

# PROGRESS REPORTS

2006



**FISH DIVISION**  
**Oregon Department of Fish and Wildlife**

2006 Warner Valley Fish Investigations- Warner Suckers

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## INTRODUCTION

The Warner sucker (*Catostomus warnerensis*) is endemic to the Warner Valley, an endoreic subbasin of the Great Basin in southeastern Oregon and northwestern Nevada. This species was historically abundant and their historical range includes 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). 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 Valley is a northeast-southwest trending endorheic basin which extends approximately 90 km (Figure 1). The elevation of the valley floor is approximately 1,370 m and the basin is bound by fault block escarpments, the Warner Rim on the west and Hart Mountain and Poker Jim Ridge on the east. The Warner basin was formed during the middle Tertiary and late Quaternary geologic periods as a result of volcanic and tectonic activity (Baldwin 1976). Abundant precipitation during the Pleistocene Epoch resulted in the formation of Pluvial Lake Warner (Hubbs and Miller 1948). At its maximum extent approximately 11,000 years ago, the lake reached approximately 100 m in depth and 1,300 km<sup>2</sup> in area (Snyder et al. 1964, Weide 1975).

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

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.

In 2006, precipitation and snow pack were abundant and Hart and Crump Lakes were full throughout the summer. Both lakes have been watered continuously since 1993. In 2006, we conducted investigations in Hart and Crump Lakes to quantify the abundance of Warner suckers, to search for evidence of recent recruitment, and to estimate sucker abundance relative to nonnative fish abundance. In addition, we Passive Integrated Transponder (PIT)-tagged suckers to determine growth rates and movements, radio tracked suckers to document seasonal spawning migration, and fished a screw trap at the mouth of Honey Creek to collect information on recruitment.

## METHODS

Trap nets were used to sample in Hart and Crump Lakes from 3 April to 22 June 2006. Trap nets used to capture fish in Hart and Crump Lakes had wide rectangular openings that were 3 ft (0.9 m) tall by 6 ft (1.8 m) wide which narrowed to vertical baffle slots that were 3 ft (0.9 m) tall by 0.75 ft (0.22 m) wide, followed by four funneling hoops that were 2.5 ft (0.76 m) in diameter with 0.5 ft (0.15 m) diameter fyke openings. Nets were a total of 12 ft (3.7 m) long with a lead net measuring 50 ft (15 m) long by 3 ft (0.9 m) tall. Six of the nets had  $\frac{3}{4}$  inch mesh, five had  $\frac{1}{2}$  inch mesh, and one had  $\frac{1}{4}$  inch mesh. The lead nets were typically connected to a metal "T" fence post driven into the substrate at the lake shore, stretched tight with a boat, and the purse rope on the collection chamber was secured offshore with an 8-10 lb (3.6-4.5 kg) navy anchor. Nets were set perpendicular to the shoreline. Pairs of nets were sometimes set in deep offshore waters with the lead nets tied together. Nets were accessed using a 20 foot sled boat powered by a 150 hp jet outboard motor. Nets were typically set on Mondays, checked and reset approximately every 24 hrs during the week, and pulled on Fridays (four overnight net sets per week). Nets were not fished over the weekends. At each trap location we recorded the time the net was set, the time the net was checked, water depth, water temperature, air temperature, weather, and trap location. Trap location was obtained from a hand held global positioning system (GPS). On one occasion, trammel nets (200 feet long by 8 feet deep with a combination 8"/2" mesh) were fished offshore in both Hart and Crump Lakes (one net per lake).

All fish captured were identified to species and counted. The fork length (FL) of each Warner sucker and redband trout *Oncorhynchus mykiss* was measured to the nearest millimeter and each fish was weighed on a digital balance to the nearest gram. The fork length of a subsample of the other species collected was also measured to the nearest millimeter. We determined the sex of each sucker, when possible, using a combination the following characteristics: presence of breeding tubercles, presence of eggs or milt, anal fin morphology, and spawning coloration (Coombs et al. 1979). Captured Warner suckers and redband trout were checked for the presence of PIT tags with a hand held reader. If a tag was present, the code was recorded. If none was present, fish were anesthetised with MS-222, a small  $\approx 0.5$  cm incision was made in the ventral cavity, and a half-duplex PIT tag (23 x 3mm) was inserted into the ventral cavity. Fish smaller than 60 mm FL were not tagged. All equipment was sterilized prior to surgery and antibiotic was applied to the incision and the tag. Fish were also tagged with colored FLOY® t-bar anchor tags immediately below the dorsal fin. Following processing, fish were allowed to recover, and then released into the lake offshore from the location where they were captured. Radio transmitter tags (Lotek®) were inserted via surgery into 10 Warner suckers, five each from Hart and Crump Lakes, respectively. Surgical procedures were similar to those used for PIT tags, except that the incision was larger  $\approx 1$  cm, a canula was used to thread the trailing antenna, and sutures were used to close the incision. Radio-tagged fish were held in a live box for 24 hours prior to release. Movements of radio tagged fish were tracked each week using a mobile radio tracking receiver either from the boat, truck, or from an Oregon State Police airplane. Each time a fish was located, the date was recorded and coordinates were determined using a hand held GPS receiver.

A five foot diameter rotary screw trap was fished at the mouth of Honey Creek from 1 May through 2 June, 2006 (19 trap nights). The trap was checked every  $\approx 24$  hours and all fish were counted and released back into the lake. All Warner suckers were measured to the nearest millimeter and suckers  $\geq 60$  mm FL were weighed and tagged with PIT and FLOY® tags, using the same procedure we used for suckers captured in trap nets. In early June we pulled the screw trap because diversion of water for irrigation reduced the stream flow to a trickle.

## RESULTS

### Catch and Distribution

We captured a total of 114 Warner suckers and 6 redband trout in Hart and Crump Lakes in 2006 (Table 1). The locations of trap nets, trammel nets, and the screw trap are shown in Figure 1.

**Table 1.** Catch of fish by species and gear type for sampling in the Warner Lakes in 2006.

Species	Crump Lake			Hart Lake				Grand total
	Trap nets	Trammel net	Lake total	Trap nets	Trammel net	Screw trap	Lake total	
Warner sucker	59	1	60	41	9	4	54	114
Redband trout	6	0	6	0	0	0	0	6
Tui chub	2,215	44	2,259	3,411	192	4	3,607	5,866
White crappie	3,671	17	3,688	7,339	37	1	7,377	11,065
Black crappie	805	2	807	1,871	6	2	1,879	2,686
Juvenile crappie	88	0	88	204	0	38	242	330
Largemouth bass	4	0	4	6	0	0	6	10
Brown bullhead	312	0	312	445	0	1	446	758
Total	7,160	64	7,224	13,317	244	50	13,611	20,835

We captured a total of 20,477 fish during 452 overnight trap net sets in Hart and Crump Lakes. This catch included 101 Warner suckers, 41 in Hart Lake and 60 in Crump Lake. We also captured 6 redband trout in Crump Lake. Trap net catch was dominated by white crappie *Pomoxis annularis* and tui chub *Gila bicolor*. Other species collected included black crappie *Pomoxis nigromaculatus*, brown bullhead *Ameiurus nebulosus*, and largemouth bass *Micropterus salmoides*. The majority of the suckers were captured from locations near the mouth of Honey Creek and in the southern extent of Crump Lake (Table 2; Figure 1).

We captured nine Warner suckers from offshore locations in Hart Lake and one in Crump Lake using trammel nets. Trammel nets killed many crappies and stressed the suckers, which were often extensively tangled and required removal by cutting the netting. The use of this gear type is not advised for capture of suckers, particularly at locations where crappies and bullheads are abundant.

We captured three adult suckers and one juvenile sucker in the screw trap that was fished in the mouth of Honey Creek. All suckers were captured between 1 May and 17 May. No redband trout were captured in the screw trap. Other species, collected in small numbers, included white crappie, brown bullhead, and tui chub. Temperatures recorded at the mouth of Honey Creek when the screw trap was operated ranged from 4.9°C to 20.2°C, peaking on 17 May (**APPENDIX A**).

