ANNUAL PROGRESS REPORT

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OREGON

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SUMMARY

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

Objectives for FY 1990

We had three objectives for our review of resident and native trout in this fiscal year.

1. Review the history of trout management problems, objectives, and activities and the status of information on Oregon trout populations.

2. Review current literature and obtain data on bull trout populations in Oregon. Prepare a profile of their life history, habitats, and ecological characteristics.

3. Review inventory data for trout collected by district biologists, and develop a database of historical stocking records for selected watersheds.

Accomplishments in FY 1990

Progress was made on the first two objectives. Objective 3 was completed.

Job 2. Determine Diversity Within Oregon's Rainbow Trout Populations

Objectives for FY 1990

1. Determine diversity within Oregon's rainbow trout populations using life history characteristics.

2. Determine diversity within Oregon's rainbow trout populations using biochemical characteristics.

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

Accomplishments in FY 1990

Progress was made on all objectives.

Findings in FY 1990

The estimated number of adult rainbow trout that moved upstream past J.C. Boyle Dam on the Klamath River from October 1989 to September 1990 continues to be less than 10% of the estimated total that passed the dam 1 year after construction.

The Spencer Creek upstream trap captured 926 adult rainbow trout from 4 March through 5 May. Only eight of these had migrated over J.C. Boyle Dam. Only one adult trout had migrated downstream past Keno Dam. We believe most of the adults migrating to Spencer Creek originated from the free-flowing Keno Reach.

Spring Creek rainbow trout spawn every month of the year except September. Rainbow trout from Spencer Creek spawn throughout March, April, and May while rainbow trout from Deming Creek spawn during a period of 4 weeks in April and May.

Scale data from Spring Creek suggests that rainbow trout can live up to 8 years and spawn up to 6 times. Scale data from Deming Creek suggests that rainbow trout spawn only once or twice.

Native rainbow trout from the Upper Klamath Basin represent a previously unknown, highly divergent evolutionary line. Populations associated with Klamath River and Klamath Lake comprised one divergent group while a second group was found from Jenny Creek and headwaters of the Williamson and Sprague rivers, except for Deming Creek which comprised a third divergent group.

Job 3. Hatchery Supplementation Effects on Oregon's Rainbow Trout Populations

Objectives for FY 1990

1. Determine if native Metolius River rainbow trout have introgressed with, or been otherwise adversely affected by, introduced hatchery trout.

2. Determine if hatchery rainbow trout can be successfully sterilized using methyl testosterone.

Accomplishments in FY 1990

Progress was made on all objectives.

Findings in FY 1990

We began experiments to determine the relative resistance of wild rainbow trout from the Metolius River to *Ceratomyxa shasta*. All hatchery controls were infected by *C. shasta* while 26, 94, and 74% of the wild rainbow trout from Bakeoven Creek (Deschutes River), Riverside Campground (Metolius River), and Gorge Campground (Metolius River), respectively, were infected.

We examined 400 hatchery rainbow trout that were treated with methyl testosterone and held at the hatchery for 2 years. We found 12% mature, precocious males with milt present and no mature females.

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

Introduction

Job 1 is a review of the history and effectiveness of management programs for native trout in Oregon. This review involves two levels of evaluation: (1) a general assessment of the management goals and activities of federal and state (Oregon) fishery agencies since the nineteenth century; and (2) a more specific review of the life history, ecological characteristics, and current status of native trout populations in Oregon. This information is needed to develop a long-term management strategy and to identify immediate research needs for the conservation of Oregon's native trout.

Methods

Interviews were conducted with biologists from selected districts in the Northeast, Central, Southeast, and Northwest Regions of the Oregon Department of Fish and Wildlife. Additional information was collected from the Oregon State University library and from annual reports and bulletins of the Oregon Department of Fish and Wildlife and its predecessor agencies. Inventory data were obtained from biologists, and published reports were reviewed to assess the current status and historical distribution of bull trout (*Salvelinus confluentus*) populations in Oregon.

Historical stocking records for trout in selected river basins were obtained from district files and hatchery records and entered into a computerized database. These include all available records for trout (excluding steelhead) stocked in ponds, lakes, and rivers from the 1920s to the present for the following basins: Goose and Summer Lakes, John Day River, Upper Klamath Lake, Malheur Lake, and Metolius River. Statewide totals for numbers and pounds of trout released were also tabulated from records given in annual and biennial reports.

Results and Discussion

Trout management in Oregon and elsewhere developed primarily as a fish culture program. Records of total releases of trout appear in agency annual reports as early as 1897 (Appendix Table 1). Peak totals of trout released statewide were reached in 1924 when more than 30 million fry and fingerling rainbow (*Oncorhynchus mykiss*), eastern brook (*Salvelinus fontinalis*), and cutthroat trout (*O. clarki*) were distributed in Oregon streams and lakes. Oregon records of trout released are available by county beginning in the 1920s but specify only the number, species, and stream or river where fish were stocked. By the 1940s, the hatchery program shifted from the production of very large numbers of fry and fingerlings to smaller quantities of large "catchable" trout. Although the annual total number of trout released has declined fifty percent or more since 1965, the total weight of fish released in 1990 was slightly greater than it was twenty-five years earlier (Figure 1).

