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SUMMARY

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

Objectives for FY 1988

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 historical records, Oregon Department of Fish and Wildlife and other agency files, and published accounts of trout distribution, abundance, and life history in Oregon.

3. Review Oregon Department of Fish and Wildlife management activities for freshwater habitat and the availability of inventory information to support these activities for trout. Develop a conceptual approach for a statewide inventory of trout habitat.

Accomplishments in FY 1988

Progress was made on all three objectives. Review of the literature and unpublished data in agency files under the first two objectives will be continued in FY 1989.


A system of hierarchical stream classification appears to be the best method to inventory statewide trout habitat.

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

Objectives for FY 1988

1. Determine the timing and magnitude of upstream movement of adult rainbow trout in the lower Donner 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 the origin, movement, and timing of rainbow trout past Link River, Keno, and J.C. Boyle dams on the Klamath River.

4. Collect samples of rainbow trout in Harney and Upper Klamath basins for analysis of morphological and biochemical characteristics.

5. Generate homologous (within stock) and heterologous (between stock) populations of native rainbow trout for determination of genetic or environmental control of life history differentiation.
6. Collect groups of native rainbow trout and determine their relative resistance to ceratomyxosis.

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

Accomplishments in FY 1988

Progress on all seven objectives was accomplished. Objective 1 was not fully met because sampling was conducted only 3 months. Objectives 2 and 3 were not fully met because insufficient data were collected for reasons that are presented later.

Findings in FY 1988

No adult rainbow trout migrated from Malheur Lake into the lower Donner and Blitzen River during April, May, and June.

We found evidence of paternal difference in the genetic control of hatching time in progeny of rainbow trout from different environments in the Upper Klamath basin.

The estimated number of adult rainbow trout that moved upstream past J.C. Boyle Dam on the Klamath River from January through September 1988 was seven percent of the estimated total that passed the dam during the same time period in 1959.

The known range of Ceratomyxa shasta in the Upper Klamath basin was extended to Agency Lake and to two locations in the lower Williamson River.

PROJECT BACKGROUND

The existence of native trout populations is increasingly being threatened in Oregon and other western states. Because native trout thrive in pristine environments, they have been compromised by the alteration or depletion of aquatic or riparian habitat. In certain instances, attempts to compensate for the reduction in native trout populations have led to introductions of hatchery-reared trout of nonnative origin or introductions of other nonnative trout species. In 1987, the Oregon Fish and Wildlife Commission adopted the Oregon Trout Plan (ODFW 1987) that identified five objectives: (1) maintain the genetic diversity and integrity of wild trout stocks throughout Oregon; (2) protect, restore, and enhance trout habitat; (3) provide a diversity of trout angling opportunities; (4) determine the statewide management needs for hatchery trout; and (5) enhance the public awareness of Oregon's trout resources. Research by the Native Trout Project addresses principal management needs identified in objectives 1, 2, 4, and 5 of the Oregon Trout Plan.

The three objectives of Job 1 for FY 1988 are identified and justified in Goal I of the Native Trout Project Proposal (Buchanan et al. 1988). The
purpose of Goal I is to review the history and effectiveness of management programs for resident trout in Oregon and, based on existing information, characterize native trout populations in Oregon. Funds for the studies of Job 1 are provided partially by the U.S. Fish and Wildlife Service, Oregon Trout, and Oregon Department of Fish and Wildlife (ODFW) from wildlife dollars.

All seven objectives of Job 2 for FY 1988 are identified and justified in the Native Trout Project Proposal (Buchanan et al. 1988). Objectives 1 through 6 relate to Goal II of the Native Trout Project Proposal, whereas Objective 7 relates to Goal III of that proposal. The purpose of Goal II is to begin the description of the genetic diversity that exists within and between populations of native trout in Oregon. Our intent is to describe the diversity in terms of differences in life histories, biochemical and morphological characteristics, and resistance to certain pathogens or parasites. We further intend to determine whether biochemical or morphological differences can indicate life history differences. The purpose of Goal III is to examine the genetic effects of hatchery trout on native trout and to identify possible techniques to minimize adverse effects. Funds for the studies of Job 2 are provided partially by the U.S. Fish and Wildlife Service, Pacific Power and Light Company, Malheur National Wildlife Refuge, and ODFW from wildlife dollars.

