THE OREGON PLAN *for Salmon and Watersheds*

Klamath Mountains Province Steelhead Project, 1999 Annual Report

Report Number: OPSW-ODFW-2002-09

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Monitoring Report No. OPSW-ODFW-2002-09

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SUMMARY

Objectives for 1999

Project objectives were: (1) develop population health goals and allied monitoring methods for wild steelhead populations in the Klamath Mountains Province, and (2) initiate sampling to determine the status of wild steelhead in relation to population health goals.

Accomplishments in 1999

Both objectives were accomplished.

Findings in 1999

Sampling was initiated to evaluate steelhead status in relation to five of six population health goals. The goal for fish distribution was met, but the goal for life history composition was not met. Goals for fish habitat, juvenile fish densities, and numbers of returning adults were partially met.

INTRODUCTION

The steelhead supplement to the Oregon Plan for Salmon and Watersheds (OSPW) is intended to maintain wild steelhead populations in Oregon at sustainable and productive levels that provide substantial environmental, cultural, and economic benefits. The OSPW attempts to better define “sustainable and productive” by committing the Oregon Department of Fish and Wildlife (ODFW) to establish “Population Health Goals” for each Evolutionary Significant Unit (ESU) of wild steelhead within the state. In addition, section ODFW IB1S of the plan calls for ODFW to assess adult escapement and juvenile production of wild steelhead in each ESU.

The National Marine Fisheries Service identified seven ESUs for steelhead in Oregon and concluded that steelhead produced in coastal basins between Cape Blanco in southern Oregon and the Klamath River Basin in northern California constitutes one ESU. This area closely corresponds to the geologic boundaries of the Klamath Mountains Province (KMP). Steelhead in the KMP differ from those in adjoining areas because of distinctive life history and genetic characteristics (Busby et al. 1994).

Primary differences in life history parameters have been identified for wild KMP steelhead. Summer steelhead and winter steelhead differ in time of return as adults, tendency to return to fresh water on a false spawning migration (the “half-pounder” run), age at ocean entry, growth rate and migration patterns of juveniles in fresh water (ODFW 1990a; ODFW 1994). As a result of these differences, separate health goals seem warranted for summer and winter steelhead populations. Winter steelhead inhabit streams throughout the KMP, while summer steelhead are found only in a portion of the Rogue River Basin. However, the distribution of summer and winter steelhead overlap in major areas of the Rogue River Basin (Everest 1973) and as juveniles of the respective races cannot be differentiated, some population health goals will have to apply to both races.

The status of wild steelhead in the Klamath Mountains Province ESU is not readily apparent. Busby et al. (1994) concluded that the steelhead in this ESU "is not now at risk of extinction, but if present trends continue, it is likely to become so in the foreseeable future". In contrast, Chilcote (1998) concluded that almost all steelhead populations in the Oregon portion of the ESU "are relatively healthy and certainly do not warrant listing as threatened under the ESA". Uncertainty as to the status of the resource, coupled with the comprehensive conservation plan developed by Oregon and the termination of wild fish harvest in all streams except the Rogue River, lead the National Marine Fisheries Service to defer a listing of KMP steelhead under the Endangered Species Act. However, KMP steelhead remained a candidate species during 1999.

The goal of this project is to develop and implement assessment methods to determine the status of wild steelhead in the Oregon portion of the KMP. Project objectives include (1) develop population health goals and allied monitoring methods and (2) determine resource status in relation to health goals. Attainment of all of the population health goals will likely indicate that the populations of wild steelhead in the KMP are healthy and may allow managers to restore harvest opportunities for wild fish. Conversely, failure to attain any of the population health goals will likely indicate that the populations are depressed and would likely lead to actions designed to minimize fishing mortality. However, in most years it is likely that some goals will be attained while some will not be attained. Under that scenario, and depending on which goals are attained, selective fisheries, like the current one for wild winter steelhead in the Rogue River, remain as viable options for fishery managers.

METHODS

Develop Population Health Goals and Allied Monitoring

A number of measures could be used to describe the status, or health, of animal populations. Currently, ODFW has no standardized methods by which to characterize the health of salmonid fish populations. A myriad of measures were considered as alternative goals. Alternatives were rejected unless judged to be an appropriate and practical means by which to determine if wild steelhead populations attain sustainable and productive levels as called for in the OPSW.

Background data for steelhead populations in the KMP, or from technical reports in fishery science journals, were compiled and analyzed (Satterthwaite 2002). These data made it possible to develop quantitative goals that could be annually compared with estimates developed from commonly accepted sampling methods. Revisions to the adopted goals are likely as additional information, assessment criteria, or monitoring technology, becomes available.

Determine Resource Status in Relation to Population Health Goals

Sampling sites for habitat characteristics, rearing densities of juvenile fish, and fish distribution were selected with the Environmental Monitoring and Assessment Program (EMAP) developed by the Environmental Protection Agency (Stevens and Olsen 1999). EMAP selects sample sites at random within each template by laying a grid of templates over a digital map of the resource to be surveyed. Portions of KMP streams were excluded from the site selection process.

Potential sampling sites included first, second, and third order streams embedded in a hydography layer developed by the United States Geological Survey on a 1:100,000 scale. Sites drawn to characterize habitat features excluded those stream segments in areas upstream of large dams that block the passage of anadromous fish. Sites drawn to estimate the rearing densities and distribution of juvenile steelhead included only those stream segments that are within the known or suspected spawning distribution of anadromous fish. For sampling directed at juvenile steelhead, separate sample draws were made for sites in the Rogue River Basin and for sites in other coastal basins in the Oregon portion of the KMP. An estimate of steelhead distribution and abundance in non-Rogue streams was identified as a primary need by ODFW fishery managers.

Habitat Characteristics (Goal 1)

Habitat conditions at randomly selected sampling sites were estimated using standardized survey procedures described by Thom et al. (1999) and Jones and Moore (1999). All habitat units were surveyed within a 0.5 km length of the first order streams and within a 1.0 km length of second and third order streams. Within these chosen stream lengths, survey data are obtained from 20-40 habitat units. Surveys were conducted by ODFW’s Aquatic Inventories Project.

Rearing Densities of Juveniles (Goal 2)

Sampling crews used portable Global Positioning System units and topographical maps to sample as close as possible to EMAP site locations. At each site, sampling crews attempted to estimate fish numbers in four slow-water habitat units (hereafter termed pools) and four fast-water habitat units (hereafter termed riffles). Most sites were sampled only with backpack electrofishers. A few pools were sampled only with snorkeling gear, or were sampled using both techniques. No riffles were snorkeled.

Upon reaching each site, sampling crews judged whether habitat units could be effectively sampled with electrofishers. When pools were too large or complex, one sampler snorkeled each pool and attempted to count all of the age $\geq$ 1+ trout. Species composition of age ≥ 1+ trout electrofished in the other habitat units at the same site was used to apportion underwater counts of age ≥ 1+ trout to the appropriate species. Snorkelers did not attempt to count age 0+ trout.

Trout numbers at all other sites were estimated using either a removal method (Seber and LeCren 1967) or a mark-recapture method (Chapman 1951). Sampling crews used the removal method at most of the electrofishing sites. Sampling in the upstream direction and then in the downstream direction usually constituted an electrofishing pass of standardized effort. Subsequent passes were made in a manner similar to the initial pass. Passes continued until there was at least a 50% reduction in the numbers of age 0+ trout and age ≥ 1+ steelhead. When the 50% reduction criterion was not attained on the second pass, samplers made two additional passes. In these instances, samplers combined catches from the first and second pass, and combined catches from the third and fourth pass. This procedure always resulted in meeting the 50% reduction criteria.

