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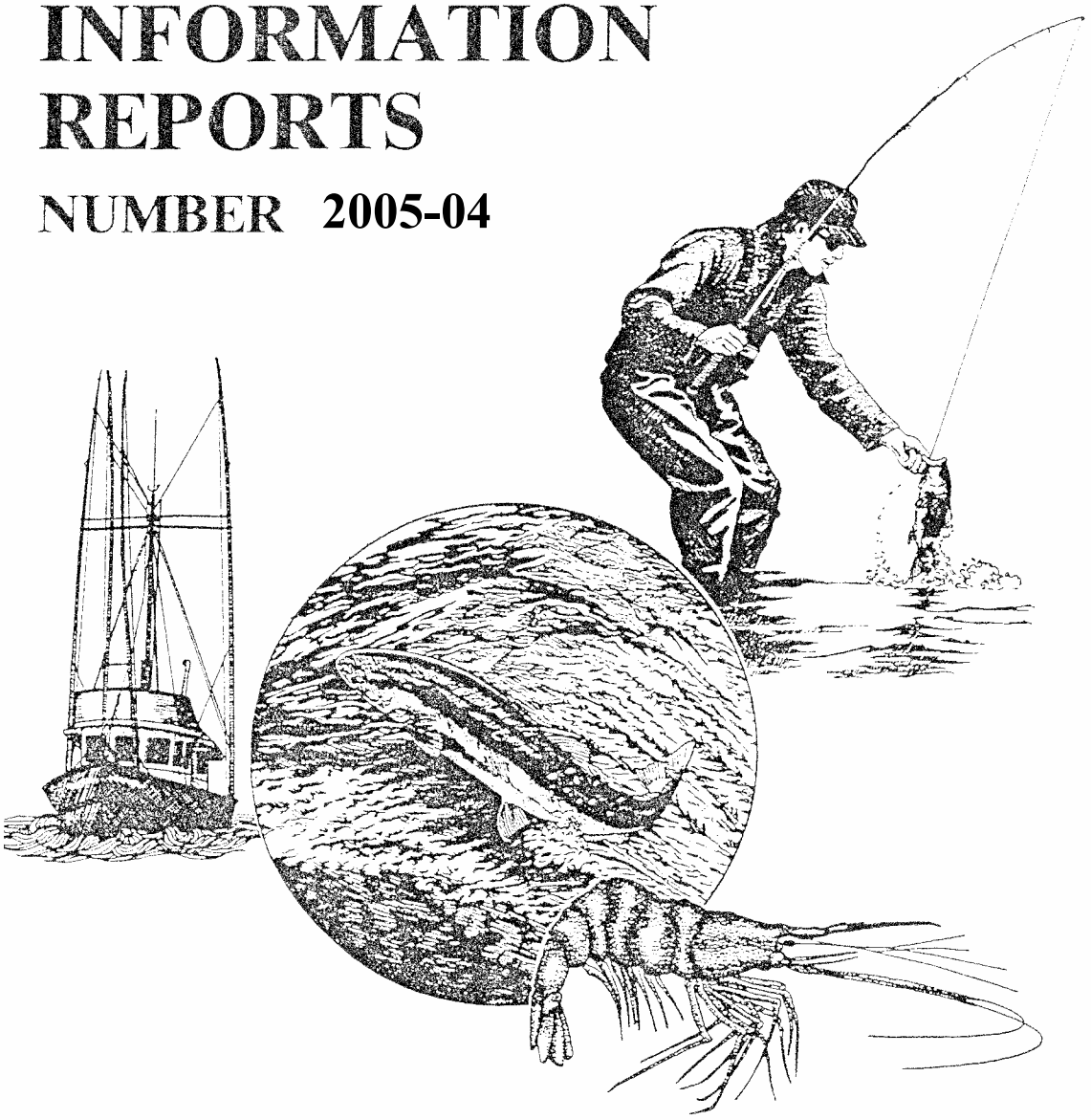

FISH DIVISION

Oregon Department of Fish and Wildlife

Timing and Location of Spawning by Bull Trout and Kokanee in the Odell Lake Watershed and Heising Spring of the Metolius River Watershed, 2003-04.

Timing and Location of Spawning by Bull Trout and Kokanee in the Odell Lake Watershed and Heising Spring of the Metolius River Watershed, 2003-04.

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INTRODUCTION

The Odell Lake watershed (Deschutes County) supports the only remaining natural adfluvial population of bull trout (*Salvelinus confluentis*) in Oregon (Buchanan et al. 1997). Little is known about its life history. Odell Lake bull trout were isolated from other bull trout populations in the upper Deschutes River basin approximately 5,500 years ago when a lava flow impounded Odell Creek (Johnson et al. 1985). Because of their isolation and low abundance, Odell Lake bull trout are considered at "high risk" for extinction (Ratliff and Howell 1992). When Columbia River bull trout populations were listed threatened in 1998, the Odell Lake population was included in the listing (63 FR 31647) Subsequent to listing, federal, state and tribal biologists worked cooperatively with private landowners to develop a draft recovery plan for the Odell Lake Recovery Unit (U.S. Fish and Wildlife Service (USFWS) 2002). The Odell Lake Recovery Unit consists of Odell and Davis Lakes, Odell Creek and all tributaries.