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

Introduction

All three objectives for Job 1 in FY 1988 are listed in the Native Trout Project Proposal under Objective 1 (Tasks 1.2, 1.6, and 1.7) (Buchanan et al. 1988). During this first year of study, we emphasized review of trout habitat and life history information as background for understanding management problems and potential solutions.

Methods

Species and basin management plans prepared by ODFW were reviewed to identify common problems and proposed solutions for habitat management throughout the state. Data sources that contain habitat inventory information were identified and will be analyzed to determine specific inventory needs or to recommend critical areas for protection or enhancement of trout populations.

Results and Discussion

Our review indicated a continued threat of attrition of trout habitat throughout the state. Among the impediments to habitat protection cited in the management plans is the lack of inventory information needed to identify critical habitats. Our review also indicated a particular need for information at a broad scale of resolution to monitor, for example, whether natural production potential will be maintained statewide despite local changes in habitat conditions that will inevitably occur. A periodic "snapshot" of the entire state is needed to define statewide priorities and to
minimize the risk that wild stocks will be lost to piecemeal attrition of habitat.

We concluded that two important factors need to be addressed in a statewide habitat inventory: (1) the total area of habitat potentially available to a population for production and (2) the integrity and organization of that habitat into unfragmented systems capable of sustaining healthy populations. A review of habitat inventory methods suggests that hierarchical stream classification offers a promising approach to address both factors. We are evaluating remote sensing techniques as one information source for developing a hierarchical classification of watershed and stream types that can be applied to statewide management of trout habitat.

We will choose a few river basins east of the Oregon Cascades to develop a method for watershed classification and inventory of trout habitat. Among the factors we may use to classify watershed types are seasonal flow characteristics, patterns of land use, and successional stage and condition of riparian communities in each basin. Concurrent research on trout populations in the Upper Klamath basin (Job 2) may allow us to interpret the effects of stream characteristics on the diverse life history traits of native stocks. From analysis in the Klamath and one or more other watersheds, we will recommend a method for statewide classification and inventory of stream habitat for trout.

**JOB 2. A STOCK CHARACTERIZATION OF OREGON'S NATIVE TROUT**

**Introduction**

Activities described here reflect the first 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 both the diversity of Oregon's native trout and the possible effects of hatchery supplementation is beyond the scope of this study. We have chosen to limit efforts primarily to rainbow trout *Oncorhynchus mykiss* in the Harney and Upper Klamath basins for reasons given in Buchanan et al. (1988). Much of our effort in FY 1988 was focused on the Donner und Blitzen River in Harney basin, and on the Klamath River, Spencer Creek, Spring Creek, Deming Creek, and the Williamson River in Upper Klamath basin.

The Donner und Blitzen River originates on the west side of Steens Mountain in southern Harney County and flows north through the Blitzen Valley into Malheur Lake. Page Springs Dam, near the community of Frenchglen, diverts much of the mainstem Donner und Blitzen River into two primary canals (east and west) for irrigation of Malheur National Wildlife Refuge. On the mainstem Donner und Blitzen River, in sequence downstream from Page Springs Dam, lie Buckeroo, Grain Camp, Busse, Sod House, and Springer (now submerged in Malheur Lake) dams. Although these dams were originally built to divert river water for ranching purposes, they were rebuilt in the 1920 to 1940 era with provisions to allow upstream passage of adult fish.

The Klamath River originates in Upper Klamath Lake and flows about 408 km before draining into the Pacific Ocean. The upper river sustains a relatively large population of native rainbow trout despite alterations to habitat. At
river kilometer (RK) 407, 372.5, and 359, respectively, lie Link River, Keno, and J.C. Boyle dams, which supply water to hydroelectric facilities operated by Pacific Power and Light Company. The Klamath River enters California at RK 333 upstream from Copco Reservoir. Spencer Creek originates about 3 km south of Lake of the Woods in the Winema National Forest, then flows about 29 km southeasterly into J.C. Boyle Reservoir at RK 363.5 on the Klamath River.