At the few pools where fish numbers were estimated with the mark-recapture method, trout captured on the first electrofishing pass were marked by removing the tip of the upper lobe of the caudal fin. Marked fish were held for five minutes before being released back into the pool. Marked fish that appeared to be stressed were not released back into the pool. Samplers waited about one hour and then electrofished the pool until a minimum of 25% of the marked fish were recaptured.

Before the start of electrofishing, sampling crews installed blocknets with 1/8 inch or 1/4 inch mesh at the upstream and downstream ends of each habitat unit. Successive habitat units were sampled as much as possible. Captured fish were identified to the lowest possible taxon. Samplers did not attempt to visually differentiate age 0+ steelhead from age 0+ cutthroat trout.

At those sites where no age ≥ 1+ steelhead were captured, samplers surveyed downstream to search for natural or artificial barriers. I excluded data from those sites where barriers blocked adult steelhead from reaching the sampling site.

I estimated the density of juvenile trout as the number of fish divided by the surface area of the wetted channel within a habitat unit. The sampling crew picked location that appeared to typify the mean length and mean width of the unit, and measured those distances to the nearest 0.1 meter. Other habitat variables estimated within each unit included maximum depth, substrate composition, numbers of boulders, and numbers of large pieces of wood.

Fish Distribution (Goal 3)

Data from sampling sites for fish densities (Goal 2) was also used to characterize the distribution of juvenile steelhead. Sampling crews recorded steelhead as present or absent at each site, with one exception. Sites with age 0+ trout, but without age ≥ 1+ steelhead, were excluded from the sample because the age 0+ trout may have been juvenile steelhead. I also excluded data from those sites where sampling crews found either natural or artificial barriers that blocked adult steelhead from reaching the sampling site. I used the data to estimate the proportion of sites inhabited by juvenile steelhead. The 95% confidence interval was estimated following procedures described by Zar (1984).

Production Rates of Fry (Goal 4)

Sampling associated with this population health goal is scheduled to begin in 2000.

Adult Abundance (Goal 5)

Freshwater returns of late-run adult summer steelhead to the Rogue River are estimated from catches with beach seines set at Huntley Park. ODFW (1990b) and ODFW (1994) provide detailed descriptions of the estimation methods. ODFW also estimates the number of steelhead that pass an underwater counting station on the Rogue River at Gold Ray Dam. Steelhead passing the counting station from 16 May to 31 December are classified as summer steelhead, while those passing from 1 January to 15 May are classified as winter steelhead. Steelhead with fin clips are classified as hatchery fish.

Life History (Goal 6)

A scale analyst classified the life histories of wild late-run adult summer steelhead captured in the Rogue River at Huntley Park. Samplers collected scales from wild steelhead longer than 41 cm. This length represents a reliable method by which to differentiate immature half-pounders from adult steelhead (Everest 1973). Scale samples were read at a magnification factor of 88. Regenerated scales and scales obtained from fish classified as large half-pounders were excluded from analysis. I used the data to estimate the proportion of wild late-run adult summer steelhead that exhibited half-pounder life histories. The 95% confidence interval was estimated following procedures described by Zar (1984).

RESULTS AND DISCUSSION

Develop Population Health Goals and Allied Monitoring

Six population health goals were developed for KMP steelhead (Satterthwaite 2002), and were subsequently adopted by ODFW. These goals encompass some of the key elements associated with steelhead life history including quality and quantity of habitat (Goal 1), rearing densities of juvenile fish (Goal 2), distribution of juvenile fish (Goal 3), production rates of juvenile fish in nursery streams (Goal 4), abundance of adult fish (Goal 5), and life history diversity (Goal 6).

Goals one through three apply to steelhead throughout the KMP. Goals four through six apply primarily to summer steelhead for two reasons. First, fishery management agencies are more concerned about the status of wild summer steelhead as compared to wild winter steelhead, at least in the KMP. Second, more biological data is available for summer steelhead as compared to winter steelhead. Satterthwaite (2002) presented the details relating to goal development, so only a list of adopted goals follow:

Goal 1: Characteristics of fresh water habitat in areas accessible to steelhead should become more similar to ODFW benchmarks of habitat quality established for streams in western Oregon.

Goal 2: During late summer and autumn, the mean density of trout fry should be at least 0.50 fish/m^2 and the mean density of age ≥ 1+ steelhead should be at least 0.10 fish/m^2 (0.05 fish/m^2 in riffles).

Goal 3: Juvenile steelhead should be present in at least 80% of sites accessible to spawners, or the percentage of sites inhabited by juvenile steelhead should increase through time.

Goal 4: Mean production rates in intermittent streams used by spawning summer steelhead should be a minimum of 7,000 trout fry per kilometer.

Goal 5: Annual returns to Gold Ray Dam should be a minimum of 4,000 wild summer steelhead and 4,000 wild winter steelhead, while annual returns to the Rogue River should be a minimum of 10,000 wild late-run adult summer steelhead.

Goal 6: Fish with half-pounder life histories should compose at least 95% of the late-run adult summer steelhead in the Rogue River.

Determine Resource Status in Relation to Population Health Goals

Habitat Characteristics (Goal 1)

Surveys of each habitat unit produced estimates for about 50 parameters associated with aquatic and riparian habitat. Parameters initially chosen to represent key indicators of the quality and quantity of habitat for KMP steelhead are listed in Table 1. Habitat goals were met in 1998 and in 1999 for some habitat parameters, but not for others (Table 1).

Relative to other coastal streams in Oregon, KMP streams can be characterized as having a high density of streamside conifers, good streamside shading, and adequate spawning gravel of appropriate quality for spawning salmonids. However, KMP streams appear to be lacking in pool area and instream wood (Barry Thom, ODFW, personal communication). The relative paucity of pools may be limiting steelhead production because the densities of age ≥ 1+ steelhead are greater in pool habitat as compared to riffle habitat (see Rearing Densities of Juveniles (Goal 2).

Table 1. Summary statistics associated with selected habitat parameters estimated at randomly selected sites in the South Coast Gene Conservation Area, 1998 and 1999. Sample sizes were 43 in 1998 and 47 in 1999, unless otherwise noted. Data was received from Barry Thom, Aquatic Inventories Project, ODFW, Corvallis.

			Quartiles					
	ODFW	Mean(SD)	25th		50th		75th	
Habitat parameter	Goal	1999	1998	1999	1998	1999	1998	1999
% pool habitat	>35	19(12)	--	9	--	17	--	25
Deep pools/km	--	2.4(2.9)	0	0	0	1.5	3.5	3.5
Wood pieces/0.1 km	>20	13(10)	4	5	9	11	14	20
% shade	>70	81(18)	70	75	84	85	94	94
Conifers/0.33 km	--	70(106)	0	0	20	40	105	90
% fines in riffles[a]	<10	18(17)	6	5	13	10	25	24
% gravel in riffles[a]	≥35	42(15)	20	31	38	40	45	55

[a] Sample sizes were 28 in 1998 and 37 in 1999.

Rearing Densities of Juveniles (Goal 2)

Survey crews completed density sampling for juvenile trout at 45 of the 57 EMAP sites in the Rogue River Basin and at 48 of the 65 EMAP sites in other coastal basins. A total of 29 sites were not sampled for various reasons (Appendix Table 1). In addition, I did not estimate numbers of age 0+ trout resident in pools at three sites because I judged that those pools were too large, or were too complex, to accurately estimate numbers of small trout.

