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2014 Warner Sucker Investigations (Lower Twentymile Creek)

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Photograph of a hoop net set in a deep pool in lower Twentymile Creek.

Paul D. Scheerer[1], James T. Peterson[2], and **Shaun Clements[1]**

[1]Oregon Department of Fish and Wildlife, 28655 Highway 34, Corvallis, Oregon 97333

[2]USGS Oregon Cooperative Fish and Wildlife Research Unit, 104 Nash Hall, Oregon State University, Corvallis, OR 97331

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CONTENTS

Abstract— Warner suckers (*Catostomus warnerensis*) are endemic to the lakes and tributaries of the Warner basin, southeastern Oregon. The species was listed as threatened by the U.S. Fish and Wildlife Service in 1985 because of habitat fragmentation and the threats from introduced non-native fish. Recent recovery efforts have focused on providing passage at irrigation diversion dams that limit sucker movement within the Warner basin. To provide a baseline to assess the effectiveness of passage restoration activities in lower Twenty Mile creek we: 1) obtained a population estimate for suckers in the lower Twentymile Creek drainage, 2) described their current distribution, and 3) tagged suckers with a passive integrated transponder (PIT) to assess future passage success at the Dike irrigation diversion. We captured fish using three gear combinations (backpack electrofishing, hoop nets, mobile PIT antenna). We used a Bayesian Jolly-Seber (J-S) open population estimator to estimate sucker population size, apparent survival, and immigration. We installed a fixed, flat-plate PIT-tag antenna near the upstream boundary of the survey to evaluate the timing and numbers of suckers moving upstream during our study. We estimated there were 482 suckers in lower Twentymile Creek. We estimated an apparent survival of 88% over the duration of the study and an 8% immigration rate. We found some evidence that fish length was positively related to survival, no evidence that the apparent survival of translocated fish differed from those residing in the study area, no evidence that capture probabilities differed with the number of hoop net sets, and no evidence that hoop net capture probabilities differed from the probability of detection with the mobile PIT antenna. We only detected one sucker at our fixed PIT antenna. We PIT tagged a total of 147 suckers that we can monitor in 2015 to assess passage success at the newly reconstructed Dike Diversion.

INTRODUCTION

The Warner sucker 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 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.

Recently, there have been several efforts to provide fish passage at barriers throughout the basin to address criterion 2. Twentymile Creek has at least 3 barriers to fish passage including Greaser Reservoir, the MC Diversion, and the Dike Diversion. To partially address passage issues in this basin, the Lake County Watershed Council, the BLM, and River Design Group worked with contractors to modify the Dike Diversion this winter. To inform progress towards criteria two, and provide baseline data to assess the effectiveness of modifications to the Dike Diversion, our objectives in 2014 were to: 1) obtain a population estimate for suckers in the lower Twentymile Creek drainage, 2) describe their current distribution, and 3) tag suckers with a passive integrated transponder (PIT) to assess future passage success at the Dike irrigation diversion.

METHODS

In the spring of 2014, we surveyed the fish assemblage and habitat in a 3.15 km section of lower Twentymile Creek between the Cahill wing deflector and the Dike irrigation diversion (Figure 1). This stream section (sample frame) was divided into ~500 m long, contiguous survey reaches. Reach breaks coincided with habitat breaks (i.e., we did not end a site in the middle of a pool) and thus were often slightly greater or less than 500 m. We marked the lower boundary of each reach by placing a metal-staked flag on the right bank, just above the water's edge, and recorded both the upper and lower boundary coordinates using a hand held Global Positioning System (GPS). The study area was bound on the upstream end by an impassable irrigation diversion dam (Dike diversion). Additionally, a second irrigation diversion dam (MC diversion) was located 1.65 km upstream from the beginning of the study area. This unscreened dam diverted all of the water into an irrigation canal and nearly desiccated the lower section of the surveyed area. Precipitation during 2013 and 2014 was sparse and stream flows during the spring of 2014 resembled typical late summer flows.

We captured fish using three gear combinations from 28 April through 18 June. The capture probability for Warner suckers is very low when using backpack electrofishing (Scheerer et al. 2013). To increase the catch of suckers and compare capture efficiency of a range of techniques, we used a combination of backpack electrofishing, mobile PIT antenna tracking, and hoop nets. We surveyed the entire sample frame (downstream to upstream) 13 times. We conducted four electrofishing surveys (single pass, upstream), one every two weeks during the sampling period (weeks one, three, five, and seven). During each survey, we used the same approximate fishing effort and each survey took 2–3 d to complete. During each electrofishing survey, we divided each stream reach into 100 m sections and conducted a single upstream pass in each section. All fish were netted and placed in an aerated bucket until processing. At the upstream end of each 100 m section, we anesthetized all suckers using methyl sulfonate (20 g/L) buffered with sodium bicarbonate (20 g/L), measured fork length (FL) to the nearest 1 mm, scanned each sucker for