Our review indicates that, until very recently, little information has been collected on the population status, life history, genetic diversity, or

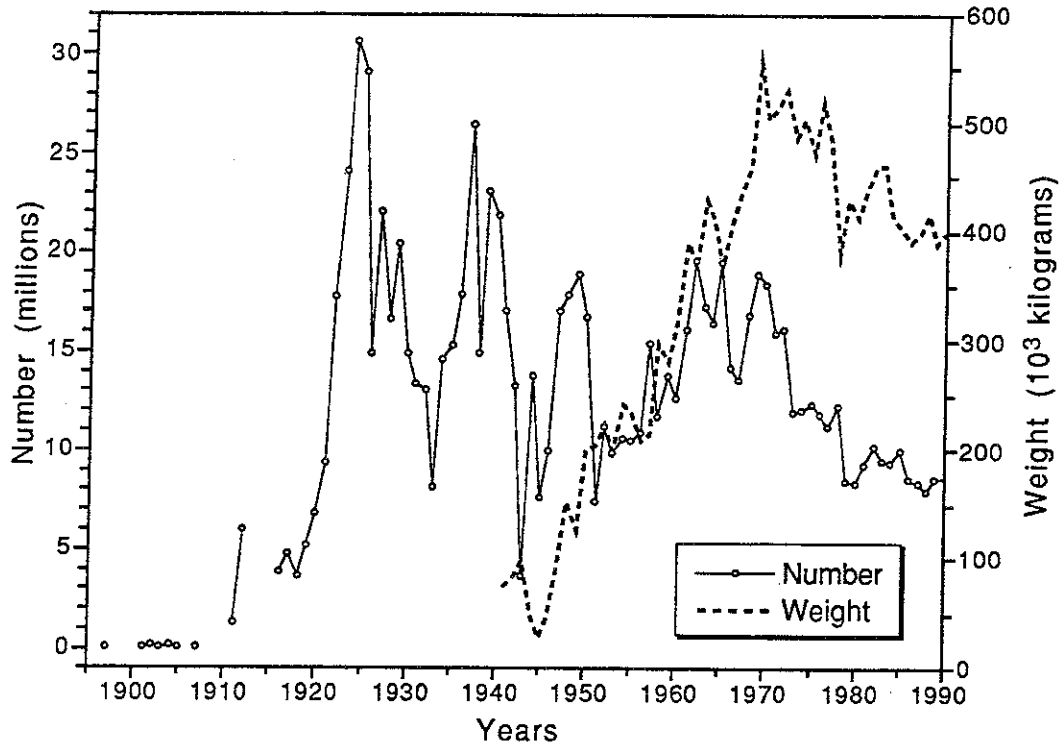

Figure 1. Total number and weight of hatchery-reared rainbow (excluding steelhead), cutthroat, brook, and brown trout released in Oregon waters, 1897-1990. Release numbers are listed by species in Appendix Table 1.

ecology of native trout populations in Oregon. The goal of trout management has been to maintain or increase angler harvest. Success of the catchable trout program has been measured in pounds and numbers of fish released, numbers of fish released per number of anglers, number of areas stocked, costs per pound of fish, conversion efficiencies in hatcheries, angler-days of use, and fish caught per hour of angling. Basic life history information and genetic and ecological measures of performance are needed to insure that hatchery programs do not adversely affect native trout stocks, other aquatic species, and stream ecosystems.

The distribution and abundance of bull trout populations in Oregon have been greatly reduced since European settlement. Populations are now found primarily in the upper reaches of tributaries to the Columbia, Snake, and Klamath rivers. Their decline can be attributed to multiple causes including widespread habitat loss, overharvest, interaction with exotic species, and chemical treatment programs.

JOB 2. DETERMINE DIVERSITY WITHIN OREGON'S RAINBOW TROUT POPULATIONS

Introduction

Activities described here reflect the third year of a 5-year effort described in Goal II 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 in the Harney and Upper Klamath 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) and Buchanan et al. (1989).

Materials and Methods

Life History Characteristics

Fyke traps to capture adult trout that moved upstream were installed in fish ladders at Link River, Keno, and J.C. Boyle dams. Trapping continued throughout the reporting period. The traps were operated Monday through Friday during periods when many fish were captured and at least weekly during the winter, when fish movement was limited. An upstream weir and trap was installed in lower Spencer Creek (0.8 km from the mouth) and operated from 6 March to 21 May 1990. Captured rainbow trout were anesthetized with MS-222 and tagged with a numbered Floy anchor tag. A downstream weir and trap was installed immediately upstream of the upstream weir. The downstream trap was operated from 1 to 23 October 1989 and 23 March through September 1990.

Redd counts and maturity surveys were conducted for rainbow trout in several streams to determine spawning timing and distribution. Redd counts on Spring Creek (tributary of the Williamson River) were made every 2 weeks in cooperation with the Klamath Management District. Each newly identified redd was marked with a colored rock. Snorkel surveys were conducted in November and December to estimate the proportions of rainbow and brown trout spawning in Spring Creek. Redd counts or maturity surveys were also done in Deming, Spencer, Fall, and Jenny creeks (Upper Klamath Basin) and Smyth, Riddle, and Kiger creeks (Harney Basin).

Rainbow trout scale samples were taken from Spring Creek and Deming Creek to determine age and spawning runs. Scales were mounted and impressed in acetate. The scale reading project identified annuli as bands of closely spaced circuli while "spawning checks" were identified by crossing over of circuli usually accompanied by bands of resorbed circuli. While it was sometimes difficult to differentiate true annuli from "summer checks" or other marks on scales, the spawning checks were obvious.

Biochemical Characteristics

Wild rainbow trout were collected from Klamath River, Spencer Creek, Rock Creek, Trout Creek, Upper Williamson River, Paradise Creek, Cold Creek, and Deming Creek (Upper Klamath Basin) for starch gel electrophoresis. Specimens were frozen immediately on dry ice and stored at -20°C. Procedures for electrophoresis were those of Aebersold et al. (1987). Nomenclature of

enzymes and loci followed Allendorf and Utter (1979) with modifications suggested by Buth (1983). Allelic homogeneity of populations of rainbow trout in different basins was tested by multivariate analysis of variance (Manova) of the arcsine transformation of the "100" allele frequency at each locus. Differences between populations within Upper Klamath Basin were estimated using Nei's genetic distance (Nei 1972, 1978), and populations were clustered into groups using unweighted pair-group method with arithmetic averages (UPGMA) algorithm (Sneath and Sokal 1973).