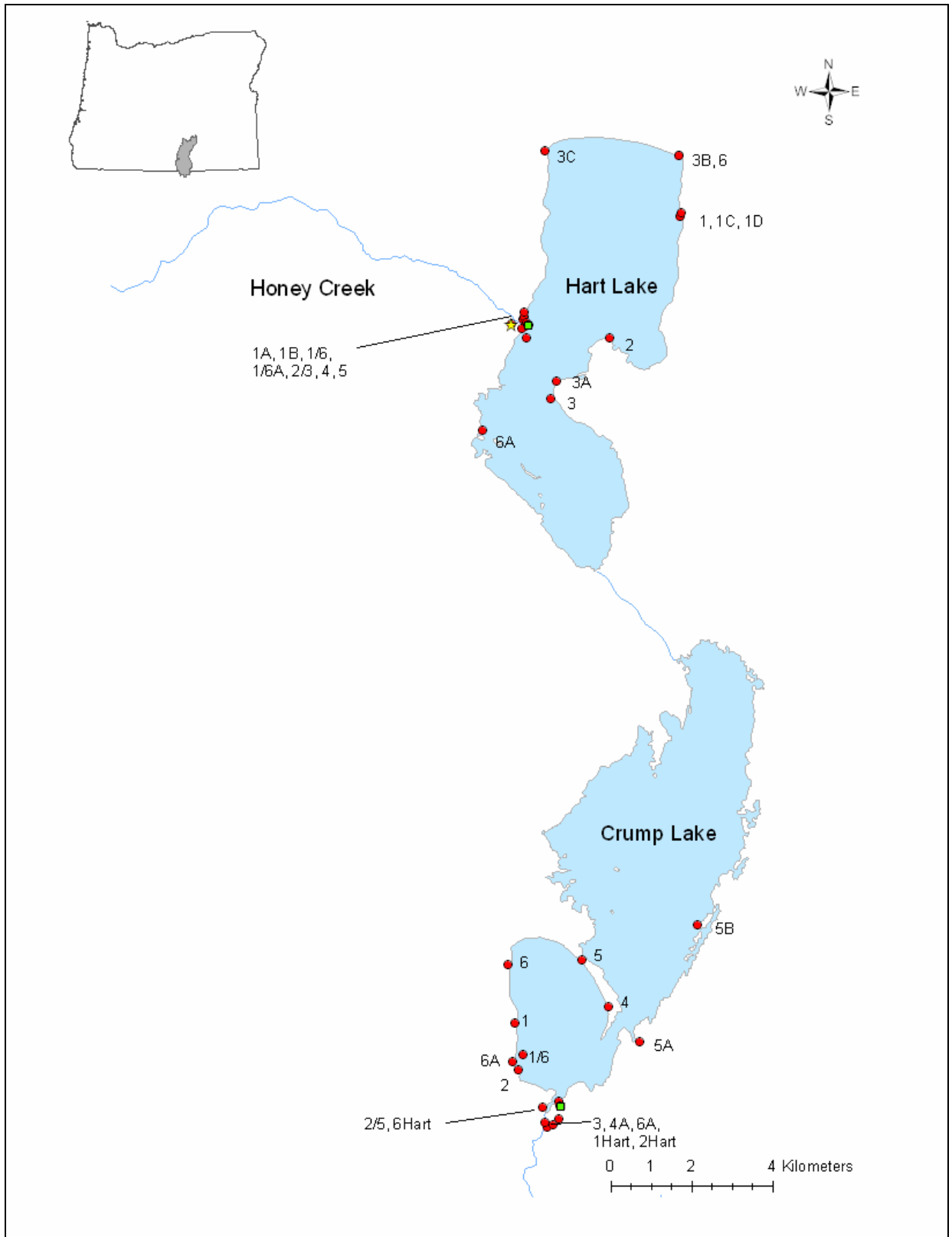


Figure 1. Locations of trap nets (circles), trammel nets (squares), and screw trap (star) fished in the Warner Lakes in 2006.



**Table 2.** Locations of different gear types used to sample in the Warner Lakes in 2006, dates of operation, number of overnight trap sets, and numbers of Warner suckers and redband trout captured. Gear locations are shown on Figure 1.

Gear type	Mesh	UTM Coordinates (Zone 11T)		Start Date	End Date	Trap Nights	Numbers captured	
		Easting	Northing				Suckers	Redband
<b>Hart Lake</b>								
trapnet 1	3/4"	267838	4700907	5-Apr	6-Apr	2	0	0
trapnet 1A	3/4"	263847	4698556	11-Apr	14-Apr	4	0	0
trapnet 1B	3/4"	263861	4698612	18-Apr	5-May	11	0	0
trapnet 1C	3/4"	267838	4700907	9-May	17-May	6	0	0
trapnet 1D	3/4"	267867	4700986	18-May	31-May	7	0	0
trapnet 1/6	3/4"	263898	4698092	8-Jun	9-Jun	1	0	0
trapnet 1/6A	3/4"	263886	4698385	13-Jun	21-Jun	4	7	0
trapnet 2	3/4"	265967	4698006	5-Apr	31-May	30	3	0
trapnet 2/3	3/4"	263987	4698414	9-Jun	21-Jun	5	6	0
trapnet 3	1/2"	264455	4696594	5-Apr	14-Apr	6	0	0
trapnet 3A	1/2"	264613	4696998	18-Apr	28-Apr	7	0	0
trapnet 3B	1/2"	267853	4702383	2-May	19-May	12	1	0
trapnet 3C	1/2"	264558	4702635	23-May	8-Jun	10	2	0
trapnet 4	1/2"	263797	4698340	5-Apr	20-Jun	39	7	0
trapnet 4/5	3/4"	263917	4698472	21-Jun	21-Jun	1	0	0
trapnet 5	3/4"	263888	4698742	5-Apr	20-Jun	39	13	0
trapnet 6	1/4"	267853	4702383	5-Apr	18-Apr	7	2	0
trapnet 6A	1/4"	262732	4695875	19-Apr	31-May	23	0	0
trammel net	2"	263941	4698423	7-Jun	7-Jun	1	9	0
screw trap	1/8"	263555	4698457	1-May	6-Jun	19	4	0
<b>Crump Lake</b>								
trapnet 1	3/4"	262921	4681373	5-Apr	8-Jun	35	8	0
trapnet 1/6	3/4"	263081	4680604	9-Jun	20-Jun	4	0	0
trapnet 2	1/2"	262951	4680223	5-Apr	8-Jun	35	2	0
trapnet 2/5	1/2"	263928	4679414	9-Jun	20-Jun	4	0	0
trapnet 3	3/4"	263924	4678985	5-Apr	20-Jun	38	24	3
trapnet 4	3/4"	265252	4681696	5-Apr	6-Apr	2	0	0
trapnet 4A	3/4"	263615	4678798	11-Apr	20-Jun	36	24	3
trapnet 5	1/2"	264657	4682838	5-Apr	6-Apr	2	0	0
trapnet 5A	1/2"	266002	4680788	11-Apr	5-May	14	0	0
trapnet 5B	1/2"	267527	4683603	9-May	8-Jun	18	0	0
trapnet 6	1/2"	262828	4682808	5-Apr	26-Apr	12	1	0
trapnet 6A	1/2"	262829	4680448	28-Apr	8-Jun	23	0	0
trapnet 1Hart	3/4"	263575	4678933	1-Jun	8-Jun	5	0	0
trapnet 2Hart	3/4"	263758	4678857	1-Jun	8-Jun	5	0	0
trapnet 6Hart	1/4"	263528	4679296	1-Jun	8-Jun	5	0	0
trammel net	2"	263955	4679318	7-Jun	7-Jun	1	1	0

