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COASTWIDE ABUNDANCE OF NORTH AMERICAN STEELHEAD TROUT

by

Jeffrey T. Light

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FISHERIES RESEARCH INSTITUTE
School of Fisheries
College of Ocean and Fishery Sciences
University of Washington
Seattle, Washington, 98195

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ABSTRACT

The average number of adult steelhead returning to the Pacific coast of North America each year was estimated from sport harvest data, counts at dams, and other run size information collected by resource agencies from 1970 through 1986. The estimates were rough, owing to the imprecise nature of the data and the wide interannual variability that is apparently typical of many steelhead populations, but they reflect the best information available and provide a general view of the magnitude of steelhead abundance. The total annual abundance of all Pacific coast stocks was estimated to be 1.6 million adult fish. The Columbia River Basin is the center of abundance for steelhead and produces 29% of the total coastwide population. The region of next highest abundance is Coastal Oregon (21%), followed by California (17%), Coastal Washington and Puget Sound (14%), British Columbia (14%), and Alaska (5%). The proportion of hatchery fish was estimated at 51% overall, and ranged from 3% in Alaskan populations to 80% in populations from the Columbia River Basin. Abundance estimates were similar (in magnitude) to estimates published in 1972, but the proportion of hatchery fish in the totals has increased.

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INTRODUCTION

The last comprehensive estimate of the abundance of steelhead trout (*Salmo gairdneri*) along the Pacific coast of North America was reported by Sheppard (1972). Since that time, run size information for many steelhead stocks has improved considerably. This report makes use of this improved information and provides a current estimate of the coastwide abundance of adult North American steelhead.

METHODS AND RESULTS

The goal of this study was to estimate the average number of adult steelhead of both hatchery and wild origins that return annually to coastal streams, measured before harvest by inshore commercial and sport fisheries. The data were organized by state or by region within a state (e.g. coastal Oregon) (Figure 1). Abundance estimates were constructed on the basis of information obtained from published literature, from unpublished agency reports, and from consultation with agency personnel. In general, estimates were based on catch statistics coupled with harvest efficiency estimates, actual counts of adults passing over dams, population surveys on selected streams, smolt abundance estimates coupled with smolt-to-adult survival information, or the number of streams known to contain steelhead multiplied by the average estimated population sizes in those streams. The abundance estimates were generated by different methods for each region according to the type and quality of information available.

Alaska

In Alaska, hatchery production of steelhead is limited to an annual release of approximately 84,000 smolts (1982-1986 average) (Marianne McKean and Steven Schwartz, Alaska Dept. of Fish and Game [ADF&G], 1987 personal communication). An estimated 2,000 adults return annually from these plantings (smolt-to-adult survival = 2-3%) (Frank Van Hulle, ADF&G, 1987 pers. comm.).

The majority of Alaskan steelhead are wild (naturally produced) fish. No reliable estimate of the total wild population is available, but many of the steelhead-producing streams in Alaska have been surveyed and classified into general categories (Darwin Jones, ADF&G, 1985 [unpublished data], Van Hulle 1985). For example, an "excellent" steelhead producing stream contains over 500 adults, whereas a "poor" producer has fewer than 100 adults (D. Jones, ADF&G, 1986 pers. comm.). This generalized classification system was used to estimate the abundance of wild Alaskan steelhead. The total adult population of wild fish was derived initially by multiplying an average estimated population size of each class of stream by the number of streams in that class and then adding the numbers for each class. These estimates were then reviewed and revised by ADF&G personnel to reflect the best information available from knowledgeable area biologists (Appendix 1). The average adult steelhead population (hatchery and wild fish) in Alaska was estimated to be 75,000 fish (Table 1).

