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Population Assessment of Lahontan Cutthroat Trout, 2005

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INTRODUCTION

Five of the six native Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) populations in Oregon exist in the Coyote Lakes basin of southeast Harney County (ODFW 2005). The major drainages in the Coyote Lakes Basin are Willow and Whitehorse Creeks. Both drainages originate on the north slope of Trout Creek Mountain, terminate in the dry Coyote lake bed and are currently isolated from each other or any other basin. Populations of Lahontan cutthroat in Willow and Whitehorse Creeks have been protected under the ESA as a threatened species since 1991 and are also listed as threatened under State of Oregon statute (Hanson et al.1993).

Along with changes in management and land use activities, the federal recovery plan for Lahontan cutthroat trout requires the assessment of habitat conditions and population abundance at five year intervals (Coffin and Cowan 1995). Population monitoring of cutthroat in Willow and Whitehorse creeks was initiated in 1985 and has occurred on a five year interval since then (Jones et al. 1998, ODFW Aquatic Inventory Project unpublished data). The goals of this project was to continue population monitoring by obtaining an estimate of Lahontan cutthroat trout in Willow Creek and Whitehorse Creek, and to test the application of the EMAP sampling design (Stevens and Olsen 2004) to obtain this estimate. Additionally, we determined distribution of cutthroat trout in tributaries where presence was suspected but not verified, and monitored dirstribtuion of the Antelope Creek populations.

METHODS

We employed the Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP) sample design which evaluates status, trend, and distribution of species over a large landscape with a desirable degree of statistical rigor. The EMAP design is a probabilistic sampling strategy that ensures a representative sample by a random and spatially balanced site selection method (Stevens 2002, Stevens and Olsen 2004). Further, the EMAP design takes into account spatial patterns of resource distribution when calculating estimates of variance to provide higher precision for a given level of sampling effort (Stevens and Olsen 2002).

Our sample frame was based on a 1:24,000 digital stream coverage. Potential Lahontan cutthroat trout distribution totaled 110 km (Figure 1) and was determined by consulting ODFW biologists and examining past sampling efforts. Because beaver pond size and numbers have increased substantially over the past 10 years (Talabere 2002, ODFW Aquatic Inventory Project unpublished data, Jones et al. 1998) and variance among beaver ponds is relatively high (Talabere 2002), the sample frame was divided into two strata, beaver pond and free-flowing stream. To delineate the beaver pond strata we conducted a comprehensive inventory a week prior to sampling. Crews walked the entire sampling frame and upper and lower bounds of all beaver ponds and beaver pond complexes were located, recorded, and mapped using GPS and GIS technology. Once the locations of each frame were determined we used GIS to classify candidate sites among the two strata. To allow for some flexibility to accommodate lack of access at some sites we classified more sites than we planned to sample.

Based on logistical considerations, we planned on sampling 50 sites to obtain population estimates. To achieve optimum expected precision of the overall estimate we used the following equations to allocate sites among the two strata:

$$n_B = n\frac{\sigma_B L_B}{\sigma_B L_B + \sigma_F L_F}$$

$$n_F = n\frac{\sigma_F L_F}{\sigma_B L_B + \sigma_F L_F}$$

where,

n_B = number of samples for beaver pond stratum
n_F = number of samples for free-flowing stratum
σ_B = the expected standard deviation for beaver ponds (0.816),
σ_F = the expected standard deviation for the free-flowing reaches (0.247),
L_B = the total stream length for beaver ponds,
L_F = total stream length for the free-flowing reaches, and
n = the total number of sample

Sampling proceeded among sites within each stratum along a predetermined order. This order ensured that sites selected for sampling followed a random spatially-balanced spatial distribution. Sites that could not be sampled because of logistical issues were replaced with the next highest priority.

Beaver pond sample sites consisted of one discrete beaver pond, and free-flowing sites measured 30 active channel units and included a mix of habitat types. Field crews set block nets at the upstream and downstream bounds of each site. Two-pass depletion – removal estimates were conducted at each site using backpack electro-shockers and a 50% reduction criterion between passes for age 1+ cutthroat trout. A pass consisted of a slow, deliberate progression from the downstream to the upstream net, and a quick return sweep back to the downstream net. To evaluate the accuracy of removal estimates at beaver pond sites having deep and complex pools, we attempted to obtain mark-recapture population estimates. To obtain these estimates we marked all fish captured during electrofishing with a partial caudal clip and returned them to the sample reach. The following day the site was electrofished and all fish captured were inspected for caudal fin clips. Captured fish were measured for fork length and released. All sites were sampled at water temperatures below 18°C. Sampling occurred from 07 July to 19 September 2005.

Removal estimates of population abundance at individual sampling sites were calculated using the methods described by White et al. 1982. Mark-recapture estimates of population abundance at individual sampling sites were calculated using the Petersen formula (Ricker 1975). Estimates of population abundance within strata and associated precision were calculated using local neighborhood estimator methods described by Stevens and Olsen (2002).