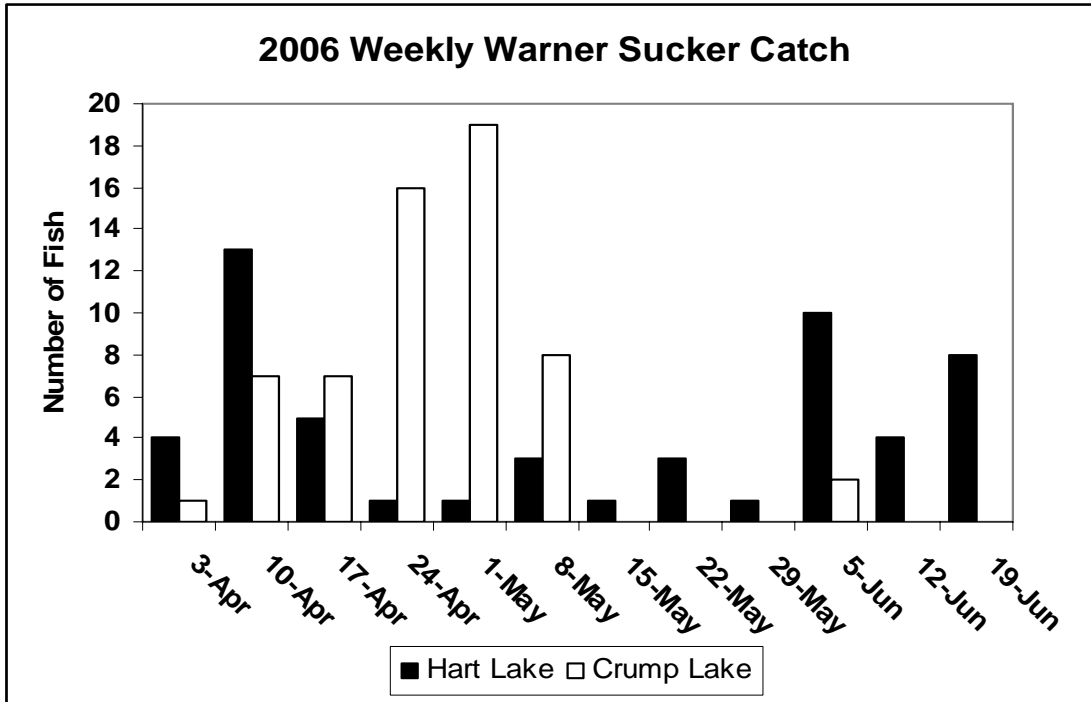
## Warner Sucker Abundance

We were unable to obtain a mark-recapture estimate for Warner suckers because none of the fish we marked in 2006 were recaptured. In the past 13 years of study dating back to 1990, 1996 was the only year when a sufficient number of suckers were captured to obtain a Schnabel population estimate (estimate = 493 adults; 95% CL: 439-563) (White et al. 1990; White et al. 1991; Allen et al. 1994; Allen et al. 1995; Allen et al. 1996; Bosse et al. 1997; Hartzell et al. 2001). A total of 301 fish were marked and the total catch was 835 fish, which included 276 recaptures, many of which were captured multiple times (Allen et al. 1996). The 2006 trap net catch of 101 fish was lower than the catch from sampling in 2001 (n=183), 1997 (n=179), 1996 (n=835), 1991 (n=103), and 1990 (n=190), and greater than the catch from sampling in 1995 (n=22) and 1994 (n=93). Note that 1994 and 1995 followed several years of drought (1987-1992) and the lakes were completely desiccated in 1992. Table 3 shows a comparison of the catch per unit of effort (CPUE) for 2006 with past CPUE values. The 2006 effort (452 trap nights) was substantially greater than past effort. The 2006 CPUE values were among the lowest on record for Hart Lake and within the range of values for Crump Lake, despite the highest catch on record. When comparing CPUE over time, one must consider the different time periods when sampling occurred each year and the relatively low sampling effort in Crump Lake in past years. We found that our catch rates varied substantially across our sampling period and varied between lakes. Our peak catches in Hart Lake occurred in April and June and occurred in Crump Lake from April through mid-May (Figure 2). Comparing the 2006 CPUE estimates with past estimates may be misleading if past sampling effort was concentrated over a short time period or did not occur during the spring months.

**Table 3.** Catch per unit of effort and sampling dates for Warner suckers from 1990 to 2006.

Year	Number of Suckers		Number of trap nights		Suckers per trap night		Sampling dates	
	Hart	Crump	Hart	Crump	Hart	Crump	Hart	Crump
1990	190	16	122	9	1.6	1.8	4/4 - 7/27	4/1 - 5/15
1991	103	0 <sup>1</sup>	175	0	0.6	-	3/19 - 7/31	3/19 - 7/31
1993	0	0	70	0	0.0	-	6/11 - 8/15	6/11-8/15
1994	93	3	40	15	2.3	0.2	7/12 - 8/14	7/12 - 8/14
1995	19	1	104	40	0.2	0.0	6/12 - 7/20	6/12 - 7/20
1996	835	11	252	36	3.3	0.3	4/24 - 6/6	4/24 - 6/6
1997	193	2	137	60	1.4	0.0	4/29- 6/12	4/29 - 6/12
1998	0	0	2	2	0.0	0.0	8/25	8/25
1999	201	2	9	8	22.3	0.3	5/18- 5/19; 11/16	5/18 - 5/19; 11/16
2001	176	5	63	24	2.8	0.2	4/14 - 5/22	4/14 - 5/22
2004	0	1	0	6	-	0.2	-	5/25
2005	0	0	9	14	0.0	0.0	7/28	5/25; 7/21
2006	41	60	214	238	0.2	0.3	4/3 - 6/21	4/3 - 6/21

<sup>1</sup> In 1991, 69 suckers were collected from the Crump Lake shoreline that died from winterkill.