At the time of listing, the USFWS considered over-harvest, predation, non-native species, water quality and habitat degradation to be the primary threats to bull trout within the Odell Lake watershed (USFWS 2002). An analysis of the Odell Lake Watershed (U.S. Forest Service (USFS) 1999a) identified the following suspected limiting factors:

1. Angling mortality.
2. Competition with other fish species for food, space, and spawning habitat.
3. Hybridization with brook trout (*Salvelinus fontialis*).
4. Limited spawning and rearing habitat in the tributaries of Odell Lake.
5. Partial migration barriers created by railroad crossings.
6. Historic poaching in tributaries.
7. Superimposition of bull trout redds by spawning kokanee salmon (*Oncorhynchus nerka*).

Identification of these limiting factors was based on limited data and relied heavily on professional judgment. The draft recovery plan for the Odell Lake Recovery Unit specifies the need to develop and conduct scientifically sound research and monitoring. Starting in 2003, the Oregon Department of Fish and Wildlife (ODFW) initiated several research projects designed to obtain information about the distribution and abundance of bull trout and the interactions of bull trout and kokanee within the Odell Lake watershed. Because of the extremely small size of the Odell bull trout population, we explored addressing the impacts of limiting factor number seven in the Metolius River watershed. Like the Odell watershed, the Metolius watershed has tributaries that support sympatric populations of spawning bull trout and kokanee salmon; however bull trout are much more abundant in this system.

Our objectives for 2003 were to:

1. Conduct spawning surveys in Trapper Creek through November to obtain data on the timing and locations of spawning by bull trout and kokanee as well as the number and locations of bull trout redds.

2. Survey additional Odell Lake and Odell Creek tributaries to locate previously unknown bull trout spawning areas.

3. Collect baseline information regarding the superimposition of bull trout redds by kokanee salmon in both Trapper Creek and Heising Spring, tributary to lower Jack Creek in the Metolius River watershed.

4. Measure physical characteristics of bull trout redds in Trapper Creek and Heising Spring.

5. Evaluate the feasibility of conducting redd superimposition studies in Heising Spring and transferring inferences to Trapper Creek.

Additional objectives for 2004 were to:

1. Fabricate and install kokanee exclusion screens on bull trout redds in Trapper Creek and evaluate their effectiveness in preventing superimposition of bull trout redds.

2. Conduct a statistical creel census to determine the extent of incidental bull trout catch and mortality in Odell Lake.

Results of the creel census will be presented in a separate report. Results of the spawning surveys and redd superimposition studies are presented in this report.

BACKGROUND

Odell Lake Recovery Unit

The Odell Lake Recovery Unit consists of Odell and Davis Lakes, Odell Creek and all tributaries (Figure 1). It encompasses an area of approximately 302 square kilometers (km), located within the Deschutes National Forest in Deschutes and Klamath Counties, Oregon. Approximately 15% of the recovery unit is located within the Diamond Peak Wilderness. Elevations range from 1,337-2,667 meters (m).

Odell Lake is a natural lake with a surface area of approximately 1,457 hectares (ha). Average depth is approximately 40 m and maximum depth is approximately 86 m (Johnson et al. 1985). Water temperatures range from summer surface temperatures approaching 21^{o} Centigrade (C), to 2^{o} C year-round at deeper levels (USFWS 2002). Approximately 38 km of tributary streams flow into Odell Lake. Trapper Creek is the largest (*see* Figure 1). Other significant tributaries include Crystal and Hemlock (Fire) creeks. Odell Creek is the sole outlet from Odell Lake, flowing northeast to Davis Lake. Maklaks and McChord Cabin Creeks, and an unnamed tributary hereafter referred to as “No Name Creek,” are cold water tributaries to Odell Creek (USFS 1999a; USFS and Bureau of Land Management (BLM) 1999). Davis Lake is approximately 1,578 ha with a maximum depth of 61 m. It receives inflow from Odell, Ranger, and Moore creeks, as well as subsurface springs. Although Davis Lake has no surface outlet, it is believed that a number of connected seeps allow water to flow into Wickiup Reservoir northeast of Davis Lake. During the summer, outflow exceeds inflow causing the lake level to drop by as much as 1 m between spring and fall months (Johnson et al. 1985).

Bull trout, mountain whitefish (*Prosopium williamsonus*) and redband trout (*Oncorhynchus mykiss* spp) are native to Odell and Davis Lakes. Introduced species include rainbow trout (*O. mykiss* spp), lake trout (*Salvelinus namaycush*), kokanee salmon and tui chub (*Gila bicolor*).