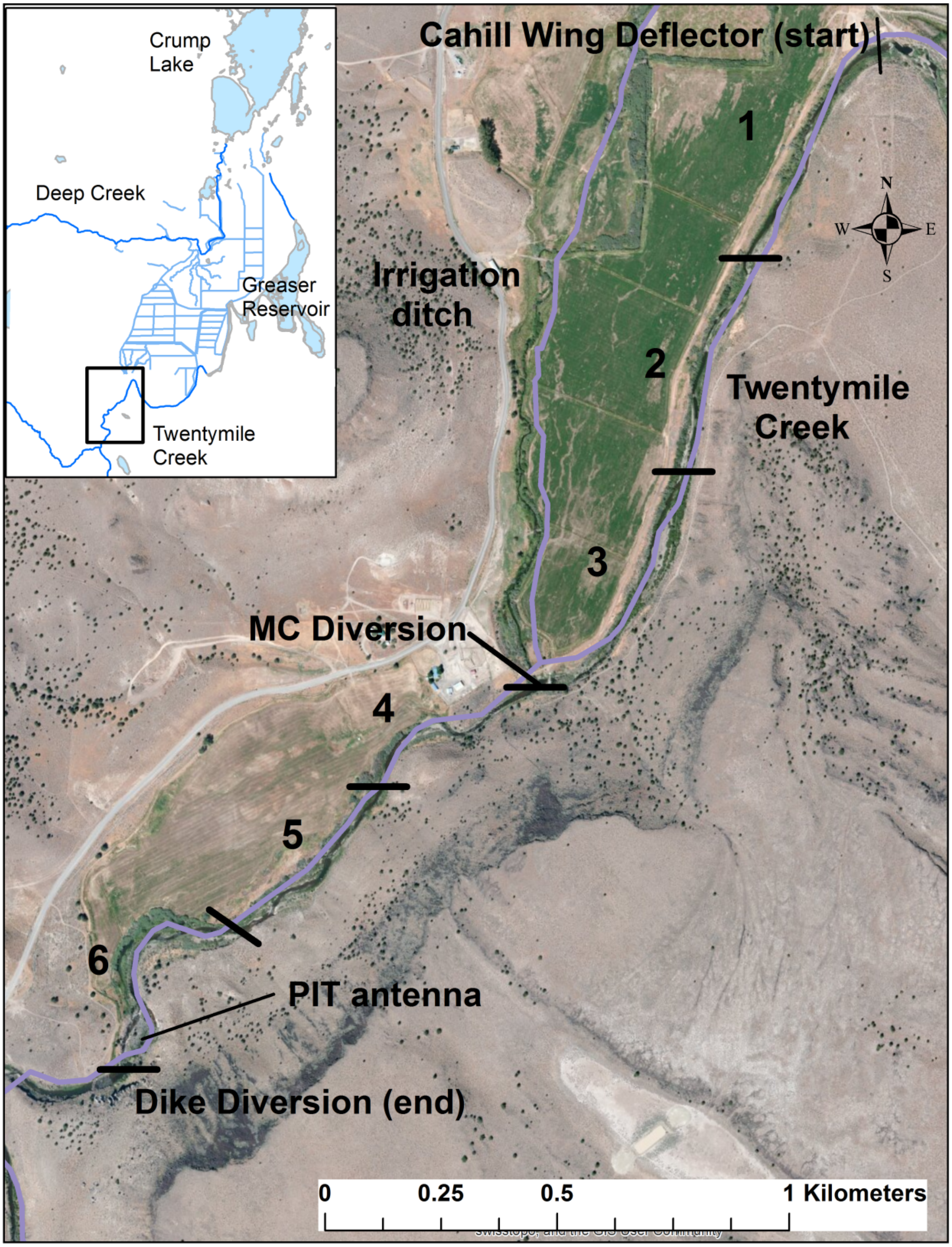

Figure 1. Study area sampled in lower Twentymile Creek in 2014. Reach boundaries are marked with dark bars and reaches are numbered. The stream flows from the Dike diversion (reach 6) towards the Cahill wing deflector. The inset map shows the study area (rectangle) relative to irrigation ditches, Greaser Reservoir, Deep Creek, and Crump Lake.

previously-implanted PIT tags using a hand-held PIT tag reader, and recorded detections of PIT tags when observed. We marked all un-tagged suckers ≥60 mm FL with half-duplex PIT tags in the anterior ventral side of the body cavity. We implanted a 12 mm PIT tag in 60-99 mm suckers and a 23 mm PIT tag in suckers ≥100 mm. We double marked each sucker with a partial upper caudal fin clip. We recorded the approximate numbers of other fish species collected. After processing, we released the fish back to the 100 m stream section from which they were captured. During subsequent surveys, we scanned each fish for an existing PIT tag, looked for fin clips, recorded the number of tagged and un-tagged suckers, and recorded the PIT-tag number when one was detected. If no PIT tag was detected, we installed one as described above.

