ANNUAL PROGRESS REPORT

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OREGON

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CONTENTS

SUMMARY

JOB 1: A Review of Resident and Native Trout Management in Oregon

Objectives for FY 1989

1. Review available literature on the zoogeography and ecology of trout populations in the western United States and the implications for trout management.

2. Review literature and historical accounts of the physical characteristics of native stream ecosystems and habitats in the region and changes in these conditions that have occurred since European settlement.

3. Prepare a standard survey for interviewing Oregon Department of Fish and Wildlife (ODFW) biologists and other resource professionals to evaluate management objectives and review the current status of inventory information for native trout populations and their habitats.

Accomplishments in FY 1989

Progress was made on all three objectives. A computerized data base was developed for cataloging literature citations reviewed for Objectives 1 and 2. Key references were annotated as they were reviewed. A standardized survey form was completed as described in Objective 3. Interviews will begin and literature review will continue through 1990.

Job 2. A Stock Characterization of Oregon's Native Trout

Objectives for FY 1989

1. Determine the timing and magnitude of upstream movement of adult rainbow trout in the lower Downer und Blitzen River.

2. Determine the timing and magnitude of downstream movement of juvenile rainbow trout in the east diversion canal of the lower Donner und Blitzen River.

3. Determine origin, movement, and timing of rainbow trout past Link River, Keno, and J.C. Boyle dams (Klamath River) and into Spencer Creek.

4. Collect samples of rainbow trout for analysis of morphological and biochemical characteristics.

5. Develop homologous (within stock) and heterologous (between stock) populations of native rainbow trout for determination of genetic or environmental control of life history differentiation.

6. Determine the relative resistance of rainbow trout groups within the Klamath and Deschutes basins to ceratomyxosis.

7. Attempt to sterilize a group of hatchery rainbow trout by methods that use synthetic hormone treatment to possibly prevent interbreeding between hatchery and native rainbow trout.

Accomplishments in FY 1989

Progress on all seven objectives was accomplished.

Findings in FY 1989

No large (> 45 cm) rainbow trout migrated from Malheur Lake into the lower Donner und Blitzen River during April, May, and June 1989. Only three rainbow trout ranging from 9.1 to 26.1 cm in fork length were captured at the Sod House Dam trap on the lower Donner und Blitzen River.

The Gauging Dam above Page Springs Dam on the Donner und Blitzen River was once thought to be a barrier to the upstream migration of hatchery and wild rainbow trout. However, one trout tagged at Page Springs Dam moved 6.4 km upstream and was reported caught above the Gauging Dam by an angler.

The estimated number of adult rainbow trout that moved upstream past J.C. Boyle Dam on the Klamath River from February 1988 through September 1989 continues to be less than 10 percent of the estimated total that passed the dam during the same time periods in 1959.

Wild rainbow trout from Cold, Jenny, and Johnson creeks and Deming Creek were found to be highly susceptible to ceratomyxosis but wild rainbow trout from other areas within the Upper Klamath basin (Spencer and Spring creeks) were resistant. These data suggest that native trout from Deming Creek and the Jenny Creek complex have remained reproductively isolated from other native rainbow trout populations in the Upper Klamath basin.

JOB 1. A REVIEW OF RESIDENT AND NATIVE TROUT MANAGEMENT IN OREGON

Introduction

All three objectives for this job in FY 1989 are included in the native Trout Project proposal (Buchanan et al. 1988) under Goal 1, Objective 1 (Tasks 1.1, 1.2, and 1.6).

Results and Discussion

Freshwater rivers in the western United States have a relatively scant fish fauna compared with those east of the Rocky Mountains. Major tectonic and climatic events since the Miocene Epoch have dramatically shaped the landscape, controlled the environment, and limited the diversity of faunal groups that survived in the region. On the other hand, long isolation of drainage systems and diverse environmental conditions created by geological events have contributed to a high degree of endemism among western families of

fishes (McPhail and Lindsey 1986; Minckley et al. 1986; Sheldon 1988). For example, at least 16 subspecies of cutthroat trout *Oncorhynchus clarki* are recognized in the recent literature (Allendorf and Leary 1988).

Endemic fish populations in the western United States have adapted to patterns of disturbance that were established through long periods of geological history. For example, river flows vary substantially with regional conditions of climate, geology, and topography. Within regions, natural disturbances such as fires created a patchwork of landscapes in a diversity of developmental stages. Frequency and patterns of disturbance, in turn, may be reflected in the structure of fish communities or the life histories of local fish populations (Resh et al. 1988; Minshall et al. 1989).

In the relatively short time since Europeans settled in the United States, historical patterns of environmental disturbance across native landscapes and ecosystems have changed dramatically (Bormann and Likens 1979; Cronon 1983; White 1980; Vale 1982). In the western United States, irrigation diversions, dams, roads, and logging and grazing activities have modified the region from a patchwork of native landscapes in many stages of development to few relatively undeveloped "islands" in a homogeneous matrix of disturbance. Introductions of nonnative fishes throughout the West have directly altered stream communities and, together with habitat modifications, have contributed to substantial losses of endemic taxa (Moyle et al. 1986; Miller et al. 1989; Williams et al. 1989; Moyle and Williams 1990). The risk of further losses is great among highly specialized populations unable to adapt to rapid environmental change.