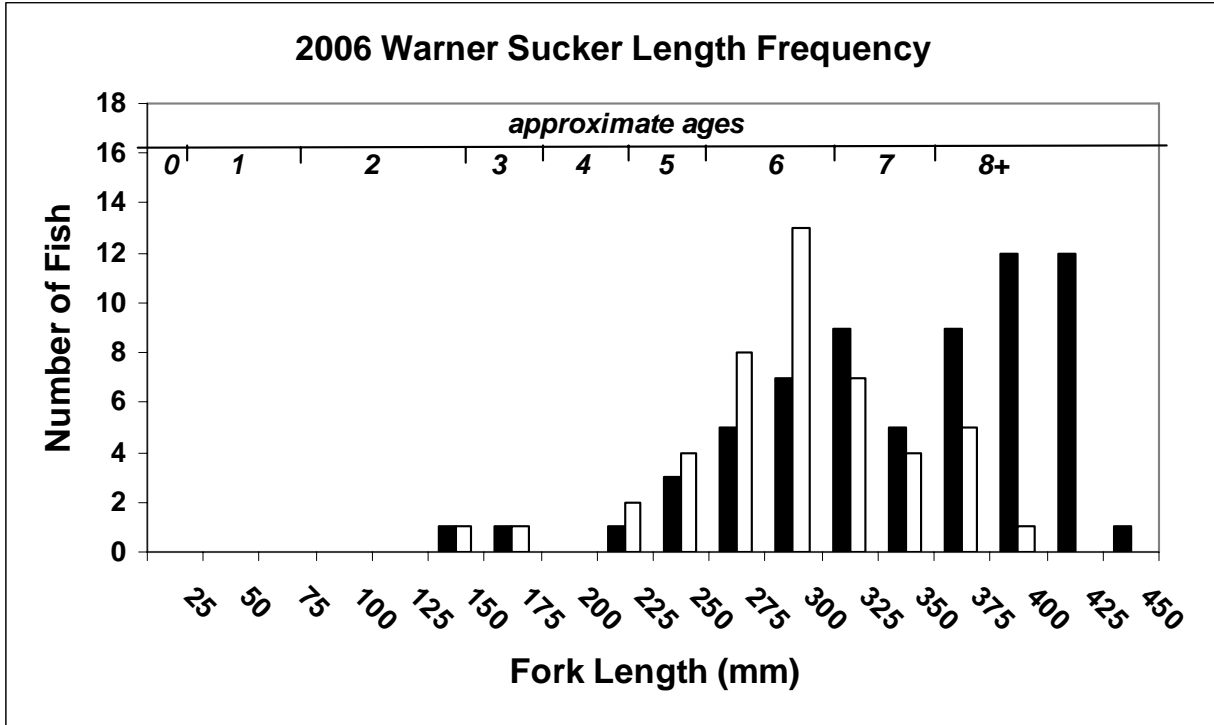


**Figure 2.** Weekly trap net catch of Warner suckers in Hart and Crump Lakes in 2006.

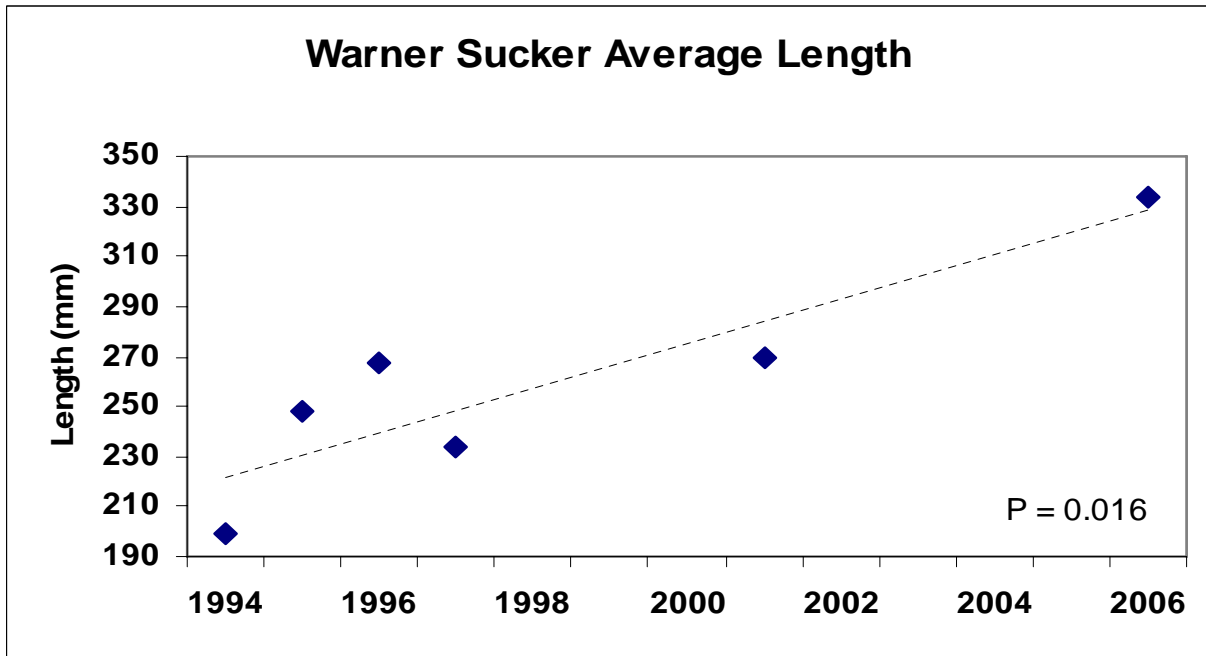
### Warner Sucker Length Frequency Distributions and Weight-Length Relationships

The length frequency distribution for Warner Suckers captured in 2006 is shown in Figure 3. The majority (91%) of the suckers were larger than 250 mm FL indicating that minimal recruitment has occurred in recent years. Based on the length-at-age relationship developed by Coombs et al. (1979), fish larger than 250 mm FL are  $\geq 6$  years old. The average size for suckers was 334 mm FL (SD=74 mm; range 55-395 mm; N=114). The average female fish (mean=361 mm; SD=64 mm; range 170-450 mm; N=66) was significantly larger than the average male fish (mean=310 mm; SD=51 mm; range 160-400 mm; N=46) ( $t=4.63$ ;  $p<0.00001$ ). The average length of suckers has increased substantially since 1994 (Figure 4).

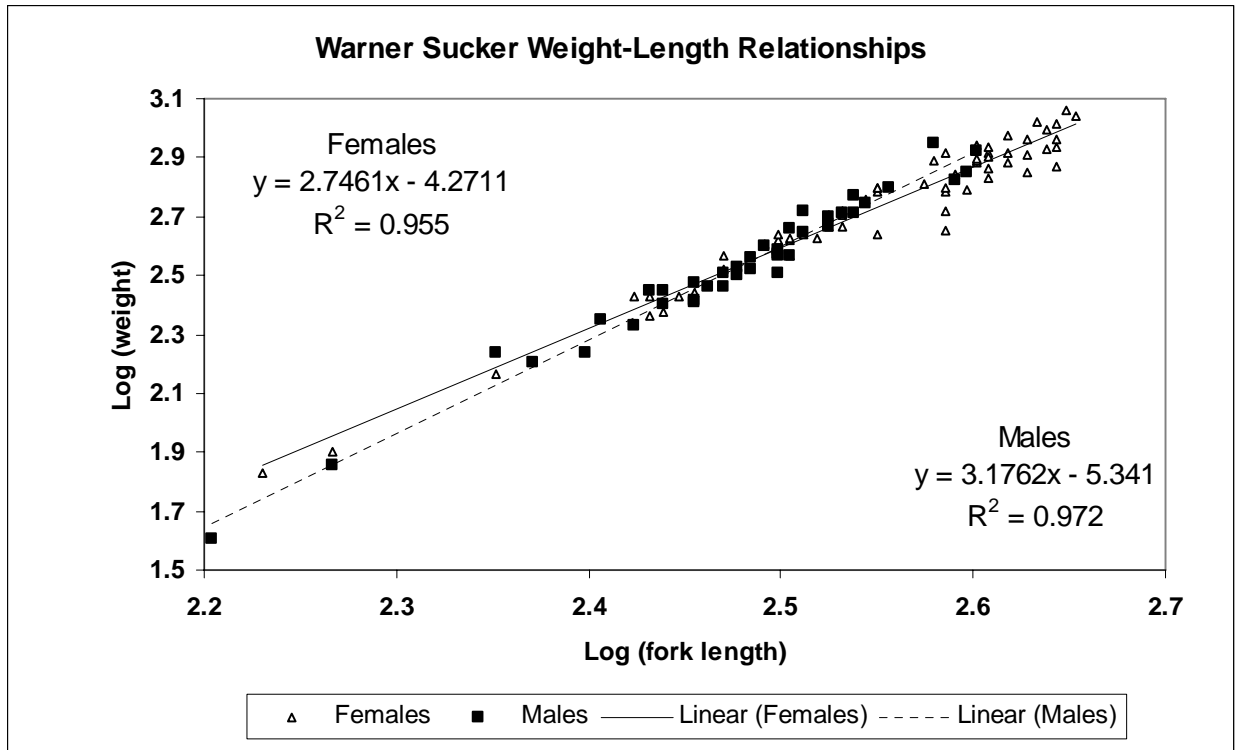
The average weight for suckers ranging from 160-450 mm FL was 516 g (SD=256 g; range 40-1,156 g; N=106). The average weight for female suckers ranging from 170- 450 mm FL was 602 g (SD=255 g; range 68-1156 g; N=65), which was significantly larger than the average weight of 385 g for male suckers ranging from 160- 400 mm FL (SD=187 g; range 40-882 g; N=40) ( $t=4.99$ ;  $p<0.00001$ ). Strong weight-length relationships exist for both male and females (Figure 5). The slopes of these relationships for males and females were significantly different (ANCOVA,  $F=12.6$ ,  $df= 102$ ,  $P< 0.05$ ). Interestingly, the larger males (>285 mm) were heavier at a given size than the females.



**Figure 3.** Length frequency histogram for male (white bars) and female (black bars) Warner Suckers captured in the Warner Lakes in 2006. Approximate ages are from Coombs et al. 1979.



**Figure 4.** Relationship between the average fork length of Warner Suckers in the Warner Lakes and year. The dotted line is a fitted regression line ( $P = 0.016$ ).



**Figure 5.** Power relationship of weight (g) to fork length (mm) for adult Warner suckers collected from Hart and Crump Lakes, 5 April through 21 June 2006.