Develop Homologous and Heterologous Populations of Rainbow Trout

To produce progeny for tests of genetic differences in disease resistance, performance, and behavior, 15 male and 9 female rainbow trout from Spring Creek were mated with 15 males and 7 females from Deming Creek. Mature rainbow trout were collected using the techniques reported in Hemmingsen et al. (1988) during consecutive weeks beginning in early April and held at Oregon Department of Fish and Wildlife's Klamath Hatchery until they were mated on 24 April. Eggs from each female were divided into 30 equal portions and each portion was fertilized by sperm from a different male to create 480 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. After dead and unfertilized eggs had been removed, remaining eggs in each cell were covered with moist cheese cloth, and cells were randomly ordered in ice chests under ice and transferred to aquaculture facilities at Oregon State University. Here, cells were randomly ordered in drip incubation trays at 12°C.

Results and Discussion

Life History Characteristics

The trap at Link River Dam operated 4,899.5 hours during the reporting period and captured only 6 rainbow trout (Table 1). The trap at Keno Dam operated 5,087 hours and captured 27 rainbow trout (Table 2). The trap at J.C. Boyle Dam operated 5,028.5 hours and captured 384 rainbow trout (Table 3). Eighty-five percent of these were captured within two pulses in April-May, 1990 and in October, 1989. We compared our estimates of monthly trout passage at J.C. Boyle Dam in 1988, 1989, and 1990 with those reported in 1959 (Hanel and Gerlach 1964) (Table 4). Contemporary passage is less than 10% of that reported 1 year after the construction of J.C. Boyle Dam.

We operated the upstream trap and weir in Spencer Creek approximately 1,802 hours during the reporting period. However, high water and debris hindered trapping during March. Some fish were probably able to bypass the weir and escape the trap. The Spencer Creek trap captured 926 adult rainbow trout from 4 March through 5 May (Table 5). Only eight of these were tagged fish that had migrated over J.C. Boyle Dam. Only one tagged adult trout migrated downstream past Keno Dam to the Spencer Creek trap. We believe most adults migrating to Spencer Creek originated from the Keno reach (a 4.8 km free-flowing reach between Keno and J.C. Boyle dams). The downstream trap and weir in Spencer Creek operated approximately 2,162 hours and captured 352 fry, 8,434 yearling rainbow trout, and 185 adults (Table 6).

Table 1. Rainbow trout captured in the upstream trap at Link River Dam, October 1989 through September 1990.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
1989:					
October	2	21.5-42.8	32.2	2	356.5
November	0	--	--	--	367.5
December	0	--	--	--	213.5
1990:					
January	1	52.0	52.0	0	376.5
February	0	--	--	--	216.5
March	0	--	--	--	548.0
April	1	--	--	0	695.0
May	0	--	--	--	693.5
June	2	28.7-63.3	46.0	0	569.5
July	0	--	--	--	329.5
August	0	--	--	--	301.5
September	0	--	--	--	232.0
TOTAL	6			2	

Using spawning timing from redd counts and/or samples to characterize maturity of rainbow trout within the Upper Klamath Basin, we found that the Spring Creek rainbow trout spawn every month of the year except September (Figure 2). Rainbow trout from Spencer Creek spawn throughout March, April, and May while rainbow trout from Deming Creek spawn during a period of 4 weeks in April and May. Additional samples of adults suggest that Fall Creek rainbow trout spawn in December and January while Jenny Creek rainbows spawn in April and May. Samples collected in the Harney Basin suggest that Smyth Creek rainbows spawn in April and May while Kiger Creek rainbow are able to spawn from April to June.

An analysis of 36 rainbow trout scales from Deming Creek indicate that 75% were on their first spawning run at the time of capture and 25% were on their second spawning run (Table 7). Analysis of 89 rainbow trout scales from Spring Creek found fish up to 8 years old with 10% captured on their first, 44% on their second, 30% on their third, and 15% on their fourth or fifth spawning runs (Table 8).

Table 2. Rainbow trout captured in the upstream trap at Keno Dam, October 1989 through September 1990.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
1989:					
October	6	16.8-24.6	19.9	4	409.5
November	11	16.5-28.5	21.6	11	367.0
December	1	26.1	26.1	1	213.5
1990:					
January	0	--	--	--	374.0
February	0	--	--	--	222.0
March	3	17.3-21.2	18.7	3	629.5
April	1	21.2	21.2	1	691.5
May	2	21.9-22.4	22.2	2	719.5
June	1	24.1	24.1	0	630.0
July	2	16.3-17.3	16.8	2	331.0
August	0	--	--	--	327.5
September	0	--	--	--	172.0
TOTAL	27			24	

Table 3. Rainbow trout captured in the upstream trap at J.C. Boyle Dam, October 1989 through September 1990.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
1989:					
October	86	15.0-26.7	18.1	71	385.0
November	4	<15.0-24.0	--	1	367.5
December	0	--	--	--	213.5
1990:					
January	0	--	--	--	375.0
February	0	--	--	--	223.5
March	43	15.0-38.4	18.6	42	623.0
April	198	15.1-38.5	18.6	160	689.0
May	11	15.0-22.3	18.3	7	694.0
June	14	38.4	38.4	1	629.5
July	2	12.3-13.1	12.7	0	333.5
August	12	--	--	9	325.0
September	14	--	--	9	170.0
TOTAL	384			300	

Table 4. Expanded monthly estimates of upstream passage of rainbow trout at J.C. Boyle Dam 1959 (Hanel and Gerlach 1964), 1988, 1989, and 1990 through September.