A major challenge for resource managers is to define the appropriate temporal and spatial scales associated with management goals and to direct patterns of human disturbance accordingly. In Oregon, one or a few hatchery stocks have been used throughout a large area to achieve production goals. This "coarse-grained" approach to management is inappropriate, however, if the goal is to maintain diversity of native populations. On the other hand, a "fine-grained" approach to habitat management is not adequate to maintain the diverse ecological conditions to which native trout populations have adapted. In the past, habitat protection has been implemented in a case-by-case response to local development proposals. Little consideration has been given to the cumulative effects of individual changes throughout an entire stream, watershed, or region. Coarse-grained land management across larger spatial scales is needed to sustain a sufficient variety of healthy, connected watersheds if the goal is to sustain diverse fish communities statewide (Hunter et al. 1988). Neither fish nor land management agencies have adequately resolved problems of scale created when management goals and activities alter the historical disturbance patterns to which western fish communities and populations have adapted.

Options for future management of native trout populations in Oregon are in large part limited by the landscape alterations and fish management decisions that have been made during the past century. Choosing future direction will require an understanding of the historical changes that have shaped present-day populations. In the next year, we will conduct interviews with district biologists throughout the state to review what is known about life history and stock status of native trout populations, historical watershed and stream habitat conditions to which trout may have been adapted,

and current management objectives and information needs. We will develop a database of historical stocking records to evaluate effects or risks of hatchery programs on native populations of trout.

JOB 2: A STOCK CHARACTERIZATION OF OREGON'S NATIVE TROUT

Introduction

Activities described here reflect the second year of a 5-year effort to attain Goals II and III of the Native Trout Project Proposal (Buchanan et al. 1988). A complete description of the diversity of Oregon's native trout is beyond the scope of this study. We have chosen to limit efforts primarily to rainbow trout *Oncorhynchus mykiss* in the Deschutes, Harney (Figure 1), and Upper Klamath (Figure 2) basins for reasons given in Buchanan et al. (1988). A thorough review of each river system within these basins was presented in Hemmingsen et al. (1988).

Materials and Methods

Objectives 1 and 2: Determine the Timing and Magnitude of Upstream and Downstream Movement of Rainbow Trout in the Lower Donner und Blitzen River

We modified concrete structures at Sod House Dam in early April 1989 to permit more efficient upstream passage of rainbow trout. Traps to capture adult trout moving upstream were installed in one step of each ladder at Sod House, Grain Camp, and Page Springs dams. Each trap consisted of a V-shaped fyke at the downstream end which permitted entry. Passage of adult rainbow trout over the next upstream set of stoplogs was blocked by a weir. Stream flow was adjusted as needed to allow fish passage.

Traps were monitored for rainbow trout at least four times each week throughout the study period. During periods when stream flow fluctuated or when it appeared that many fish would be caught, traps were monitored twice daily. No more than 1 day elapsed between visitations to a particular trap. Fish handling and data collection were described by Hemmingsen et al. (1988).

Three self-cleaning rotary screens were installed in diversion canals by Malheur Refuge personnel in April 1989. Bypass pipes that diverted downstream migrants to the Blitzen River were installed by mid-June in the East and West canals. A downstream trap was installed in the East Canal bypass on 26 June 1989. Downstream sampling of trout moving into the East Canal began on 26 June and continued until 5 August.

Objective 3: Determine Origin, Movement, and Timing of Rainbow Trout in the Upper Klamath River

Fyke traps to capture adult trout that moved upstream were installed in fish ladders at J.C. Boyle, Keno, and Link River dams. Trapping began in October 1988 and continued throughout the reporting period. The traps were operated Monday through Friday during periods when many fish were captured and at least once a week during the winter time when fish movement was limited. An upstream weir and trap were installed in lower Spencer Creek from 17 March