### PIT Tagging and Tag Recoveries

A total of 105 Warner suckers and four redband trout were PIT-tagged. Only two PIT-tagged suckers were captured, both in Hart Lake offshore from the mouth of Honey Creek. Both were tagged on 1 May 2001 near the mouth of Honey Creek. Both were females measuring 385 mm FL when recaptured on 20 June 2006 and 21 June 2006. These fish grew 98 mm and 100 mm, or approximately 20 mm (0.8 in) per year, which is similar to growth rates reported by Hartzell et al. 2001. The 2006 PIT-tagging details are in **APPENDIX B**.



### Movement of Radio Tagged Warner Suckers

We had mixed results tracking radio tagged Warner suckers. We were only infrequently able to locate tagged suckers from the boat or truck and we were only able to read the tag codes that identified individual fish when we were within  $\approx 50$  m. On the two occasions when aerial tracking was conducted (18-May and 16-June) only 6 and 5 of the 10 fish were found, respectively. One tagged fish is known to have died soon after release (Hart 098). Despite these problems, we were able to document movement of tagged fish from Crump Lake south into Deep Creek, movements offshore in northern Crump Lake, movements of fish along the western shore of Hart Lake, and movements into Honey Creek up to the last irrigation diversion below the road (Figure 6). We did not find any tagged fish that moved between lakes (we used tags with different frequencies in Hart and Crump Lakes). Also, no tagged fish were detected in the lakes north of Hart Lake.

## Warner Sucker Sex Ratios and Sexual Maturation

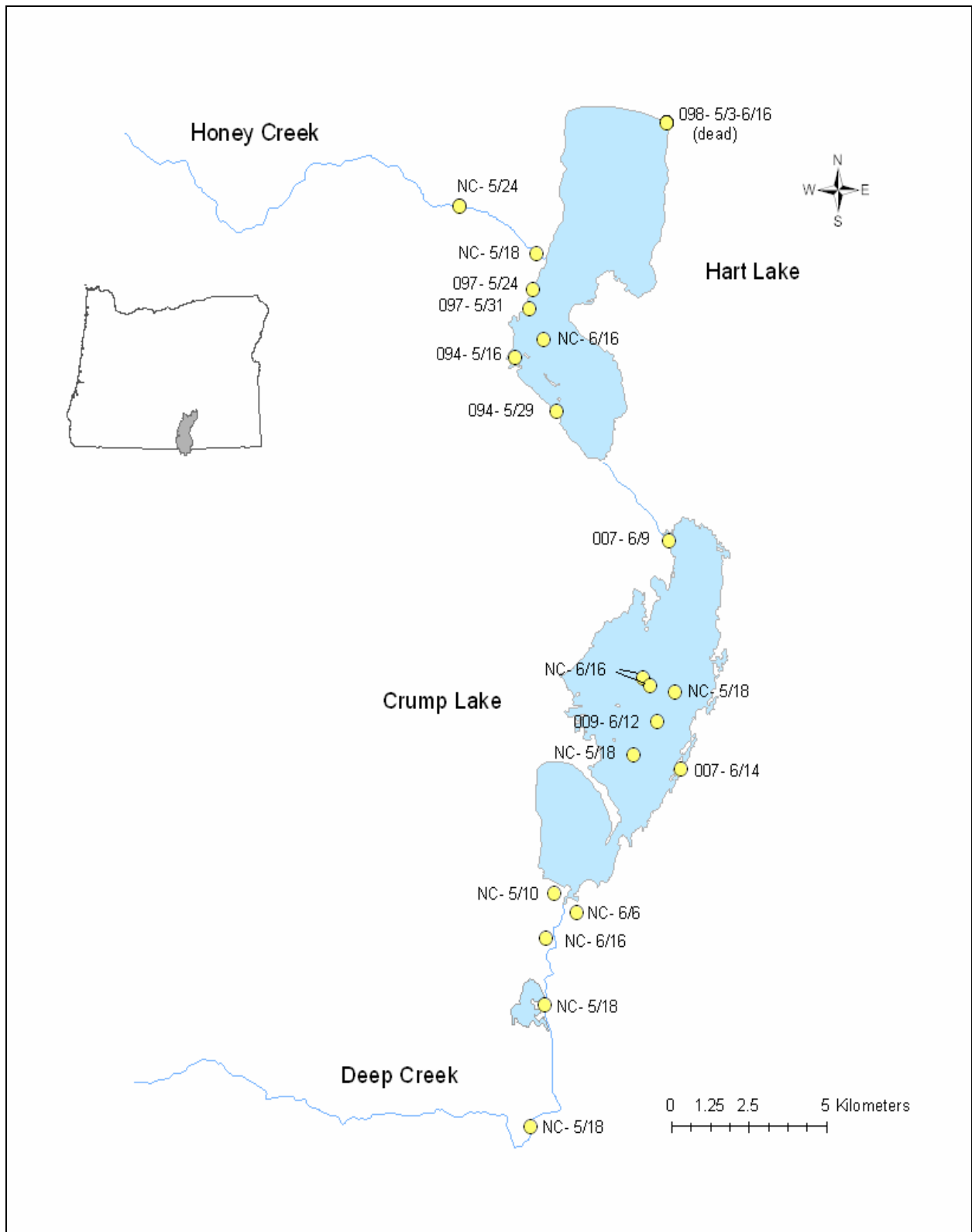
We were able to determine the sex of 112 Warner suckers. Sixty six fish were females (59%) and 46 were males (41%) resulting in a female:male ratio of 1.4:1. This ratio is identical to results from 2001 (Hartzell et al. 2001). Suckers showed signs of maturation beginning in early-May. In May, swollen females were common and most males had notable spawning tubercles on their anal and lower dorsal fins. In addition, males typically had a red lateral band. Spawned out females were captured in late-May through June. Fish less than 60 mm did not show signs of maturation or external sex characteristics.

## Warner Sucker Larvae

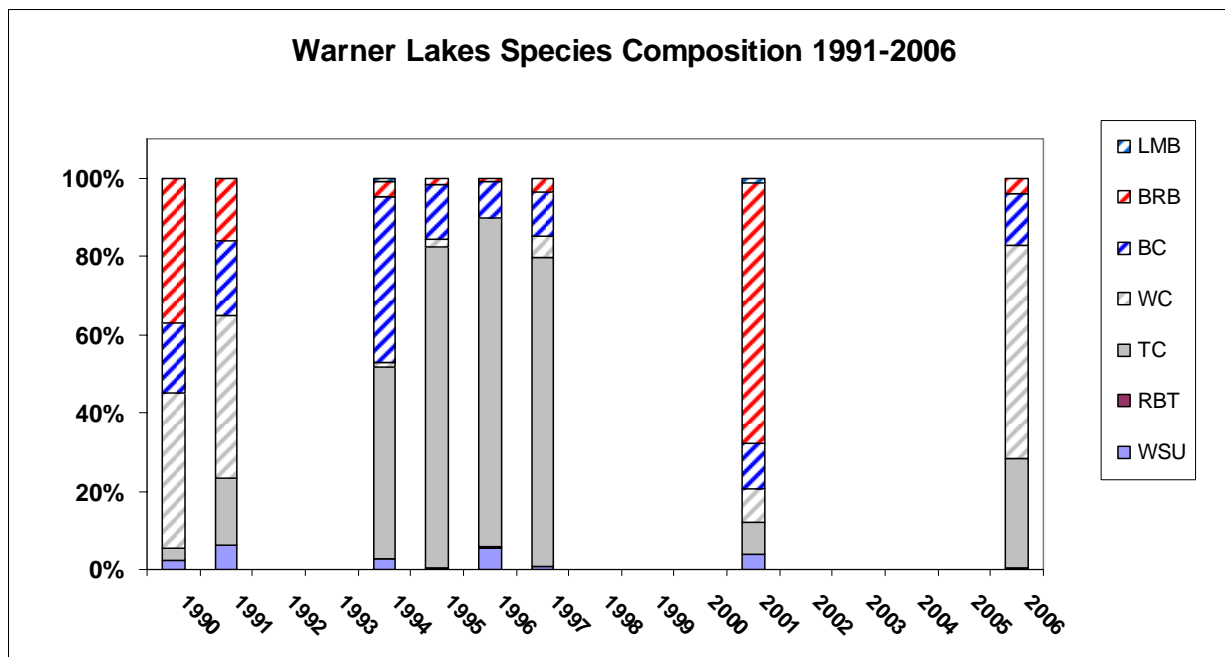
Larval fish were first abundant at the mouth of Honey Creek beginning in early-June. Fish were collected on 6 June, 9 June, and 14 June. The majority of these fish were identified as larval Warner suckers (S. Remples, Oregon State University, pers. comm.). These fish ranged in size from 11 to 16 mm. Sucker eggs incubate in ~2 weeks at 12°C, the larvae are typically 8-9 mm at hatch, and swim up in ~2 weeks at 11-12 mm (Dr. Doug Markle, Oregon State University, pers. comm.). Thus these larvae probably resulted from spawning which occurred in early to mid-May. Since no sucker larvae were collected in the screw trap fished at this location, it is possible these larvae resulted from lake spawning.