Month	1959	1988	1989	1990
January	--	--	0	0
February	--	0[a]	0	0
March	--	20	5	51
April	--	92	135	207
May	289[a]	20	64	12
June	532	11	15	16
July	48	5	2	5
August	333	18	46	27
September	1,980	67	147	59
October	2,252	227	166	
November	95	47	8	
December	0	0	0	
TOTAL	5,529	507	588	

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

Table 5. Rainbow trout captured in the upstream trap at the Spencer Creek weir, March through May 1990.

Date	Number of fish trapped	Fork length (cm) Range	Mean	Number of fish tagged	Hours of trapping
3/6-3/10	13	16.0-20.8	19.4	13	92.5
3/11-3/17	35	15.3-48.5	24.3	34	169.5
3/18-3/24	306	15.0-52.7	26.7	306	166
3/25-3/31	124	15.1-59.0	26.5	120	166
4/1-4/7	238	15.3-56.8	32.0	223	169.5
4/8-4/14	75	17.1-55.6	34.2	73	169
4/15-4/21	112	15.0-56.2	37.8	107	166.5
4/22-4/28	13	17.1-51.3	37.2	13	169.5
4/29-4/30	0	--	--	0	43
5/1-5/5	10	19.1-50.2	35.6	10	116.5
5/6-5/12	0	--	--	0	162
5/13-5/19	0	--	--	0	165
5/20-5/21	0	--	--	0	47.5
Total	926			899	

Table 6. Rainbow trout captured in the downstream trap at the Spencer Creek weir, October 1989 and March through September 1990.

Date	Number of rainbow trout			Hours trap operated
	Fry	Juveniles	Adults	
10/1-10/7	8	0	0	169
10/8-10/14	27	0	0	168.5
10/15-10/21	26	0	0	171.5
10/22-10/23	3	0	0	51.5
3/1-3/3	0	0	0	0
3/4-3/10	0	0	0	0
3/11-3/17	0	0	0	0
3/18-3/24	0	633	1	12
3/25-3/31	0	153	0	20
4/1-4/7	0	206	1	156
4/8-4/14	0	59	7	163
4/15-4/21	0	74	11	166.5
4/22-4/28	0	67	6	165.5
4/29-4/30	0	367	2	50.0
5/1-5/5	0	2,160	56	116.5
5/6-5/12	0	1,840	64	167
5/13-5/19	0	594	19	162
5/20-5/26	0	470	17	47.5
5/27-5/31	0	687	0	30.5
6/1-6/9	0	1,068	1	80.0
6/10-6/16	0	215	0	<25.0
6/17-6/23	0	0	0	0
6/24-6/30	18	12	0	26.0
7/1-7/7	15	1	0	24
7/8-7/14	--	--	--	0
7/15-7/21	16	7	0	24
7/22-7/28	23	0	0	22.5
7/29-7/31	0	0	0	0
8/1-8/8	3	0	0	18
8/9-8/27	--	--	--	0
8/28-8/31	29	0	0	48
9/1-9/13	9	1	0	27.5
9/14-9/18	9	0	0	26.0
9/19-9/28	166	0	0	24.0

Table 7. Age composition, spawning runs, and average length at age of rainbow trout sampled in Deming Creek, a tributary of the South Fork Sprague River, April 1990.

Age (years)	Number	Average length, mm	Number first spawning run	Number second spawning run
1	1	180.0	1	0
2	10	205.8	10	0
3	16	418.9	14	2
4	7	470.6	2	5
>4	2	501.0	0	2
Total	36		27	9