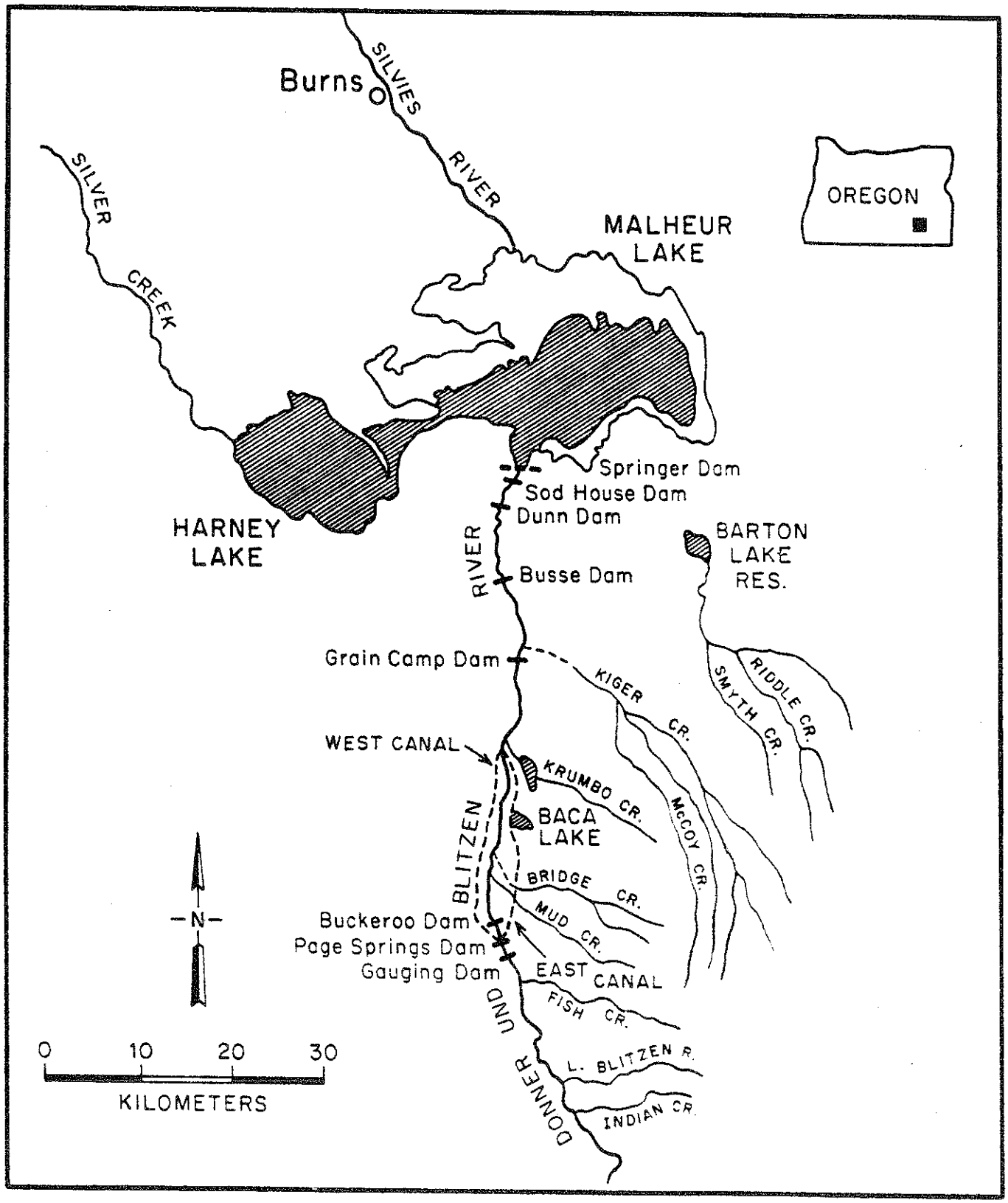

Figure 1. The Harney Basin.

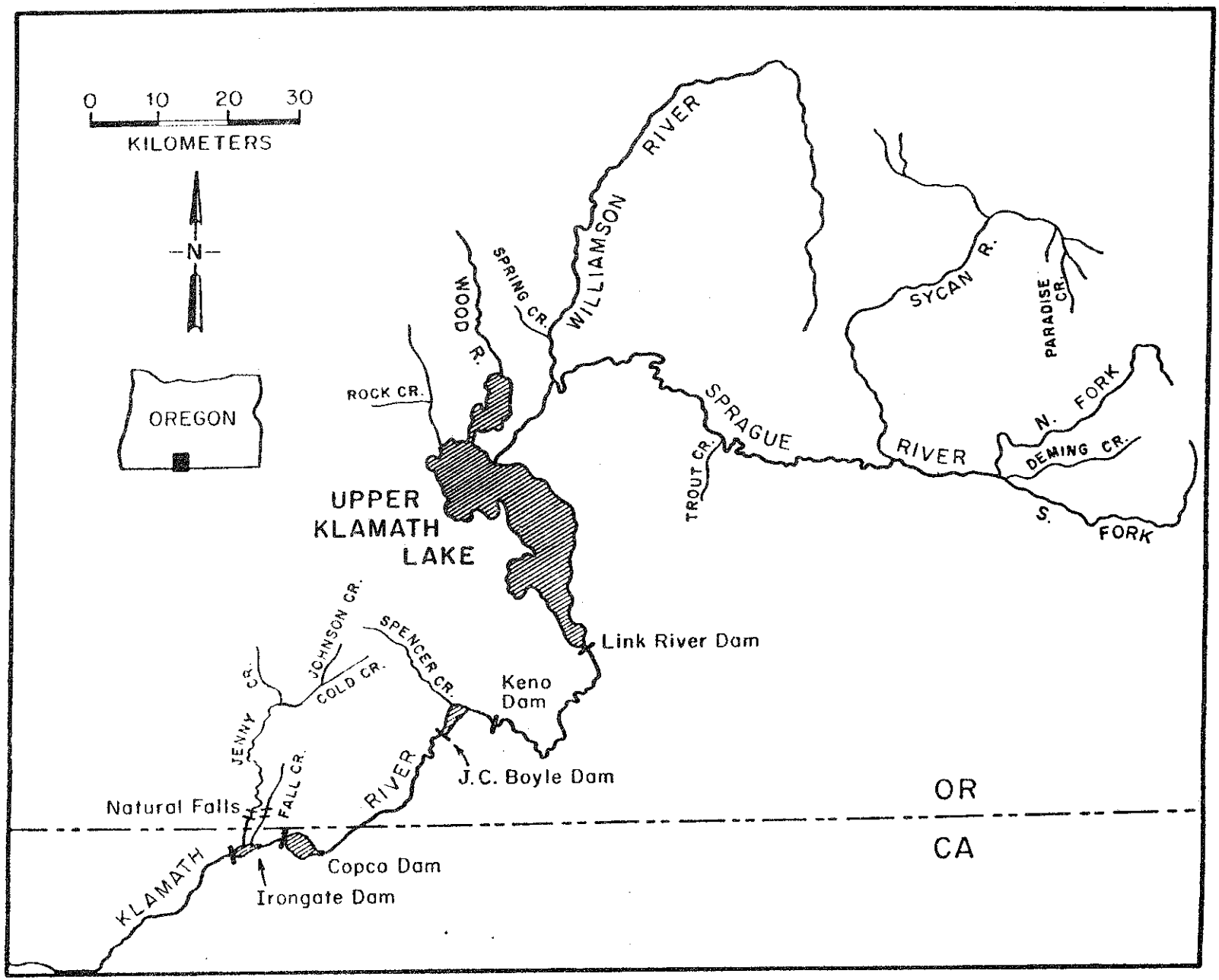

Figure 2. The Upper Klamath Basin.

to 30 June 1989. Captured rainbow trout were netted, anesthetized with MS-222, and identified with a numbered Floy anchor tag. Fork length and scale samples were collected from each fish.