Field crews conducted distribution surveys in Antelope creek, a population where Lahontan cutthroat trout from Whitehorse Creek were planted in 1972 (ODFW 2005), and in Dry and Sheepline Creeks, where cutthroat trout were suspected but not verified. Starting at the mouth, or at the downstream end of inhabitable water, crews worked upstream electorshocking the first 50 of every 500 meters. When trout were not detected at a site, crews moved downstream 250 meters and shocked another 50 meters to determine the end of upstream distribution within a quarter of a kilometer.

RESULTS

Based on our inventory, we divided the sampling frame into 12 km of stream channels impounded by beaver dams and 98 km of free-flowing channel (Figure 1). This frame composition and the expected variance for each stratum resulted in a target allocation of 33% of the samples in beaver ponds and 67% in free-flowing channels.

We sampled 61 sites, 20 of which were allocated to the beaver pond strata and 41 to the free-flowing strata (Figure 1, **Appendix A**). We were unable to obtain valid population estimates at 10 of these sites because of various reasons including dry channels and landowner denial (**Appendix A**).

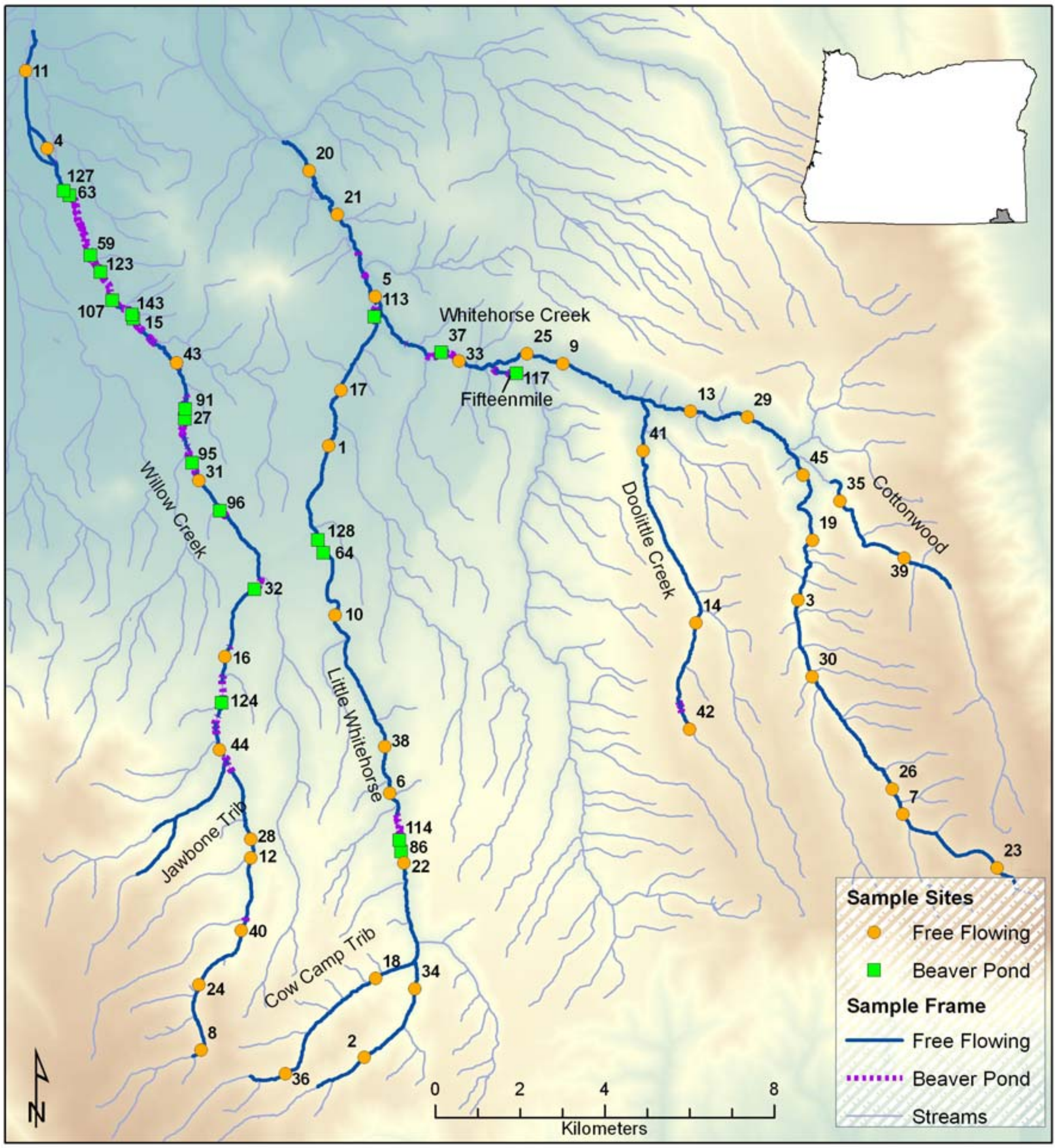

Figure 1. Sample frame and corresponding sample points for Lahontan cutthroat trout at free-flowing and beaver pond reaches in the Willow and Whitehorse Creek basins, 2005. Values next to each sample point denote sample number.