We sampled a portion (~33%) of the deep pools in the sample frame using six-panel hoop nets (0.92 m diameter, 13 mm mesh) that had either a single 15.2 m lead or dual 7.6 m wings (13 mm mesh). The majority of pools were located upstream of the MC diversion (where the stream was flowing). We set 6 to 8 nets/day during weeks one through six and 18 nets/day during week seven. We fished the nets overnight (three to five net sets per week) for seven weeks. The number of overnight sets per week varied slightly. We removed the hoop nets from the stream at least 48 hours prior to when electrofishing was conducted. We set nets in the same pools during weeks 1-6. During week seven, we set nets in additional (shallower) pools in the study frame. We combined the weekly catch from all hoop nets and counted this as one hoop net pass. We processed the fish as described above.

During week 8, we surveyed the entire sample frame with a mobile PIT antenna (two consecutive daily passes). We recorded the tag number and Universal Transverse Mercator (UTM) coordinates when a PIT tag was detected. The typical tag read range using this mobile PIT antenna was approximately 0.75 m for the 23 mm tags and 0.5 m for the 12 mm tags (estimated using test tags).

During our initial (week 1) of electrofishing and hoop netting, we had low sucker catch rates. Such low catch rates would limit our ability to obtain precise estimates of recapture rates (and estimates of capture/recapture probabilities) and assess passage success at the Dike Diversion. So, starting in week 2, we captured suckers outside of the study area and relocated them into the study area. We set hoop nets and electrofished pools to capture the suckers, inserted PIT-tags, and released them into known pools in the study area.

We installed a fixed, flat-plate PIT-tag antenna near the upstream boundary of the survey (~100 m downstream of the Dike diversion) to evaluate the timing and numbers of suckers moving upstream during our study. We tested antenna performance and downloaded data weekly.

Following the third electrofishing pass, we collected habitat data in each 500 m stream reach including: wetted width (m), average depth (m), maximum depth (m), aquatic vegetation (as a percentage of total surface area), dominant substrate type, percent pools, and number of pools. We took width, depth, substrate, and aquatic vegetation measurements at transects located 50, 150, 250, 350, and 450 m from the downstream boundary of each reach. We calculated average depth at each transect 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. We waded through each 100 m stream section and recorded the single deepest water depth (maximum depth). 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 (<0.063 mm), sand (0.063-2 mm), gravel (3-64 mm), cobble (65-256 mm), boulder (>256 mm), bedrock (native consolidated rock), or embedded. We recorded stream temperature at the beginning and end of the 500 m reach, recorded UTM coordinates, and took photographs. We also recorded stream temperatures at the beginning and end of each sampling day throughout the study.

Data analysis

The fish sampling took place over eight weeks. Thus, the closure assumptions required by closed capture population estimators (i.e., no immigration, emigration, births or deaths) may have been violated. Additionally, there is substantial heterogeneity in sucker capture probabilities (Scheerer et al. 2013). In the current study, fish were captured and recaptured using multiple gears, and marked fish (only) were detected using an antenna. The latter meant that the probability of detection for unmarked fish using the mobile antenna was zero. Finally, fish captured outside of the study area were moved to locations within the study area. To analyze this complex data, we used a Bayesian Jolly-Seber open population estimator (Kéry and Schaub 2011) to estimate sucker population size, apparent survival, and immigration, also termed probability of entry. The model estimates apparent survival, as opposed to true survival, because it cannot distinguish mortality from emigration (i.e., a fish leaving the study area during the sample period). This approach can also be used to model the demographic rates and capture probabilities using covariates and can incorporate additional variation (heterogeneity) in model parameters using random effects. The random effects in our model represented unique effects associated with each capture occasion and each individual fish on the model parameters that were unexplained by the covariates. Abundance was estimated during model fitting using data augmentation (Kéry and Schaub 2011). All models were fit with Markov Chain Monte Carlo (MCMC) methods in WinBUGS version 1.4 (Lunn et al. 2000) with 225,000 iterations with 30,000 burn in samples as determined by a Gibbsit analysis (Raftery and Lewis 1996).

We were primarily interested in obtaining the best predicting model of demographic rates, capture probability, and population size. Therefore, we constructed global models for each model parameter. The global capture probability model contained: sampling method, number of hoop net sets, fish total length, and two random effects corresponding to sample occasion and individual fish. The global apparent survival and immigration models contained fish total length, whether or not a fish was relocated into the study area, and a random effect corresponding to each interval between sample occasions. To account for the movement of fish into the study area, immigration (or probability of entry) for each relocated fish was fixed at zero for the intervals prior to stocking and was fixed at one for the interval corresponding to the stocking event. To accommodate the large number of parameters and avoid problems with the lack of parameter identifiability, we conducted model selection for each parameter individually. Here we modeled two parameters as constant and fit all subsets of the global model for the remaining parameter. The best approximating model for each parameter was determined using Deviance Information Criteria (DIC; Spiegelhalter et al. 2002). We then combined the best approximating models for each parameter in a single model and evaluated all subsets of the combined model to determine the best approximating Jolly-Seber model. We report the parameter estimates and random effects (expressed as variance components) from the best approximating model and express precision of the estimates using 95% credible intervals, which are equivalent to 95% confidence intervals.