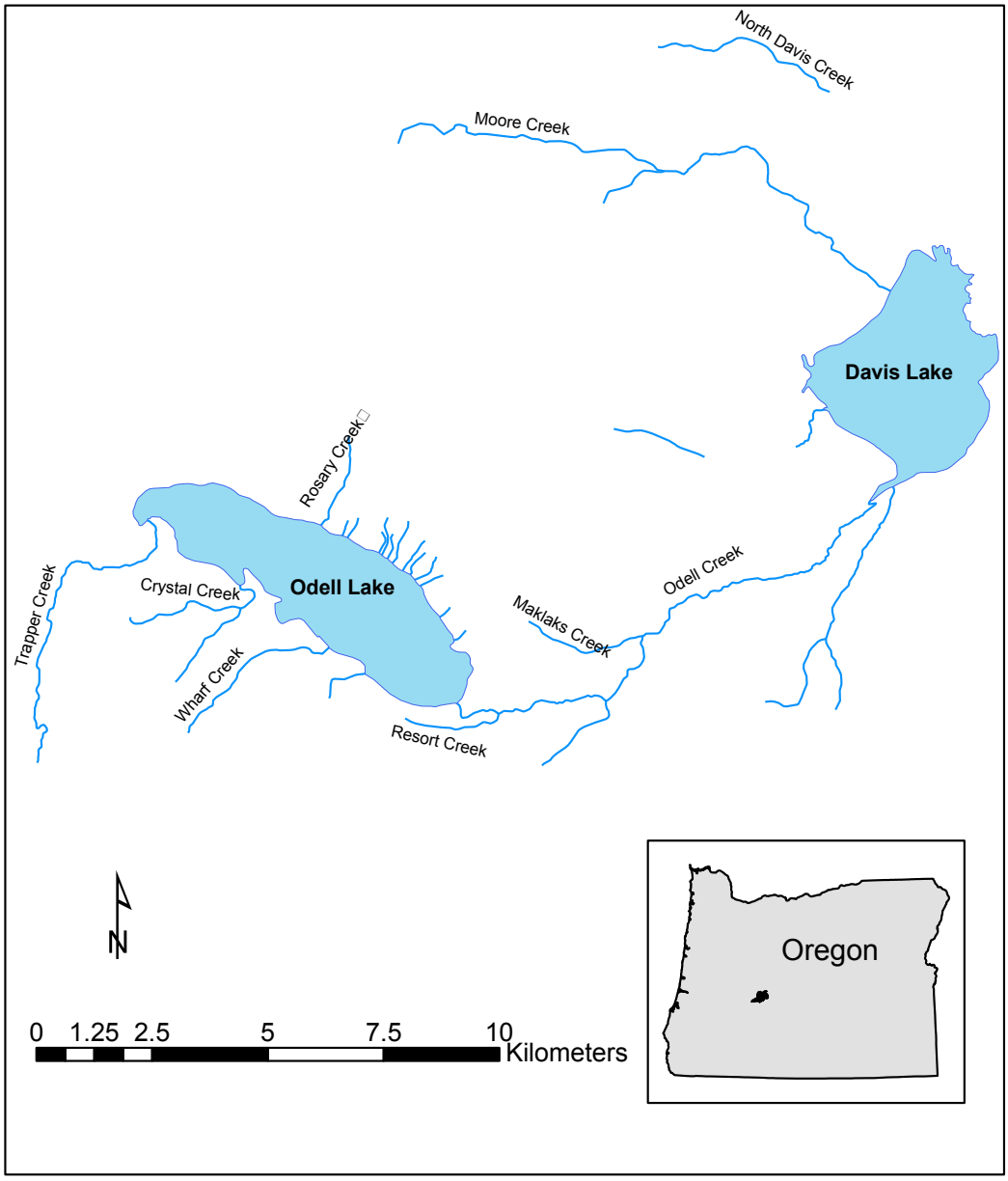

Figure 1. Map of the Odell Watershed including major tributaries and Odell and Davis Lakes.

Species currently found in Davis Lake and its tributaries include rainbow trout, mountain whitefish, brook trout, tui chub, and largemouth bass (*Micropterus salmoides*). In the past, Davis Lake has been stocked with rainbow trout, kokanee salmon, coho salmon (*O. kisutch*), fall chinook salmon (*O. tshawytscha*) and Atlantic salmon (*Salmo salar*).

The size of the bull trout population within the Odell Lake Watershed is unknown. However, available data indicate that the population is precariously small. Distribution is generally limited to Odell Lake and Trapper Creek. Bull trout are occasionally found in Odell

Creek (USFS 2001), but are not known to spawn there. Bull trout have also been reported in Davis Lake, but they are likely limited by high summer water temperatures. One bull trout was caught by an angler at the Davis Lake inlet of Odell Creek in June, 2000 (S. Marx, ODFW, pers. comm., 2001, cited in USFWS 2002). Bull trout historically occurred in Crystal Creek, but have not been observed there in recent years (USFS 1994). A single bull trout was recently observed in Fire Creek (also referred to as Hemlock Creek, USFS 2003). Also in 2003, a 114 mm juvenile bull trout was captured in the lower reach of Maklaks Creek (USFS 2003). In 2004, juvenile bull trout were observed in Odell and No Name Creeks (USFS 2004).