## Nonnative Fishes

Nonnative fishes dominated our catch (Table 1). Crappies (black and white) totaled 68% of the catch and brown bullheads made up another 4%. Changes in species composition have occurred since sampling began in 1990 (Figure 7, **APPENDIX C**). Prior to the lakes drying in 1992, the catch was dominated by nonnative fishes, with white crappie being the most abundant nonnative fish captured. For several years following the drought, native fishes dominated the catch, with tui chub being the most abundant native fish captured. Since 1997, nonnative fish have become reestablished and have dominated the catch. Bullheads were the most abundant nonnative fish the 2001 catch and white crappie were the most abundant nonnative fish the 2006 catch. It is unclear why bullheads were dominant only in 2001 and why they have declined so dramatically since 2001. Length frequency histograms for tui chub and nonnative fishes sampled in the lakes are in **APPENDIX D**.



**Figure 6.** Tracking locations and dates of radio tagged fish. Each point is identified with the tag code number and date of tracking. Most codes, labeled as NC, were not identified.



**Figure 7.** Fish species compositions from trapping in Hart and Crump Lakes, 1990-2006. Fish species codes are: WSU- Warner sucker, RBT- redband trout, TC- tui chub, WC- white crappie, BC- black crappie, BRB- brown bullhead, and LMB- largemouth bass. White crappie, black crappie, brown bullhead, and largemouth bass are nonnative (hatched bars). Warner sucker, redband trout and tui chub are native (solid bars). Note that drought caused the lakes to dry completely in 1992.

## 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). In most years Hart and Crump Lakes hold water year round, however during droughts the suckers inhabiting the lakes are lost when the lakes desiccate (White et al. 1991; Allen et al. 1994). Stream suckers recolonize the lakes following desiccation (Allen et al. 1994). Irrigation dams and diversions limit movements and genetic exchange between lake and stream suckers (and redband trout) by blocking both the upstream spawning migrations from the lakes into the streams and the downstream migration of young fish into the lakes. To make matters worse, when young fish are able to enter the lakes, they face a gauntlet of introduced fishes which both prey upon and compete with them. These conditions have gone relatively unchanged in the 21 years since listing.

The results of our investigations indicate that the Warner sucker and redband trout populations in Crump and Hart Lakes are severely depressed. The 2006 CPUE for suckers in Hart Lake was one of the lowest on record. Compared to 2001, the last year that substantial trapping was conducted, the 2006 CPUE declining more than 90 percent. Abundant precipitation and stream flows allowed us to set traps farther south in Crump Lake than during most previous sampling efforts. The Crump Lake sucker catch was the highest on record, but so was the total effort and the resultant sucker CPUE was also quite low. To increase the probability of recapturing sufficient numbers of Warner suckers to obtain mark-recapture abundance estimates in the lakes during future sampling efforts, we recommend concentrating



all of the sampling effort in one of the two lakes or adding an additional sampling crew to increase the sampling effort in each lake.

We did not find evidence of substantial recruitment of suckers. The 2006 sucker size distribution was dominated by large, older aged fish. Only one small sucker was captured in the screw trap during peak flows in May. It appears that the situation may actually be getting worse as both the proportion of nonnative fish in the catch and the average sucker length has increased since the lakes were recolonized in 1993.

The collection of larval suckers in the weed beds near the mouth of Honey Creek suggests that either some lake spawning of suckers occurred in 2006 or that fish which spawned in Honey Creek migrated downstream after stream flows dropped and the screw trap was pulled. It is unlikely that these larval fish bypassed the screw trap since it blocked  $\geq 75\%$  of the Honey Creek channel during operation.

Our radio tracking documented the movement of suckers into Honey Creek. One fish moved past several irrigation dams, perhaps before the boards were installed. We located this fish immediately downstream of the diversion dam which is immediately below the county road crossing north of Plush, OR. We also documented the apparent spawning migration of suckers from Crump Lake south into lower Deep Creek. Areas in lower Deep Creek may have suitable habitat for sucker spawning and rearing and these areas may produce the recruits that colonize Crump Lake, although our length frequency analysis does not indicate that successful recruitment has occurred for many years.

Nonnative fish continue to dominate the catch in Hart and Crump Lakes. Native fish dominated the catch for several years after the lakes were recolonized in 1993. However, it was not long before nonnative fishes increased their abundance and dominated the catch, as they did prior to the desiccation of the lakes (Hartzell et al. 2001). In 2006, crappies dominated the catch (68%) and were very abundant in the traps fished near Honey Creek. We collected adult crappies in May and June for stomach analysis, but unfortunately these fish were discarded when the freezer where they were stored was cleaned out. In the future, we recommend collecting crappies in early-June to assess the extent of crappie predation on young suckers in the vicinity of Honey Creek.

Because impassable diversion dams and unscreened canals act to fragment the habitat of Warner suckers and redband trout in the basin, we recommend future studies to identify which irrigation diversions impede upstream migration of lake suckers and redband trout. This information will allow managers to prioritize restoration funding that can be used to assist local landowners in restoring passage both upstream and downstream of irrigation diversions. With the presence of over 100 fish that were PIT-tagged (half-duplex tags) in 2006, and the marking of additional fish in the future, it will be possible to track the seasonal movements of suckers past fixed stations that could be placed on tributary streams and at selected irrigation diversion structures.

In 2007, we plan to conduct distributional surveys of suckers in the Warner basin tributaries. Where possible, we will obtain density estimates that will allow us to monitor trends in stream sucker distribution and abundance over time. Ultimately, the persistence of Warner suckers in the basin relies on the healthy stream populations, the status of which is currently unknown.