British Columbia

In British Columbia, approximately 841,000 steelhead smolts are released from hatcheries each year (1982-1985 average: Brian Ludwig, British Columbia (B.C.) Ministry of Environment, 1987 pers. comm.). The smolt-to-adult survival rate for these hatchery fish is estimated to be 4% (Art Tautz, B.C. Ministry of Environment, 1986 pers. comm.). Approximately 33,600 adult hatchery-reared steelhead are therefore expected to return to the coast each year. This figure agrees with an independent estimate of 30,000 to 40,000 hatchery returns annually developed by Tautz (1987 pers. comm.) based on hatchery counts. Hatchery fish are thought to represent 15% of the total adult spawning population (A. Tautz, 1987 pers. comm.), implying a wild adult spawning population of around 190,400 fish. Thus the total number of steelhead returning to the British Columbia coast each year is approximately 224,000 (Table 1).

Coastal Washington and Puget Sound

Detailed harvest and escapement information is available for most of the major steelhead-producing streams in the Puget Sound area and along the coast of Washington. In a few coastal streams (e.g., Willapa, Naselle), population sizes were derived by coupling sport catch statistics with harvest efficiency estimates (Robert Gibbons, Washington State Department of Game [WDG], 1987 pers. comm.). Details of the calculations are provided in Appendix 2. Hatchery:wild ratios were estimated from data for four systems (Skagit, Lake Washington, Green, Quillayute) where hatchery and wild run size estimates were available. The total annual abundance of adult steelhead in this region was estimated to be 215,000 fish, of which 70% were hatchery fish and 30% were of wild origins (Table 1).

Columbia River Basin

The steelhead-producing tributaries of the Columbia River are found in the states of Washington, Idaho, and Oregon. Hatcheries in these states release large numbers of steelhead each year (Wahle and Smith 1979; Idaho Dept. of Fish and Game (IDF&G) 1987 [unpublished data]; WDG 1982a, 1983a, 1984b-1986b, 1987; Oregon Dept. of Fish and Wildlife [ODF&W] unpublished reports).

Adults that pass Bonneville dam (the first dam they encounter) on their upstream migration are counted as they pass special viewing facilities at the dams (Jensen 1986). These counts, deemed accurate to within 5% of the total fish passing over the dams (Mike Matylewich, Columbia River Intertribal Fish Commission [CRITFC], 1987 pers. comm.), were used to estimate the average adult population in the Columbia River Basin upriver of Bonneville (Appendix 3). The ratio of hatchery to wild adults was estimated from an analysis of scales from fish sampled at Bonneville dam in 1984-1986 (Mike Matylewich, CRITFC, 1987 pers. comm.). An average of 80% of the sampled adults were hatchery fish.

The numbers of adult fish from Columbia River tributaries below Bonneville were estimated from sport-catch statistics (Washington and Oregon), and from dam counts on the Willamette River (Oregon only) (Appendix 3). These estimates include the approximately 3,000 fish harvested incidentally each year by commercial salmon fisheries in the lower river (Mathew Schwartzberg, CRITFC, 1987 pers. comm.). The proportions of hatchery and wild adult winter steelhead returning to Oregon tributaries of the lower Columbia River were estimated to be 75% hatchery and 25% wild fish

(Kenaston 1987 [unpublished report]). The ratio of hatchery to wild fish was assumed to be the same for Washington tributaries (Appendix 3).

The combined upper and lower river estimates imply a total abundance of approximately 452,000 fish (Table 1).

Coastal Oregon

Estimates of adult production of summer and winter steelhead and hatchery and wild steelhead in Oregon's coastal streams were obtained from Ken Kenaston (ODF&W, 1987 unpublished report) (Appendix 4). His estimates were derived from sport-catch statistics (Eden and Swartz 1987) and harvest efficiency estimates (Kenaston and MacHugh 1983, 1985). An average of 330,000 fish (hatchery and wild stocks combined) were estimated to return annually to coastal streams over the 5-year period 1980-81 through 1984-85.

Kenaston (1987 unpublished report) estimated the ratio of hatchery to wild fish from scale pattern analysis (Kenaston and MacHugh 1983, 1985). The proportions of hatchery and wild adults along Oregon's coast were estimated to be 222,000 (67%) hatchery and 108,000 (33%) wild fish (Table 1).