Deming Creek flows from an elevation of 2,170 m in the Gearhart Mountain Wilderness Area for 23 km with an average width of less than 4 m. Most of the lower 16 km are low gradient and have been trenched or diverted for irrigation. The upper 7 km are less altered, and the gradient increases from 1.2% to nearly 10%. Deming Creek is fed by some small springs and surface runoff from Gearhart Mountain. It joins South Fork Sprague River 140 km above its confluence with the Williamson River. Spring Creek flows from an elevation of 1,270 m for 3.5 km with an average width of 50 m and slope of 1.4%. It is fed almost entirely by springs that maintain constant flow and temperature, and joins the Williamson River 8 km above the confluence of the Sprague River and 26 km above Upper Klamath Lake.

The Williamson River originates from springs in the Fremont National Forest about 29 km northwest of the community of Beatty and flows north then west for 66 km into Klamath Marsh. It exits Klamath Marsh at RK 65 and flows south and slightly west draining into Upper Klamath Lake about 18 km from the community of Chiloquin.

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

Traps that captured upstream moving adult rainbow trout were installed at Page Springs, Grain Camp, and Sod House dams on the Lower Donner und Blitzen River. Each trap consisted of a V-shaped fyke open at the downstream end. The traps were monitored at least four times each week throughout April, May, and June 1988. The maximum time between visitations to each trap was 48 hours. During periods of extreme diurnal fluctuation in stream flow or when many fish were likely to be caught, traps were monitored twice daily. Captured rainbow trout were netted and anesthetized with tricaine methanesulfonate (MS-222). Fork length and scale samples were collected from each fish. To help describe movement of adult trout, fish with fork lengths of 18 cm or longer were tagged with numbered Floy anchor tags inserted just below the anterior portion of the dorsal fin. Signs located at Malheur National Wildlife Refuge headquarters, Malheur Field Station, Frenchglen Hotel, Frenchglen Store, Camper Corral, and B & B Sporting Goods in Burns informed anglers of the possibility of catching a tagged rainbow trout. Collection boxes with each sign permitted voluntary return of tags from angler-caught trout.

A trap that captured downstream moving juvenile rainbow trout was installed at a small diversion dam about 0.4 km downstream from Page Springs Dam in the east diversion canal. The trap consisted of an inclined screen that diverted most of the water flow and directed fish into a flexible tube 15 cm in diameter. Fish then passed into a covered box that floated in a nearby
pool, where they remained until they could be sampled. The trap was designed
to sample about half the water through the east canal when the flow during
April, May, and June 1988 was lowest.

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
February 1988 and continued throughout the reporting period. The traps were
operated continuously, Monday through Friday, during periods when many fish
were captured and 3 days each week at other times. The maximum time between
visitations to each trap was 48 hours. 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. Water
temperatures and pH measurements were also collected.

Objective 4. Collect Rainbow Trout for Morphological and Biochemical Analysis

Most samples of rainbow trout were collected by electrofishing with a
backpack shocker. Juveniles were preferred, although older fish were taken as
needed. Collected fish were killed with a lethal dose of MS-222. In cases
where rainbow trout were killed for other purposes (see Objective 5, page 7),
those fish were also used for this objective. Samples were immediately placed
on dry ice, transported to Corvallis, and stored frozen.

Objective 5. Generate Homologous and Heterologous Populations
of Rainbow Trout

To satisfy this objective, mature rainbow trout from two different
environments within the Upper Klamath basin were collected. On 20 and 28
April, a seine and fyke net were set across Spring Creek downstream from a
primary spawning area and anchored in place so that passage of adult rainbow
tROUT was blocked. Upstream about 0.5 km, a second seine was spread across
the stream and allowed to drift with the current. Snorkelers kept the lead
line from snagging the stream bottom while other assistants maneuvered the
ends of the seine next to the shoreline. Adult trout in the spawning area
were thereby herded downstream and captured in either the blocking seine or
fyke net. Rainbow trout near maturity were transported to Klamath Hatchery
and held in an isolated raceway. Immature or spawned females and excess males
were released back into Spring Creek.