## ACKNOWLEDGEMENTS

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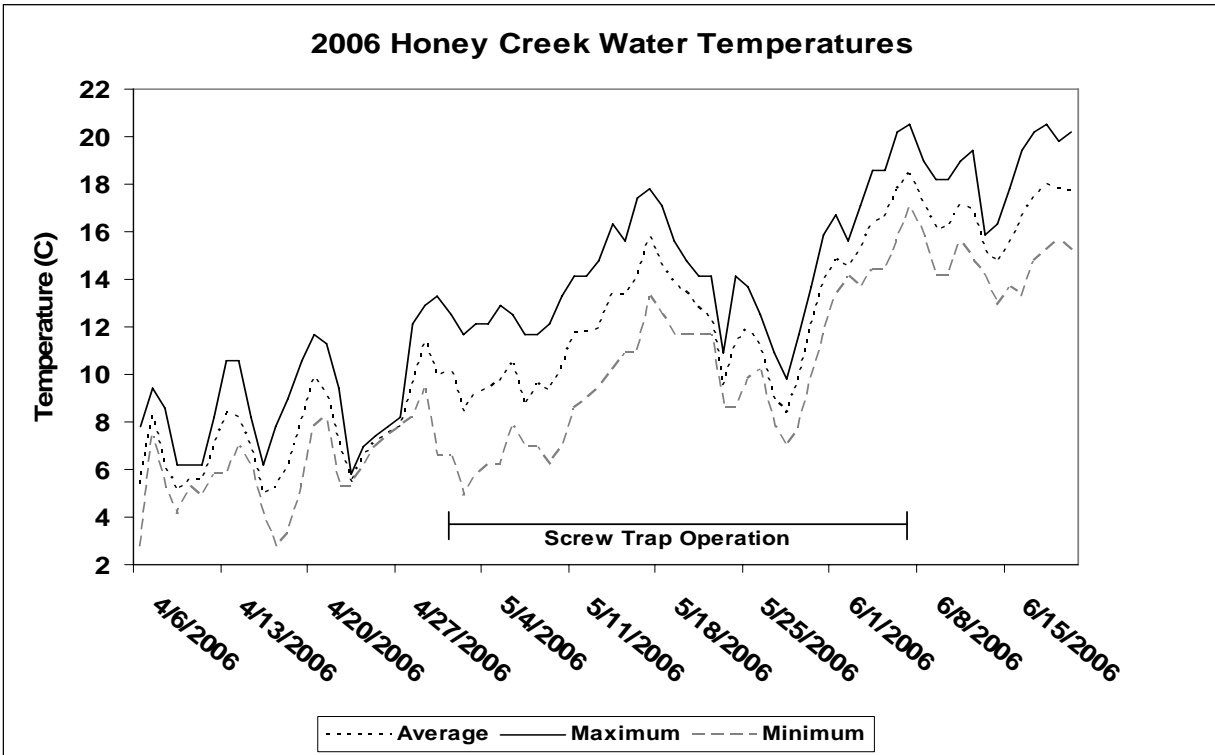
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APPENDIX A. Temperatures collected at the mouth of Honey Creek, 2006.



## APPENDIX B. Details of 2006 PIT tagging of Warner Suckers in Hart and Crump Lakes.

Date	Identification Code	Net	Length (mm)	Weight (g)	Sex	Tubercles	Radio Tag	Comments
5-Apr-06	120006451126	Crump 1	425		F			
5-Apr-06	120006367815	Hart 4	380		M	N		
5-Apr-06	120006923511	Hart 5	305		M	N		
6-Apr-06	120005637918	Hart 4	385		M	N		
6-Apr-06	120007084418	Hart 5	370		M	N		
11-Apr-06	132628538	Crump 2	300	337	M	Y		captured 4/11/06; released into Hart
11-Apr-06	132628543	Crump 3	400	768	F			captured 4/11/06; released into Hart
11-Apr-06	132628545	Hart 4	405	828	F			captured 4/11/06; released into Hart
11-Apr-06	132628539	Hart 4	350	558	M	N		captured 4/11/06; released into Hart
11-Apr-06	132628542	Hart 5	320	368	M	Y		captured 4/11/06; released into Hart
12-Apr-06	132628541	Crump 1	305		M	Y		captured 4/12/06; released into Hart
12-Apr-06	132628544	Crump 1	355		M	N		captured 4/12/06; released into Hart
12-Apr-06	none	Crump 6	55		?			too small to PIT tag; released
12-Apr-06	132628540	Hart 5	340	513	M	Y		captured 4/12/06; released into Hart
13-Apr-06	132628529	Crump 3	430	1052	F			
13-Apr-06	132628575	Crump 3	320	368	F			
13-Apr-06	132628578	Crump 3	380	882	M	Y		
13-Apr-06	132628536	Hart 2	275	254	M	N		
13-Apr-06	132628534	Hart 5	405	856	F			
13-Apr-06	132628537	Hart 5	400	830	M	N		
13-Apr-06	132628535	Hart 5	345	586	M	N		
13-Apr-06	132628533	Hart 5	295	320	M	Y		
13-Apr-06	132628531	Hart 6	285	278	F			
13-Apr-06	132628530	Hart 6	325	442	M	Y		
14-Apr-06	132628573	Hart 2	390	692	F			
14-Apr-06	132628572	Hart 5	325	520	M	Y		
18-Apr-06	132628570	Crump 4a	285	296	M	Y		
19-Apr-06	132628567	Crump 1	335	502	M	Y		
19-Apr-06	132628568	Hart 4	375	650	F			
20-Apr-06	132628577	Crump 3	425	920	F			
20-Apr-06	132628571	Crump 3	250	174	M	Y		
20-Apr-06	132628574	Crump 4a	295	366	F			
20-Apr-06	132628569	Crump 4a	185	72	M	Y		
20-Apr-06	132628579	Crump 4a	255	222	M	Y		
20-Apr-06	132628566	Hart 4	450	1096	F			
21-Apr-06	132628593	Hart 2	270	282	M	Y		
21-Apr-06	132628594	Hart 5	270	270	F			
21-Apr-06	132628591	Hart 5	305	365	M	Y		
25-Apr-06	132628587	Crump 1	315	406	F		660-006	released into Crump
25-Apr-06	132628562	Crump 3	340	464	F		660-003	released into Crump
25-Apr-06	132628584	Crump 3	300	317	M	Y	660-007	released into Crump
25-Apr-06	132628585	Crump 3	295	288	M	Y	660-095	released into Hart
25-Apr-06	132628588	Crump 4a	340	520	F		660-009	released into Crump
25-Apr-06	132628590	Crump 4a	330	422	F		660-097	released into Hart
25-Apr-06	132628592	Crump 4a	305	334	M	Y	660-100	released into Hart
25-Apr-06	132628589	Crump 4a	265	214	M	Y	660-098	released into Hart
25-Apr-06	132628586	Crump 4a	290	288	M	Y	660-094	released into Hart
26-Apr-06	132628582	Crump 2	325	434	F			
26-Apr-06	132628580	Crump 3	335	504	F			
26-Apr-06	132628583	Crump 3	345	514	M	Y		
26-Apr-06	132628581	Crump 3	235	160	M	Y		
27-Apr-06	132628628	Hart 4	445	1156	F			
28-Apr-06	132628625	Crump 3	435	986	F			
28-Apr-06	132628626	Crump 3	315	370	M	Y		
28-Apr-06	132628629	Crump 4A	265	270	F			
2-May-06	132628624	Honey Creek	275	280	M	Y		
3-May-06	132628623	Crump 1	275	238	F			
3-May-06	132628621	Crump 3	400	774	F			
3-May-06	132628619	Crump 3	285	260	M	Y		
3-May-06	132628620	Crump 4A	335	462	F			
3-May-06	132628618	Crump 4A	320	415	F			
3-May-06	132628622	Crump 4A	225	174	M	Y		
4-May-06	132628607	Crump 1	160	40	M	N		
4-May-06	132628613	Crump 3	170	68	F			
4-May-06	132628615	Crump 4A	415	940	F			
4-May-06	132628612	Crump 4A	295	330	F			
4-May-06	132628609	Crump 4A	315	416	F			ripe, full of eggs
4-May-06	132628608	Crump 4A	340	506	F			
4-May-06	132628611	Crump 4A	310	396	M	N		
4-May-06	132628614	Crump 4A	390	664	M	N		
4-May-06	132628610	Crump 4A	315	386	M	Y		