California

In California, steelhead populations are not extensively monitored and no sport catch accounting system (e.g. punch cards) is used. There is no commercial fishery for steelhead in this state. Although population sizes have been routinely examined in only a few streams (U.S. Fish and Wildlife Service 1965), estimates of the average adult production were possible from a combination of creel census data, returns to hatcheries, fish ladder counts, diving surveys, trapping, and tagging studies (Eric Gerstung, California Dept. of Fish and Game (CDF&G), 1987 pers. comm.).

On average, 275,000 steelhead are thought to return to California streams each year (E. Gerstung, CDF&G, 1987 pers. comm.). Of these, 60,000 (22%) are from hatcheries and the remaining 215,000 (78%) are from wild populations (Table 1). An additional 200,000 to 300,000 "half pounders" (steelhead which return to freshwater in the same year they migrated to the sea as smolts) return annually to some of California's salmonid-producing streams (primarily the Klamath and Eel Rivers), but these were not included in the adult population estimate in Table 1.

DISCUSSION

The total coastwide abundance of adult steelhead was estimated at approximately 1.6 million fish. The largest proportion of these fish (29%) return to the Columbia River Basin. The next highest proportion return to coastal Oregon (21%), followed by California (17%), coastal Washington and Puget Sound (14%), British Columbia (14%), and Alaska (5%). Hatchery fish comprise 51% of the total population and are most abundant in coastal Washington, Oregon, and Puget Sound streams, and in the Columbia River Basin. Wild fish predominate in Alaska, British Columbia and California.

Run size estimates in this report represent only the general situation over a period of years and are imprecise owing to the nature of the data and interannual variability in run size. The yearly counts of summer-run fish passing Bonneville dam on the Columbia River illustrate this variability. Between the 1965-66 and 1986-87 run years, these counts

showed up to a four-fold difference in the number of returns (Jensen 1986; M. Matylewich, CRITFC, 1987 pers. comm.). These dam counts provide an insight into the dynamics of annual abundance that is relatively free of the sources of error that afflict run size estimates derived from harvest data (e.g., fishing conditions, angler interest, etc.). They do not fully reflect the true nature of yearly abundance in the Columbia River because fisheries below Bonneville dam remove fish before they can be counted at the dam, and because the number of smolts released from hatcheries each year that will contribute to adult returns in later years is not constant (Wahle and Smith 1979). They do, however, demonstrate the variable nature of steelhead run sizes. Such variability must be fully considered when evaluating the accuracy of the abundance estimates presented in this report.

Sheppard (1972) estimated that 1.5 million adult steelhead were present along the North American coast (excluding Alaska). His results were based on catch estimates and the assumption that the combined annual sport and commercial harvest represented 50% of the total average run. The present estimate of 1.6 million fish is surprisingly close to his, and might indicate that there has been little change or even an increase in the coastwide abundance of steelhead over the past 15 years. However, in light of the imprecise estimates (as discussed above) and the different methods and data, it is inadvisable to assess changes in the status of steelhead stocks through a direct comparison of these two studies. Furthermore, while the numbers themselves may be similar, they do not reflect changes in the structure of steelhead populations such as the proportions of hatchery and wild fish. For example, since 1970, artificial production of steelhead has increased substantially (B.C. Dept. of Fisheries and Oceans 1982, Wahle and Smith 1979), and although it is difficult to determine whether wild populations have increased or decreased over this time, it is believed that the number of hatchery fish returning to the coast each year has increased (Billings 1987; Peter Hahn, WDG, 1986 pers. comm.; Don Swartz, ODF&W, 1987 pers. comm.).

Sheppard (1972) predicted that the status of many steelhead stocks would decline over the years from increased fishing pressures, mortality at hydroelectric projects, or habitat degradation. Since his publication there has been no clear trend in fishing pressure, but evidence suggests increased harvest and effort by sport and commercial fisheries in recent years (Kent Ball, IDF&G, 1987 pers. comm.; Billings 1987; Bijsterveld and James 1986; Michael R. Dean, ADF&G, 1987 pers. comm.; Eden and Swartz 1987; K. Kenaston, ODF&W, 1987 pers. comm.; Maurine Kostner, Canadian Dept. of Fisheries and Oceans, 1987 pers. comm.; Northwest Power Planning Council (NWPPC) 1986; Pollard 1985; Van Hulle 1985; WDG 1963-1973; 1974a,b; 1975; 1976a,b-1981a,b; 1982b,c; 1983b,c; 1984a,c; 1985a,c; 1986a). In addition, progress has been made to alleviate dam-related mortality of juveniles and adults in the Columbia River Basin (Raymond 1979, NWPPC 1986). No estimates of gains or losses of steelhead from habitat enhancement or degradation have been developed that allow an assessment of this aspect of the resource on a coastwide or even regional basis.