Rainbow trout from Deming Creek were collected by electrofishing on 28
and 29 April. Although our intent was to collect fish of both sexes,
unspawned, mature females were unavailable. Males were collected and held in
a live cage placed in the creek. On 29 April, mature males were killed and
spawned separately into 1.1 liter plastic bags. Those bags were then filled
with bottled oxygen, sealed, placed over ice at 4.50 C, and transported to
Klamath Hatchery. Spawned males were stored according to procedures described
previously under Objective 4.
Also on 29 April at Klamath Hatchery, sperm from Spring Creek males was collected and stored as described for Deming Creek males. Eggs from nine Spring Creek females were collected, then each was divided into 18 equal portions. Families were created by adding equal amounts of sperm from nine Spring Creek males and nine Deming Creek males to a portion of the eggs from each female. Families were placed in 51 mm incubation cells (McIntyre and Blanc 1973) and randomly ordered in a trough for incubation at 6.7°C at the hatchery.

On 4 June, after dead and unfertilized eggs had been removed, all remaining eggs in each family were transferred to aquaculture facilities at Oregon State University and incubated at 10°C. With the onset of hatching on 7 June, hatched eggs in each family were counted at 8-hour intervals until all hatched. Means and variances of hatching time were tested using the separate variance t-test and Levene W-test, respectively, available in BMDP Statistical Software (Dixon 1985).

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

Several salmonid species, including rainbow trout, are susceptible to infection by the myxosporean parasite Ceratomyxa shasta (Zinn et al. 1977). Infection by C. shasta may result in ceratomyxosis (Schafer 1968; Johnson 1975), a disease that can cause high mortality in certain salmonid populations (Ratliff 1981). Variable susceptibility to infection by the parasite has been demonstrated among stocks of certain species, such as chinook salmon Oncorhynchus tshawytscha (Zinn et al. 1977), coho salmon O. kisutch (Hemmingsen et al. 1986) and summer steelhead O. mykiss (Buchanan et al. 1983; Wade 1987). In cases that involved salmonid stocks that were resistant to infection by C. shasta, resistance was demonstrated to be heritable (Hemmingsen et al. 1986; Wade 1987). Those results suggest that resistance to ceratomyxosis can be used to characterize native trout stocks and provide specific examples of the general use of disease resistance for that purpose (IHssen et al. 1981). Because native rainbow trout and C. shasta are known to coexist in Upper Klamath Lake, we hypothesized that certain populations of rainbow trout in Upper Klamath basin are resistant to infection by C. shasta. In 1988, we began experiments to determine the relative resistance of native rainbow trout populations in Harney basin and in the Upper Klamath basin to infection by C. shasta.

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). Identification of a site where native trout could be exposed to C. shasta and infected by the parasite if they were susceptible to ceratomyxosis was our first objective. We obtained juvenile Cape Cod rainbow trout, known to be susceptible to ceratomyxosis (Zinn et al. 1977), from Klamath Hatchery. On 19 and 20 May 1988, samples of 120 Cape Cod rainbow trout were placed in 1.5 cu m live-boxes at six locations in the Upper Klamath basin. Those locations included the Williamson River (RK 19) 1.6 km above the confluence with the Sprague River; the Williamson River about 3 km above the confluence with Upper Klamath Lake; the east side of Agency Lake; Upper Klamath Lake at Modoc Point; Upper Klamath Lake at Pelican Marina; and the mainstem Klamath River (RK 362) near the fish ladder below J.C. Boyle Dam. On 24 May live-boxes were placed
in the lower Donner und Blitzen River (Harney basin) at Sod House Dam and in Malheur Lake near the mouth of the Donner und Blitzen River.

Trout in the live-boxes were monitored regularly and fed Rangen's trout diet treated with oxytetracycline (TM-50) to control bacterial infection. Mortalities were collected and frozen for subsequent analysis. Water temperature at all exposure sites varied diurnally, but exceeded the lower threshold at which C. shasta becomes infective (Udey et al. 1975). After 17 days of exposure at sites in Harney Basin or 24 days of exposure at sites in the Upper Klamath basin, half the fish from each group, referred to as Lot 1, were transferred to Corvallis and reared on pathogen-free well water in individual aquaria for each group. The remaining fish, referred to as Lot 2, were given additional exposure time then transferred to Corvallis on 21 June.