We captured a total of 287 Lahontan cutthroat trout at the 51 sites where valid removal population estimates were obtained. No other fish species were captured. Age 1+ fish were estimated to be >75mm FL based on length frequency analysis (Figure 2). Given this size cutoff, 265 of the fish captured were age 1+ and 22 were young-of-the-year (YOY). Of the 51 sites sampled, no fish were found at 13 of the sites and only six sites had densities greater than 0.21 fish/m^2 (Figure 3). Averaqge densities at free flowing sites were higher than those at beaver pond sites (Table 1); however this difference was not statistically different ($p < 0.2$, t-test assuming unequal variances). Although our resolution of detecting spatial patterns in age 1+ density was hampered by our low sampling intensity, a general pattern observed was highest densities near the headwaters of Whitehorse, Little Whitehorse and Cottonwood Creeks and lowest densities in the lower portion of Willow Creek where beaver dams were prominent. YOY cutthroat were only found at three sites, site 44 in Willow Creek and sites 30 and 19 in Whitehorse Creek.

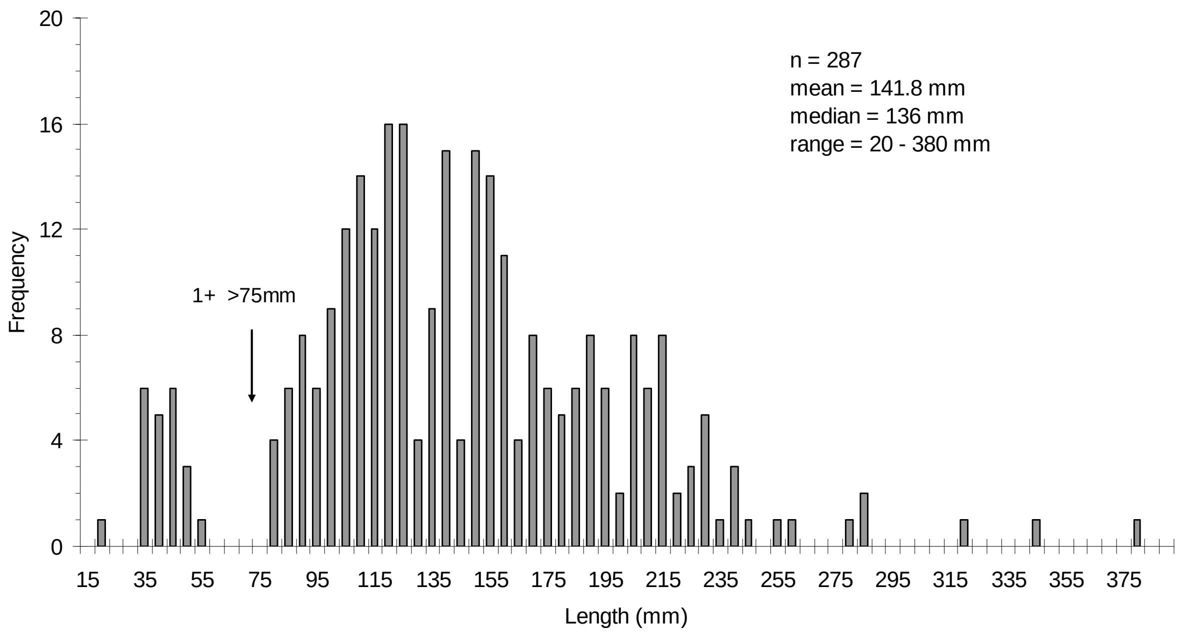

Figure 2. Length frequency of Lahontan cutthroat trout captured by electrofishing in Willow and Whitehorse Creeks, 2005. Lengths are grouped by 5 mm intervals.

We were only able to conduct a mark-recapture estimate at one beaver pond site, site number 95. We captured and marked a total of 25 fish during electrofishing passes conducted at the first day of sampling. On the following day, we captured a total of 16 fish, 10 of which were marked. The resulting population estimate and 95% confidence interval was 40$\pm$14 age 1+ cutthroat. Given the removal estimate of 26, these results suggest that removal methods may have underestimated abundance in beaver ponds by as much as 35%. Similar bias has been observed for electrofishing removal estimates of other stream resident populations of salmonids sampled in complex habitat (Rosenberger and Dunham 2005, Peterson et al. 2004).