Cutthroat trout inhabited numerous sites. Cutthroat trout composed 14% (106/745) of the age ≥ 1+ trout captured in the Rogue River basin and composed 17% (178/1,059) of the age ≥ 1+ trout captured in other coastal basins. The predominance of steelhead among older trout suggested that juvenile steelhead predominated the catches of age 0+ trout.

I assumed that all age ≥ 1+ *O. mykiss* captured during the density surveys were juvenile steelhead. Length data appeared to support the assumption that few, if any, resident rainbow trout inhabited any of the sampling sites. Samplers captured only six *O. mykiss* that were longer than 25 cm in fork length (Table 2). Electrofishing catches of *O. mykiss* were dominated by fish in the 10-15 cm length interval. The length distributions of *O. mykiss* appear to be appropriate for juvenile steelhead prior to the formation of the second or third freshwater annulus on their scales (ODFW 1990a, ODFW 1994).

Results indicated that densities of juvenile trout varied greatly among sampling sites. Density estimates of age 0+ trout ranged between 0 and 3.6 fish/m^2 (Appendix Tables 2 and 3), while density estimates of age ≥ 1+ steelhead ranged between 0 and 0.28 fish/m^2 (Appendix Tables 2 and 3).

Table 2. Length frequency distributions of age ≥ 1+ trout captured at EMAP sites sampled in the Klamath Mountains Province, 1999.

		Fork length interval (cm)						
Basin	Species	<10	10-15	15-20	20-25	25-30	30-35	35-40
Rogue	*O. mykiss*	67	327	126	20	3	1	1
Other	*O. mykiss*	173	446	113	6	1	0	0
Rogue	*O. clarki*	23	60	17	0	0	0	0
Other	*O. clarki*	5	92	46	20	3	1	0

Rearing densities of age 0+ trout and age ≥ 1+ steelhead in the Rogue River Basin and in the coastal basins exhibited non-normal distributions. Age 0+ trout reared in most pools and in most riffles at densities of less than 1.0 fish/m^2 (Figure 1). However, age 0+ trout reared in a few pools at densities of 1-4 fish/m^2, and also reared in a few riffles at densities of about 1-3 fish/m^2 (Figure 1).

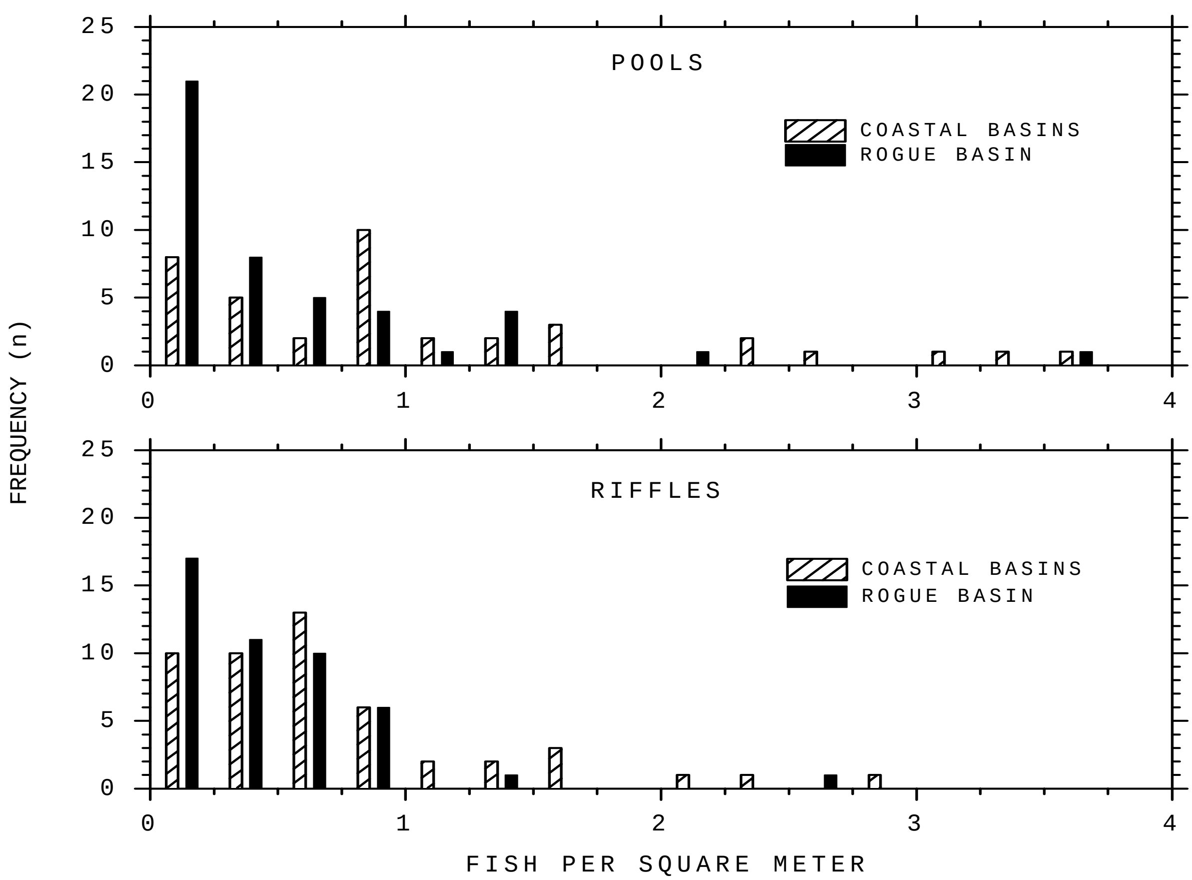

Figure 1. Estimated densities of age 0+ trout in KMP streams, 1999.