Trapper Creek is the only tributary to Odell Lake with a known spawning and rearing population of bull trout. Spawning and rearing habitat is located within the lower 1.3 km of Trapper Creek between the mouth and a 2.3 m waterfall. Bull trout have been observed spawning in this area during August, September and October (Dachtler and Sanchez 2000; ODFW 1999). According to surveys conducted by the USFS, approximately 1% of the total habitat in the lower 1.3 km of Trapper Creek contained good spawning habitat and less than 3% contained fair spawning habitat for bull trout. Less than 3% of the area contained good rearing habitat and less than 2% contained fair rearing habitat for bull trout fry. Additionally, large numbers of kokanee salmon may spawn on top of the bull trout redds, which may negatively affect the survival of bull trout embryos (Foerster 1968).

The USFS has conducted annual snorkel surveys in Trapper Creek since 1996 (Dachtler and Sanchez 2000). A total of 180 age 0 to age 4 bull trout (approximately 20-160 mm) were observed in the 2004 snorkel survey. Redd surveys have been conducted in the lower 1.3 km of Trapper Creek by USFS and ODFW personnel since 1994. However, bull trout redds are difficult to detect in Trapper Creek due to the lack of algal growth on undisturbed substrate and large substrate size. Additionally, bull trout redds may be superimposed by kokanee redds near the end of the spawning period. In 1998, nine redds and 11 adult bull trout were counted during spawning surveys. In 1999, a fyke trap placed near the mouth of Trapper Creek captured 48 adult bull trout and a total of 24 bull trout redds were counted. In 2000, the fyke trap captured 39 adult bull trout and a total of 12 bull trout redds were counted. A total of 11 bull trout redds were counted in 2001.

Heising Spring

The Metolius River and its tributaries originate from springs, glaciers and lakes in the eastern portion of the Cascade Mountains of central Oregon and drain 816 square kilometers within the 26,939 square km Deschutes River Basin. Both adult bull trout and kokanee salmon migrate into the Metolius River from Lake Billy Chinook to spawn in coldwater tributaries, including Heising Spring. Heising Spring enters Jack Creek just before its confluence with the Metolius River and provides a stable flow of cold water and abundant spawning gravel in its 0.3 km length. Annual redd surveys and angler creel surveys on Lake Billy Chinook indicate that bull trout are abundant within the Metolius basin. For example, 1,045 bull trout redds were counted during the 2004 survey.

METHODS

Spawning surveys were conducted in the 1.3 km section of Trapper Creek from the mouth upstream to the falls from late August through November. Surveys were conducted at least weekly and up to three times each week during the peak of the spawning season. Crystal, Hemlock, Maklaks and Odell creeks, Trapper Creek upstream of the falls and two unnamed

tributaries were also surveyed less frequently from late August into November. Redds were observed from the bank and flagged with surveyor tape. Flags were marked with an identification number and date observed.

Starting in 2003, a piece of rebar was driven into the streambed next to the pocket of each bull trout redd so that bull trout redds could continue to be identified after superimposition by kokanee. For each bull trout redd, the combined length of the pocket and mound, maximum depth of the pocket, and maximum width of the mound were measured and recorded. Spawning substrate size was determined by counting gravel along a 0.5 m length of each pocket and mound of selected redds. A flow meter (Model 2000 Flo-Mate, Marsh-McBirney, Inc.) was used to measure stream velocities over the center of the mound for each bull trout redd in 2003. At each of these locations, velocities were measured at 20%, 60% and 80% of the depth of the water column. Lengths of bull trout observed near redds were estimated by visually locating reference points in the substrate at the head and tail of each fish, then measuring the distance between these points.

Prior to the arrival of the first kokanee in 2004, “kokanee exclusion screens” were placed over 5 of the 8 bull trout redds located downstream of a boulder weir which presents a formidable migration barrier to kokanee. Exclusion screens were constructed of vinyl-coated wire fencing with 1" spaced mesh. The screens were designed to cover the entire surface of the mound and pocket of each individual redd. The screens were placed horizontally over redds and staked down at each corner with a piece of rebar. After placement, each exclusion screen was observed and cleaned twice a week.

Heising Spring was surveyed weekly from early September through November. Starting in 2003, bull trout redds were identified and measured by methods used in Trapper Creek, except that wooden dowels were used to mark redd locations, and, because of the relatively large number of redds, white painted rocks were also placed at the head of each bull trout redd. Lengths of bull trout observed near redds were estimated by methods used in Trapper Creek. No flow measurements were taken for redd sites in Heising Spring.

The dimensions of bull trout redds in Heising Spring and Trapper Creek were compared using a t-test assuming unequal variance between treatment groups.

RESULTS

Trapper Creek

A total of 17 bull trout redds were observed in Trapper Creek during the 2003 surveys (Table 1). Two redds were already present when spawning surveys began on 22 August. An additional 6 redds had been constructed by the end of August; another eight were constructed during September. The last bull trout redd was observed during mid-October.

A total of 12 bull trout redds were observed during the 2004 survey season. Six redds were constructed by 1 September; another four were constructed by 7 September and the last two redds were completed by 7 October.

Table 1. Characteristics of bull trout redds observed in Trapper Creek, 2003 and 2004.