The status of steelhead stocks along the Pacific coast of North America has no doubt changed to some degree in the 15 years since Sheppard's (1972) publication but the existing information is inadequate to fully determine the extent or direction of possible changes. Changes may not be reflected in overall numerical abundance, but may instead be manifested through localized shifts in abundance or through qualitative changes (e.g. shifts in the proportion of hatchery and wild fish) in certain populations. The importance of steelhead as a Pacific coast gamefish underscores the need to obtain better information in order to develop more detailed run size estimates. Accurate run size information could

then be used to measure future changes in steelhead abundance on a regional or coastwide basis.

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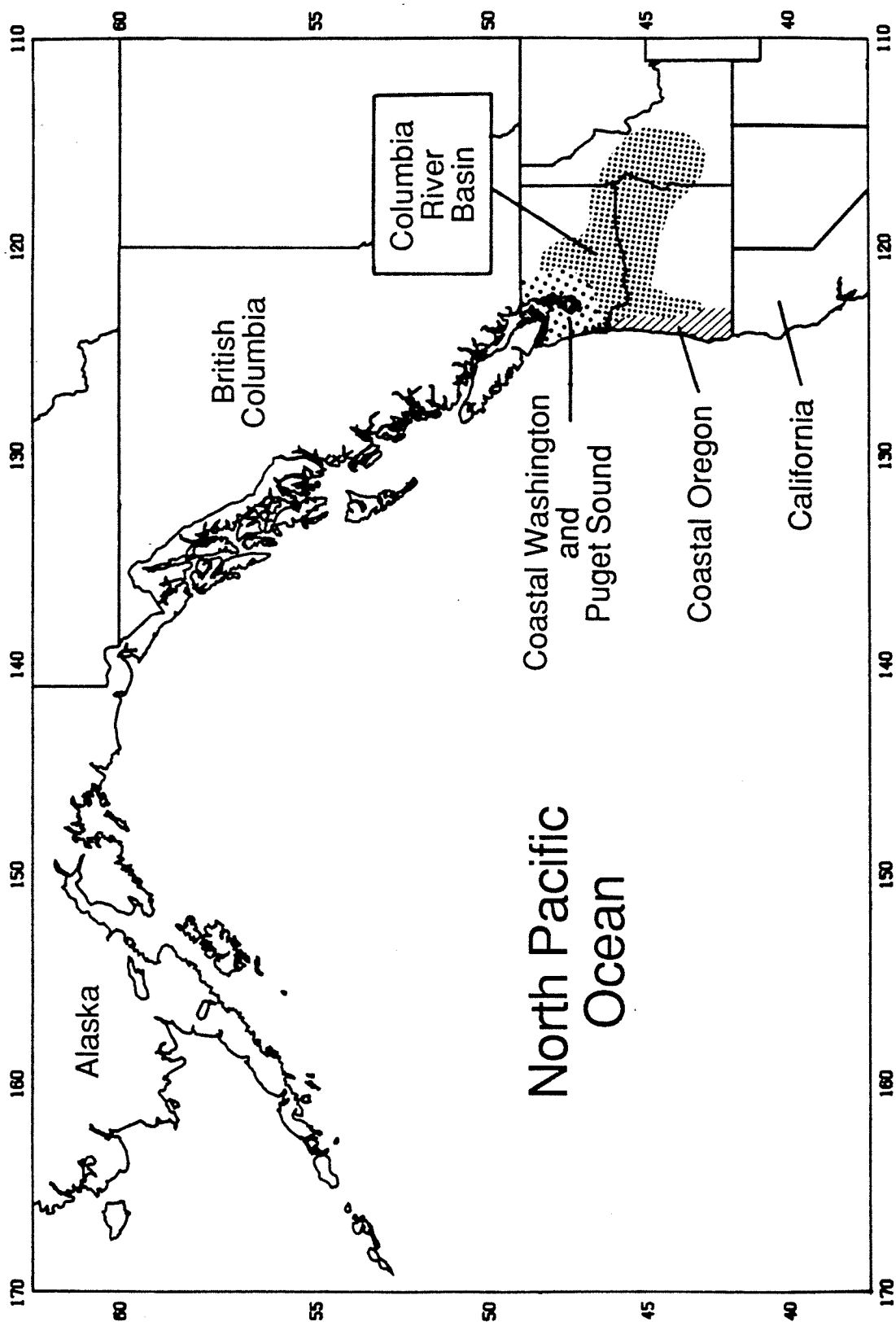