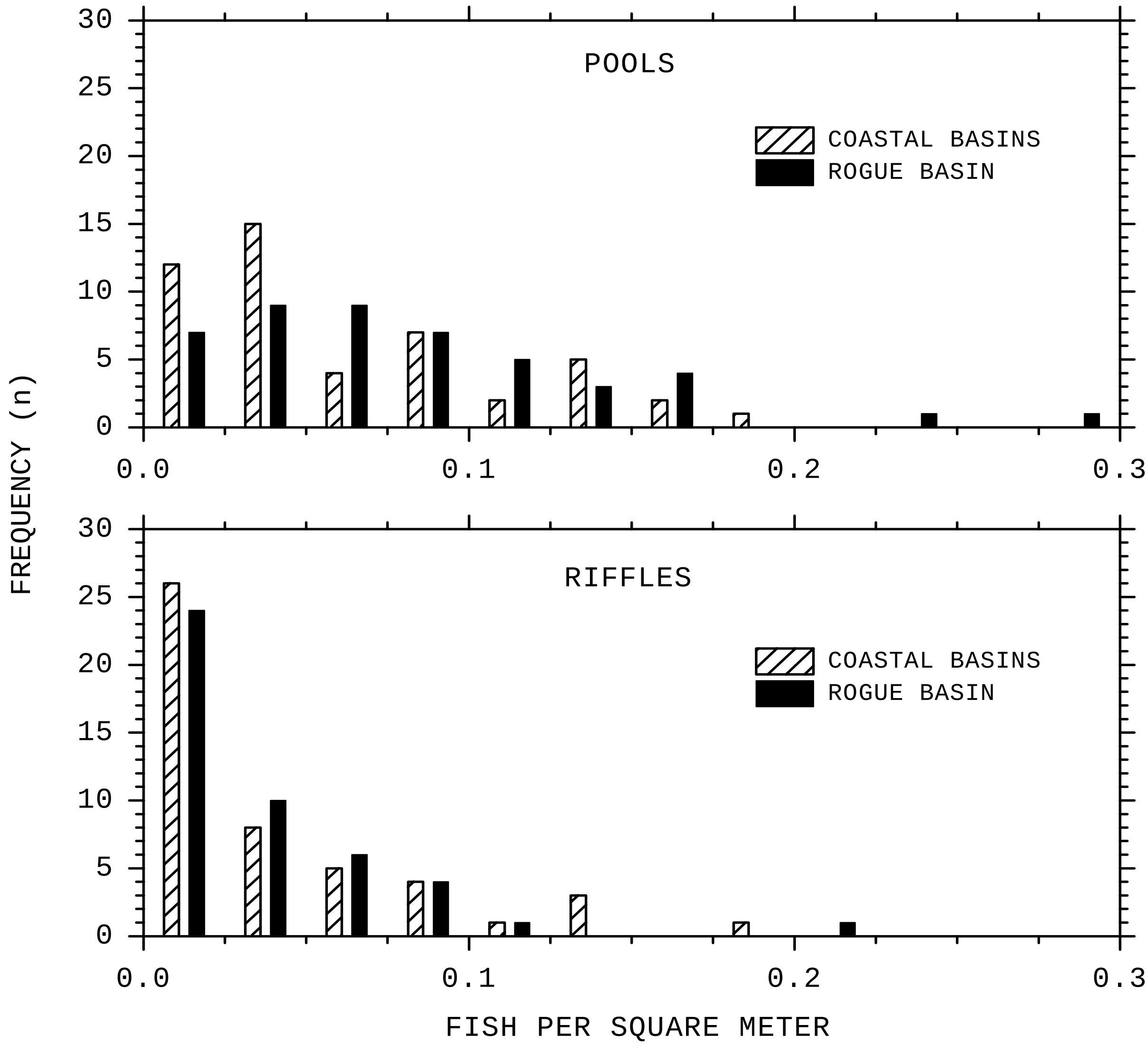

Figure 2. Estimated densities of age ≥ 1+ steelhead in KMP streams, 1999.

Similarly, age ≥ 1+ steelhead reared in most pools and in most riffles at densities of less than 0.1 fish/m^2, and reared in a few pools and riffles at densities of 0.1-0.3 fish/m^2 (Figure 2). Various types of data transformations failed to produce data arrays that could be appropriately analyzed with parametric statistics.

Mean densities of age 0+ trout averaged more than 0.50 fish/m^2 in pools of the Rogue River Basin, and in pools and riffles of the coastal basins (Table 3). However, the mean density of age 0+ averaged 0.48 fish/m^2 in riffles of the Rogue River Basin (Table 3). These results indicate that the population health goal of 0.50 fish/m^2 was reached for subyearling trout in the KMP during 1999.

In contrast, density goals for age ≥ 1+ steelhead were not attained in the KMP during 1999. Mean densities averaged less than 0.10 fish/m^2 in pools and averaged less than 0.05 fish/m^2 in riffles

Table 3. Summary statistics associated with the estimated densities (fish/m^2) of age 0+ trout resident in streams of the Klamath Mountains Province, 1999.

Basin	Habitat type	N	Median	Quartiles 25%	Quartiles 75%	Mean	SD	*P* for normality
Rogue	pool	44	0.36	0.15	0.71	0.55	0.667	<0.001
Other	pool	46	0.66	0.46	1.13	0.96	0.873	<0.001
Rogue	riffle	45	0.38	0.20	0.58	0.48	0.444	0.002
Other	riffle	48	0.62	0.32	0.98	0.75	0.624	0.001

(Table 4). As with age 0+ trout, the density estimates of age ≥ 1+ steelhead exhibited distributions that differed significantly from normal (Table 4).

I considered the possibility that stream size could have biased estimates of trout densities and the distribution of those estimates. Juvenile steelhead will migrate from small streams in late spring and early summer to rear in larger streams (Everest 1973). In addition, densities of juvenile steelhead can increase with distance downstream within streams (Roper et al. 1994). As we sampled only first to third order streams, and as because we were unable to sample some of the larger third order streams, the density estimates could have been biased towards smaller streams. Too assess this possibility, I included stream order in our analyses of trout densities.

Table 4. Summary statistics for the estimated densities (fish/m^2) of age ≥ 1+ steelhead resident in streams of the Klamath Mountains Province, 1999.

Basin	Habitat type	N	Median	Quartiles 25%	Quartiles 75%	Mean	SD	*P* for normality
Rogue	pool	45	0.071	0.046	0.116	0.083	0.059	0.092
Other	pool	48	0.046	0.025	0.092	0.061	0.047	<0.001
Rogue	riffle	45	0.024	0.000	0.055	0.034	0.041	<0.001
Other	riffle	48	0.018	0.007	0.058	0.039	0.044	<0.001

I found that densities of age 0+ trout differed significantly between sampling sites in the Rogue River Basin and sampling sites in other coastal basins (Table 5). A Student-Newman-Keuls test indicated that densities of age 0+ trout were significantly greater in coastal basin streams as compared to streams of the Rogue River Basin. In contrast, densities of age 0+ trout did not differ significantly between different types of habitat (pools versus riffles) and did not differ significantly among first, second, or third order streams (Table 5). In addition, I was unable to detect any significant interactions among basin type, habitat type, and stream order (Table 5).

Table 5. Three-way analysis of variance on ranks of densities of age 0+ trout in KMP streams during 1999.

Source of variation	DF	Sum of squares	Mean square	F	*P* for difference
Basin	1	35,397	35,397	12.89	<0.001
Habitat	1	867	867	0.32	0.575
Stream order	2	5,238	2,619	0.95	0.387
Basin x habitat	1	1,008	1,008	0.37	0.545
Basin x order	2	8,300	4,150	1.51	0.224
Habitat x order	2	210	105	0.04	0.962
Basin x habitat x order	2	136	68	0.02	0.967
Residual	173	475,137	2,746		

For age ≥ 1+ steelhead, I found that densities differed significantly between pool habitat and riffle habitat (Table 6). A Student-Newman-Keuls test indicated that densities of age ≥ 1+ steelhead were significantly greater in pools as compared to riffles. In contrast to findings for age 0+ trout, I was unable to detect any significant difference in the density of age ≥ 1+ steelhead in the Rogue River Basin as compared to the coastal basins (Table 6). In addition, age ≥ 1+ steelhead densities did not differ significantly among streams of different orders (Table 6). However, I detected significant interactions between basin type and habitat type, and between habitat type and stream order (Table 6).

Table 6. Three-way analysis of variance on ranks of densities of age ≥ 1+ steelhead in KMP streams during 1999.