RESULTS

Lower Twentymile Creek is low gradient (<1%) and flows through private agricultural hay fields and pasture lands. During the winter of 2013 and spring of 2014, the Warner basin experienced below average precipitation, snow pack, and stream flows (Oregon Climate Service 2014; Oregon Water Resources Department 2014). Also, over the duration of our study, stream flow declined and the lower 1.65 km of the creek downstream of the MC diversion became puddled.

Within the sample frame, Warner suckers were only captured in five deep pools and the majority (65%) were collected from one particularly deep pool (>2 m), located in reach 5 (Figure 2). We captured and PIT tagged a total of 147 suckers, 75 from the study reach and 72 from pools outside of the study reach. Fish ranged in size from 60-245 mm FL, with at least two age-classes (Figure 3). We captured the majority of the suckers using hoop nets (Table 1). Also, we did not observe any PIT tag loss of double tagged fish. Habitat characteristics for the study reaches are shown in Table 2. Note, stream habitat parameters changed somewhat with declining stream flows during the study. The deepest pools remained, but shallow runs became riffles and some shallow vegetated habitat was lost.

Table 1. Weekly Warner sucker catch from hoop nets, backpack electrofishing, and detections using the mobile PIT antenna.

	Hoop nets			Electrofishing			Mobile PIT tag antenna	
Week of	Trap nights	Number of suckers	Number of recaptures	Pass	Number of suckers	Number of recaptures	Pass	Number of suckers
April 28	9	8	0	1	7	0		
May 5	16	2	0					
May 12	22	11	2	2	3	1		
May 19	22	8	1					
May 26	14	5	4	3	6	1		
June 2	23	14	3					
June 9	64	41	13	4	3	1		
June 16							1	17
June 16							2	20
	170	89	23	4	19	3		37

Table 2. Habitat characteristics of the reaches sampled in lower Twentymile Creek in 2014. Stream flows were defined as puddled (series of isolated pools connected by subsurface flow) or low (surface water flowing across 1-75% of the active channel width (Oregon Department of Fish and Wildlife 2013). Reach 6 includes ~200 m of secondary channel.

Reach	Length	Average width	Average depth	Maximum depth	Dominant substrate	Number of pools	Percent pools	Percent aquatic vegetation	Stream flow
1	500	7.2	0.31	2.00	fines	7	86.0	22.0	puddled
2	500	7.4	0.35	2.00	gravel	9	76.0	22.0	puddled
3	650	7.5	0.26	1.10	boulders	8	53.3	18.3	puddled
4	500	10.3	0.43	2.00	boulders	7	76.0	18.0	low
5	500	11.5	0.28	2.70	gravel	6	52.0	20.0	low
6	700	13.9	0.43	2.00	bedrock	6	34.0	16.0	low
	3350	9.8	0.34						