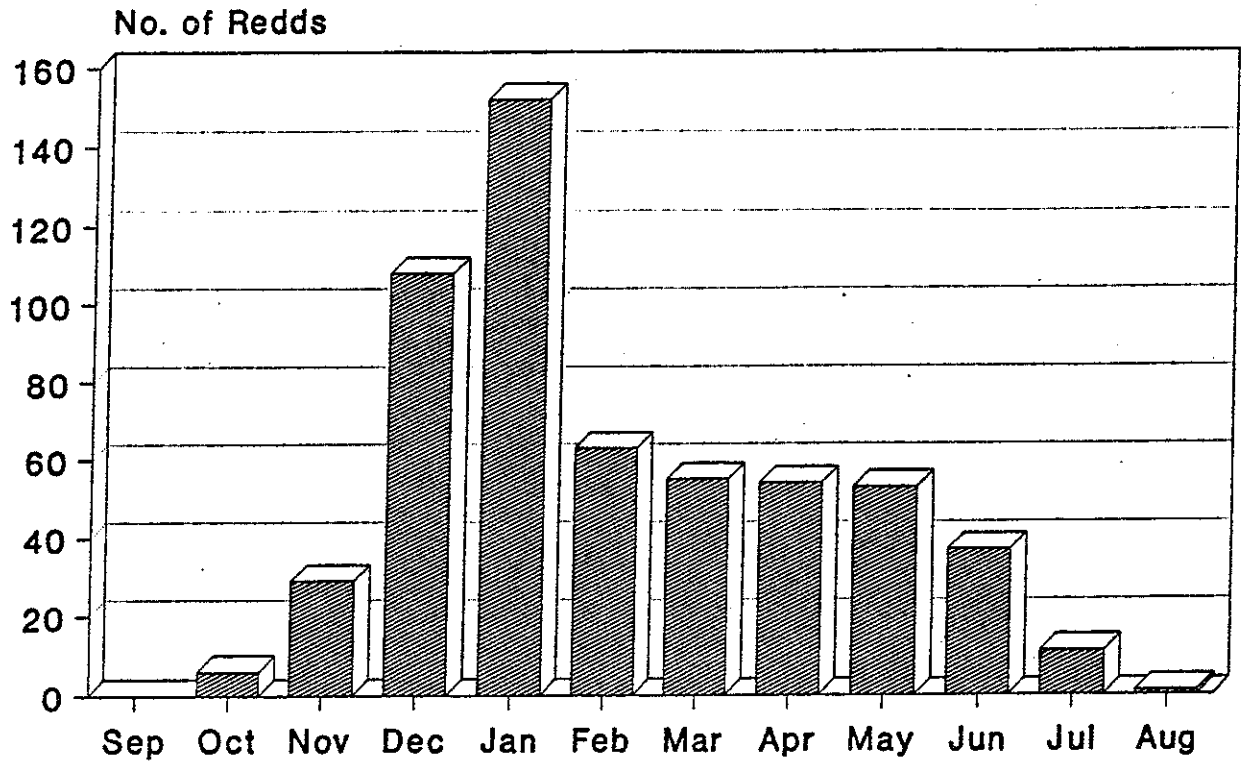

Figure 2. Spawning activity for rainbow trout from Spring Creek, tributary of the Williamson River, 1988-90.

Table 8. Age composition, spawning runs, and average length of rainbow trout sampled in Spring Creek, a tributary of the Williamson River, in May, 1989 and in April and May, 1990.

Age	Number	Average length, mm	Number first spawning run	Number second spawning run	Number third spawning run	Number fourth or fifth spawning run
1989						
3	2	461.0	2	0	0	0
4	5	451.2	2	3	0	0
5	5	475.0	0	2	3	0
6	4	534.3	0	0	3	1
7	1	578.0	0	0	0	1
8	2	593.5	0	0	0	2
1990						
3	4	445.5	3	1	0	0
4	17	530.2	2	14	1	0
5	22	541.4	0	17	3	2
6	22	576.8	0	2	17	3
7	4	609.8	0	0	0	4
8	1	633.0	0	0	0	1
Total	89		9	39	27	14

Biochemical Characteristics

Based on protein electrophoretic allelic differences at 7 loci (sAcoh-1, Gpi-B1, G3pdh-1, Ldh-B2, sMdh-B1, 2, and sSod-1) native rainbow trout from the Upper Klamath Basin represent a previously unknown, highly divergent evolutionary line. Three genetically divergent groups of native rainbow trout are identified by cluster analysis (Figure 3). Populations associated with Klamath River and Klamath Lake comprised one group while a second group consisted of populations from Jenny Creek and headwaters of the Williamson and Sprague rivers, except for Deming Creek, which comprised a third group.

Develop Homologous and Heterologous Populations of Rainbow Trout

Progeny from our within-stock and between-stock experiments are being reared at Oregon State University's Smith Farm Laboratory.

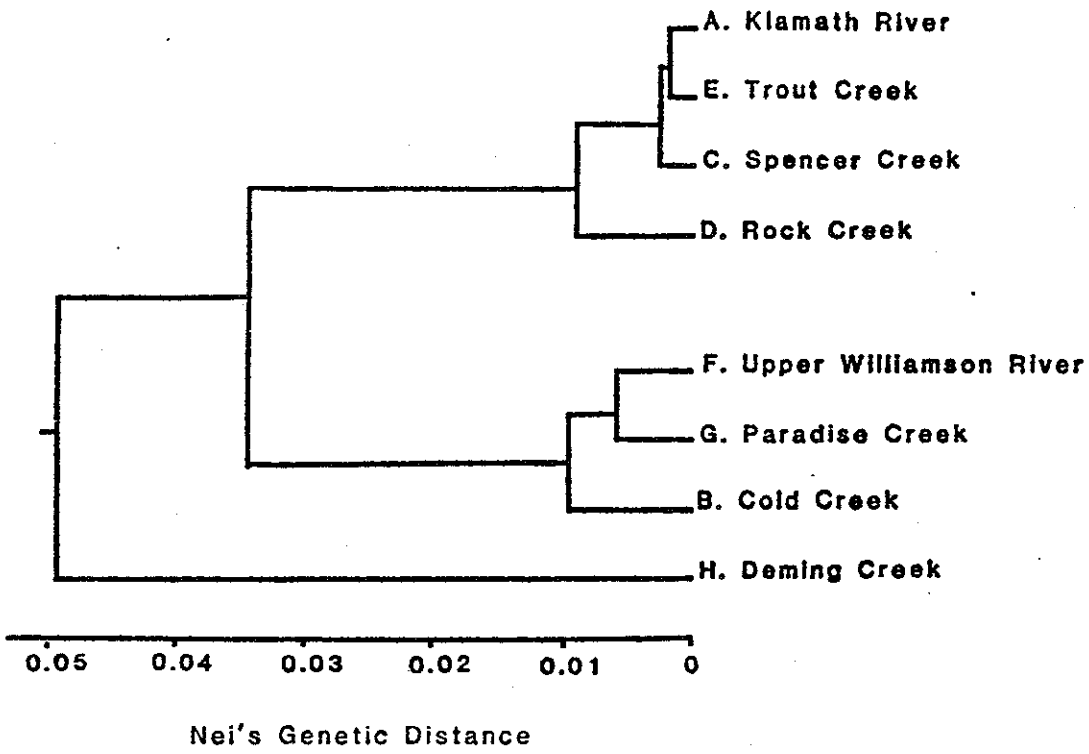

Figure 3. Genetic divergence of rainbow trout populations from the Upper Klamath Basin.

JOB 3. HATCHERY SUPPLEMENTATION EFFECTS ON OREGON'S RAINBOW TROUT POPULATIONS

Introduction

Activities described here reflect the third year of a 5-year effort described in Goal III of the Native Trout Project Proposal (Buchanan et al. 1988). We will try to determine if native trout in the Metolius River (Deschutes Basin) have introgressed with introduced hatchery trout, and if native Metolius River rainbow trout are otherwise adversely affected by introduced hatchery trout. We also conducted studies to sterilize rainbow trout from Roaring River Hatchery (Cape Cod strain).