Redd Number	Date first Observed	Bull trout present[a]	Date spawning kokanee first observed
		2003	
1	22 Aug	2, size unknown	15 Sep
2	22 Aug	1, size unknown	15 Sep
3	27 Aug	none	--[b]
4	27 Aug	1 female ~45 cm	25 Sep
5	27 Aug	2, size unknown	23 Sep
6	27 Aug	3, size unknown	25 Sep
7	28 Aug	none	23 Sep
8	28 Aug	1 female ~40 cm, 1 male ~48 cm	23 Sep
9	02 Sep	none	23 Sep
10	04 Sep	none	--[b]
11	10 Sep	1 female ~30 cm, 2 males ~48 cm	25 Sep
12	10 Sep	2 unknown sex ~45 cm	--[b]
13	10 Sep	1 male ~30 cm, 1 female ~30 cm	--[b]
14	23 Sep	1 female ~41 cm, 1 male ~30 cm	25 Sep
15	25 Sep	1 male ~46 cm, 1 female ~48 cm	25 Sep
16	29 Sep	none	--
17	13 Oct	1 male ~41 cm, 1 female ~41 cm	13 Oct
		2004	
1	28 Aug	1 female ~46 cm, 1 male ~50 cm	--[b,c]
2	29 Aug	1 female ~38 cm, 1 male ~46 cm	29 Sep
3	29 Aug	1 female ~56 cm	29 Sep
4	29 Aug	1 female ~46 cm, 1 male ~61 cm	27 Sep
5	29 Aug	1 female ~43 cm, male unknown	27 Sep
6	01 Sep	1 female ~58 cm, male unknown	29 Sep
7	04 Sep	1 female ~50 cm, 1 male ~50 cm	29 Sep
8	05 Sep	1 female ~46 cm, 1 male ~20 cm	--[b,c]
9	06 Sep	None	27 Sep
10	07 Sep	None	--[b]
11	05 Oct	None	29 Sep
12	07 Oct	1 female ~50 cm, 1 male ~56 cm	--[b,c]

a *Lengths are visual estimates.*
b *Redds located in upper portion of stream where kokanee were never observed.*
c *Three different bull trout redds were superimposed at this site.*

Counts of bull trout redds in Trapper Creek have ranged from 0 to 24 during the 11 years since surveys have been conducted (Figure 2). The highest number of redds was observed in 1999 followed by 2003 and 2004. It should be noted however that the frequency of survey visits was substantially higher in 2003-04 than in earlier years. Fewer survey visits may act to negatively bias estimates of total redds, therefore, relative to the last two years in the time series, earlier counts may be underrepresented. Additionally, a weir installed near the mouth of Trapper Creek during 1999 and 2000 captured 39 and 48 bull tout, respectively.

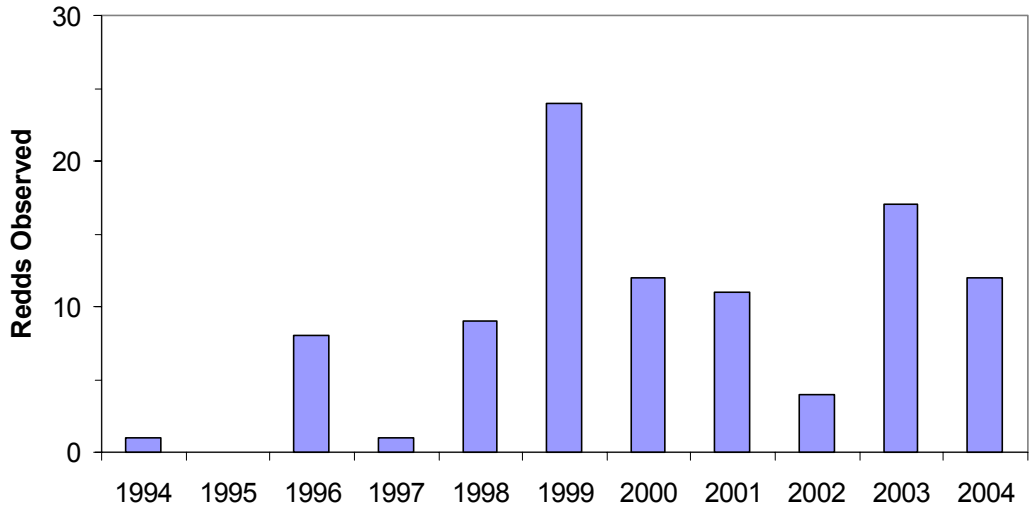

Figure 2. Bull trout redds counted in Trapper Creek, 1994-2004. No redds were observed in 1995.

Most redds observed during both seasons were associated with spawning bull trout. In 2003 bull trout were observed on 12 of the 17 redds observed, whereas in 2004, 9 of the 12 redds had spawning bull trout. Lengths of the bull trout associated with redds averaged 44 cm and ranged from 20-61 cm (Table 1).

Stream velocities of sites in Trapper Creek where bull trout redds were observed in 2003 are presented in Table 2. Velocities at redd sites averaged about 0.3 m per second and tended to decrease near the stream bottom.

Within the Odell Lake watershed, bull trout redds were observed only in the lower 1.0 km of Trapper Creek in 2003 and 2004. Locations of bull trout redds in Trapper Creek varied somewhat between the two years. Redds were distributed somewhat further upstream in 2003 compared to 2004 (Figure 3). In 2003, three of the 17 bull trout redds were located upstream of the railroad bridge crossing Trapper Creek at stream km 1.0. In 2004, eleven of the twelve bull trout redds were located between the 5810 forest road bridge and the railroad bridge. One bull trout redd was located downstream of the 5810 forest road bridge.