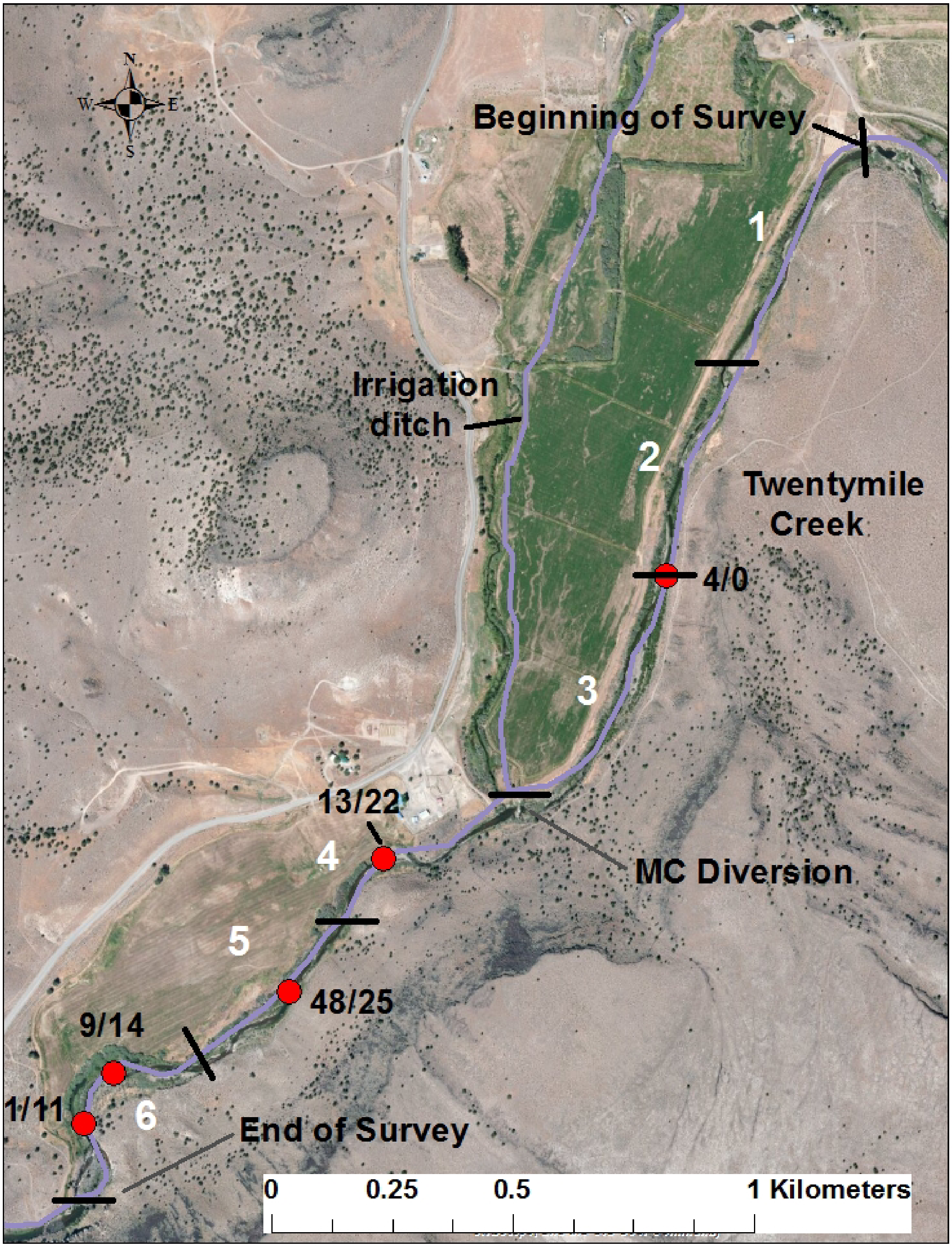

Figure 2. Distribution of Warner suckers in Twentymile Creek, 2014. Numbers in black represent the number of suckers captured in each pool followed by the number of suckers translocated into each pool from outside of the study frame. Red dots are pool locations. Black lines are reach boundaries and the white numbers are the reach numbers.

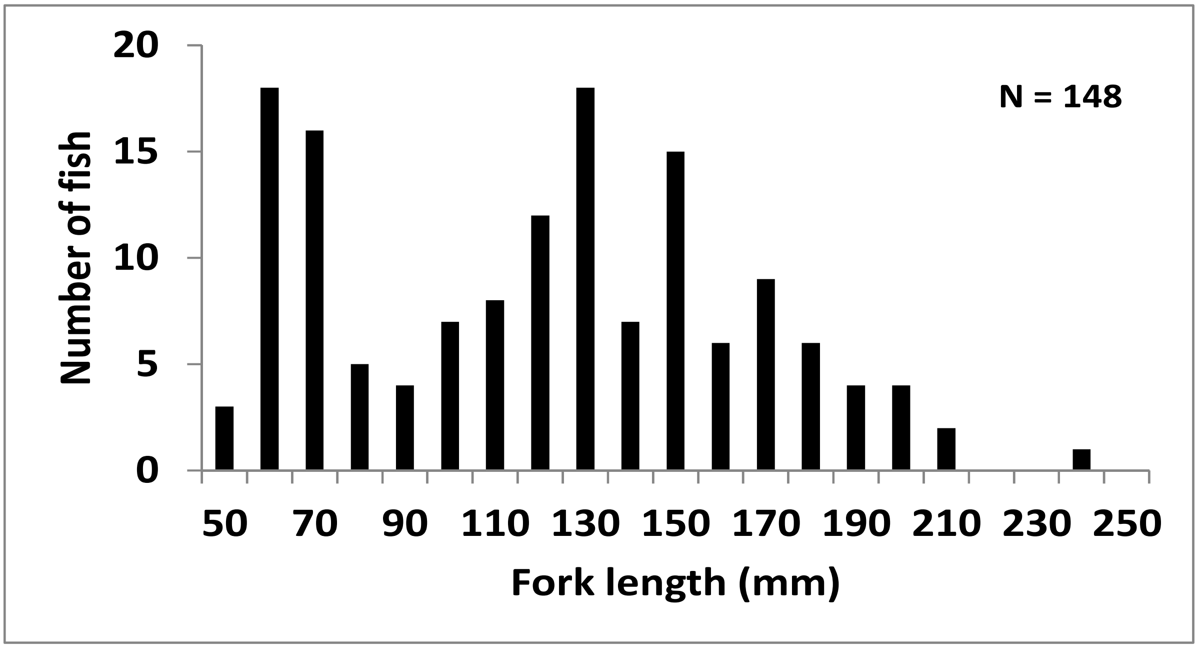

Figure 3. Length-frequency histogram for suckers captured in the sample frame in Twentymile Creek, 2014.