Experimental rainbow trout at Corvallis were fed a diet similar to that given while they were in live-boxes. 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 C. shasta spores. Live fish were killed after 60 days of rearing at Corvallis and similarly examined.

Objective 7. Attempt to Sterilize Hatchery Rainbow Trout

Sterility in salmonids can be induced by several techniques, including chromosome manipulation, application of hormones, or some combination of both (Donaldson 1986). Criteria that we considered important in the selection of a technique included (1) the ability to produce sterility in all individuals in a population; (2) the ability to produce sterility with relative ease at low cost; and (3) the ability to eliminate "false spawning" in adult fish. "False spawning" is defined as the attempted mating by one sterile and one fertile fish. The outcome would be no progeny from the fertile individual. Based on a literature review, we decided that treatment with the synthetic hormone 17α-methyltestosterone (MT) offered the best chance of meeting our criteria.

During January 1988, rainbow trout at Roaring River Hatchery were treated with MT. At 3 and 10 days after hatching, about 10,000 alevins were immersed for 2 hours in 35 liters of solution that contained 400 ug MT per liter 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 liter 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 per 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

Nine rainbow trout were captured in the trap at Page Springs Dam, and all were tagged then released upstream from the trap. One of those tagged fish was caught by an angler about 3 km above Page Springs Dam. Fifty-four rainbow trout were captured in the trap at Grain Camp Dam, and 48 of those were tagged then released upstream from the trap. The difference between the total number trapped and the total number tagged (6) includes 4 mortalities, 1 fish that escaped before it was tagged, and 1 fish that was too small to tag. Two fish tagged at Grain Camp Dam were recaptured there and excluded from the total. Seven other rainbow trout tagged at Grain Camp Dam were caught by anglers between Grain Camp and Page Springs dams. No fish tagged at Grain Camp Dam were recaptured in or caught upstream from the trap at Page Springs Dam. No rainbow trout were captured at Sod House Dam, indicating that none migrated upstream from Malheur Lake during April, May, and June. Upstream movement of rainbow trout in the lower Donner und Blitzen River, as measured by fish captured in traps listed above, occurred primarily during mid-April, mid-May and mid-June. Because of reduced stream flow and lack of fish, all three traps were removed during the first week of July. Therefore, we can only speculate about the presence or absence of trout movement during other periods of the year.

Fifteen juvenile rainbow trout were captured during the entire period of operation (340 hours) of the downstream trap in the east diversion canal during April, May, and June 1988. Although some downstream movement occurred, insufficient information was obtained to satisfy Objective 2. During April and the first 2 weeks of May, water flow fluctuated greatly within 24-hour periods and between days because of snow melt and rainfall in the upper Donner und Blitzen River basin. The trap was unable to effectively capture juvenile fish under those conditions. At low flow, the inclined screen was dewatered. At high flow, water flooded the screen or separated the flexible hose from the holding box. Consequently, we can conclude little about downstream movement of juvenile rainbow trout in the lower Donner und Blitzen River.

Recommendations to Malheur National Wildlife Refuge personnel included installation of structures adequate to enable thorough evaluation of downstream movement of juvenile trout.

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

The trap at Link River Dam operated 2,835 hours during the reporting period and captured a total of 3 rainbow trout, 1 each on 27 May, 17 June, and 23 June. We occasionally electrofished the main river channel adjacent and downstream from Link River Dam and water at the mouth of the fish ladder, but found no rainbow trout. However, two salvage operations in the Eastside Canal between Link River Dam and powerhouse and in the penstock overflow produced 35 rainbow trout; all were tagged and released. These data indicate minimal upstream passage of rainbow trout from Klamath River into Upper Klamath Lake from February through September 1988. Possibly, the life history of upper Klamath River rainbow trout does not include migration into Upper Klamath
Lake, or that migration may occur at times not covered during this report period. Alternatively, passage may be restricted by the design of the fish ladder or conditions created by low river flow at the site of the old Klamath River Falls below Link River Dam.