Source of variation	DF	Sum of squares	Mean square	F	*P* for difference
Basin	1	1,156	1,156	0.47	0.358
Habitat	1	73,896	73,896	30.03	<0.001
Stream order	2	5,683	2,841	1.16	0.320
Basin x habitat	1	11,301	11,301	4.59	0.041
Basin x order	2	2,893	1,446	0.59	0.740
Habitat x order	2	17,657	8,229	3.59	0.025
Basin x habitat x order	2	1,398	699	0.28	0.467
Residual	176	433,034	2,460		

Pronounced differences in the densities of age ≥ 1+ steelhead resident in riffle habitat of coastal streams may have accounted for the interactive effects noted in the previous analysis. Median densities in riffles were 0.011 fish/m^2 in first order streams, 0.018 fish/m^2 in second order streams, and 0.069 fish/m^2 in first order streams. Medians differed significantly at $P = 0.048$ (Kruskal-Wallis H = 5.70). This finding indicates that estimates of the mean, or median, densities of age $\geq$ 1+ steelhead in the KMP may be affected if larger streams cannot be sampled at the same rates as smaller streams.

Fish Distribution (Goal 3)

Juvenile steelhead inhabited 46 of 48 (96%) EMAP sites judged to be accessible to adult steelhead in the Rogue River Basin (Appendix Tables 1 and 3). The associated 95% confidence interval was 86%-99%. A natural barrier blocked adult steelhead from reaching one site that was randomly selected through EMAP. Artificial barriers were found downstream of three sites (Appendix Table 1).

Juvenile steelhead inhabited all of the 47 (100%) EMAP sites judged to be accessible to adult steelhead in coastal basins (Appendix Tables 1 and 2). I excluded one site from the analysis because subyearling trout were the only age class in residence. Natural barriers blocked adult steelhead from reaching six other sites that were randomly selected through EMAP. No artificial barriers were encountered (Appendix Table 1).

These findings indicated that steelhead were widely distributed and inhabited almost all areas accessible to adult spawners in the KMP. Thus, the population health goal of at least 80% habitation of rearing sites by juvenile steelhead was attained in 1999.

Production Rates of Fry (Goal 4)

Sampling associated with this goal is scheduled to begin in 2000.

Adult Abundance (Goal 5)

ODFW estimated that 11,471 wild late-run summer steelhead passed the sampling site at Huntley Park in 1999. This estimate represented 115% of the 10,000 fish goal at river entry. In addition, ODFW estimated that 1,938 wild summer steelhead passed the counting station at Gold Ray Dam during 1999. This return represented only 48% of the 4,000 fish goal for this location in the upper portion of the Rogue River.

Estimates derived from both sampling sites indicate that returns of summer steelhead were relatively low in the 1990s as compared to the 1970s and 1980s (Figures 3 and 4). Returns in the 1990s appeared to be roughly comparable to returns in the 1950s (Figures 3 and 4). Such low returns do not necessarily indicate declining freshwater production because variations in ocean survival rates complicate the interpretation of trend analyses for numbers of adult salmonids (Beamish et al. 1999; Smith and Ward 1999).

In the case of summer steelhead of Rogue River origin, ODFW (1994) noted that survival rates of juvenile steelhead released from Cole M. Rivers Hatchery sharply decreased in the late 1980s. Survival rates between the smolt and half-pounder life history stages averaged 15% for juveniles released in 1976-87 and averaged 5% for juveniles

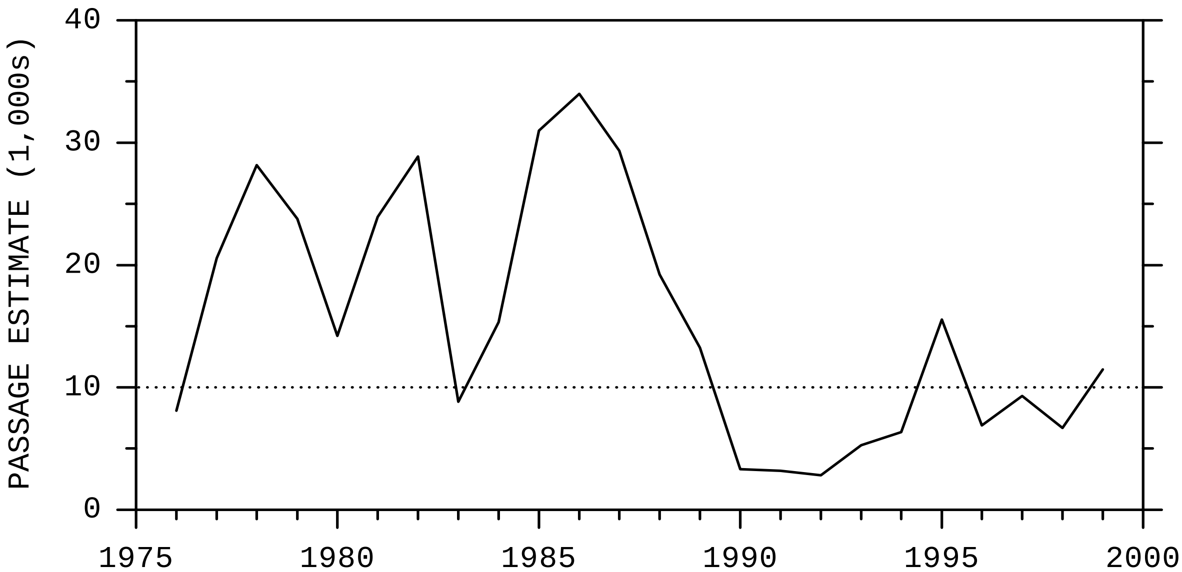

Figure 3. Estimated freshwater return of wild late-run adult summer steelhead in the Rogue River. Dotted line represents the population health goal.

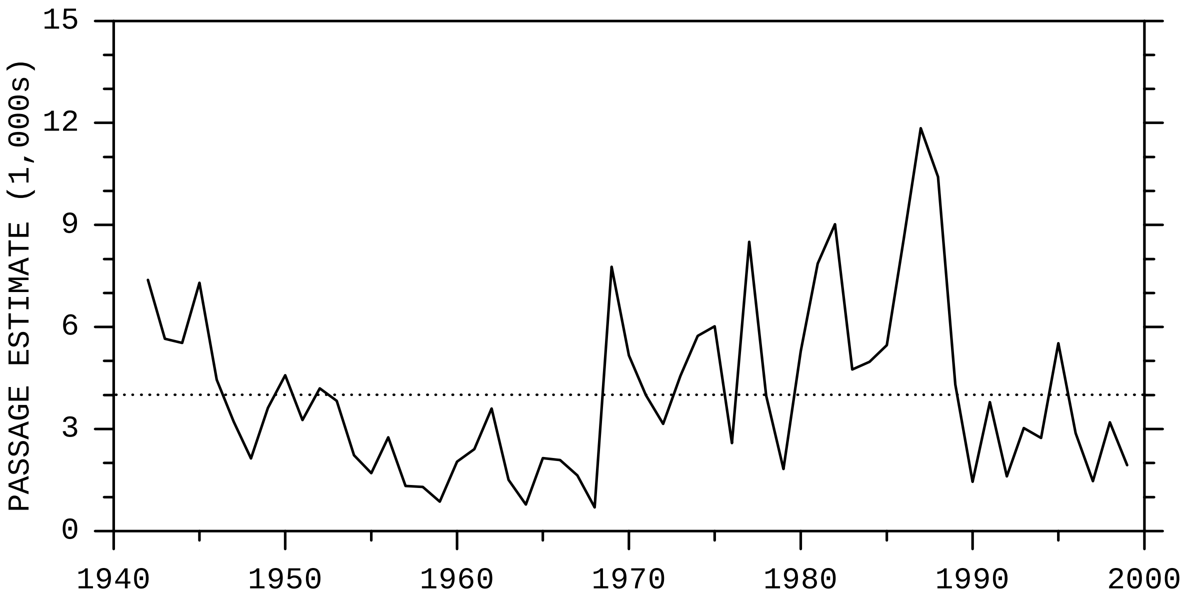

Figure 4. Estimated passage of wild adult summer steelhead at Gold Ray Dam on the Rogue River. Dotted line represents the population health goal.

released in 1988-91 (ODFW 1994). Thus, the low returns of adults in recent years may be related to low ocean survival rates rather than low freshwater production.