We estimated there were 482 suckers (95% CI: 368-638) within the sample frame in Twentymile Creek. The best approximating Jolly-Seber model contained constant apparent survival and immigration rates and modeled capture probability as a function of electrofishing, an electrofishing by total length interaction, and random effects corresponding to capture occasion and individual fish (Table 3). In the model, the capture probability for hoop nets (12.4%) was substantially larger than that for electrofishing, which varied by fish length from 1.2% for 40 mm suckers to 5.2% for 140 mm suckers (Figure 3). We estimated an apparent survival of 88% (95% CI: 81-93) over the duration of the study and an 8% immigration rate (95% CI: 5.0-13.6) (Table 3).

Model selection criteria suggested that there was some evidence that fish length was positively related to survival (ΔDIC = 3.251), but the parameter estimates were relatively wide and contained zero. In contrast, there was no evidence (ΔDIC > 10) that the apparent survival of stocked fish differed from those residing in the study area. Model selection also indicated no evidence that capture probabilities differed with the number of hoop net sets or that hoop net capture probabilities differed from the probability of detection with the mobile PIT antenna.

We only detected one Warner sucker at the fixed PIT antenna downstream of the Dike diversion. This juvenile sucker (136 mm TL) was originally captured and tagged upstream of the Dike Diversion, was transferred into the beaver pool in reach 5 on 8 May 2014, and was detected at the fixed antenna on 10 May 2014. The movement coincided with a period of higher stream discharge and cooler stream temperature, relative to the rest of the study period (Figure 4). Note that maximum stream discharge in 2014 was approximately 10% of the maximum recorded during typical (wetter) years and that immediately downstream of the PIT antenna, there is a cascade over bedrock that likely limits upstream movement during low flow periods.

Table 3. Model parameters and estimated capture probabilities for Warner suckers in the sample frame in Twentymile Creek, 2014.

Parameter	Mean	SD	Lower 95% CI	Upper 95% CI
Abundance	482	67.51	368	638
Immigration	0.079	0.022	0.050	0.136
Survival	0.887	0.033	0.810	0.930
Capture/detection probability[1]				
Intercept (hoop nets)	-1.953	0.427	-2.807	-1.136
Electrofishing	-3.059	0.990	-4.974	-1.110
Electrofishing x Total length	0.015	0.006	0.004	0.026
Random effects				
Sample occasion	1.112	0.350	0.614	1.969
Individual fish	0.576	0.233	0.184	1.080

[1]Parameters correspond to logit linear model.

