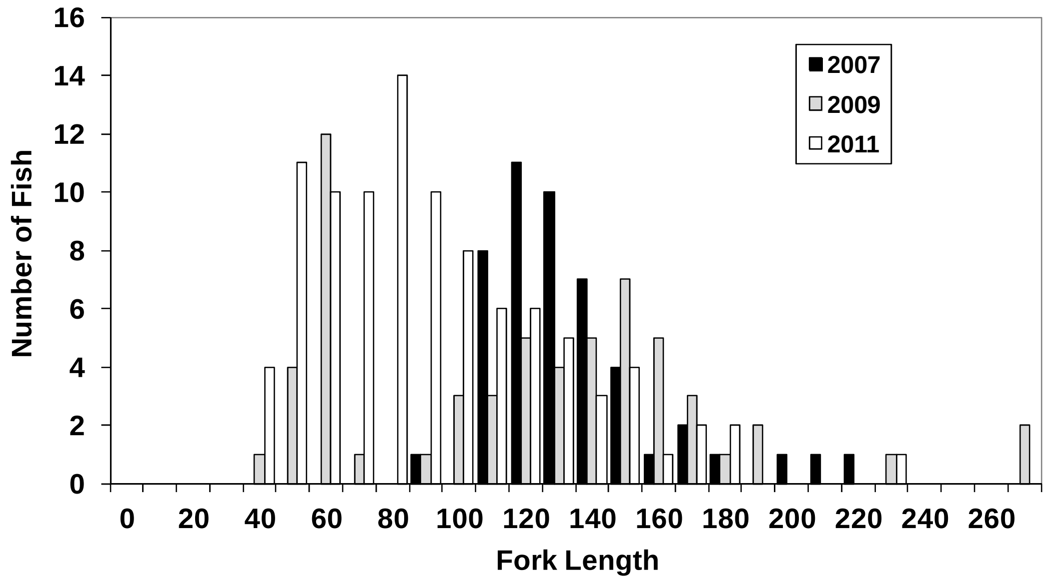


Figure 10. Length frequency histograms for Warner suckers captured at Summer Lake Wildlife Management Area in 2007, 2009, and 2011.

DISCUSSION

The Warner sucker was federally listed as threatened in 1985. Reasons for the listing included watershed degradation, irrigation diversion practices, and predation and competition from introduced fishes (U.S. Fish and Wildlife Service 1998). Irrigation dams and diversions limit movement and genetic exchange between lake and stream suckers by impeding both the upstream spawning migrations from the lakes into the streams and the downstream migration of fish into the lakes. Nonnative fishes limit recruitment in the lakes and lake suckers are periodically lost when the lakes desiccate. Stream suckers recolonize the lakes following desiccation (Allen et al. 1994) and are considered to be the stronghold for the metapopulation.

Abundance estimates for stream dwelling Warner suckers were first obtained in the 1990's. Tait and Mulkey (1993a; 1993b) and Tait et al. (1995) conducted snorkel surveys to estimate Warner sucker distribution and relative abundance in selected stream reaches in the Warner basin. They estimated 18 and 148 suckers per km in Honey Creek and Twentymile Creek, respectively (Tait et al. 1995) (Table 3). Their surveys were neither random nor comprehensive. For example, their surveys in Honey Creek stopped at the Twelvemile Creek confluence, downstream from where we found the highest densities of suckers. They acknowledged that snorkeling generally led to significant underestimation of actual abundance, but did not calibrate their estimates to adjust for this bias (Tait and Mulkey 1993a). Beginning in 2007, ODFW conducted electrofishing surveys (multiple pass depletion and mark-recapture) in the Warner tributaries on three occasions and obtained substantially higher sucker density estimates (Table 3) (Scheerer et al. 2007; Richardson et al. 2009; current study).

Table 3. Abundance estimates for Warner suckers in Warner basin tributaries in 1994, 2007, 2009, and 2011. Also listed is the distance of stream surveyed, the method used to estimate abundance, and the citation.