Materials and Methods

Metolius River Studies

We began experiments to determine the relative resistance of wild rainbow trout from the Metolius River to *Ceratomyxa shasta*, a myxosporean parasite that causes the disease ceratomyxosis. Justification for this

approach has previously been described in Hemmingsen et al. (1988). Populations of salmonids that are resistant to ceratomyxosis are found in areas where the parasite is enzootic while populations that are highly susceptible are found in areas where it is not (Bartholomew et al. 1989). The infective stage of *C. shasta* is known to occur in the Deschutes River (Johnson et al. 1979) and Suttle Lake (Bartholomew et al. 1989) which drains into the Metolius River via Lake Creek (Figure 4).

In 1989, we captured wild rainbow trout near Riverside (RK 67) and Gorge (RK 62) campgrounds. We also captured wild rainbow trout from Bakeoven Creek, tributary to the Deschutes River near Maupin, Oregon. For controls with a known susceptibility to *C. shasta*, we obtained a similar sized (age 0+) groups of juvenile Cape Cod stock of rainbow trout from Fall River Hatchery. All groups of fish were transferred on 1 September 1989 to 1.5 cu m live boxes placed in the Deschutes River at Pelton Dam near Warm Springs, a site known to produce ceratomyxosis. On 14 September all groups of fish were transferred to Corvallis and reared in separate aquaria in 12°C water free of *C. shasta*. Beginning the second day after arrival in Corvallis, all groups were given three daily baths of fungicide followed by four daily baths of bactericide to control secondary infections. Each day, wild trout were fed mealworms or tubifex worms while hatchery trout were fed a commercial diet. Dead fish were removed daily and a wet smear prepared from intestinal scrapings was examined for the presence of *C. shasta* spores (Johnson et al. 1979). Live fish were sacrificed and examined after 63 days.

Sterility Studies

A group of juvenile rainbow trout at Roaring River Hatchery was treated with the synthetic hormone methyl testosterone to induce sterility. Justification for this treatment is presented in Hemmingsen et al. (1988) and methods are detailed in Buchanan et al. (1989).

Results and Discussion

Metolius River Studies

Most rainbow trout collected survived the initial exposure period to *C. shasta*. In spite of treatments to control secondary infections, 13 fish died of other causes during the early incubation period (Table 9). All hatchery controls were infected by *C. shasta* while 26, 94, and 74% of the wild rainbow trout from Bakeoven Creek, Riverside Campground, and Gorge Campground, respectively, were infected with *C. shasta*.

Sterility Studies

During February 1990, we examined 400 2-year-old hatchery rainbow trout that were treated with methyl testosterone and held at the hatchery. We found 48 (12%) were mature males (i.e. they were dark in color with milt present); there were no mature females.