Objective 4: Collect Rainbow Trout for Morphological and Biochemical Analysis

Most samples of rainbow trout were collected by electrofishing with a backpack shocker. Our sampling targeted capture of immature fish, although older fish were taken as needed. Collected fish were killed with a lethal dose of MS-222. When rainbow trout were killed for other purposes, those fish were also used for this objective. Samples were immediately placed on dry ice, transported to Corvallis, and stored frozen.

Objective 5: Develop Homologous and Heterologous Populations of Rainbow Trout

Two separate native populations of mature rainbow trout within the Upper Klamath basin were sampled to satisfy this objective. To produce progeny for tests of genetic differences, 15 male and 10 female rainbow trout from Spring Creek were mated with 10 males and 9 females from Deming Creek. Mature rainbow trout were collected using the techniques reported in Hemmingsen et al. (1988) during consecutive weeks beginning in April and held at Klamath Hatchery until they were mated on 16 May 1989. Eggs from each female were divided into 25 equal portions, and each portion was fertilized by sperm from a different male to create 475 families. Eggs were transferred to 51-mm incubation cells (McIntyre and Blanc 1973) and randomly ordered in troughs for incubation at 6.7°C at Klamath Hatchery. On 21 June, after dead and unfertilized eggs had been removed, remaining eggs in each cell were covered with moist cheese cloth and cells were placed in ice chests under ice and transferred to aquaculture facilities at Oregon State University. Here, cells were randomly ordered in drip incubation trays supplied with 12°C water.

Objective 6. Determine the Relative Resistance of Rainbow Trout Groups to Ceratomyxosis

Ihssen et al. (1981) suggested that, within a species, stocks of fish can be characterized by their level of resistance to certain diseases. In FY 1989, we continued experiments to determine the relative resistance of native rainbow trout in the Upper Klamath basin to infection by *Ceratomyxa shasta*, a myxosporean parasite that causes the disease ceratomyxosis. Justification for this approach has previously been described in Hemmingsen et al. (1988).

Exposure of fish to water that contains the infective stage of *C. shasta* is the only practical method of inducing ceratomyxosis (Johnson et al. 1979). Samples of native and hatchery rainbow trout were collected and placed in live-boxes in the Williamson River (Hemmingsen et al. 1988). After 14 days of exposure at the challenge sites, samples of fish were maintained separately and transported to Corvallis for further rearing.

In June 1989 we again electrofished to obtain samples of juvenile native rainbow trout in the streams sampled in September 1988. In addition, we collected samples of juvenile native rainbow trout from Fall Creek, tributary of the Klamath River; Trout creek, tributary of the Sprague River; and the Williamson River at RK 120 (Figure 2). Those samples and a group of juvenile Cape Cod rainbow trout from Klamath Hatchery were placed in 1.5 cu m live-boxes located at RK 3.2 on the Williamson River for exposure to the infective stage of *C. shasta*. With the exception of Spring Creek, water temperatures at all exposure sites varied diurnally, but exceeded the lower threshold at which *C. shasta* becomes infective (Udey et al. 1975). After 7 days of exposure at the challenge sites, samples of fish were maintained separately and transported to Corvallis for further rearing.

In a third experiment, we collected samples of juvenile native rainbow trout from two locations in the Metolius River, near both Riverside and Gorge campgrounds, and from Bakeoven Creek, tributary of the Deschutes River. Those samples and a groups of juvenile Cape Cod rainbow trout from Fall River Hatchery were placed in 1.5 cu m live-boxes located in the Deschutes River at the Pelton Dam adult fish trap near Warm Springs for exposure to the infective stage of *C. shasta*. After 14 days of exposure at the challenge site, samples of fish were maintained separately and transported to Corvallis for further rearing.

At Corvallis, all fish were reared on pathogen-free well water in separate aquaria for each group. Beginning the second day of rearing, each group received three daily baths of malachite green at 1.0 ppm for one hour. Thereafter, each group received four daily baths of furanace, two at 1.0 ppm for 1 hour, followed by two at 0.5 ppm, for one hour each. Native trout were fed mealworms or tubifex worms, depending on which they preferred. Hatchery trout were fed Rangen's trout diet. All fish were monitored daily. Dead fish were removed and a wet mount of a smear prepared from intestinal scrapings (Johnson et al. 1979) was examined for the presence of sporoblasts or spores of *C. shasta*. Live fish were killed after 60 days of rearing in aquaria and similarly examined.

Objective 7. Attempt to Sterilize Hatchery Rainbow Trout

A group of juvenile rainbow trout at Roaring River Hatchery was treated with the synthetic hormone 17 @-methyltestosterone (MT) to induce sterility. Justification for this treatment is presented in Hemmingsen et al. (1988). During January 1989, at 3 and 10 days after hatching, about 24,000 alevins were immersed for 2 hours in 100 liters of solution that contained 400 ug MT IL of water. Alevins were contained in a Heath-Tecna, Inc., incubator tray that was submerged in the solution. Bottled oxygen was provided the entire time for aeration and circulation. After each immersion, the tray was returned to the incubator stack.

After fish had absorbed their yolk-sacs, treated fish were placed in a 2,000 L circular rearing tank. A similar number of untreated fish (controls) was placed in an identical tank. After the fish had received a starter diet for about 1 week (early March), the MT-treated trout were placed on a diet

that contained 25 mg MT/kg feed. That diet was administered ad libitum daily for 90 days. Controls were treated similarly except that their diet lacked MT.