We estimated the total population of age 1+ Lahontan cutthroat trout at 13,600 ± 27% in Willow and Whitehorse creeks (Table 1). About 80% of this abundance occurred in free-flowing stream channels. Further, the estimate of abundance of the beaver pond stratum had lower precision than the estimate for the free flowing stratum. Based on site occupancy rates in each sampling stratum (71% for free-flowing and 87% for beaver ponds), the population of age 1+

cutthroat occupied a total of 91 km of the Willow and Whitehorse watersheds. In all, we sampled about 2% of the habitat to obtain population estimates. This included sampling 1.6 % of the free-flowing habitat and 3.8% of beaver ponds. An abundance estimate of YOY could not be calculated because sample sites where YOY were detected were too few.

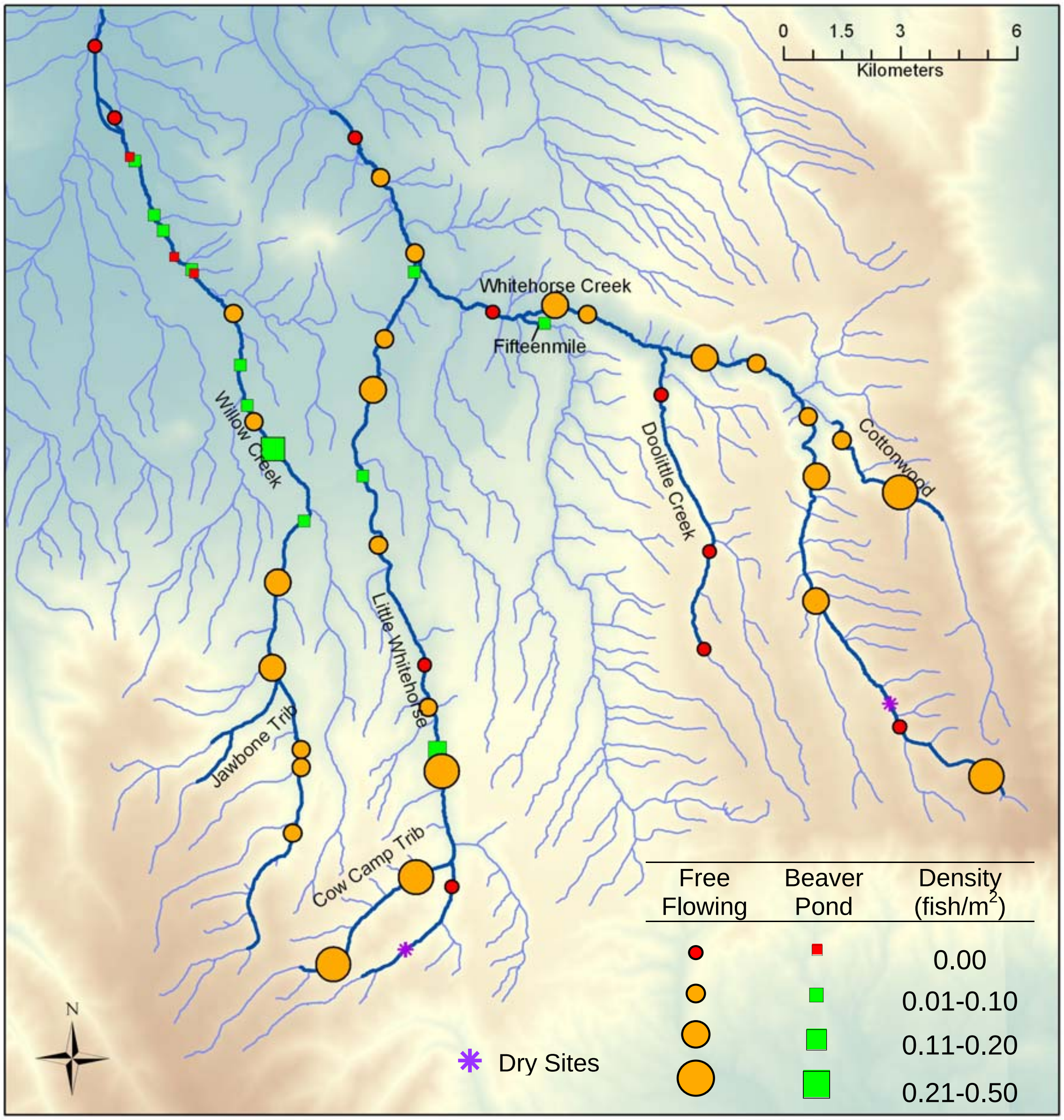

Figure 3. Density of Lahontan cutthroat trout at free-flowing and beaver pond sample sites in the Willow and Whitehorse Creek basins, 2005.

Table 1. Frame size, sample size average density and estimated abundance of age 1+ Lahontan cutthroat trout in Willow and Whitehorse creek basins.