In 2003, kokanee were first observed by the Trapper Creek Campground host during the evening of 14 September. ODFW field personnel confirmed this observation on 15 September. Within 10 days, kokanee were observed holding or actively constructing redds over all 13 bull trout redds located downstream of the railroad bridge. Kokanee were abundant in Trapper Creek by 29 September, and most areas of small to medium-sized substrate appeared to be disturbed by spawning kokanee. By 21 October, only 3 of 13 bull trout redds located downstream of the railroad bridge (numbers 7, 8 and 9) remained visible without the aid of flagging and rebar stakes. The last redd constructed by bull trout (number 17) was not visible without the aid of flagging or rebar within two weeks of its original construction.

Table 2. Stream velocities (m/s) measured over bull trout redds in Trapper Creek, 2003.

Redd number	Stream width (m)	Stream depth (m) over mound	Velocity at % of depth			
			20	60	80	mean
1	9.5	0.37	0.36	0.30	0.08	0.25
2	9.5	0.34	0.43	0.33	0.18	0.31
3	8.2	0.43	0.31	0.29	0.26	0.29
4	5.2	0.34	0.53	0.46	0.32	0.44
5	7.0	0.70	0.28	0.25	0.21	0.25
7	11.6	0.30	0.29	0.26	0.24	0.26
8	7.3	0.55	0.29	0.28	0.25	0.27
9	7.3	0.49	0.36	0.28	0.20	0.28
10	5.8	0.52	0.38	0.36	0.27	0.34
11	7.0	0.70	0.28	0.25	0.21	0.25
13	7.0	0.43	0.28	0.31	0.39	0.33
14	7.0	0.40	0.38	0.36	0.32	0.35
16	6.1	0.34	0.35	0.42	0.38	0.38
Mean		0.45	0.35	0.32	0.25	0.31