Results and Discussion

Objectives 1 and 2: Determine the Timing and Magnitude of Upstream and Downstream Movement of Rainbow Trout in the Lower Donner und Blitzen River

We caught and tagged only a few rainbow trout at Page Springs Dam, primarily during the first half of June (Table 1). Of the 10 fish captured, 2 were less than 18 cm and were not tagged. Fork length ranged from 9.0 to 36.3 cm. All appeared to be in good physical condition. The Page Springs trap was operated for 2,646 hours.

Table 1. Rainbow trout captured in the upstream trap at Page Springs Dam, April through July 1989.

Date operated	Number of fish trapped	Fork length (cm)[a] Range	Fork length (cm)[a] Mean	Number of fish tagged	Hours of trapping
04/06-09	1	9.0	9.0	0	96
04/10-16	0			0	168
04/17-23	0			0	168
04/24-30	0			0	114
05/01-07	0			0	168
05/08-14	0			0	168
05/15-21	2	13.0-36.3	24.6	1	168
05/22-28	0			0	168
05/29-31	0			0	72
06/01-04	4	22.7-27.0	25.4	4	96
06/05-11	2	23.7-25.8	24.8	2	168
06/12-18	1	23.7	23.7	1	156
06/19-25	0			0	168
06/26-30	0			0	168
07/01-09	0			0	216
07/10-16	0			0	168
07/17-23	0			0	168
07/24-31	0			0	48

[a] *Length values pertain to all fish, including recaptures, that entered the trap on a given day.*

Eighty-three percent of captured rainbow trout were trapped at Grain Camp Dam (Table 2). Trout appeared to move throughout the sampling period. The 64 fish captured included one recapture. Five fish died, four wedged in the trap grates and one found in the ladder. All other captured trout were released in good physical condition.

Three trout (9.1, 18.2, and 26.1 cm fork length) were captured at the Sod House trap during April through June of 1989, but only the largest one was tagged. We captured over 1,500 common carp *Cyprinus carpio* during 1,220 hours of trapping at Sod House Dam. The trap was closed at the end of June 1989.

Table 2. Rainbow trout captured in the upstream trap at Grain Camp Dam, April through July 1989.

Date operated	Number of fish trapped	Fork length (cm)[a] Range	Mean	Number of fish tagged	Hours of trapping
04/06-09	5	25.5-28.5	27.3	5	96
04/10-16	7	24.1-35.5	29.0	7	168
04/17-23	7	24.6-30.7	27.4	6	168
04/24-30	0	--	--	0	158
05/01-07	11	26.0-35.0	29.0	9	168
05/08-14	3	27.4-30.0	30.8	1	168
05/15-21	0	--	--	0	168
05/22-28	2	29.9-26.1	28.0	2	168
05/29-31	0	--	--	0	72
06/01-04	0	--	--	0	96
06/05-11	5	23.7-30.7	26.7	5	156
06/12-18	7	24.4-29.0	26.5	7	168
06/19-25	5	25.5-32.4	30.0	5	168
06/26-30	1	23.6	23.6	1	168
07/01-09	6	23.2-37.9	27.1	6	216
07/10-16	0	--	--	0	168
07/17-23	5	25.5-32.7	28.6	4	168
07/24-31	0	--	--	0	192

[a] *Length values pertain to all fish, including recaptures, that entered the trap on a given day.*

Sixty-eight rainbow trout were tagged during the 1989 study period. One tagged trout was recaptured dead at the top step of Grain Camp ladder and nine were caught by anglers (Table 3). Five of the nine angler-caught trout were tagged at Grain Camp Dam and caught between there and Page Springs Dam. One fish was tagged at Grain Camp Dam, moved past Page Springs Dam and was caught by an angler 0.8 km above Page Springs Dam. Apparently some trout are able to move upstream through the spillway velocity barrier at Page Springs Dam

without using the fish ladder. Two trout tagged at Page Springs Dam were caught by anglers below Page Springs Dam. One trout tagged at Page Springs Dam moved upstream past the Gauging Dam and was caught 6.4 km above Page Springs Dam. The Gauging Dam was once thought to be a barrier to the upstream migration of hatchery and wild rainbow trout. One trout tagged at Grain Camp Dam in 1988 was recaptured at the same dam in 1989.

Table 3. Summary of tagged rainbow trout recaptured from the Donner und Blitzen River in 1989.

Fish tag number	Date tagged	Location tagged	Date recaptured	Location recaptured
101[a]	05/10/88	Grain Camp	05/07/89	Trap at Grain Camp
141	04/08/89	Grain Camp	06/25/89	0.4 km below Page Springs Dam
152	04/18/89	Grain Camp	06/12/89	0.8 km below Page Springs Dam
153[b]	04/20/89	Grain Camp	06/19/89	0.8 km above Page Springs Dam
156	04/23/89	Grain Camp	05/28/89	0.2 km below Page Springs Dam
210[c]	05/16/89	Page Springs	06/25/89	6.4 km above Page Springs Dam
171	06/03/89	Page Springs	06/18/89	0.6 km below Page Springs Dam
212	06/08/89	Page Springs	07/04/89	0.2 km below Page Springs Dam
181	06/16/89	Grain Camp	09/08/89	1.2 km below P-Ranch
186	06/25/89	Grain Camp	07/16/89	1.6 km below P-Ranch
200	07/23/89	Grain Camp	07/26/89	Top step of Grain Camp ladder

[a] *This fish was tagged in 1988 at Grain Camp Dam and recaptured at Grain Camp Dam in 1989.*
[b] *This fish was not trapped at Page Springs Dam. Apparently some fish are able to bypass the fish ladder and move upstream through the high velocity barrier at Page Springs Dam.*
[c] *This fish moved upstream past the Gauging Dam.*

We captured 270 rainbow trout during spring and early summer in 1987-89 (Table 4). Eighty percent of the total were captured at Grain Camp Dam while 19% and 1% were captured at Page Springs and Sod House dams, respectively. We only trapped three rainbow trout at Sod House Dam in 1988 and 1989.