Stratum	Frame size (km)	Sites (n)	MeanFish/m2 (SD)	Estimate ± Relative 95% CI
Free-flowing	98	36	0.090 (0.019)	10,800 ± 29%
Beaver pond	12	15	0.058 (0.030)	2,800 ± 63%

Total	110	51	0.080 (0.016)	13,600 ± 27%

Lahontan cutthroat trout were detected at two of four sample sites in Sheepline Creek, where we determined the distribution to extend up to 500m from the mouth. At the time of sampling (late September) Dry Creek was dry and therefore did not contain trout (Figure 4a). Field crews did not detect cutthroat trout in Antelope Creek which was only puddled in a 30 meter stretch near the spring where trout were detected in 1998 (Talabere, personal communication) (Figure 4b, **Appendix A**). The nearby reaches of Antelope Creek were dry. This absence for trout may represent the loss of the Antelope population.

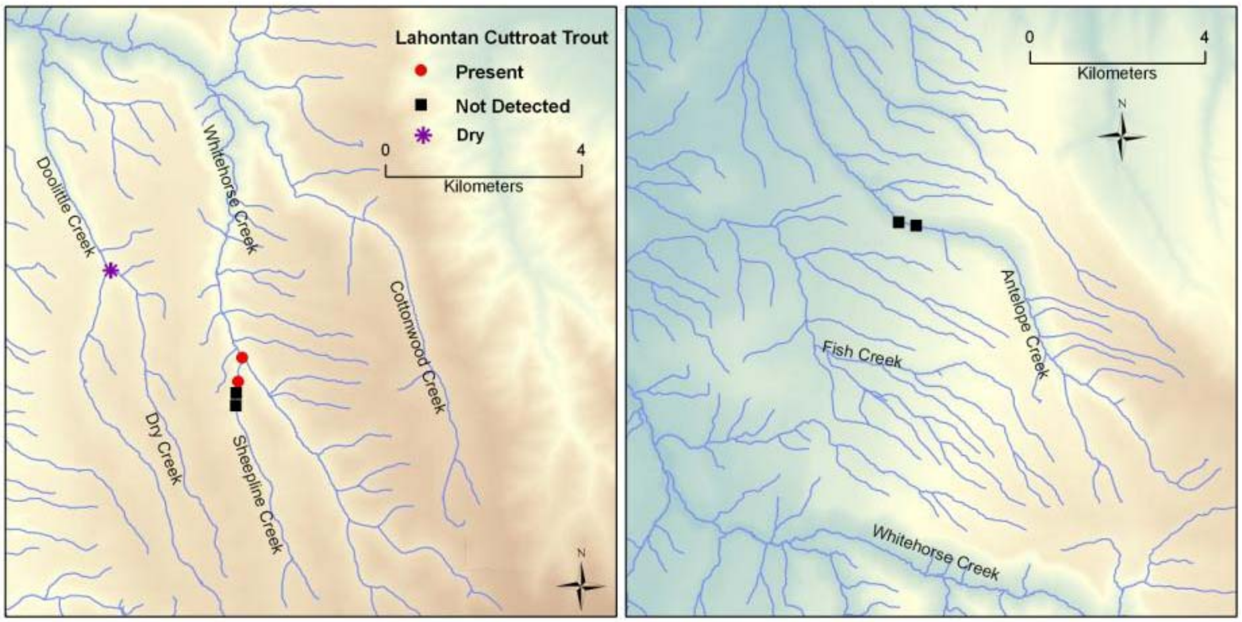

Figure 4. Presence of Lahontan Cutthroat trout at sample sites in a) Dry and Sheepline Creeks and b) Antelope Creek.

DISCUSSION

Our sampling indicated that about 14,000 age 1+ Lahontan cutthroat occupied Willow and Whitehorse creeks during the summer of 2005. About 91 km of these drainages were used for rearing and the highest concentrations of fish were found in the upper portions of each watershed. Locations of high population density were similar to those detected in 1985, 1989 and 1994 (Jones et al. 1998). Sampling results further showed that about 80% of the population occurred in free-flowing stream reaches and only 20% occurred in beaver dam pools. This finding should be interpreted cautiously because sampling validation suggested that our estimates in beaver ponds may be negatively biased. However, adjusting our estimate of abundance in beaver ponds for the level of bias we measured only results in an overall population of about 15,000 fish which is well within our level of confidence of the unadjusted estimate.

Abundance in 2005 ranks second lowest among estimates obtained back through 1989 (Figure 5). However direct comparisons between past estimates and the 2005 estimate need to be qualified for differences in methodology. During prior years sample sites were not randomly selected (Perkins et al. 1991, Jones et al. 1998) and thus likely did not constitute a completely unbiased sample of fish density. In 2005 sites were selected using protocols that provided a spatially balanced random sample that is inherently unbiased (Stevens and Olsen 2004). Because of this difference in methodology it is possible that estimates prior to 2005 are positively biased relative to the 2005 estimate. The level of this bias is likely insufficient to account for the higher abundances estimated in 1994 and 1999 compared to the 2005 estimate. Thus, we believe population abundance has declined from levels occurring in 1994 and 1999.