In contrast to summer steelhead, a relatively large number of winter steelhead passed Gold Ray Dam in 1999. ODFW estimated that 7,997 wild fish passed the counting station, which represented 200% of the 4,000 fish goal for the upper portion of the Rogue River. The

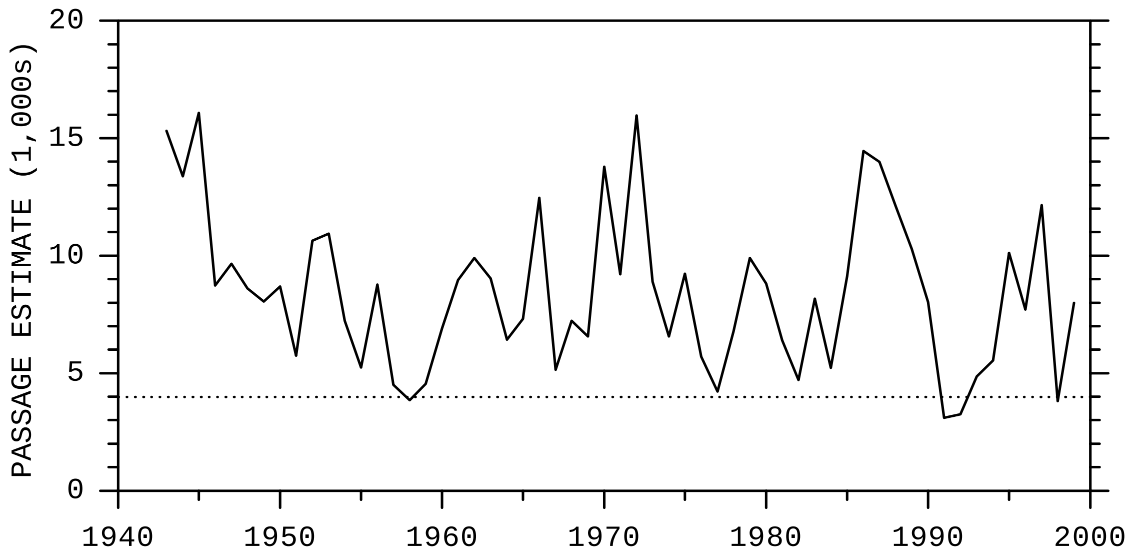

Figure 5. Estimated passage of wild adult winter steelhead at Gold Ray Dam on the Rogue River. Dotted line represents the population health goal.

1999 return was similar to the average return of 8,400 fish for the period of record (1943-99). As with summer steelhead, returns of winter steelhead to the upper portion of the Rogue River have increased since the early 1990s (Figure 5).

Life History (Goal 6)

Readable scales were collected from 141 wild adult late-run summer steelhead seined at Huntley Park in 1999. Of these, 123 fish (87%) were judged to have made a previous migration as half-pounders. The 95% confidence interval associated with the point estimate was 81%-92% half-pounder life histories.

This finding indicated that the population health goal of 95% half-pounder life histories was not attained for wild late-run summer steelhead that returned to the Rogue River in 1999. The relative abundance of half-pounder life histories among returning adults was the second lowest on record (Figure 6). While estimates from 1990-98 are not available, the relative abundance of half-pounder life histories may have decreased during the 1990s, when low numbers of half-pounders returned to the Rogue River.

ACKNOWLEDGMENTS

David Humphreys, Joshua Malin, Steven Mazur, Peter Samrin, Peggy Savage, and Christopher Volpe assisted with estimating the densities of juvenile trout. Lisa Borgerson interpreted the scale samples.

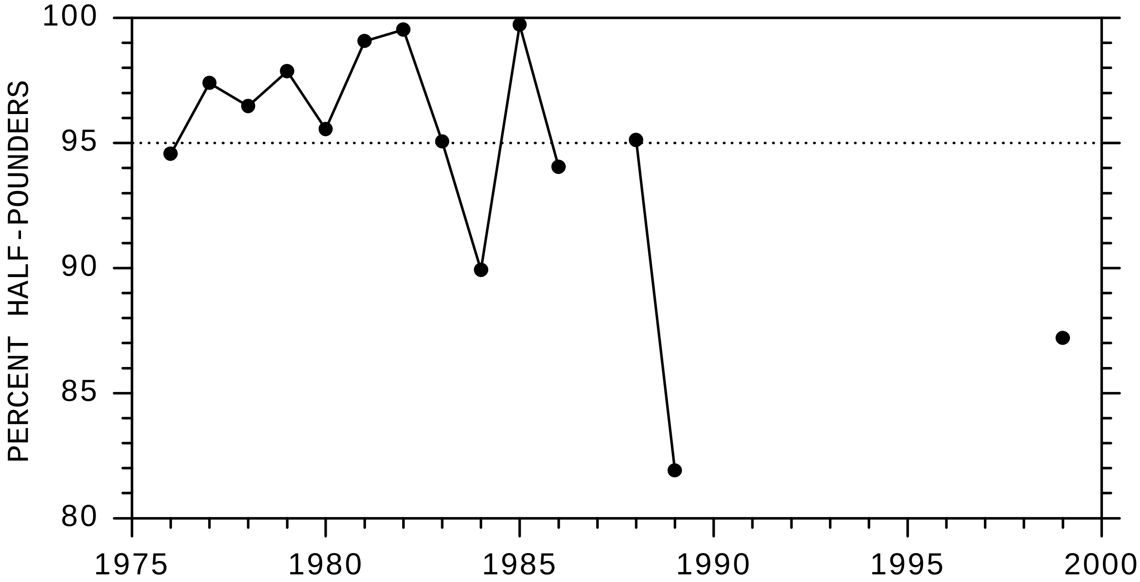

Figure 6. Relative abundance of the half-pounder life history among wild late-run adult summer steelhead in the Rogue River. Dotted line represents the population health goal.

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APPENDIX

Data from randomly selected sites sampled in 1999 to determine the density and distribution of juvenile salmonids

Appendix Table 1. Sampling sites where densities of juvenile steelhead were not estimated in 1999.