Because of a delay in the construction of a rotary screen trap, we could not determine timing and magnitude of downstream movement of trout during the early spring in the diversion canals of the lower Donner und Blitzen River. Downstream sampling did not begin until 26 June. Some juvenile rainbow trout were captured in the downstream trap in the East Canal bypass between 26 June and 5 August (Table 6). Over 4,500 hatchery rainbow trout were released in the Donner und Blitzen River in late June and early July 1989. We captured 19 of these fish in the bypass. We also trapped 41 wild rainbow trout from the bypass in 920 hours of operation. Fork length of the captured wild trout ranged from 9.9 to 21.5 cm. Six wild trout were captured in the first week of August.

Table 4. Summary of rainbow trout captured and tagged in the lower Donner und Blitzen River in spring and early summer, 1987-89.

Trapping location	1987		1988		1989	
	Captured	Tagged	Captured	Tagged	Captured	Tagged
Sod House	--	--	0	0	3	1
Grain Camp	95	91	57	48	64	59
Page Springs	32	28	9	9	10	8

Table 5. Rainbow trout trapped in the East Canal downstream trap, 26 June 1989 to 5 August 1989.

Date operated	Hatchery rainbow trout	Wild rainbow trout	Fork length (cm) of wild trout		Hours of trapping
			Range	Mean	
06/26-30	0	12	9.9-15.4	13.2	108
07/01-09	17	14	10.3-21.0	15.1	
07/10-16	1	4	12.5-14.5	13.7	
07/17-23	1	2	17.1-20.6	18.8	692
07/24-31	0	3	14.0-17.7	15.8	
08/01-05	0	6	11.1-21.5	13.7	120

We expected to capture and tag more rainbow trout in 1988 or 1989 than we did. During a similar time period in Spring 1987, ODFW employees caught 127 rainbow trout in upstream traps located at Grain Camp and Page Springs dams (personal communication from Bill Hosford, Oregon Department of Fish and Wildlife, Hines). We caught only 66 trout in 1988 and 74 trout in 1989 at these dams. Fluctuations in stream flow and debris accumulations frequently appeared to reduce our trapping efficiency. However, the traps were routinely maintained and should have captured any trout whose movement had been impeded. No large (>45 cm) adult rainbow trout migrated from Malheur Lake into the lower Donner und Blitzen River during April, May, and June 1989. Only three trout were captured at Sod House Dam in 1989. The Sod House trap did capture common carp and should have also collected rainbow trout if trout were present and moving.

The trap at Page Springs Dam accounted for only 10 (13%) of the adult rainbow trout captured. We believe that passage problems may exist in the Page Springs ladder at low flows, and at high flows trout may be able to move upstream through the spillway velocity barrier. Another possibility for the low numbers observed is that most of the current population of wild trout rear and spawn in the river above Page Springs Dam. Although the trap at Grain

Camp captured the majority of adult trout, most of the mortalities observed during the study period also occurred there. Anglers caught 13% of the native rainbow trout we tagged in 1989, 13% in 1987, and 14% in 1988.

Objective 3: Determine Origin, Movement, and Timing of Rainbow Trout in the Upper Klamath River

The trap at Link River Dam operated 5,060 hours during the reporting period and captured 123 rainbow trout (Table 6), 90% in April and May 1989. The trap at Keno Dam operated 4982 hours and captured 76 rainbow trout (Table 7), 83% in October and November 1988. The trap at J.C. Boyle Dam operated 4,524 hours and captured 433 rainbow trout (Table 8), 86% of these were captured within two pulses in April to May 1989 and in September 1989. We compared our estimates of monthly trout passage at J.C. Boyle Dam in 1988 and 1989 with those reported in 1959 (Hanel and Gerlach 1964) (Table 9). Contemporary passage appears to be less than 10% of that 30 years ago.

Table 6. Rainbow trout captured in the upstream trap at Link River Dam, October 1988 through September 1989.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
1988:					
October	0	--	--	--	382
November	0	--	--	--	330
December	0	--	--	--	424
1989:					
January	0	--	--	--	314
February	0	--	--	--	352
March	2	34.5-41.5	38.0	2	444
April	20	22.3-55.5	40.1	17	695
May	91	18.3-58.5	30.1	74	689
June	10	29.5-53.0	42.4	6	386
July	0	--	--	--	311
August	0	--	--	--	313
September	1	14.6	14.6	0	420
TOTAL	124			99	

Table 7. Rainbow trout captured in the upstream trap at Keno Dam, October 1988 through September 1989.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
1988:					
October	33	17.0-53.2	23.9	26	367
November	30	16.7-27.2	21.0	29	360
December	1	24.5	24.5	0	383
1989:					
January	0	--	--	--	306
February	0	--	--	--	339
March	2	21.2-29.8	25.5	2	440
April	4	23.8-26.0	24.9	2	696
May	0	--	--	--	520
June	4	21.8-26.5	24.4	3	444
July	0	--	--	--	330
August	2	28.6-30.2	29.4	2	385
September	0	--	--	--	412
TOTAL	76			64	

Table 8. Rainbow trout captured in the upstream trap at J.C. Boyle Dam, October 1988 through September 1989.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
1988:					
October	98	14.4-34.5	18.6	86	321
November	24	6.0-28.3	18.5	22	364
December	0	--	--	--	384
1989:					
January	0	--	--	--	152
February	0	--	--	--	0
March	2	31.7-42.0	36.9	2	295
April	135	15.3-52.1	22.2	123	723
May	63	15.2-46.8	22.3	52	737
June	9	15.1-30.8	23.9	6	419
July	1	15.3	15.3	1	335
August	26	15.1-24.5	19.3	18	426
September	75	15.1-37.3	19.7	42	368
TOTAL	433			352	

Table 9. Expanded monthly estimates of upstream passage of rainbow trout at J.C. Boyle Dam 1959 (Hanel and Gerlach 1964), 1988, and 1989 through September.