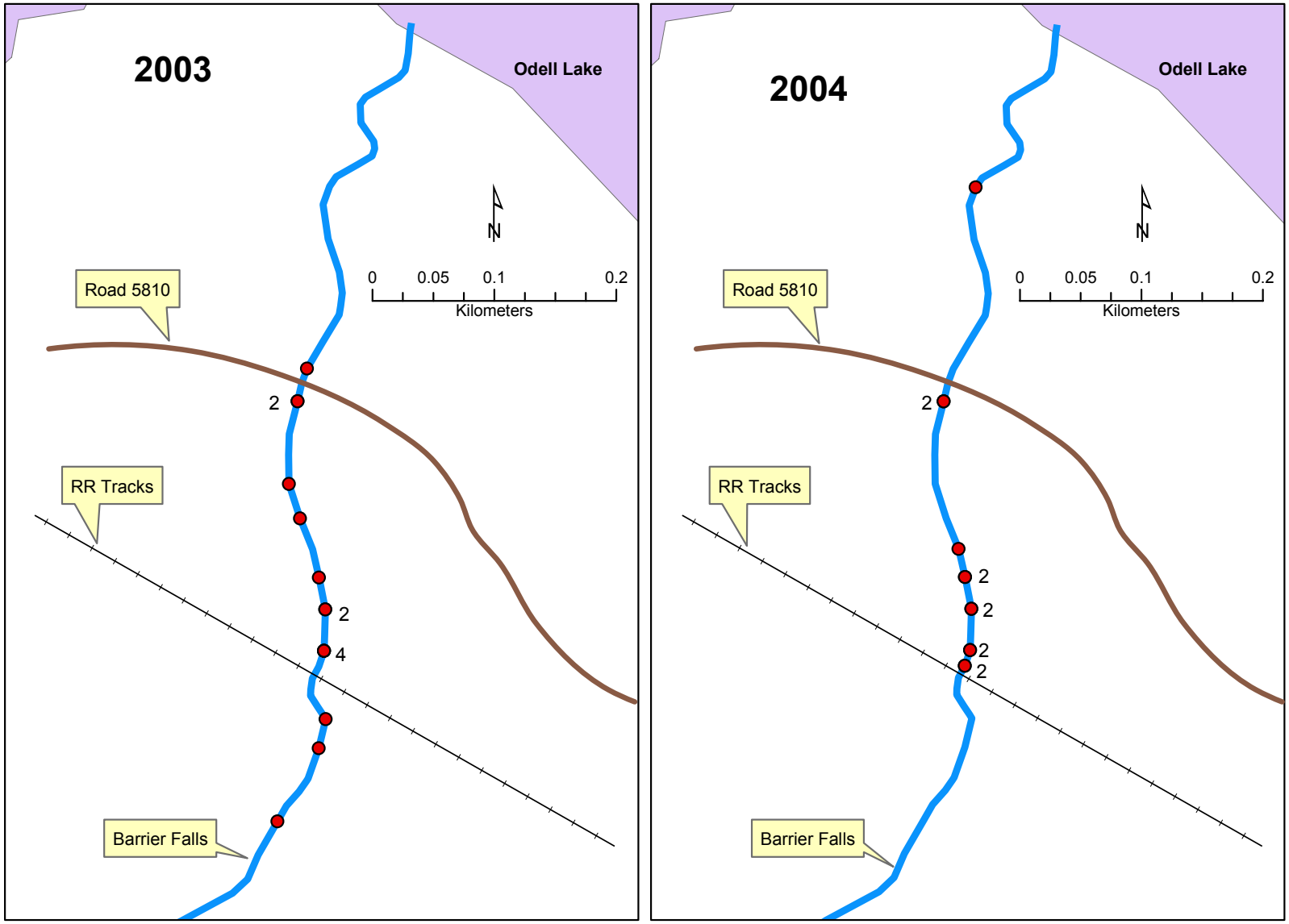

Figure 3. Locations of bull trout redds observed in Trapper Creek during the 2003 and 2004 spawning seasons. Redd locations are denoted by circles. Numbers next to circles indicate number of redds at sites having multiple redds.

In 2003, gravel was more abundant on bull trout redds after kokanee spawned. Pebble counts in both the pockets and mounds of bull trout redds increased dramatically after kokanee had initiated spawning (Table 3). These results suggest that spawning kokanee displaced gravel onto existing bull trout redds. Kokanee were last observed spawning in Trapper Creek on 6 November. Twelve spawned kokanee carcasses measured on 21 October averaged 351 mm fork length (range = 340-370 mm, SD= 10 mm).

Table 3. Pebble count for Trapper Creek bull trout redds, 2003.

Redd number	Pebble count (N per 0.5 m)			
	Before kokanee [a]		After kokanee [b]	
	pocket	mound	pocket	mound
3	5	12	--	--
4	9	17	35	30
7	6	19	40	20
9	8	19	35	35
10	12	17	--	--
13	15	25	--	--
Average	8	18	37	28

a *Pebbles counted on 15 September.*
b *Pebbles counted on 21 October.*

In 2004, kokanee were first observed in Trapper Creek on 20 September. By 1 October, kokanee were observed holding or actively constructing redds in small to medium-sized substrate downstream of the railroad bridge. Exclusion screens were placed over five bull trout redds on 20 September. Kokanee were observed attempting to spawn over the exclusion screens 10 days after they were placed. Additionally, kokanee were observed holding over the exclusion screens throughout the spawning season. The screens appeared to prevent kokanee from excavating bull trout redds. Kokanee redds were observed around the perimeter of 2 out of 5 exclusion screens. On 5 October, kokanee eggs were observed in the pocket of redd number 7. The kokanee, unable to excavate gravel underneath the exclusion screens, deposited eggs on top of the screens but were unable to bury them. By 1 November, kokanee were no longer observed upstream of the forest road 5810 bridge. The two exclusion screens placed on redds immediately downstream of the railroad bridge were removed on 4 November. The remaining three screens were removed on 11 November. Kokanee were still present in Trapper Creek on 11 November, but were no longer actively spawning. Seventeen spawned kokanee carcasses measured on 4 November averaged 332 mm FL, (range 300-365).

Other Odell Lake Watershed Tributaries

During both years of the study no bull trout redds or spawning adults were observed in any other Odell Lake tributaries, however spawning kokanee were observed in several other locations. In 2003, kokanee were first observed in Crystal and Hemlock creeks on 6 October and in Odell Creek on 16 October. Kokanee were not present in these streams on 25 September. No kokanee or kokanee redds were observed in Maklaks Creek. In 2004, Crystal Creek was surveyed on 14 September and 22 September. Kokanee were first observed spawning on 22 September. Hemlock, Alder, Thunder, Solomon, Quit and Odell Creeks were

surveyed 20 September and 11 October. Kokanee were first observed spawning on 11 October. In Odell Creek, kokanee were observed up to 300 yards downstream of the Odell Lake outlet. Maklaks and No Name Creek were surveyed 5 times each between 8 September and 25 October. No adult bull trout, kokanee or redds were observed.

Heising Spring

Forty-five bull trout redds were counted in Heising Spring during the 2003 spawning season. Twenty-nine bull trout redds were present in Heising Spring when surveys began on 3 September. Eleven adult bull trout were observed during the survey; two were observed on one redd in Heising Spring and nine were observed in Jack Creek near its confluence with Heising Spring. Forty-one of the total redds observed were constructed by 9 September. Three new bull trout redds and 11 adult bull trout (20-45 cm) were observed on 24 September. The last bull trout redd was observed on 7 October.

A total of 50 bull trout redds were observed in Heising Spring during the 2004 spawning surveys. Thirteen bull trout redds were present when surveys began on 25 August. On 2 September, the first adult bull trout and seven new redds were observed. Twelve additional redds were observed on 7 September. Half of all redds observed were constructed by 15 September. The last six adult bull trout were observed on 21 September. The last three bull trout redds were observed on 28 September.