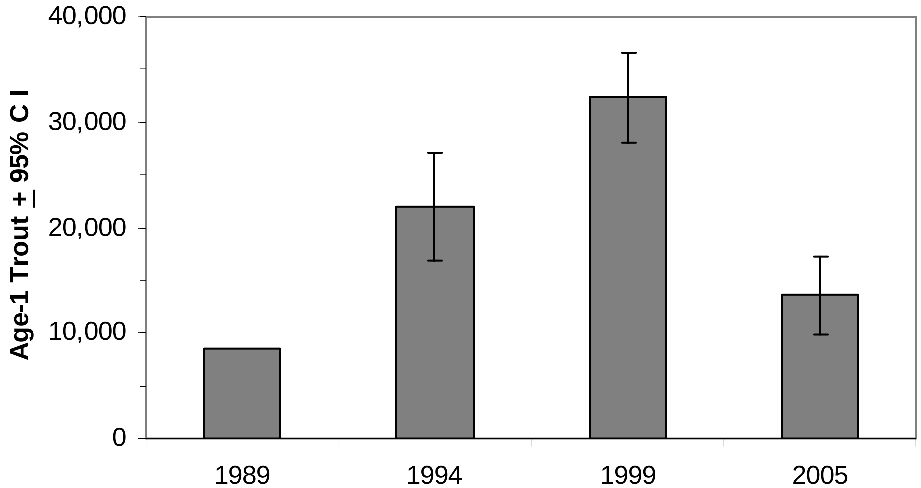

Figure 5. Estimated abundance of age 1+ Lahontan cutthroat trout in Willow and Whitehorse Creeks from periodic sampling from 1989-2005. Confidence intervals are not available for the 1989 estimate.

Accordingly, the abundance of YOY was drastically reduced relative to previous estimates. In 1994 the abundance of YOY was estimated to be 17,536 ± 6028 (Jones et al. 1998). The decline in YOY is likely a result of below average water years and indicative of a period of low productivity and recruitment. However, sampling in 2005 occurred from early July to late August, whereas past sampling efforts occurred in mid-October. It is possible that sampling in 2005 occurred prior to emergence of a portion of the fry.

We were unable to find a strong selection of beaver pools as summer rearing habitat. Although not statistically significant, densities in beaver ponds averaged lower than densities in free flowing sites. This result was unexpected given the findings of Talabere (2002), in which Willow Creek cutthroat had the highest densities in beaver ponds. A possible reason for the disagreement among these results may be due the effect of water temperature on abundance and how beaver pond sample sites were distributed among the two studies. In our study, most of the beaver pond sites were located in lower reaches of the drainages where peak summer water temperatures are high. In Talabere's study, beaver pond sites were distributed more uniformly throughout Willow Creek. Even though beaver ponds may not be intensively used for summer rearing habitat in Willow and Whitehorse Creeks, they may provide critical winter refuge. Other studies have shown cutthroat trout to actively select beaver ponds during the winter (Jakober et al. 1998, Lindstrom et al. 2004).

Stream flow regime has been speculated to have a strong influence on the abundance of desert trout populations (Dambacher et al. 2001, Zoellick et al. 2005). Periods of higher stream flow may act to increase available wetted channel, cool peak stream temperatures and increase connectivity among populations that become isolated during periods of low flow. Although occurring over a limited time scale, flow regimes in SE Oregon stream basins have varied during the period when population assessments have occurred for cutthroat trout in Willow and Whitehorse Creeks (Figure 6). Sample events occurred during two below average flow periods separated by a period of above average flow. Since most age 1+ cutthroat trout in Willow and Whitehorse Creeks tend to be 1-2 years old (Jones et al. 1998, Talabere 2002), flow occurring during the two years prior to sampling may have the strongest influence on abundance. The relationship between average annual flow over this period and abundance shows a significant statistical relationship ($P<0.05$, Figure 7). This relationship indicates that trout abundance in these basins is higher during higher flow regimes and suggests that management actions that result in higher stream flows in the Willow and Whitehorse basins could improve the status of these populations.

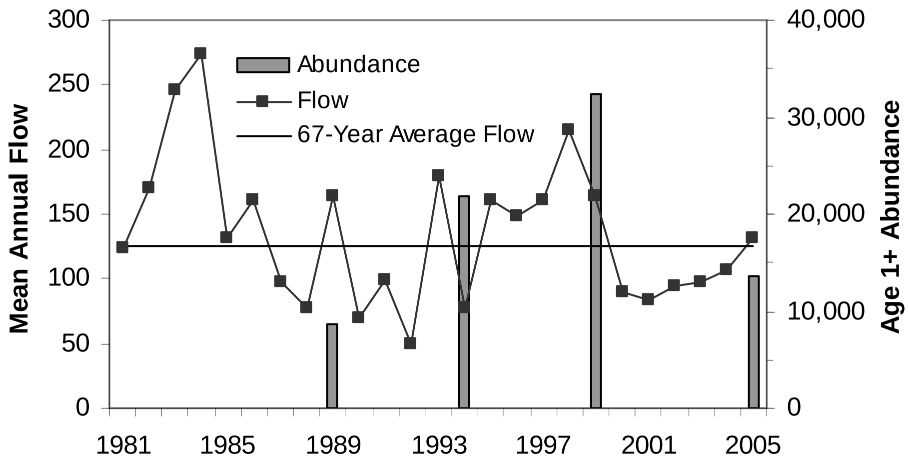

Figure 6. Mean annual stream flow in the Blitzen River near Frenchglen and estimated abundance of Lahontan cutthroat trout in Willow and Whitehorse Creeks. Stream flow data obtained from http://waterdata.usgs.gov/or/nwis/annual/?search_site_no=10396000.