Month	1959	1988	1989
January	--	--	0
February	--	0[a]	0
March	--	20	5
April	--	92	135
May	289[a]	20	64
June	532	11	15
July	48	5	2
August	333	18	46
September	1,980	67	147
October	2,252	227	
November	95	47	
December	0	0	
TOTAL	5,529	507	

[a] *Estimates were made for the second half of the month only.*

We operated the upstream trap and weir in Spencer Creek approximately 2,266 hours during the reporting period. However, high water and debris hindered trapping during March and April. Some fish were probably able to bypass the weir and escape the trap. The Spencer Creek trap captured 42 adult rainbow trout from 17 March through 30 June (Table 10). Only 2 of these were tagged fish that had migrated over J.C. Boyle Dam. The downstream trap and weir in Spencer Creek operated approximately 2,895 hours and captured 2,371 fry and 573 yearling rainbow trout (Table 11).

Objective 4: Collect Rainbow Trout for Morphological and Biochemical Analysis

Samples of rainbow trout were collected from the Klamath River below J.C. Boyle Dam; Cold Creek, an upper tributary of Jenny Creek system that is separated from the Klamath River by an 18-meter impassable falls; Spencer Creek, a tributary of Klamath River that has no falls or barrier separation; Rock Creek, a northern tributary of the Upper Klamath Lake; Trout Creek, a tributary of the Sprague River; the upper Williamson River above Klamath Marsh; and Paradise Creek, a tributary of the Sycan River (Figure 2). These and similar samples collected in FY 1988 will be analyzed for biochemical and morphological characteristics in FY 1990.

Table 10. Rainbow trout captured in the upstream trap at the Spencer Creek weir, March through June 1989.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
March	0	--	--	--	150[a]
4/1-4/8	9	17.7-25.2	21.5	9	163[b]
4/9-4/15	18	18.2-45.0	26.8	16	169[b]
4/16-4/22	13	16.5-33.0	24.8	10	151[b]
4/23-4/30	0	--	--	0	192[b]
5/1-5/6	0	--	--	--	116
5/7-5/13	1	20.0	20.0	1	192
5/14-5/20	0	--	--	--	146
5/21-5/27	0	--	--	--	169
5/28-5/31	0	--	--	--	96
6/1-6/3	0	--	--	--	78
6/4-6/10	1	25.5	25.5	1	164
6/11-6/17	0	--	--	--	168
6/18-6/24	0	--	--	--	146
6/25-6/30	0	--	--	0	166

[a] *High water and debris hindered trapping operations during most of the month.*
[b] *High water continued and some fish were able to bypass the weir.*

Objective 5: Develop Homologous and Heterologous Populations of Rainbow Trout

High mortality and a potential mixing of isolated progeny of matings between Spring Creek and Deming Creek brood adults, which occurred at the aquaculture facilities at Oregon State University, this ended the usefulness of these families for homologous and heterologous experimentation. We plan to repeat these matings in spring 1990.

Objective 6: Determine the Relative Resistance of Rainbow Trout Groups to Ceratomyxosis

Based on results from exposures conducted in fall 1988 and summer 1989 (Table 12), wild rainbow trout from Cold, Jenny, and Johnson creeks (lower Klamath River system) and Deming Creek (upper Sprague River system) are highly susceptible to infection by *C. shasta*. From exposures conducted with Cape Cod rainbow trout, we found no evidence of the infective stage of *C. shasta* in Deming Creek and Campbell Reservoir (Table 13) or in the Jenny Creek complex, which includes Cold and Johnson creeks. These results suggest that native trout from Deming Creek and the Jenny Creek complex have remained

Table 11. Rainbow trout captured in the downstream trap at the Spencer Creek weir from June through September 1989.

Date	Number of rainbow trout			Hours of trapping
	Fry	Juveniles	Adults	
6/1-6/3	1	163	1	78
6/4-6/10	3	152	1	164
6/11-6/17	0	71	0	168
6/18-6/24	1	49	0	146
6/25-6/30	2	0	0	166
7/1-7/8	25	12	0	168
7/9-7/15	62	0	0	168
7/16-7/22	70	0	0	177
7/23-7/31	184	29	1	241
8/1-8/5	55	4	0	95
8/6-8/12	374	34	0	172
8/13-8/19	311	4	0	162
8/20-8/26	423	18	1	172
8/27-8/31	262	18	0	116
9/1-9/2	111	8	0	51
9/3-9/9	200	10	0	170
9/10-9/16	143	1	0	165
9/17-9/23	25	0	0	123
9/24-9/30	119	0	0	193

reproductively isolated from other native rainbow trout populations in the Sprague and Klamath rivers, respectively, that may have gained resistance to the parasite.

Since the infective stage of *C. shasta* is known to exist in the lower Williamson River (Table 13) and Upper Klamath Lake (Table 13; Hemmingsen et al. 1988), we expected that native rainbow trout from the Klamath River would be resistant to infection by the parasite. We believe that results from exposures in 1988 and 1989 confirmed that hypothesis, even though 1 of 22 native Klamath River rainbow trout contained spores of *C. shasta* (Table 12). However, we are presently unable to explain why Cape Cod rainbow trout exposed in the Klamath River had a low (1988) or nonexistent (1989) rate of infection by *C. shasta* (Table 13).