Stream	EMAP #	UTM-E	UTM-N	Site description
				ROGUE RIVER BASIN
Big Butte Creek (South Fork)	92	534700	4711625	Channel too large to effectively sample (steelhead present)
Deer Creek	814	459605	4679289	No water in stream channel
Schoolhouse Creek	1875	524103	4701801	No water in stream channel
Walpole Creek	2012	507027	4727610	Natural barrier present downstream of site
Silver Creek	3231	423851	4700675	Remote site that was not visited
Indigo Creek (West Fork)	3383	427929	4707735	Remote site that was not visited
Lawson Creek	3550	406731	4699591	Remote site that was not visited
Collier Creek	3819	414711	4694305	Remote site that was not visited
Caris Creek	8770	481980	4685904	Artificial barrier present downstream of site
Griffen Creek	9267	506256	4692630	Stream too turbid to effectively sample (steelhead present)
Willow Creek	9276	504123	4694223	Unable to obtain access to site
Whetstone Creek	9377	505569	4697775	Stream too turbid to effectively sample
Griffen Creek	9518	506318	4688307	Artificial barrier present downstream of site
Larson Creek	9604	515198	4684069	Artificial barrier present downstream of site
				COASTAL BASINS
Tincup Creek	5191	417855	4688822	Remote site that was not visited
Chetco River	5960	425399	4673463	Channel too large to effectively sample
Butler Creek	10001	395407	4733448	Site could not be safely accessed with sampling gear
Panther Creek	10005	395230	4725538	Natural barrier present downstream of site
Hunter Creek (Big South Fork)	10016	389839	4688786	Natural barrier present downstream of site
Tincup Creek	10017	419097	4688531	Remote site that was not visited
Tincup Creek	10018	416792	4687559	Remote site that was not visited
Deep Creek	10021	391613	4684452	Natural barrier present downstream of site
Sunrise Creek	10023	397085	4681317	Natural barrier present downstream of site
Chetco River	10024	422141	4681294	Channel too large to effectively sample
Chetco River	10025	423804	4681118	Channel too large to effectively sample
Sunrise Creek	10026	398305	4680264	Natural barrier present downstream of site
Granite Creek	10028	425922	4680092	Site could not be safely accessed with sampling gear
Boulder Creek	10029	416134	4679649	Remote site that was not visited
Pistol River (South Fork)	10033	400337	4674639	Natural barrier present downstream of site
Chetco River (North Fork)	10046	399783	4658875	Unable to obtain access to site

Appendix Table 2. Estimated densities (fish/m^2) of juvenile salmonids that reared in coastal basins (Rogue River Basin excepted) of the Klamath Mountains Province, 1999. Fish are yearlings of older, unless otherwise noted. Dashed lines indicate that age 0+ trout were not counted during snorkel surveys.

		NAD-27 location		Age 0^+ trout		Steelhead		Cutthroat		Age 0^+ coho	
Stream	EMAP #	UTM-E	UTM-N	Pools	Riffles	Pools	Riffles	Pools	Riffles	Pools	Riffles
Anvil Creek	392	385441	4732504	0.88	0.65	0.092	0.079	0.008	0.000	0.000	0.000
Red Cedar Creek	419	392113	4729978	0.93	0.72	0.048	0.033	0.024	0.004	0.010	0.000
Elk River tributary	4659	388139	4729653	0.49	0.56	0.045	0.000	0.000	0.000	0.000	0.000
Eagle Creek tributary	5015	403670	4677107	0.65	0.56	0.026	0.033	0.003	0.000	0.000	0.000
Pistol River (South Fork)	5431	392398	4676655	0.92	1.69	0.100	0.093	0.016	0.004	0.000	0.000
Hunter Creek	5537	383604	4692889	0.50	0.03	0.050	0.000	0.001	0.000	0.000	0.000
Winchuck River (South Fork)	5662	405515	4647958	1.26	0.99	0.067	0.015	0.030	0.004	0.000	0.000
Chetco River	5950	424736	4669300	--	0.13	0.053	0.000	0.000	0.000	0.000	0.000
Elk River	10002	394502	4729968	0.89	1.52	0.019	0.110	0.000	0.003	0.000	0.000
Elk River	10003	400660	4729557	1.55	0.92	0.083	0.079	0.002	0.003	0.000	0.000
Brush Creek	10004	382789	4727085	0.18	0.35	0.136	0.026	0.025	0.000	0.000	0.000
Brush Creek	10006	383972	4724642	0.23	0.23	0.043	0.011	0.068	0.018	0.000	0.000
Brush Creek	10007	384719	4724003	0.31	0.34	0.139	0.043	0.129	0.031	0.000	0.000
Brush Creek	10008	386370	4723766	0.05	0.02	0.016	0.000	0.108	0.065	0.000	0.000
Myrtle Creek	10009	386308	4719496	0.46	0.23	0.101	0.010	0.126	0.009	0.000	0.000
Myrtle Creek	10010	385823	4718890	1.51	0.22	0.012	0.000	0.000	0.000	0.000	0.000
Mussel Creek	10011	387513	4718614	0.51	0.30	0.094	0.000	0.087	0.000	0.000	0.000
Mussel Creek	10012	388531	4718460	0.51	0.41	0.040	0.006	0.050	0.003	0.000	0.000
Euchre Creek	10013	391418	4716609	0.67	1.10	0.031	0.018	0.006	0.000	0.000	0.000
Cedar Creek	10014	388027	4709058	0.64	0.74	0.046	0.042	0.060	0.004	0.000	0.000
Hunter Creek	10015	384740	4691101	0.41	0.11	0.012	0.000	0.000	0.000	0.000	0.000
Meyers Creek	10019	385742	4684606	0.70	0.68	0.178	0.046	0.000	0.012	0.000	0.000
Pistol River	10020	398114	4684808	0.93	0.71	0.091	0.073	0.003	0.000	0.000	0.000
Crook Creek	10022	385130	4681082	0.12	0.58	0.029	0.018	0.029	0.000	0.000	0.000
Pistol River (South Fork)	10027	393736	4679827	1.37	1.43	0.030	0.043	0.000	0.000	0.000	0.000
Eagle Creek	10030	403673	4676900	0.75	0.82	0.038	0.052	0.000	0.000	0.000	0.000
Pistol River (South Fork)	10031	397201	4675168	1.01	0.69	0.023	0.017	0.010	0.000	0.000	0.000
Pistol River (South Fork)	10032	400134	4674908	0.00	0.00	0.022	0.000	0.000	0.000	0.000	0.000

Appendix Table 2. Continued.

Stream	EMAP #	NAD-27 location		Age 0+ trout		Steelhead		Cutthroat		Age 0+ coho	
		UTM-E	UTM-N	Pools	Riffles	Pools	Riffles	Pools	Riffles	Pools	Riffles
Chetco River (South Fork)	10034	410143	4671148	0.57	0.68	0.040	0.144	0.000	0.000	0.000	0.000
Chetco River (South Fork)	10035	410646	4670582	1.13	0.72	0.125	0.140	0.011	0.000	0.000	0.000
Basin Creek	10036	410625	4670419	0.55	0.41	0.004	0.019	0.044	0.008	0.000	0.000
Henry Creek	10037	427359	4670818	1.72	1.24	0.158	0.000	0.000	0.000	0.000	0.000
Madstone Creek	10038	425689	4668026	0.24	0.11	0.072	0.135	0.000	0.000	0.000	0.000
Red Mountain Creek	10039	414734	4666907	0.55	0.38	0.006	0.017	0.000	0.000	0.000	0.000
Chetco River (South Fork)	10040	414549	4666496	0.55	0.39	0.008	0.018	0.000	0.000	0.000	0.000
Bravo Creek	10041	397487	4665269	2.71	1.48	0.159	0.179	0.006	0.000	0.000	0.000
Chetco River (North Fork)	10042	396481	4663393	3.43	2.03	0.028	0.014	0.000	0.000	0.000	0.000
Chetco River (North Fork)	10043	399321	4660684	0.42	0.31	0.001	0.017	0.000	0.000	0.000	0.000
Willow Creek	10044	404685	4659590	0.91	0.92	0.128	0.053	0.143	0.041	0.000	0.000
Joe Hall Creek	10045	396103	4658796	2.42	1.50	0.090	0.000	0.000	0.000	0.000	0.000
Winchuck River (East Fork)	10047	412765	4658828	0.78	0.51	0.035	0.024	0.037	0.000	0.000	0.000
Hamilton Creek	10048	399939	4656470	3.59	2.83	0.000	0.000	0.000	0.000	0.000	0.000
Jack Creek	10049	403215	4654938	2.26	0.93	0.133	0.063	0.022	0.007	0.000	0.000
Jack Creek	10050	400972	4654714	3.03	2.44	0.034	0.011	0.017	0.000	0.000	0.000
Winchuck River	10051	408358	4653368	0.56	0.52	0.026	0.064	0.002	0.001	0.000	0.000
Winchuck River (South Fork)	10052	401999	4649522	0.14	0.32	0.021	0.008	0.003	0.000	0.000	0.000
Winchuck River (South Fork)	10053	408233	4647122	0.12	0.15	0.080	0.042	0.091	0.076	0.000	0.000
Chetco River	10063	425828	4673738	--	0.97	0.092	0.093	0.000	0.000	0.000	0.000