			Abundance estimate			
Water body	Year	Distance surveyed (km)	Fish per km	Estimate (95% CI)	Method	Citation
Honey Creek	1994	7.1	18		snorkle counts	Tait et al. 1995
	2007	2.9[a]	59	2,202 (418-3,986)	electrofishing, GRTS sample design	Scheerer et al. 2007
	2011	25.6		4,495 (3,668-5,448)	electrofishing, mark-recapture, Bayesian model	This study
	2011	25.6	176	2,105[b] (1,372-3,201)	electrofishing, mark-recapture, Ricker model	This study
Twentymile Creek	1994	9.3	148		snorkle counts	Tait et al. 1995
	2007	2.0[a]	237	4,746 (0-12,529)	electrofishing, GRTS sample design	Scheerer et al. 2007
	2009	21.3	219	4,612 (3,820-5,567)	electrofishing, mark-recapture, Ricker model	Richardson et al. 2009
Deep Creek	2007	0.7[a]	19	150 (0-438)	electrofishing, GRTS sample design	Scheerer et al. 2007

[a]The estimate was expanded for entire subbasin from the randomly sampled segments.

[b]This estimate includes suckers larger than 99 mm; all other estimates are for suckers larger than 59 mm.

In 2007, we used a spatially balanced, random sampling design (Generalized Random Tessellation Stratified or GRTS design), and estimated nearly 7,000 suckers in the Warner tributaries (Table 3) (Scheerer et al. 2007). The estimates had low precision, which was a result of the patchy distribution of stream suckers and high variability in fish density between sample locations. Due to this low precision, we conducted comprehensive mark-recapture surveys in 2009 and 2011. In 2009, we obtained an abundance estimate of approximately 4,600 suckers in Twentymile Creek drainage, with markedly improved precision. This estimate was nearly identical to the 2007 estimate. In 2011, we obtained an abundance estimate of approximately 4,500 suckers in Honey Creek using a Bayesian modeling approach and 2,100 suckers using single-sample mark-recapture procedures (Ricker 1975). We used the Bayesian modeling approach because the Ricker model has been found to underestimate abundance (Price and Peterson 2010) and we wanted to assess the magnitude of this bias. The Ricker model assumes equal capture probabilities among size classes, an assumption that is often violated (Peterson and Paukert 2009; Price and Peterson 2010). Because we calculated capture probabilities based on data collected for suckers in the eastern U.S. and used these in our Bayesian model, we plan to re-sample a section of Honey Creek (in segment 3) on multiple occasions in 2012 to estimate capture probabilities specific to Warner suckers, which will further improve the accuracy of our estimates. Obtaining accurate estimates will be essential for future effectiveness monitoring of proposed passage improvement projects.

In 2011, we noted a substantial reduction in the number of suckers captured in Honey Creek between successive electrofishing passes, which were conducted approximately one month apart. This reduction did not appear to be related to thermal stress, as stream temperatures remained relatively cool during the summer of 2011 (Figure 11) and well below 28°C, the upper temperature considered harmful for adult Klamath suckers (Wood et al. 2006). However, we noted that Snyder Creek was very turbid during our second pass and most of the submerged aquatic vegetation downstream of Snyder Creek had died. Previous investigators (Coombs et al. 1979; Tait et al. 1995) also documented high turbidity and low flows in lower Honey Creek and in Snyder Creek during the late summer months. Tait and Mulkey (1993a) reported a similar reduction in counts of juvenile suckers over a six week period between June and August 1992. The potential loss of a year-class is concerning and may represent a barrier to recovery. In 2012, we plan to evaluate whether there is an annual bottleneck to survival of juvenile suckers in Honey Creek using repeated sampling and length frequency analysis. If a bottleneck exists, managers may choose to address this issue before, or concurrent with, addressing stream passage issues.