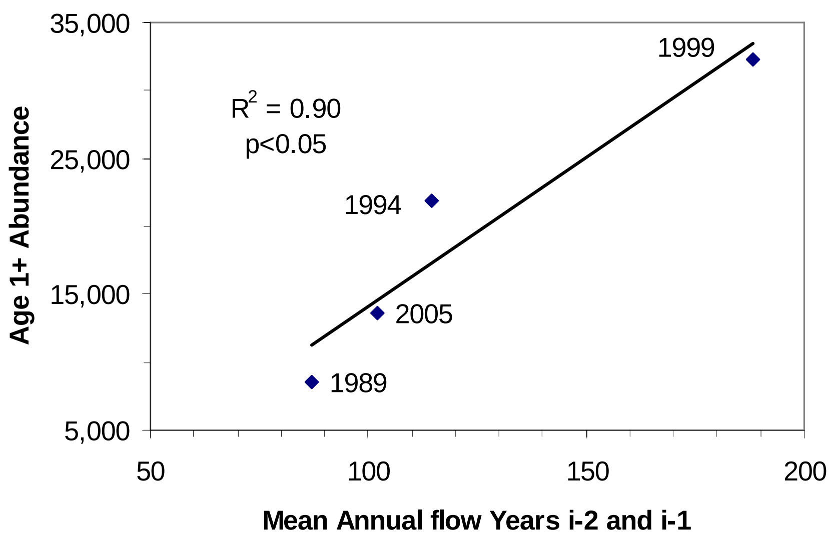

Figure 7. Relationship between mean annual stream flow in the in the Blitzen River near Frenchglen during the prior two water years and estimated abundance of Lahontan cutthroat

trout in Willow and Whitehorse Creeks. Values next to data points denote years trout were sampled.

The EMAP methodology employed to select sample sites in 2005 provided relatively high precision despite the relatively low sampling intensity. We were able to obtain 95% confidence intervals that were within 27% by sampling 51 sites that only comprised 2% of the sampling frame. The neighborhood variance estimator associated with the EMAP sampling protocol contributed to this high level of precision. Using the conventional estimate for variance yields a 95% confidence interval of ±34%, 25% larger than that provided by EMAP. We recommend continuing to use the EMAP sampling methodology for future population assessments of Lahontan cutthroat in Willow and Whitehorse Creeks. A sample size of 60 points should increase precision and provide higher resolution to estimate distribution patterns.

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APPENDIX A

Status and results of sites sampled for Lahontan cutthroat trout in Willow and Whitehorse Creeks, 2005.

Appendix Table A-1. Site-specific data for free-flowing stratum. Site ID corresponds to sampling priority order.