Figure 1. Map showing regions used in this study.

Table 1. Estimated average annual abundance of adult North American steelhead (hatchery and wild stocks).

Region	Number of Adults (nearest 1,000)[1]		
	Hatchery (%)	Wild (%)	Total
Alaska	2,000 (3)	73,000 (97)	75,000
British Columbia	34,000 (15)	190,000 (85)	224,000
Coastal Washington and Puget Sound	151,000 (70)	64,000 (30)	215,000
Columbia River Basin (Wash., Oregon, Idaho)	330,000 (73)	122,000 (27)	452,000
Coastal Oregon	222,000 (67)	108,000 (33)	330,000
California[2]	60,000 (22)	215,000 (78)	275,000
Total	799,000 (51)	772,000 (49)	1,571,000

[1]Rounding to the nearest 1,000 was for convenience only, and was not intended to reflect the precision of the estimates (i.e., the estimates could have as easily been rounded to the nearest 10,000). The figures shown could fluctuate by more than one-third from year to year. See text for discussion.

[2]Does not include age .0 fish (half-pounders).

Appendix 1

Estimated Annual Abundance of Alaskan Steelhead

A. Hatchery steelhead.

1. Average annual smolt releases (1982-1986) (M. McKean and S. Schwartz, ADF&G, 1987 personal communication) = 84,100.

2. Estimated smolt-to-adult survival rate = 2-3% (F. Van Hulle, ADF&G, 1987 pers. comm.).

3. Estimated adult hatchery fish returning to the coast each year (before harvest) (Van Hulle, ADF&G, 1987 pers. comm.): 2,000

B. Wild steelhead (Van Hulle, ADF&G, 1987 pers. comm.)[1].

Annual Run Size	Number of Streams by Region (number of steelhead) Southeast	Cook Inlet	Kodiak Island	Alaskan Peninsula	Total No. of Streams	Estim. No. of Fish
≥501	11 (24,750)	1 (1,700)	3 (8,500)	0	15	34,950
201-500	28 (10,175)	2 (1,000)	5 (1,500)	0	35	12,675
101-200	147 (18,250)	2 (300)	6 (900)	0	155	19,450
≤100	154 (5,566)	0	3 (50)	9 (450)	166	6,066
	340 (58,741)	5 (3,000)	17 (10,950)	9 (450)	371	73,141

C. Estimated total annual adult abundance (hatchery and wild stocks): 75,141

[1] Conservative estimates (F. Van Hulle, ADF&G, 1987 pers. comm.).