Appendix Table 3. Estimated densities (fish/m^2) of juvenile salmonids that reared in the Rogue River Basin of the Klamath Mountains Province, 1999. Fish are yearlings of older, unless otherwise noted. Dashed lines indicate that age 0+ trout were not counted during snorkel surveys.

		NAD-27 location		Age 0^+ trout		Steelhead		Cutthroat		Age 0^+ coho	
Stream	EMAP #	UTM-E	UTM-N	Pools	Riffles	Pools	Riffles	Pools	Riffles	Pools	Riffles
Grave Creek	8	473777	4719486	0.31	0.23	0.090	0.049	0.000	0.000	0.000	0.000
Elk Creek (West Branch)	80	521878	4727158	0.11	0.19	0.020	0.025	0.085	0.032	0.274	0.160
Trail Creek	139	513422	4728808	0.84	0.85	0.072	0.065	0.024	0.030	0.567	0.222
Evans Creek	163	504327	4722949	0.35	0.54	0.052	0.033	0.000	0.000	0.000	0.000
Sam’s Creek	196	500082	4705859	2.19	0.60	0.150	0.000	0.000	0.000	0.000	0.000
Rock Creek	238	496329	4724471	1.31	0.90	0.042	0.081	0.000	0.006	0.191	0.049
Wolf Creek	266	463731	4725617	0.18	0.38	0.076	0.009	0.001	0.000	0.000	0.000
Taylor Creek	302	452282	4708504	0.47	0.58	0.056	0.059	0.000	0.000	0.000	0.000
Jumpoff Joe Creek	309	460311	4707804	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Jumpoff Joe Creek	316	464555	4707348	0.04	0.29	0.004	0.000	0.000	0.000	0.000	0.000
Sixmile Creek	325	439750	4683821	0.44	0.56	0.083	0.023	0.000	0.000	0.000	0.000
Boulder Creek	367	402752	4719774	0.19	0.32	0.102	0.099	0.017	0.008	0.000	0.000
Billings Creek	383	413943	4722026	1.26	0.85	0.012	0.000	0.000	0.000	0.000	0.000
Saunder's Creek	427	387013	4699613	0.11	0.51	0.048	0.010	0.000	0.000	0.000	0.000
Fall Creek	453	436348	4683251	0.14	0.13	0.072	0.065	0.000	0.000	0.148	0.000
Dunn Creek	557	449459	4649113	0.65	0.46	0.094	0.017	0.000	0.000	0.092	0.000
Wood Creek	566	444522	4655495	0.17	0.34	0.046	0.007	0.000	0.000	0.313	0.032
Illinois River (West Fork)	576	436670	4651928	0.10	0.24	0.032	0.016	0.012	0.016	0.019	0.000
Soda Creek	629	540481	4688829	0.40	0.17	0.063	0.000	0.035	0.000	0.000	0.000
Bear Creek	652	527924	4671259	--	0.48	0.108	0.039	0.000	0.000	0.000	0.000
Williams Creek	743	479529	4678800	3.60	2.67	0.233	0.006	0.038	0.007	0.013	0.000
Williams Creek (East Fork)	781	478478	4669411	0.48	0.34	0.087	0.037	0.031	0.007	0.000	0.000
Deer Creek (North Fork)	803	463855	4681531	0.17	0.20	0.037	0.000	0.143	0.026	0.641	0.143
Murphy Creek	852	472504	4687719	0.21	0.09	0.161	0.036	0.086	0.000	0.190	0.006
Crooks Creek	914	458824	4684002	0.09	0.16	0.057	0.000	0.037	0.000	0.233	0.020
Coyote Creek	990	472823	4725180	0.58	0.51	0.049	0.035	0.000	0.000	0.000	0.000
Last Chance Creek	1117	486603	4728904	1.48	1.31	0.116	0.029	0.000	0.000	0.000	0.000
Fourbit Creek	2638	546845	4705180	0.15	0.09	0.021	0.033	0.187	0.058	0.000	0.000

Appendix Table 3. Continued.

Stream	EMAP #	NAD-27 location		Age 0^+ trout		Steelhead		Cutthroat		Age 0^+ coho	
		UTM-E	UTM-N	Pools	Riffles	Pools	Riffles	Pools	Riffles	Pools	Riffles
Whiskey Creek	2652	448255	4723518	0.22	0.28	0.078	0.062	0.000	0.000	0.104	0.007
Rueben Creek	2702	453272	4722495	0.37	0.18	0.047	0.015	0.000	0.000	0.136	0.008
Taylor Creek (South Fork)	3001	446729	4705155	0.77	0.58	0.066	0.000	0.132	0.023	0.028	0.026
Swede Creek	3086	441647	4691888	0.05	0.12	0.128	0.088	0.000	0.000	0.000	0.000
Swede Creek	3103	440281	4692932	0.17	0.24	0.158	0.084	0.000	0.000	0.000	0.000
Briggs Creek	3414	434089	4691909	0.12	0.22	0.019	0.074	0.000	0.000	0.011	0.000
Silver Creek	3461	434016	4702472	0.40	0.37	0.121	0.000	0.000	0.000	0.000	0.000
Dan’s Creek	4127	415971	4722321	0.00	0.00	0.091	0.007	0.037	0.000	0.000	0.000
Little Windy Creek	4233	439690	4723506	0.50	0.64	0.069	0.000	0.000	0.000	0.000	0.000
Neil Creek	7219	529853	4668037	0.55	0.84	0.102	0.044	0.000	0.000	0.000	0.000
Sterling Creek	7408	502998	4670347	0.23	0.39	0.132	0.103	0.000	0.000	0.000	0.000
Little Applegate River	7749	507675	4667055	1.09	0.96	0.167	0.055	0.000	0.000	0.000	0.000
Little Applegate River	7760	510088	4666478	0.85	0.48	0.276	0.215	0.000	0.000	0.000	0.000
Powell Creek	8504	475554	4678995	0.57	0.65	0.049	0.022	0.022	0.000	0.000	0.000
Deer Creek tributary	8939	464172	4674083	0.15	0.14	0.028	0.014	0.000	0.000	0.000	0.000
Kane Creek	9403	498173	4693208	1.42	0.99	0.137	0.000	0.000	0.000	0.000	0.000
Kane Creek	9449	469734	4696619	0.91	0.50	0.070	0.000	0.000	0.000	0.000	0.000