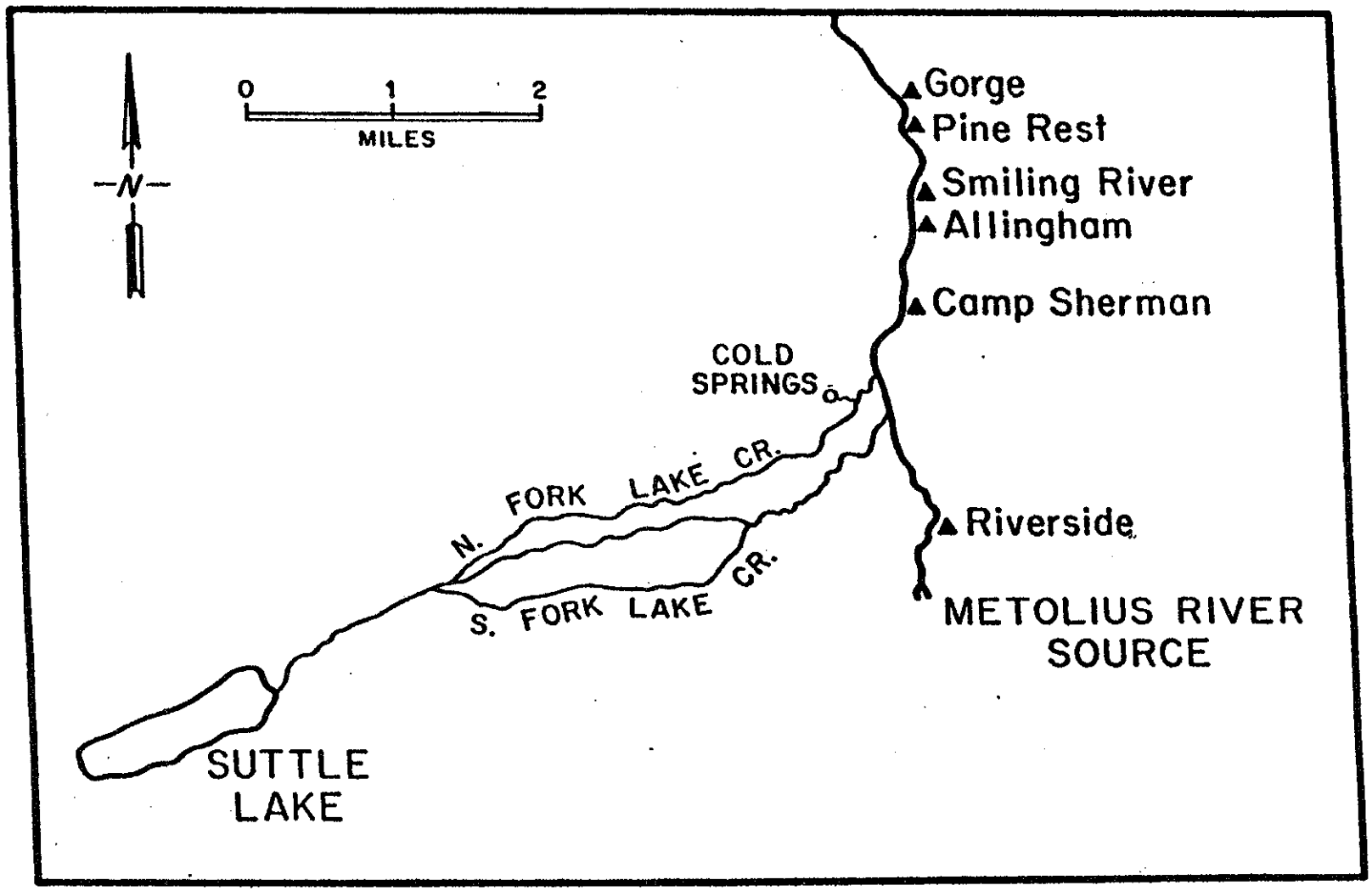

Figure 4. Upper Metolius River with U.S. Forest Service campgrounds listed.

Table 9. Incidence of infection with *Ceratomyxa shasta* in various rainbow trout groups exposed at Pelton Dam on the Deschutes River during 1989.

Source of fish	Number of fish challenged	Number of fish transferred to Corvallis	Number dead before initial spore detection[a]	Number of fish that remained	Proportion infected with C. shasta[b]	
					Number	Percent
Fall River Hatchery (Cape Cod stock)	70	67	0	67	67	100
Bakeoven Creek (Deschutes R.)	52	52	1	51	13	26
Metolius River:						
Riverside C.G.	45	45	12	33	31[c]	94
Gorge C.G.	42	42	0	42	31[d]	74

[a] Incidental mortality from handling stress, bacterial infection, etc. that occurred prior to detection of the first *C. shasta* spore in the control group.
[b] Infection with *C. shasta* was defined as the presence of the sporoblast or spore stage in an intestinal smear.
[c] *C. shasta* was not detected in two fish that died on the first day that spores were detected in the control group.
[d] Two of 31 fish had *C. shasta* spores, but were still alive at termination of the experiment (63 days after exposure).

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Appendix Table 1. Total annual number of hatchery-reared rainbow (excluding hatchery steelhead), brook, cutthroat, and brown trout released in Oregon waters from earliest available records through 1990.[a]

Years	Notes	Rainbow	Brook	Cutthroat	Brown	Total
1897	b	--	18,800	--	5,175	23,975
1898	c	--	--	--	--	--
1899	c	--	--	--	--	--
1900	c	--	--	--	--	--
1901	d,e	30,000	75,000	--	--	105,000
1902	d,f	--	122,000	8,000	--	130,000
1903	d,g	7,692	33,670	21,010	--	62,372
1904	d,h	51,315	118,569	22,600	--	192,484
1905	d	17,585	200	29,490	--	47,275
1906	d,i	--	--	--	--	--
1907	d	37,900	--	12,900	--	50,800
1908	c	--	--	--	--	--
1909	d,i	--	--	--	--	--
1910	d,i	--	--	--	--	--
1911	j	--	--	--	--	1,340,890
1912	j	--	--	--	--	6,044,546
1913	k	--	--	--	--	--
1914	k	--	--	--	--	--
1915	k	--	--	--	--	--
1916	j	2,484,676	1,104,151	244,750	--	3,833,577
1917	j	4,292,616	45,746	443,955	--	4,782,317
1918	j	2,631,962	253,110	809,102	--	3,694,174
1919	l	3,202,252	1,025,388	937,272	--	5,164,912
1920	l	4,066,769	1,370,701	1,387,475	--	6,824,945
1921	l	5,448,724	3,170,740	783,200	--	9,402,664
1922	l	10,544,373	6,016,692	1,155,105	--	17,716,170
1923	l	15,831,996	4,548,057	3,753,539	--	24,133,592
1924	l	17,947,184	5,468,341	7,194,052	--	30,609,577
1925	l	17,599,652	6,514,273	3,879,493	1,131,450	29,124,868
1926	l	6,791,638	5,730,824	2,323,731	--	14,846,193
1927	l	10,904,375	8,493,768	2,670,496	--	22,068,639
1928	l	11,463,090	4,535,337	650,465	--	16,648,892
1929	l	11,528,265	7,351,018	1,547,823	--	20,427,106
1930	l	9,269,150	4,825,935	761,987	--	14,857,072
1931	l	9,366,000	3,488,520	1,488,417	6,000	14,348,937
1932	l	8,740,500	2,605,600	1,724,100	0	13,070,200
1933	l	3,904,300	1,788,200	2,436,100	0	8,128,600
1934	l	5,473,900	4,901,500	3,382,000	863,600	14,621,000
1935	l	6,392,500	11,363,040	2,811,000	1,164,000	21,730,540
1936	l	8,955,750	6,690,900	1,750,500	435,000	17,832,150
1937	l	10,756,120	13,366,500	2,181,915	145,000	26,449,535
1938	l	9,756,325	2,451,000	1,889,967	810,000	14,907,292
1939	l	12,428,702	7,027,112	2,213,507	1,393,599	23,062,920
1940	l	12,895,666	6,199,116	1,854,995	931,117	21,880,894
1941	l	11,321,177	4,791,989	863,779	83,185	17,060,130
1942	l	9,978,217	2,284,223	873,847	67,404	13,203,691

Appendix Table 1 (continued).