The trap at Keno Dam operated a total of 2,609 hours and captured 31 rainbow trout during the reporting period. Of that total, 9 were captured during March, 12 were captured during April, 7 were captured during June, and 3 were captured July. The trap at J.C. Boyle Dam operated a total of 2,975 hours and captured 233 rainbow trout during the reporting period (Table 1). That total represents only 7% of the estimated passage over J.C. Boyle Dam in 1959 (Hanel and Gerlach 1964).

We plan to monitor upstream passage at the dams in 1989 and 1990 to determine annual and seasonal variation. Origin of the rainbow trout captured in the three traps on the upper Klamath River in FY 1988 is unknown at this time.

Table 1. Expanded estimates of upstream passage of rainbow trout at J.C. Boyle Dam, 1959 (Hanel and Gerlach 1964) and 1988.

<table>
<thead>
<tr>
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<td>January</td>
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<tr>
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<td>2,371</td>
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</table>

<sup>a</sup> Estimates were made for the second half of the month only.

Objective 4. Collect Rainbow Trout for Morphological and Biochemical Analysis

In Harney basin, samples of rainbow trout were collected from Black Canyon, Cottonwood, and Dinner creeks and the Little Donner und Blitzen River. In Upper Klamath basin, samples of rainbow trout were collected from Brownsworth, Buckboard, Coyote, Deming, Leonard, Long, Pothole, Spring, and Whitworth creeks. Analysis of biochemical and morphological characteristics of these samples is planned for the next fiscal year.
Objective 5. Generate Homologous and Heterologous Populations of Rainbow Trout

Significant differences in the mean ($P \leq 0.01$) and variance ($P \leq 0.01$) of hatching times occurred between progeny of matings between Spring Creek females with Spring Creek males and Spring Creek females with Deming Creek males. Progeny of Deming Creek males hatched after incubation for about 300 temperature units, measured in $^\circ$C, whereas progeny of Spring Creek males hatched after incubation for about 310 temperature units. These first-year results provide evidence of paternal difference in the genetic control of hatching time. Although such genetic differences have not previously been reported, they should be expected. McIntyre and Blanc (1973) found significant additive variation for rainbow trout eggs incubated in troughs. Additive genetic variation in rainbow trout hatching in natural environments could be altered by natural selection or the stochastic effects of small population size. Our results suggest that differences between rainbow trout from the two locations may also exist for other quantitative traits.

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

No mortality from ceratomyxosis occurred in Cape Cod rainbow trout that comprised Lot 1 exposed in the lower Donner und Blitzen River or near the mouth of that river in Malheur Lake. After 10 June, all rainbow trout at both sites held for extended exposure (Lot 2) died. We suspect the deaths were associated with poor water quality caused by low stream flow and high water temperature ($20^\circ$-$23^\circ$C).

Within the Upper Klamath basin, Cape Cod rainbow trout exposed at both locations in the Williamson River and in Agency Lake suffered high mortality from ceratomyxosis (Table 2). These results extend the known range of $C. \text{shasta}$. Prior to this experiment, Upper Klamath basin waters known to contain the infective stage of $C. \text{shasta}$ were limited to the Klamath River and Upper Klamath Lake (Johnson et al. 1979).

Based on those results, the lower site on the Williamson River (RK 3.2) was chosen for exposure of native trout groups. In September 1988, we electrofished to obtain samples of juvenile native rainbow trout from Cold, Deming, Johnson, Jenny, Spencer, and Spring creeks, and the Klamath River (RK 360) in the Upper Klamath basin. Those samples were placed in live-boxes located at RK 3.2 on the Williamson River for exposure to the infective stage of $C. \text{shasta}$. A group of Cape Cod rainbow trout from Klamath Hatchery was also exposed there as a control. Groups of Cape Cod rainbow trout were also placed in live-boxes located in most streams from which native trout samples were collected (Table 3), thereby providing verification of results with native trout. Trout in the live-boxes were maintained as previously described. Again, water temperature at all exposure sites varied diurnally, but exceeded the lower threshold at which $C. \text{shasta}$ becomes infective. Groups of fish were transferred to Corvallis for further rearing on 30 September or later. Results of that work will be presented in a subsequent report.
Table 2. Incidence of mortality among juvenile Cape Cod rainbow trout exposed to *Ceratomyxa shasta* in Harney and Upper Klamath basins during summer 1988.