Table 12. Incidence of mortality among groups of wild rainbow trout from the Upper Klamath basin exposed to *Ceratomyxa shasta* in the Williamson River (RK 3.2) during September 1988 or June 1989.

Source of wild rainbow trout	Number exposed	Number that died during exposure	Number transferred and reared	Number that died during rearing	Number of rearing mortalities with spores of *C. shasta*
			September 1988		
Cold Creek	9	0	9	9	8
Deming Creek	30	2	28	27	21
Jenny Creek	18	2	16	16	14
Johnson Creek	8	1	7	7	7
Klamath River (RK 360)	45	0	45	7	0
Spencer Creek	67	8	59	58	0
Spring Creek	63	0	63	63	0
			June 1989		
Deming Creek	21	2	19	19	10
Fall Creek	18	2	16	16	15
Jenny Creek[a]	26	4	22	22	17
Klamath River (RK 360)	22	0	22	9	1
Spencer Creek	30	0	30	25	1
Spring Creek	17	0	17	17	0
Trout Creek	30	9	21	21	9
Williamson River (RK 120)	16	4	12	12	9

[a] *Group comprises fish from Jenny, Cold, and Johnson creeks.*

Based on results from exposures both years, native rainbow trout from Spencer and Spring creeks appear resistant to infection by *C. shasta* (Table 12). However, we were unable to detect any incidence of infection in Cape Cod rainbow trout exposed in either of those streams (Table 13). Perhaps Spencer Creek and Spring Creek rainbow trout gained their from historical exposure to nearby infected areas since rainbow trout from Spencer Creek and Spring Creek are progeny of spawners that migrate from the Klamath River and the Williamson River, respectively. The infective stage of *C. shasta* occurs in both the Klamath River and the lower Williamson River. Continuing mark and recapture studies will provide more insight on both populations.

Native rainbow trout from Trout Creek, tributary to the Sprague River, displayed an intermediate level of resistance to infection by *C. shasta* (Table 12). We did not detect any infection by the parasite in Cape Cod rainbow

Table 13. Incidence of mortality among juvenile Cape Cod rainbow trout exposed to *Ceratomyxa shasta* in Upper Klamath basin during September 1988 or June 1989.

Exposure site	Number exposed	Number that died during exposure	Number transferred and reared	Number that died during rearing	Number of rearing mortalities with spores of *C. shasta*
			September 1988		
Campbell Reservoir	73	2	71	17	0
Fort Creek	76	13	63	59	0
Jenny Creek	75	4	71	12	0
Klamath River:					
RK 362	75	3	72	39	9
RK 370	30	2	28	2	0
Spencer Creek	70	2	68	25	0
Upper Klamath Lake at Modoc Point	65	43	22	20	15
Williamson River:					
RK 3.2	73	10	63	63	61
RK 72	70	63	7	4	0
RK 81	71	7	64	41	0
Wood River	65	18	47	11	0
			June 1989		
Deming Creek	58	15	43	0	0
Fall Creek	60	0	60	11	0
Jenny Creek	56	0	56	4	0
Klamath River (RK 362)	55	35	20	5	0
Spencer Creek	50	11	39	1	0
Spring Creek	59	0	59	4	0
Trout Creek	55	0	55	3	0
Williamson River:					
RK 3.2	60	0	60	60	55
RK 120	55	3	52	1	0

trout exposed in Trout Creek (Table 13). Intermediate resistance of Trout Creek rainbow trout may have resulted from the mating of spawners from a susceptible, resident population with spawners of a resistant, migratory population (Hemmingsen et al. 1986). Further work on the Trout Creek and Sprague River populations is in progress.

We found a high rate of infection by *C. shasta* in Cape Cod rainbow trout exposed in the lower Williamson River (RK 3.2) both years (Table 13). We did not detect any infection in Cape Cod rainbow trout exposed at three sites in the upper Williamson River above Upper Klamath Marsh (RK 72, 81, and 120). We have not sampled juvenile native rainbow trout known to rear in the lower Williamson River, but native Spring Creek rainbow trout, which spend part of their life history in the lower Williamson River, appear to resist infection by *C. shasta*. In contrast, 9 of 12 native rainbow trout captured in the Williamson River above Upper Klamath Marsh near RK 120 became infected with *C. shasta*. These results suggest at least two possibilities. If native rainbow trout above Upper Klamath Marsh truly have intermediate resistance, they may be the consequence of two interbreeding populations, as discussed for Trout Creek rainbow trout. If they are truly susceptible to infection, then distinct and reproductively isolated populations of native rainbow trout exist within the Williamson River. Further experiments will be conducted to determine possible explanations and characterize Williamson River rainbow trout.

Samples of juvenile native rainbow trout collected from the Metolius River and Bakeoven Creek then exposed in the Deschutes River were transferred to Corvallis on 14 September 1988 and reared until mid-November 1988. Results of this experiment will be reported in a subsequent annual report.

Objective 7: Attempt to Sterilize Hatchery Rainbow Trout

MT-treated rainbow trout were identified with a left ventral (LV) fin clip and stocked in two Cascade Mountain lakes during June and July 1989. Those fish will be monitored for growth and longevity. Samples of MT-treated trout remain at Roaring River Hatchery for comparison with untreated fish releases of hormone-treated juvenile rainbow trout into lakes of the Cascade Mountains, 1989. Final evaluation will be based on the percentage of sterile individuals at the normal time of maturity.

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