Appendix 2

Estimated Annual Abundance of Adult Steelhead in Coastal Washington and Puget Sound Streams

		Average No. of Fish
A.	Winter-run stocks (hatchery and wild origins).	
1.	Puget Sound Streams.	
a.	Green[1]	12,061
b.	Lake Washington[1]	3,402
c.	Nisqually[1]	5,600
d.	Nooksack (1986-87 estimate only)[2]	6,018
e.	Puyallup[2]	11,663
f.	Samish[2]	1,475
g.	Skagit[1]	15,459
h.	Snohomish[3]	23,149
i.	Stillaguamish[2]	8,865
2.	Hood Canal[4].	4,021
3.	Strait of Juan de Fuca (1986 estimates only)[4].	
a.	Elwha	6,357
b.	Other streams	5,210
4.	Coastal stocks.	
a.	Chehalis (1986-87 estimate only)[5]	7,307
b.	Hoh[1]	11,912
c.	Humptulips[5]	8,022
d.	Naselle[6]	1,978
e.	Queets (1980-1986 average)[5]	15,312
f.	Quillayute[1]	25,037
g.	Quinault[5]	18,433
h.	Willapa[6]	2,910
5.	Total annual abundance, all winter-run stocks:	194,191
B.	Summer-run stocks.	
1.	Hatchery origins.	
a.	Average (1981-1986) number of smolts released each year (626,038)[7] multiplied by a 3% smolt-to-adult survival rate:[8]	18,781
2.	Wild origins[8]:	
a.	Average hatchery:wild ratio of adult fish = 90:10[8].	2,087

Appendix 2. (cont'd.) Estimated Annual Abundance of Adult Steelhead in Coastal Washington and Puget Sound Streams.

	Average No. of Fish
3. Total annual abundance, all summer-run stocks.	20,868
C. Total number of adults (all stocks) returning each year before harvest (194,191 winter-run + 20,868 summer-run fish):	215,059

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[1]Based on average run size estimates, Washington State Dept. of Game (WDG) unpublished data (1977-78 to 1985-86).

[2]Run size estimates based on catch data (1985-86 return years) combined with estimated escapement relative to escapement goals (Robert Gibbons, WDG, 1987 personal communication).

[3]Estimated wild run size and mean annual catch, 1980-81 to 1985-86 return years, expanded by 15% (assuming an 85% exploitation rate, R. Gibbons, WDG, 1987 pers. comm.).

[4]Point No Point Treaty Council and WDG, 1986.

[5]Quinault Fish Division and WDG, 1987.

[6]Based on a doubling of the mean annual (1979-80 to 1984-85 return years) sport catch (WDG 1980b, 1981a, 1982b, 1983b, 1984a, 1985a), assuming a 50% exploitation rate (R. Gibbons, WDG, 1987 pers. comm.).

[7]Washington State Dept. of Game. 1982a, 1983a, 1984b, 1985b, 1986b, 1987.

[8]Robert Gibbons, WDG, 1987 pers. comm.

Appendix 3

Estimated Annual Abundance of Adult Steelhead in the Columbia River Basin

A. Upper Columbia River (above Bonneville dam)

1. Summer-run stocks. Average number of adults counted annually at Bonneville dam, 1977-1986 (Jensen 1986): 209,419

2. Winter-run stocks. Average number of adults returning to Oregon tributaries each year. (From 1975-1984 sport-catch statistics, Table 8, Eden and Swartz 1987, expanded by a 30% harvest efficiency estimate [D. Swartz, ODF&W, 1987 personal communication]): 4,253

3. Total average adult returns each year, before harvest: 213,672

   a. Number of hatchery fish (80%)[1] = 170,938.

   b. Number of wild fish (20%)[1] = 42,734.

B. Lower Columbia River (below Bonneville dam)

1. Washington tributaries. (From sport-catch statistics, Washington Dept. of Game, 1976b-1980b, 1981a, 1982b, 1983b, 1984a-1986a).

   a. Summer-run stocks. Average annual catch expanded by an estimated 50% harvest efficiency (Mark Chilcote, WDG, 1987 pers. comm.): 28,536

   b. Winter-run stocks. Average annual catch expanded by an estimated 40% harvest efficiency (M. Chilcote, WDG, 1987 pers. comm.): 59,017

   c. Total average adult production, Washington stocks (combined summer and winter stocks expanded by an additional 25% to account for caught and released wild fish not included in harvest data [M. Chilcote, WDG, 1987 pers. comm.]): 109,441

2. Oregon tributaries (From Kenaston [1987 unpublished report]).

   a. Summer-run stocks. Five-year average (1980-1981 through 1984-1985): 47,000

   b. Winter-run stocks. Five-year average (1980-1981 through 1984-1985): 79,000

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[1]M. Matylewich, CRITFC, 1987 pers. comm.