<table>
<thead>
<tr>
<th>Exposure site and lot number</th>
<th>Number exposed</th>
<th>Number that died during exposure</th>
<th>Number transferred and reared</th>
<th>Number that died during rearing</th>
<th>Number of rearing mortalities with spores of <em>C. shasta</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harney Basin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donner und Blitzen River:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>60</td>
<td>3</td>
<td>57</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Lot 2</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Malheur Lake:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>60</td>
<td>2</td>
<td>58</td>
<td>44(^a)</td>
<td>0</td>
</tr>
<tr>
<td>Lot 2</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Upper Klamath Basin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Williamson River (RK 3.2):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>59</td>
<td>0</td>
<td>59</td>
<td>59</td>
<td>55</td>
</tr>
<tr>
<td>Lot 2</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
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<td>Williamson River (RK 19):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>65</td>
<td>0</td>
<td>65</td>
<td>65</td>
<td>64</td>
</tr>
<tr>
<td>Lot 2</td>
<td>55</td>
<td>13</td>
<td>42</td>
<td>42</td>
<td>41</td>
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<tr>
<td>Agency Lake:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>61</td>
<td>0</td>
<td>61</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Lot 2</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Modoc Point:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>55</td>
<td>38</td>
<td>17</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Lot 2</td>
<td>55</td>
<td>55</td>
<td>5</td>
<td>--</td>
<td>--</td>
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<tr>
<td>Pelican Marina:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>60</td>
<td>6</td>
<td>54</td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>Lot 2</td>
<td>60</td>
<td>14</td>
<td>46</td>
<td>46(^c)</td>
<td>6</td>
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<tr>
<td>Klamath River (RK 362):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot 1</td>
<td>60</td>
<td>15</td>
<td>45</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>Lot 2</td>
<td>60</td>
<td>23</td>
<td>37</td>
<td>32</td>
<td>2</td>
</tr>
</tbody>
</table>

\(^a\) Plugged effluent screen caused suffocation of 44 fish midway through rearing.

\(^b\) High winds caused waves to wash live-box onto shore.

\(^c\) Water failure during rearing killed all fish midway through rearing.
Table 3. Sites in the Upper Klamath basin where Klamath Hatchery rainbow trout were exposed to possible infection by Ceratomyxa shasta.

<table>
<thead>
<tr>
<th>Water body</th>
<th>River kilometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campbell Reservoir</td>
<td>--</td>
</tr>
<tr>
<td>Williamson River (3 sites)</td>
<td>3.2, 19, 74</td>
</tr>
<tr>
<td>Klamath Lake at Modoc Point</td>
<td>--</td>
</tr>
<tr>
<td>Wood River</td>
<td>14.5</td>
</tr>
<tr>
<td>Fort Creek</td>
<td>1.6</td>
</tr>
<tr>
<td>Klamath River (2 sites)</td>
<td>362, 370</td>
</tr>
<tr>
<td>Spencer Creek</td>
<td>1.6</td>
</tr>
<tr>
<td>Jenny Creek</td>
<td>31</td>
</tr>
</tbody>
</table>

Objective 7. Attempt to Sterilize Hatchery Rainbow Trout

MT-treated and untreated rainbow trout were identified with differential fin clips and stocked in several Cascade Mountain lakes during June 1988 at an average size of 2.5 g (Table 4). Those fish will be monitored for growth and longevity. Final evaluation will be based on the percentage of sterile individuals at the normal time of maturity. Samples of MT-treated trout will remain at Roaring River Hatchery for such evaluation.

Table 4. Number of juvenile rainbow trout either treated with 17 @-methyltestosterone (MT) or untreated and released in Cascade Mountain lakes during 1988.

<table>
<thead>
<tr>
<th>Lake</th>
<th>Treated</th>
<th>Untreated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Blair</td>
<td>3,500</td>
<td>0</td>
</tr>
<tr>
<td>Bradley</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Bug</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Fay</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Lizard</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Rae</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Warner</td>
<td>265</td>
<td>265</td>
</tr>
</tbody>
</table>

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REFERENCES