Years	Notes	Rainbow	Brook	Cutthroat	Brown	Total
1943	l	7,517,921	1,601,734	2,040,378	0	3,642,112
1944	l	8,664,933	3,123,210	2,011,972	--	13,800,115
1945	l	5,767,724	858,633	1,034,086	--	7,660,443
1946	l	7,486,128	1,371,454	1,056,479	105,986	10,020,047
1947	m	11,766,581	1,731,299	1,525,936	--	15,023,816
1948	m	12,101,070	2,614,967	3,104,933	--	17,820,970
1949	m	11,914,788	3,652,318	3,320,657	--	18,887,763
1950	m	12,038,412	4,077,030	656,169	--	16,771,611
1951	m	4,821,561	1,819,314	700,411	102,889	7,444,175
1952	m	7,313,719	3,365,507	535,130	544	11,214,900
1953	m	6,325,055	3,043,178	399,738	119,817	9,887,788
1954	m	6,800,621	3,247,094	458,228	118,743	10,624,686
1955	m	7,262,744	2,715,809	291,983	208,240	10,478,776
1956	m	7,421,631	2,420,142	974,429	62,055	10,878,257
1957	m	12,458,815	1,666,539	976,807	324,948	15,427,109
1958	m	9,025,486	1,609,509	823,562	258,502	11,717,059
1959	m	10,970,444	1,844,519	739,839	174,142	13,728,944
1960	m	9,886,577	1,617,504	1,068,217	84,449	12,656,747
1961	m	12,661,916	2,093,419	1,146,890	171,422	16,073,647
1962	m	16,416,461	2,346,117	725,803	97,520	19,585,901
1963	m	14,086,949	2,071,533	913,304	202,402	17,274,188
1964	m	13,828,357	1,819,617	536,613	250,790	16,435,377
1965	m	16,920,802	1,796,759	551,516	183,538	19,452,615
1966	m	11,822,563	1,594,129	507,812	211,283	14,135,787
1967	m	11,125,427	1,521,192	555,879	339,348	13,541,846
1968	m	14,435,484	1,422,566	606,890	366,472	16,831,412
1969	m	16,729,206	1,144,623	900,183	80,025	18,854,037
1970	m	15,935,434	1,138,205	1,207,448	121,373	18,402,460
1971	m	13,928,584	1,452,657	542,549	--	15,923,790
1972	m	14,270,843	1,059,175	617,827	136,373	16,084,218
1973	m	11,137,678	0	674,188	119,264	11,931,130
1974	m	11,411,750	117,626	480,367	23,582	12,033,325
1975	n,o,p	--	--	--	--	12,345,382
1976	n,o	--	--	--	--	11,852,696
1977	n,q	--	--	--	--	11,161,030
1978	r	10,566,038	1,129,538	507,690	0	12,203,266
1979	r	7,807,733	377,030	216,310	11,716	8,412,789
1980	r	7,149,094	590,281	562,083	2,412	8,303,870
1981	r	7,961,536	981,451	189,854	119,691	9,252,532
1982	r	8,400,357	909,855	756,027	119,627	10,185,866
1983	r	7,681,659	894,029	846,844	9,901	9,432,433
1984	r	8,143,990	580,271	654,638	0	9,378,899
1985	r	8,669,695	807,636	412,014	37,460	9,926,805
1986	r	7,892,726	296,820	236,272	123,118	8,548,936
1987	r	7,674,978	537,650	153,563	13,892	8,380,083
1988	r	7,420,162	397,274	72,997	79,316	7,969,749
1989	r	7,671,231	717,112	79,376	84,262	8,551,981
1990	r	7,765,771	539,618	134,884	133,994	8,574,267

Appendix Table 1 (continued):

Notes:

[a] Blank cells in the table indicate that we found no record of releases for that year.

[b] Release numbers taken from the Fifth and Sixth Annual Reports of the Fish and Game Protector.

[c] Unable to locate any record of the number of trout released during this time period.

[d] Release numbers taken from the Annual Reports of the Department of Fisheries of the State of Oregon.

[e] Report listed trout releases for the month of June, 1901.

[f] There was no report on the number of rainbow trout, if any, that were released.

[g] Numbers are only for trout released during June, July, and November of 1903.

[h] Release numbers are for the months of May, June, and July of 1904.

[i] Applications to receive fish for distribution were reported, but the total number of fish released was not given.

[j] Release numbers from: Finley, W.L. 1912. Game and Fish Protection and Propagation in Oregon. Portland.

[k] We found no records to indicate the number of trout released during these years. In the 1917 Biennial Report of the Fish and Game Commission, the game warden does include a report from the US Department of Agriculture, Forest Service, indicating that an unspecified number of trout were released by the Forest Service.

[l] Release numbers from the biennial reports of the Game Commission of the State of Oregon. Annual totals are reported by fiscal year (July 1-June 30) rather than calendar year.

[m] Release numbers from the annual reports of the Fishery Division of the Oregon State Game Commission (name changed to Oregon Wildlife Commission, 1971-1974). Unlike the biennial reports, these totals are for a calendar year, not a fiscal year.

[n] Release numbers taken from the biennial reports of the Oregon Department of Fish and Wildlife.

[o] The annual reports of the Oregon Department of Fish and Wildlife give somewhat different release numbers than the biennial report.

1975 Annual Report: Rb-10,332,811
Ct-521,321
Bt-1,125,892
Br-39,060
Total: 12,019,084

1975-76 Biennial Report: 1975 Total: 12,345,382
1976 Total: 11,852,696
No data for individual species.

[p] The former Wildlife Commission listed releases by calendar year, while the Fish Commission listed releases by brood year.

[q] Release numbers taken from the biennial reports of the Oregon Department of Fish and Wildlife. Only the total number of trout released for the entire two-year period was reported. The release number for 1977 was calculated by subtracting the 1976 data from the total given in the 1976-77 biennial report. Annual totals for individual species could not be calculated in this manner.

[r] Release numbers from computer files of the Fish Propagation Section of the Fish Division, Oregon Department of Fish and Wildlife in Portland.