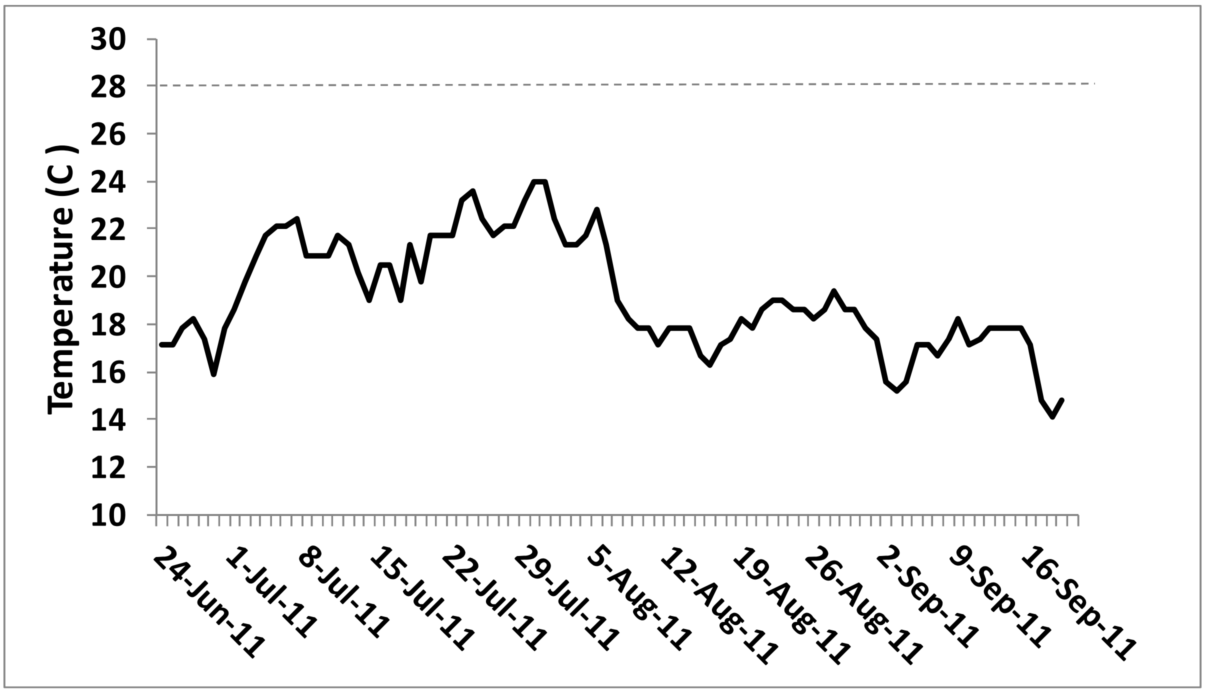


Figure 11. Maximum daily stream temperatures recorded in lower Honey Creek, summer 2011. The dashed line represents the thermal critical maximum temperature considered to be harmful to Klamath suckers (Wood et al. 2006).

During the current study and previous investigations (Tait and Mulkey 1993a, Scheerer et al. 2008; Richardson et al. 2009), researchers noted high incidences of external parasites, lesions and deformities. The most common parasite we observed was *Lernaea* sp. This parasitic copepod, commonly called fish lice, has no intermediate host and can easily spread among fishes. As water levels drop during the summer, available habitat is reduced and water temperatures typically increase, which may result in increased fish densities in suitable, available habitats. A combination of crowding and potential temperature-induced stress may increase the levels of infection. The U.S. Fish and Wildlife Service Fish Health Center, in coordination with ODFW Fish Pathology Section, will conduct a fish health investigation during the summer of 2012, collecting samples of fish from Honey Creek.

DeHaan and VonBargen (2011) recently completed a survey of the genetic diversity in tributary populations of Warner suckers and found no differences in the levels of genetic variation between populations, suggesting that no population currently faces an increased risk of threats from reduced genetic diversity. They also found that Warner suckers exhibited a relatively high level of genetic variation among the different tributaries (Twelvemile, Deep, Honey, and Snyder Creeks) and tests of allele frequency heterogeneity suggested that each tributary contained a genetically independent spawning population. These results, combined with the high levels of genetic variation documented among populations, as indicated by pairwise F_{ST} estimates, suggests that gene flow among Warner sucker populations is relatively low. This is not surprising considering the many passage barriers in the basin. In 2012, they plan to analyze samples from the Warner lakes and use genetic assignment tools to help infer individual movement patterns by assigning unknown origin fish from Hart and Crump lakes to their tributary of origin. This data may be useful for assessing the movement patterns of Warner suckers and determining the origin of the suckers recruited into the lakes.

We continued to monitor the refuge population of Warner suckers located at the Summer Lake Wildlife Management Area and found that the population was abundant with evidence of recent successful reproduction and recruitment. This population was established in 1991 during a prolonged drought when Hart and Crump Lakes desiccated completely. All individuals that were originally transferred from Hart Lake to the Summer Lake irrigation ditch were later moved to the USFWS Dexter Fish Technology Center in New Mexico, and subsequently died. The Summer Lake population was founded by the offspring of Hart Lake fish that successfully spawned in the Summer Lake irrigation ditch. Because refuge populations, established from small numbers of individuals, can result in low levels of genetic diversity in the refuge population (Mock et al. 2004; Stephen et al. 2005), we were concerned that individuals in the current Summer Lake population may be highly related if only a small number of adults originally spawned in the irrigation ditch. DeHaan and VonBargen (2011) obtained estimates of genetic diversity from several Warner sucker populations and found the levels did not differ significantly between Summer Lake and populations in the two tributaries (Honey and Snyder Creeks) that drain into Hart Lake. In addition, they did not observe an increased number of closely related fish in the Summer Lake population, suggesting that an increased risk of inbreeding was not likely in this population. Although the Summer Lake population has not been used to re-establish extirpated sucker populations, information on the level of genetic diversity in this population is important if the population is to be maintained and potentially utilized in the future to repopulate the Warner Basin population, following future periods of drought in the basin.