Appendix 3. (cont'd.) Estimated Annual Abundance of Adult Steelhead in the Columbia River Basin.

c. Total average adult production, Oregon stocks:	126,000
3. Incidental annual harvest by commercial fisheries in the lower river mainstem[2]:	3,000
4. Total Average adult production, all lower- river stocks combined:	238,441
a. Number of hatchery fish (75%)[3] = 178,831.	
b. Number of wild fish (25%)[3] = 59,610.	
C. Total average annual adult production, Columbia River Basin:	452,113
1. Number of hatchery fish (77%) = 349,769.	
2. Number of wild fish (23%) = 102,344.	

[2]M. Schwartzberg, CRITFC, 1987 pers. comm.

[3]Estimated proportions of hatchery and wild fish for Oregon winter-run stocks were obtained from Kenaston (1987 unpublished report). These same proportions were used for estimating the abundance of hatchery and wild fish in Washington tributaries of the lower Columbia River.

Appendix 4

Estimated Annual Abundance of Adult Steelhead in Coastal Oregon Streams

(from Ken Kenaston, ODF&W, 1987 unpublished report)

To calculate the number of adult steelhead returning to Oregon coastal streams, I used steelhead sport catch statistics, estimates of the ratio of hatchery to wild fish in the catch, and estimates of exploitation rates for those fisheries.

Steelhead sport catch estimates for coastal streams were obtained from Eden and Swartz (1987). Monthly estimates of catch were divided between summer and winter steelhead based on local run timing. Monthly estimates were summed across all appropriate months to estimate catch by run year. For example, winter steelhead fisheries commonly occur in November and December in calendar year i and January through March in year i+1.

The proportions of hatchery and wild fish in some rivers were estimated from scale samples collected by anglers in those sport fisheries (Kenaston and MacHugh 1983, Kenaston and MacHugh 1985, and ODF&W unpublished data). Where scale collections for an individual river were less than 20 fish, an average composition, calculated from several streams, was applied. Independent averages were calculated for streams managed exclusively for wild fish and those stocked with hatchery steelhead smolts.

Sport catch was expanded by dividing by an estimate of exploitation rate. Three levels of exploitation were defined, corresponding to intense, moderate, and low pressure fisheries, for summer steelhead fisheries and winter steelhead fisheries. Values for these exploitation levels were taken from examples from Oregon sports fisheries (Table A). An exploitation rate was assigned to each fishery, based subjectively on the intensity of the fishery. Individual estimates of run size for hatchery and wild steelhead were summed for a coastwide estimate of returning adult steelhead (Table B).

Appendix 4. (cont'd.) Estimated Annual Abundance of Adult Steelhead in Coastal Oregon Streams.

Table A. Exploitation rates of different Oregon fisheries grouped by steelhead race and intensity of fishery.

Type and density of fishery	Years	Number of years	Exploitation rate
Winter steelhead:			
High intensity:			
Sandy River	1960-66	7	.40
Alsea River	1982-85	4	.42
Moderate intensity:			
Upper Willamette River	1981-85	5	.21
Smith River	1947-48	2	.15
North Umpqua River	1970-83	14	.20
Low intensity:			
Upper North Umpqua	1984-85	2	.08
Upper Rogue River	1984-85	2	.08
Summer steelhead:			
High intensity:			
Upper Willamette River	1981-84	4	.44
Upper North Umpqua River	1984-85	2	.39
North Umpqua River	1970-83	14	.46
Moderate intensity:			
Deschutes River	1977, 1980-83	5	.28
Low intensity:			
Upper Rogue River	1984-85	2	.11

Table B. Average return of steelhead to Oregon coastal streams, 1980-81 through 1984-85.

Race	Hatchery (%)	Wild (%)	Total
Summer steelhead	46,000 (61)	29,000 (39)	75,000
Winter steelhead	176,000 (69)	79,000 (31)	255,000
Total	222,000 (67)	108,000 (33)	330,000