In 2003, kokanee were first observed in Heising Spring on 9 September. By 16 September, they were abundant and were first observed excavating bull trout redds. By 7 October, most of the bull trout redds were so disturbed by spawning kokanee that their dimensions could not be accurately measured and several were undetectable without the aid of flagging and stakes. Kokanee were last observed spawning in Heising Spring on 15 November. In 2004, kokanee were first observed in Heising Spring on 21 September. Forty-seven bull trout redds had been constructed by this date. Fewer kokanee were observed in 2004 than in 2003 with only 30% of the bull trout redds being superimposed by spawning kokanee.

Twenty female kokanee were captured and measured in Heising Spring in 2004. The average length (FL) was 298 mm.

Comparison of redd characteristics between Trapper Creek and Heising Spring

On average, bull trout redds measured in Heising Spring were longer, wider and more shallow in Heising Spring than in Trapper Creek (Table 4). Differences among all measurements were statistically significant in 2003 ($p<0.02$), however in 2004 only differences in lengths were significant. It's likely that the small sample size of redd measurements in Trapper Creek in 2004 ($n=6$) reduced the power of detecting significant differences among all measurements. Despite this shortcoming, this analysis indicates that bull trout redds in Heising Spring have a larger surface area and are somewhat shallower than are bull trout redds in Trapper Creek. Average pocket depth of redds measured in Trapper Creek was 20 cm greater ($P<0.001$) than those measured in Heising Spring, likely because several redds in Trapper Creek were located in pools. Compared to Trapper Creek, stream depth in Heising Spring was more uniform.

Table 4. Dimensions (cm) of bull trout redds measured in Trapper Creek and Heising Spring, 2003 and 2004.

Statistic	2003			2004		
	Length	Width	Depth	Length	Width	Depth
			Trapper Creek			
		N=17			*N=6*	
Min	80	65	30	100	70	25
Max	200	250	95	260	180	120
Mean	132	114	56	180	120	45
SD	33	52	19	56	40	7
			Heising Spring			
		N=41			*N=43*	
Min	120	80	23	130	60	15
Max	360	350	60	590	390	58
Mean	221	147	38	320	160	41
SD	70	56	8	107	68	9

DISCUSSION

In 2003 and 2004, bull trout redds and adult bull trout were observed only in lower Trapper Creek between its mouth and the falls located 1.3 km upstream. Newly constructed bull trout redds were observed from the time surveys started in late August through 13 October. These results are consistent with the results of previous surveys (Dachtler and Sanchez 2000; ODFW 1999; USFS 2003). Stream flow velocities measured over bull trout redds in Trapper Creek in 2003 were similar to bull trout preferred stream velocities determined by Fernet and Bjornson (1997).

One of our goals was to compare the spawning conditions for bull trout in Trapper Creek and Heising Spring in order to evaluate the feasibility of using Heising Spring as a surrogate for Trapper Creek for kokanee exclusion studies. In both Trapper Creek and Heising Spring, bull trout began spawning in late August and were finished by mid-October. Kokanee arrived in Heising Spring during early September and in Trapper Creek during mid-September; they had finished spawning in both streams by mid-November. Variability within the current 15-year data set for Heising Spring suggests that during any given year, the number of bull trout redds may be too low to enable a statistically valid comparison between treatments in a study of redd superimposition. Similarly, the low number of spawning kokanee observed during the 2004 survey in Heising Spring indicates that the variability in kokanee spawners could also be problematic for enabling statistically valid comparisons between treatments.

In order for the consequences of superimposition of kokanee redds in Heising Spring to be directly applicable to Trapper Creek, the sizes of spawners in both streams should be similar among species. In general, larger females tend to move larger sized substrate, construct larger redds, and deposit more eggs deeper in redds. According to data collected in 2003 and 2004, bull trout redds measured in Heising Spring were larger than those measured in Trapper Creek. However, our estimates of fish lengths suggest that fish in both streams are approximately the same size. It is possible that redds were larger in Heising Spring because the substrate in

Heising Spring is more abundant and easier to excavate than in Trapper Creek. This difference in substrate size may however be partially moderated by the larger size of kokanee in the Odell system. Initial measurements show kokanee in Trapper Creek are approximately 30-50 mm larger than kokanee spawning in Heising Spring. Because larger fish have been shown to be more effective at excavating larger substrate, any detrimental effects of kokanee superimposition detected at Heising Spring may directly apply to Trapper Creek despite differences in substrate size. We suggest starting redd surveys by August 15 in order to increase the likelihood of encountering and measuring adult bull trout. More kokanee from both streams should also be measured and compared.

Until a controlled evaluation proves otherwise, we should continue to assume that superimposition of bull trout redds by spawning kokanee will have negative consequences for the precarious Odell Lake bull trout population. Our research suggests that using kokanee exclusion screens may be a viable option for minimizing the potential of kokanee superimposition on bull trout redds. Initial evaluations conducted in 2004 indicated that screens successfully prevented kokanee from excavating bull trout redds. Additionally, these screens caused no apparent debris accumulation on the surface of redds that might interfere with water circulation into the redd interior. Short of installing a temporary or permanent barrier to prevent kokanee from entering Trapper Creek, screening appears to be a viable option for protecting bull trout redds. Rigorous estimates of juvenile abundance through calibrated snorkel surveys may be the most statistically sensitive means of detecting the success of screen placement.

ACKNOWLEDGEMENTS

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