In 2012, we plan to conduct surveys in the Warner Lakes to determine whether there has been recent recruitment and to assess size (age) structures of both Warner suckers and other native and nonnative fishes. From 2007-2010, drought conditions existed in the Warner basin and the lakes nearly desiccated. In 2010, we documented a reduction in the number of nonnatives and apparent mortality of larger white crappies in Crump Lake (Scheerer et al. 2011), compared to 2006 and 2008 (Scheerer et al. 2006; 2008). This drought was followed, in the winter of 2010-2011, by peak flows of over 3,000 cfs and 500 cfs in the Twentymile and Honey Creek subbasins, respectively. Because we have been unable to document substantial directed downstream movement of stream suckers in the spring months(Scheerer et al. 2011), we hypothesize that these winter events may act to flush suckers downstream into the lakes and may be the current mechanism by which recruitment into the lakes occurs. Further, survival of these recruits may be enhanced by the reduced abundance of predatory nonnative fishes in the lakes that we noted in 2010

(Scheerer et al. 2011). We are curious whether we will see a proportional increase in the abundance of small suckers and native tui chub in the lakes in 2012, similar to the response following the drought in the early 1990's (Allen et al. 1996; Scheerer et al. 2008). If so, suppression of nonnatives in the lakes may be a management tool that could be used to enhance sucker recruitment. These lake surveys will also allow us to capture and PIT-tag lake suckers that can be useful in the near future when we monitor the effectiveness of passage projects in Honey Creek. We installed PIT antennas at the mouths of Honey and Deep Creeks from April-June, which will allow us to document whether the migratory life history of the lake suckers persists. If sufficient numbers of lake suckers still enter the creeks to spawn during wet years, it will help to justify the expense of installing upstream passage.

ACKNOWLEDGEMENTS

We gratefully acknowledge the efforts of the field crew, B. Berger, R. Long, and R. Smit. We deeply appreciate cooperation of private landowners in the Warner Basin who generously allowed us access to their land. Thanks also to D. Banks, Lakeview ODFW and J. Leal, Lakeview BLM for their assistance and support and to the U.S. Fish and Wildlife Service Hart Mountain Refuge for housing at the McKee trailer. Thanks to M. Falcy, ODFW for assistance with the multiple-regression analyses. This work was funded by USFWS, BLM, and Ruby Pipeline funds.

REFERENCES

Allen, C. S., A. Atkins, and M. A. Stern. 1994. Status and recolonization rates of the Warner sucker *(Catostomus warnerensis)* and other fishes in the Warner lakes in SE Oregon 1994. Report to U.S. Bureau of Land Management and Oregon Department of Fish and Wildlife. 22 p.

Allen, C. S., K. E. Hartzell, and M. A. Stern. 1996. Warner Sucker Progress Report- 1996 findings. Report to U.S. Bureau of Land Management. 55 p.

Coombs, C. I., C. E. Bond, and S. F. Drohan. 1979. Spawning and early life history of the Warner sucker *(Catostomus warnerensis).* Report to U.S. Fish and Wildlife Service, Sacramento, CA.

DeHaan, P., and J. VonBargen. 2011. Genetic analysis of threatened Warner suckers. Submitted to U.S. Army Corps of Engineers. 28 p.

Jackman, S. 2011. pscl: Classes and Methods for R Developed in the Political Science Computational Laboratory, Stanford University. Department of Political Science, Stanford University. Stanford, California. R package version 1.04.1. URL: http://pscl.stanford.edu/

Mock, K. E., E. K. Latch, and O. E. Rhodes. 2004. Assessing losses of genetic diversity due to translocation: long-term case histories in Merriam's turkey (Meleagris gallopavo merriami). Conservation Genetics 5(5):631-645.

O'Hara, R. B., and D. J. Kotze. 2010. Do not log-transform count data. Methods in Ecology and Evolution 1:118-122.

Peterson, J. T., and C. P. Paukert. 2009. Converting nonstandard fish sampling data to standardized data. Pages 195-212 *in* S. A. Bonar, W. A. Hubert, and D. W. Willis, editors. Standard methods for sampling North American freshwater fishes. American Fisheries Society, Bethesda, Maryland.

Price, A. L., and J. T. Peterson. 2010. Estimation and modeling of electrofishing and seining capture efficiency for fishes in wadeable warmwater streams. North American Journal of Fisheries Management 30: 481-498.