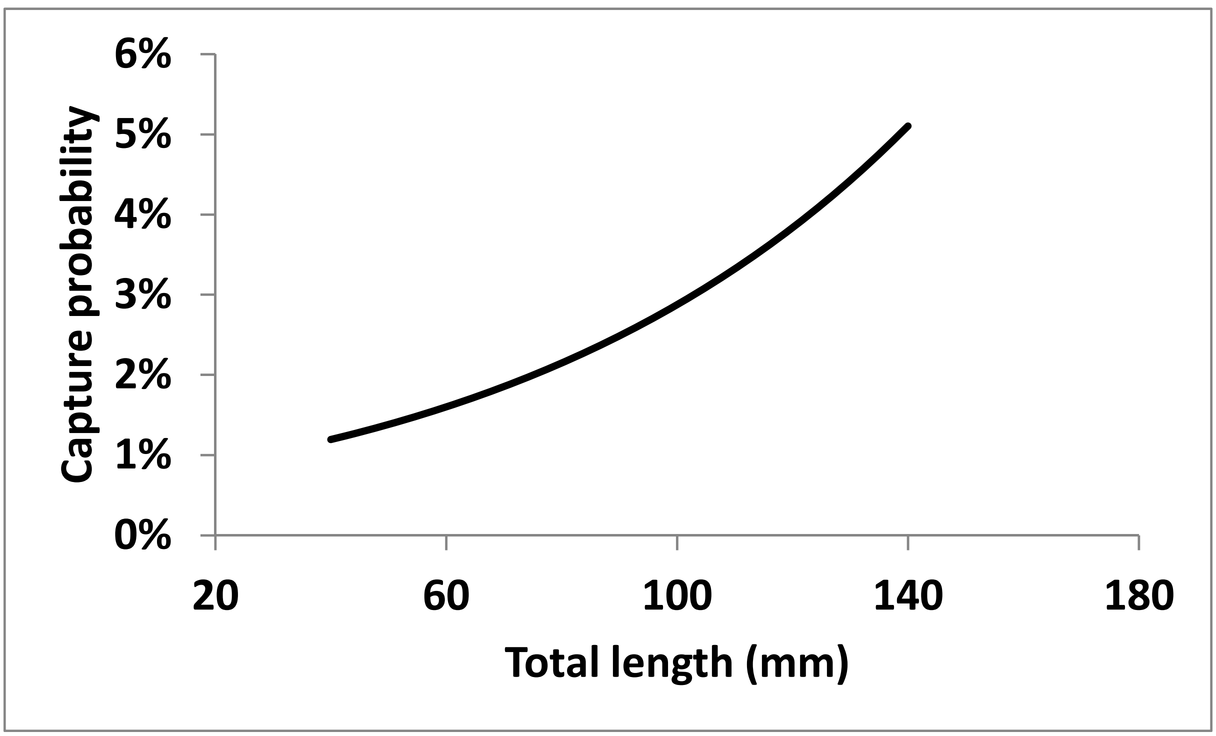

Figure 3. Electrofishing capture probability, estimated from the best approximating model, for Warner suckers.

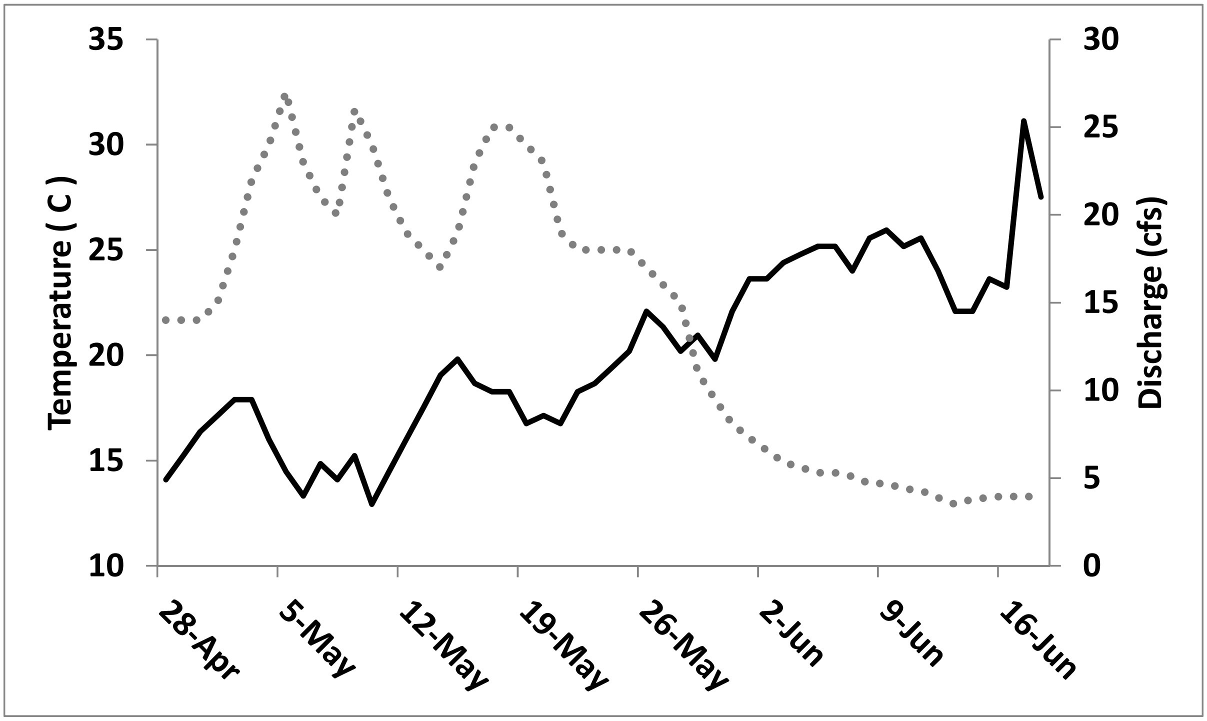

Figure 4. Maximum daily stream temperatures (solid line) and discharge (dotted line) for Twentymile Creek, from late-April through mid-June 2014.

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 within tributaries, between tributaries, and between lake and stream suckers. Recent recovery actions have focused on improving passage by replacing or reconstructing aging irrigation withdrawal structures, most of which were constructed decades ago without fish ladders or screening.

In 2014, we estimated there were 482 suckers (95% CI: 368-638) in the sample frame in lower Twentymile Creek, which was similar to our 2009 estimate of 677 suckers (299-1,334) (Richardson et al. 2009). Additionally, we PIT-tagged 147 suckers to monitor passage success at the reconstructed Dike Diversion in 2015. The suckers in this lower stream segment represent a small proportion (15%) of the total population in the drainage; the majority reside in the stream segment located immediately upstream of the Dike diversion (Richardson et al. 2009). In 2008, the original Denil ladder at this diversion was not passing suckers (Scheerer et al. 2008) and was therefore acting to fragment this population. In 2009, we documented a mass upstream movement of PIT-tagged suckers during the late spring spawning period in the stream segment above the diversion (Richardson et al. 2009). However, we did not detect suckers that were tagged downstream of the Dike diversion in this upper stream segment, so concluded that these upstream spawning areas were inaccessible to suckers residing below the Dike diversion (Richardson et al. 2009; Scheerer et al. 2011). It is uncertain whether suitable spawning areas for suckers exist below the diversion.