Site					Lahontan Cutthroat Trout > 75 mm Fork Length				
ID	Name	Status	Length (m)	Area (m^2)	Pass 1	Pass 2	$\hat{N}$	Fish /m	Fish /m^2
1	Little Whitehorse Creek	Completed	39	47	6	0	6	0.15	0.13
2	Little Whitehorse Creek	Dry Channel	--	--	--	--	--	--	--
3	Whitehorse Creek	Failed Estimate	--	--	--	--	--	--	--
4	Willow Creek	Completed	27	22	0	0	0	0.00	0.00
5	Whitehorse Creek	Completed	84	210	4	0	4	0.05	0.02
6	Little Whitehorse Creek	Completed	27	27	1	0	1	0.04	0.04
7	Whitehorse Creek	Completed	33	25	0	0	0	0.00	0.00
8	Willow Creek	Denied Permission	--	--	--	--	--	--	--
9	Whitehorse Creek	Completed	66	158	12	1	13	0.20	0.08
10	Little Whitehorse Creek	Completed	50.4	73	3	0	3	0.06	0.04
11	Willow Creek	Completed	64	79	0	0	0	0.00	0.00
12	Willow Creek	Completed	36	36	2	0	2	0.06	0.06
13	Whitehorse Creek	Completed	33	40	5	0	5	0.15	0.13
14	Doolittle Creek	Completed	12	4	0	0	0	0.00	0.00
16	Willow Creek	Completed	72	189	13	5	21	0.29	0.11
17	Little Whitehorse Creek	Completed	30	34	2	0	2	0.07	0.06
18	Little Whitehorse Creek	Completed	41	46	9	4	16	0.40	0.35
19	Whitehorse Creek	Completed	52.2	89	8	1	9	0.18	0.10
20	Whitehorse Creek	Completed	96	278	0	0	0	0.00	0.00
21	Whitehorse Creek	Completed	72	148	1	0	1	0.01	0.01
22	Little Whitehorse Creek	Completed	29.6	44	10	0	10	0.34	0.23
23	Whitehorse Creek	Completed	15	12	3	1	5	0.30	0.38
24	Willow Creek	Denied Permission	--	--	--	--	--	--	--
25	Whitehorse Creek	Completed	45	69	7	0	7	0.16	0.10
26	Whitehorse Creek	Dry Channel	--	--	--	--	--	--	--
28	Willow Creek	Completed	65	93	7	1	8	0.13	0.09
29	Whitehorse Creek	Completed	59	96	5	1	6	0.11	0.06
30	Whitehorse Creek	Completed	54	76	7	1	8	0.15	0.11
31	Willow Creek	Completed	30	35	2	0	2	0.07	0.06
33	Whitehorse Creek	Completed	40	56	0	0	0	0.00	0.00
34	Little Whitehorse Creek	Completed	34.7	26	0	0	0	0.00	0.00
35	Cottonwood Creek	Completed	24	19	1	0	1	0.04	0.05
36	Little Whitehorse Creek	Completed	36	33	7	1	8	0.23	0.24
38	Little Whitehorse Creek	Completed	26.7	41	0	0	0	0.00	0.00
39	Cottonwood Creek	Completed	26	23	9	2	12	0.45	0.49
40	Willow Creek	Completed	33	40	3	0	3	0.09	0.08
41	Doolittle Creek	Completed	12.3	10	0	0	0	0.00	0.00
42	Doolittle Creek	Completed	12	7	0	0	0	0.00	0.00
43	Willow Creek	Completed	66.1	145	2	0	2	0.03	0.01
44	Willow Creek	Completed	72	166	14	6	25	0.34	0.15
45	Whitehorse Creek	Completed	63	95	4	1	5	0.08	0.06

Appendix Table A-2. Site-specific data for beaver pond stratum. Site ID corresponds to sampling priority order.

Site					Lahontan Cutthroat Trout > 75 mm Fork Length				
ID	Name	Status	Length (m)	Area (m^2)	Pass 1	Pass 2	$\hat{N}$	Fish /m	Fish /m^2
15	Willow Creek	Completed	35.3	76	0	0	0	0.00	0.00
27	Willow Creek	Completed	15	84	1	0	1	0.07	0.01
32	Willow Creek	Completed	46.3	355	8	4	16	0.35	0.05
37	Whitehorse Creek	Failed Estimate	--	--	--	--	--	--	--
59	Willow Creek	Completed	16.6	110	1	0	1	0.06	0.01
63	Willow Creek	Completed	59	186	1	0	1	0.02	0.01
64	Little Whitehorse Creek	Misclassified	--	--	--	--	--	--	--
86	Little Whitehorse Creek	Misclassified	--	--	--	--	--	--	--
91	Willow Creek	Failed Estimate	--	--	--	--	--	--	--
95	Willow Creek	Completed	38.4	376	21	4	26	0.68	0.07
96	Willow Creek	Completed	9	27	7	3	12	1.36	0.45
107	Willow Creek	Completed	7.7	18	0	0	0	0.00	0.00
113	Little Whitehorse Creek	Completed	43.6	107	3	0	3	0.07	0.03
114	Little Whitehorse Creek	Completed	25	95	11	3	15	0.61	0.16
117	Fifteen Mile Creek	Completed	10	23	1	0	1	0.10	0.04
123	Willow Creek	Completed	43.5	158	3	0	3	0.07	0.02
124	Willow Creek	Misclassified	--	--	--	--	--	--	--
127	Willow Creek	Completed	28	106	0	0	0	0.00	0.00
128	Little Whitehorse Creek	Completed	22	62	1	0	1	0.05	0.02
143	Willow Creek	Completed	50.4	166	2	0	2	0.04	0.01

Appendix Table A-3. Site location information used to assess distribution outside of the sample frame.

			UTM Coordinates (Zone 11, Datum NAD27)		Number of Lahontan
Date	ID	Name	Easting	Northing	Cutthroat Trout
9/21/2005	Antelope 1	Antelope Creek	0408423	4683534	0
9/21/2005	Antelope 2	Antelope Creek	0408813	4683442	0
9/22/2005	shpln1	Sheepline Creek	0412951	4668461	2
9/22/2005	shpln2	Sheepline Creek	0412846	4667978	4
9/22/2005	shpln3	Sheepline Creek	0412776	4667490	0
9/22/2005	shpln4	Sheepline Creek	0412802	4667745	0
9/20/2005	Dry1	Dry Creek	0410271	4670379	Dry

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