Richardson, S.E., P. D Scheerer, S. A. Miller, S. E. Jacobs, G. Swearingen, B. Berger, J. Deibner-Hanson, J. Winkowski, M. Terwilliger, and P. Hayden. 2009. Warner Sucker Investigations (2009). Oregon Department of Fish and Wildlife, Contracts: 13420-08-J814 (USFWS), LO9PX00618 (BLM), and W66QKZ90227848 (ACOE). Annual Progress Report, Salem. 33p.

Scheerer, P. D., S. E. Jacobs, and A. V. Munhall. 2006. 2006 Warner Valley fish investigations- Warner suckers. Oregon Department of Fish and Wildlife, Annual Progress Report, Salem. 20 p.

Scheerer, P. D., M. P. Heck, S. L. Gunckel, and S. E. Jacobs. 2007. Warner sucker stream investigations- Warner suckers. Oregon Department of Fish and Wildlife, Contracts HLP073006 (BLM) and 134206M086 (USFWS), Annual Progress Report, Salem. 15 p.

Scheerer, P. D., S. E. Jacobs, K. Bratcher, G. Swearingen, and S. Kramer. 2008. Warner Valley fish investigations- Warner suckers. Oregon Department of Fish and Wildlife, Contracts: HLP083003 (BLM), E-2-50 and 134207M085 (USFWS), W66QKZ-8094-612 (ACOE), and T-17-1 (Conservation Strategy), Annual Progress Report, Salem. 37p.

Scheerer, P. D., S. E. Jacobs, M. Terwilliger, S. A. Miller, S. Gunckel, S. E. Richardson, and M. Heck. 2011. Status, distribution, and life history investigations of Warner suckers, 2006-2010. Oregon Department of Fish and Wildlife, Information Report #2011-02, Salem. 78 p.

Spiegelhalter, D., A. Thomas, and N. Best. 2006. WinBUGS, version 1.4. MRC Biostatistics Unit, Cambridge, United Kingdom. URL: http://www.mrc-bsu.cam.ac.uk/bugs/welcome.shtml.

Stephen, C. L., D. G. Whittaker, D. Gillis, L. L. Cox, and O. E. Rhodes. 2005. Genetic consequences of reintroductions: An example from Oregon prong horn antelope (Antilocapra americana). Journal of Wildlife Management 69(4):1463-1474.

Tait, C. K., and E. J. Mulkey. 1993a. Assessment of biological and physical factors limiting distribution of stream-resident Warner suckers (*Catostomus warnerensis*). Unpublished report to U.S. Bureau of Land Management and Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife Service. 35 p.

Tait, C. K., and E. J. Mulkey. 1993b. Estimation of stream-resident Warner sucker abundance and total habitat area in two basins using a statistically valid sampling design. Unpublished report to U.S. Bureau of Land Management and Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife Service. 40 p.

Tait, C. K., L. J. Hatley, and R. E. Gaither. 1995. Estimation of stream-resident Warner suckers (*Catostomus warnerensis*) abundance and distribution in summer, 1994. Unpublished report to U.S. Bureau of Land Management and Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife Service. 28 p.

U.S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants; Determination that the Warner Sucker is a threatened species and designation of critical habitat. Federal Register 50(188):39117-39123.

U.S. Fish and Wildlife Service. 1998. Recovery Plan for the Native Fishes of the Warner Basin and Alkali Subbasin. Portland, Oregon. 86 p.

White, R. K., T. L. Ramsey, M. A. Stern, and A. V. Munhall. 1991. Salvage operations and investigations of the range and stream habitat characteristics of the Warner sucker, *Catostomus warnerensis*, during spring and summer, 1991. Report to U.S. Bureau of Land Management, Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife Service. 44 p.

White, R. K., T. R. Hoitsma, M. A. Stern, and A. V. Munhall. 1990. Final report of investigations of the range and status of the Warner Sucker, *Catostomus warnerensis*, during spring and summer 1990. Report to U.S. Bureau of Land Management, Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife Service. 66 p.

Wood, T.M., Hoilman, G.R., and Lindenberg, M.K., 2006, Water-quality conditions in Upper Klamath Lake, Oregon, 2002–04: U.S. Geological Survey Scientific Investigations Report 2006-5209, 52 p.

Zeileis, A., C. Kleiber, S. Jackman. 2008. Regression Models for Count Data in R. Journal of Statistical Software 27(8). URL http://www.jstatsoft.org/v27/i08/.

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