In the winter of 2014-2015, contractors removed the old Denil ladder at the Dike Diversion and replaced it with one that is intended to facilitate passage of suckers. The current design has a gentler slope and consists of a series of ten pools. Each pool has an orifice located near the bottom corner of each weir wall for sucker passage and a notch at the top for redband trout passage (APPENDIX A). Cobble substrate was added to the ladder to increase roughness, which has been shown to improve sucker passage success (Bailey 2004).

In 2015, we plan to monitor Warner sucker passage effectiveness at the Dike Diversion. We will install PIT-tag antennas in the ladder entrance, exit, and a short distance downstream of the structure to monitor movement of PIT-tagged suckers. We will use hoop nets to capture and PIT-tag additional suckers and use the mobile PIT antenna to see whether suckers tagged in 2014 are still in the reaches downstream of the diversion. By translocating some of the PIT-tagged suckers from pools outside the study area (upstream), we may alter their migratory behavior. We will evaluate this by comparing the passage success and timing of the translocated versus the non-translocated suckers in 2015. These data will allow us to describe the timing and magnitude of sucker movements and to assess whether modifications in the design of this and future passage structures is warranted.

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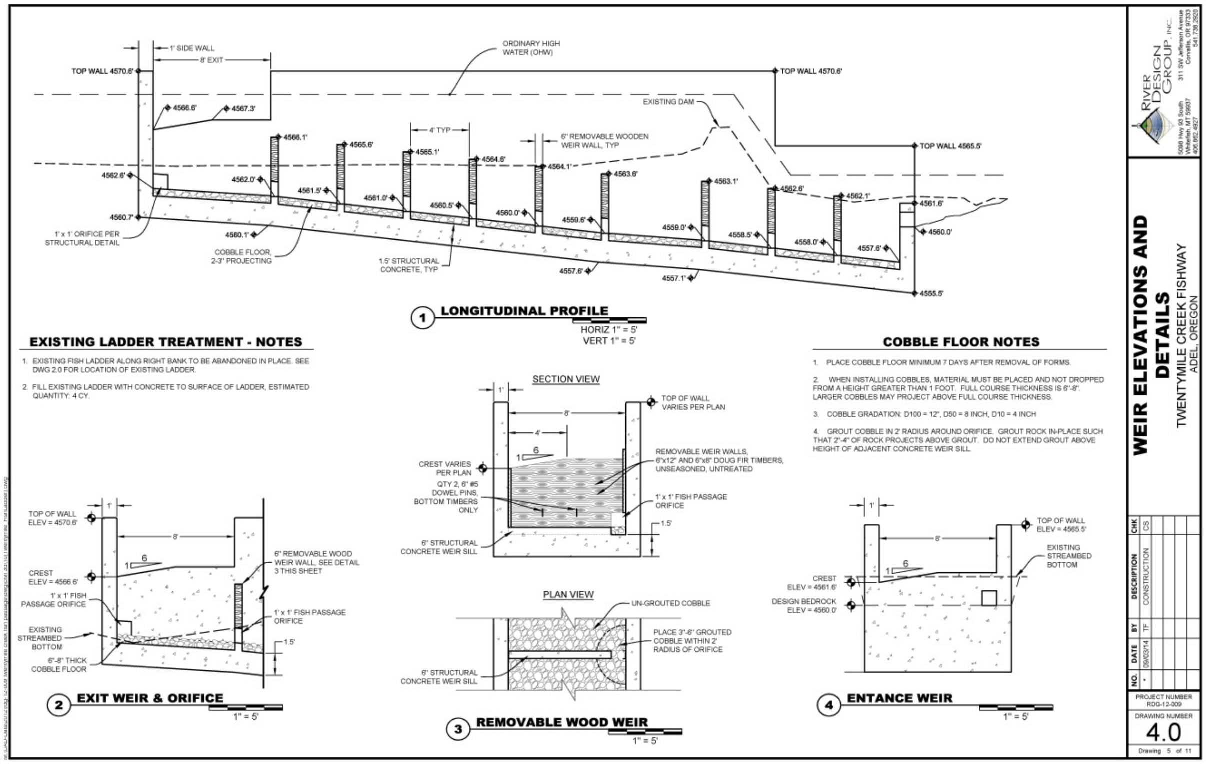
APPENDIX A. Dike diversion fishway design (top) and photograph of fishway (bottom).



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4034 Fairview Industrial Drive SE

Salem, Oregon 97302