**APPENDIX B (continued).**

Date	Identification Code	Net	Length (mm)	Weight (g)	Sex	Tubercles	Radio Tag	Comments
5-May-06	132628653	Crump 1	315	374	M	Y		
5-May-06	132628606	Crump 3	185	80	F			
5-May-06	132628605	Crump 3	355	604	F			
5-May-06	132628654	Crump 3	320	420	F			
9-May-06	132628651	Crump 3	315	322	M	Y		sperm expressed
9-May-06	132628649	Crump 4A	340	524	F			ripe, full of eggs
9-May-06	132628648	Crump 4A	335	502	F			
9-May-06	132628650	Crump 4A	310	406	F			eggs
9-May-06	132628652	Hart 3C	385	818	F			
10-May-06	132628647	Crump 3	315	436	F			
10-May-06	132628646	Crump 3	285	256	M	Y		sperm expressed
11-May-06	132628644	Crump 3	225	146	F			
11-May-06	none	Honey Creek	32		?	N		Not PIT tagged; too small
11-May-06	132628645	Honey Creek	270	230	F			
12-May-06	132628643	Crump 3	400	870	F			
18-May-06	132628642	Honey Creek	215	120	?	N		
24-May-06	132628640	Hart 3C	435	854	F			few overripe eggs-spawned out
24-May-06	132628617	Hart 3C	395	712	M	Y		spawned out
24-May-06	132628639	Hart 5	415	761	F			spawned out- belly concave
1-Jun-06	132628638	Hart 5	335	465	M	Y		
7-Jun-06	132628637	Crump-Trammel Net	355	630	F			
7-Jun-06	none	Hart-Trammel Net	405	676	F			floy tagged only; stressed
7-Jun-06	none	Hart-Trammel Net	440	1035	F			floy tagged only; stressed
7-Jun-06	none	Hart-Trammel Net	415	824	F			floy tagged only; stressed
7-Jun-06	none	Hart-Trammel Net	405	802	F			floy tagged only; stressed
7-Jun-06	none	Hart-Trammel Net	355	626	F			trap mortality
7-Jun-06	none	Hart-Trammel Net	385	610	F			trap mortality
7-Jun-06	none	Hart-Trammel Net	355	436	F			trap mortality
7-Jun-06	132628636	Hart-Trammel Net	320	456	M	Y		
7-Jun-06	none	Hart-Trammel Net	360	624	M	Y		floy tagged only; stressed
9-Jun-06	132628635	Crump 4A	280	270	F		660-012	
9-Jun-06	132628634	Hart 2/3	380	774	F			
14-Jun-06	132628604	Hart 2/3	440	744	F			spawned out-belly concave, no picture
15-Jun-06	132628633	Hart 2/3	350	570	F			
15-Jun-06	132628632	Hart 2/3	425	815	F			
15-Jun-06	132628631	Hart 2/3	440	910	F			
20-Jun-06	132628678	Hart 1/6	385	446	F			Recap FDX-A 276527798533, spawned out
20-Jun-06	132628676	Hart 1/6	395	616	F			spawned out
20-Jun-06	132628679	Hart 1/6	425	706	F			spawned out
20-Jun-06	132628677	Hart 1/6	385	624	F			spawned out
20-Jun-06	132628674	Hart 1/6	400	784	F			spawned out
20-Jun-06	132628675	Hart 1/6	440	864	F			spawned out
20-Jun-06	132628630	Hart 2/3	405	726	F			spawned out
21-Jun-06	132628673	Hart 1/6	385	526	F			Recap FDX-A 276528502356, spawned out

**APPENDIX C.** Catch per trap night for all fish species collected in the Hart and Crump Lakes from all years when sampling occurred from 1990 through 2006. Fish codes are: WSU- Warner sucker, RBT- redband trout, TC- tui chub, WC- white crappie, BC- black crappie, BRB- brown bullhead, and LMB- largemouth bass.

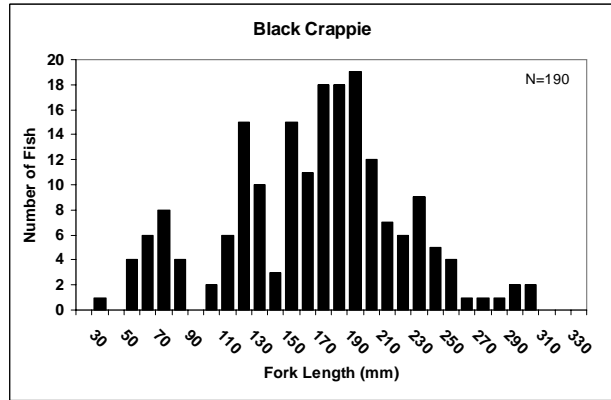
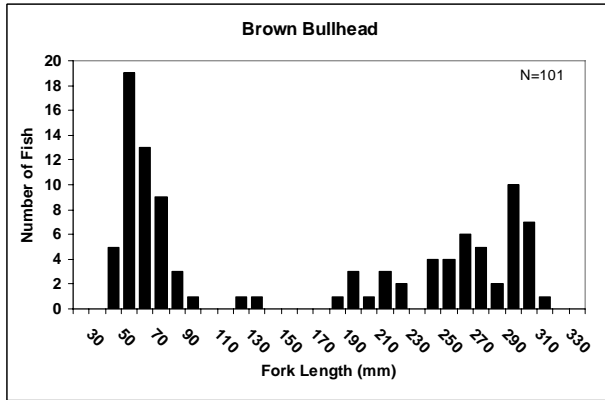
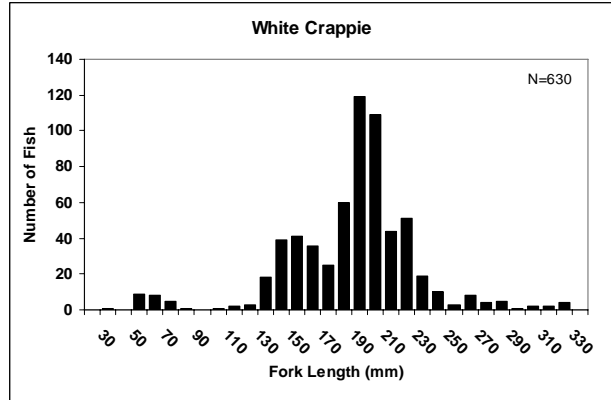
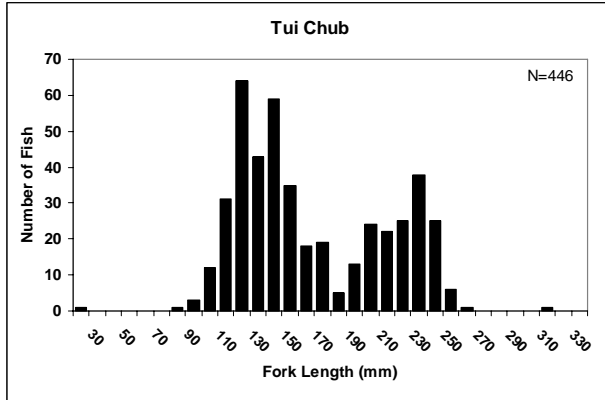
Hart Lake

Year	Trap nights	Catch per trap night						
		WSU	RBT	TC	WC	BC	BRB	LMB
1990	122	1.6	0.0	2.0	30.0	12.5	27.7	0.0
1991	175	0.6	0.0	1.7	4.0	1.8	1.5	0.0
1993	70	0.0	0.0	0.2	0.0	0.0	0.0	0.0
1994	54	2.3	0.0	11.9	0.5	20.8	3.2	0.0
1995	104	0.2	0.0	24.2	0.7	5.7	1.0	0.0
1996	252	3.3	0.2	50.1	0.1	4.8	0.6	0.0
1997	137	1.4	0.1	135.1	8.7	9.2	6.5	0.0
2001	63	2.8	0.0	4.9	3.7	4.8	41.1	0.1
2006	214	0.2	0.0	15.9	34.3	8.7	2.1	0.0

Crump Lake

Year	Trap nights	Catch per trap night						
		WSU	RBT	TC	WC	BC	BRB	LMB
1990	9	1.8	0.0	6.3	18.0	19.1	18.0	0.4
1991	0	-	0.0	-	-	-	-	-
1993	25	0.0	0.0	0.8	0.0	0.6	0.1	0.0
1994	35	0.2	0.0	85.4	1.3	46.5	0.8	1.7
1995	40	0.0	0.0	71.0	1.2	8.0	0.3	0.0
1996	36	0.3	0.2	4.5	0.1	4.7	0.2	0.0
1997	60	0.0	0.1	19.7	2.5	25.1	0.8	0.0
2001	24	0.2	0.0	4.2	7.6	11.2	27.6	2.2
2006	238	0.3	0.0	9.3	15.4	3.4	1.3	0.0

**APPENDIX D.** Length frequency histograms for tui chub, brown bullhead, white crappie, and black crappie collected from the Warner Lakes, 2006.







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