THE EFFECT OF DROUGHT AND PUMPING ON STEELHEAD AND COHO IN REDWOOD CREEK FROM JULY TO OCTOBER 1994

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Introduction

Abundance of coho (Oncorhynchus kisutch) and steelhead (0. mykiss) was assessed at 8 sites on Redwood Creek in July 1994 (Smith 1994a). Declining streamflows, due to drought conditions in 1993-4 and groundwater pumping (MBCSD), resulted in the need to resample a portion of the sites to determine late summer and fall fish survival. Resampling on 30 October 1994 occurred just prior to the first major fall rains, and conditions appeared to approximate the minimum seasonal flows on the stream.

Methods

Fish populations were resampled at five sites, including two downstream of the Muir Beach community well. Sampled habitats were electroshocked with two passes, using a backpack electroshocker, and abundance of each species and age group was estimated based upon the depletion ratio. Fish were measured in 5 mm increments (standard length). At site 2, downstream of • the Muir Woods National Monument boundary, a single 35 foot long habitat was resampled, but 175 additional feet of habitat downstream were sampled to look for coho. At site 3, upstream of Kent Canyon, 4 of the 5 habitats sampled in July were resampled. At site 5, upstream of the third bridge crossing, all 5 habitats sampled in July were resampled, and an additional habitat was added. At sites 6 and 7, downstream of the town well, only isolated pools remained; all previously sampled habitats with water were resampled. At sites 6 and 7 dissolved oxygen levels were also determined in the remaining habitats with a Yellow Springs Instruments oxygen meter.

Results

At site 6, immediately downstream of the town well, no fish were captured in the isolated pools still present on 30 October (Table 1). Only 52 feet of the originally sampled 231 feet of habitat still had water. Dissolved oxygen levels in the 2 pools within

the July sample area and in one pool upstream ranged between 1.0 and 1.8 mg/1 in the early afternoon (14:00).

At site 7, near the entrance to Muir Beach, 78 feet of the originally sampled 242 feet of streambed still had surface water. Thirty-nine feet of that habitat had dissolved oxygen levels between 1.5 and 3.4 mg/l and only 3 young-of-year (YOY) steelhead were collected. An additional 39 foot long pool/glide habitat had a very slight surface flow into it during the late afternoon and had a dissolved oxygen level of 6.5 mg/1 (@15:00). The habitat contained 11 YOY and one yearling steelhead. No coho were captured, although 1 coho was present at the site in July. Steelhead density at site 7 dropped 92 percent from July to October (Table 1), as over two-thirds of the habitat dried up and poor dissolved oxygen levels were produced in most of the remaining habitat.

At sites 2, 3 and 5 density of fish in resampled habitats had substantially declined from July to October (Table 1). Most of the decline was accounted for by drastic reductions in the abundance of YOY steelhead. The YOY steelhead decline was 89 percent at the single resampled pool at site 2, 68 percent at resampled site 3 habitats, and 51 percent at resampled site 5 habitats (Table 1). Yearling and older steelhead declines were substantially less overall; there was no loss of yearlings at site 2, a 22 percent decline at site 3 and a 50 percent decline at site 5. Newly sampled habitats at sites 2 and 5 showed low October densities similar to those of resampled habitats.

In July coho were collected only at site 3 among the resampled habitats, and no coho were lost from July to October; the same number of coho were collected in each of the 3 habitats where they were present in July.

YOY steelhead and coho showed very small increases in average size from July to October (Figure 1).

Discussion

The October sampling results show the drastic impact of drought conditions and groundwater pumping upon Redwood Creek downstream of the MBCSD well. Most of the streambed was dried, and poor dissolved oxygen levels were present in most of the remaining isolated pools. In July the two sites in the lower mile of stream had substantially higher steelhead densities than sites in the remainder of the stream (Table 1). However, almost all fish were eliminated in the lower mile of stream by October. Fortunately, the loss had little impact on the very weak coho year class, as few coho were present in the lower portion of the stream in July (Table 1).

At upstream sites on Redwood Creek, steelhead numbers also substantially declined from July to October, apparently because

of the effects of very low late summer stream flows. At site 5 both steelhead YOY and yearlings declined by about half. At the other two resampled sites most of the drastic decline in steelhead density was among YOY, rather than yearling fish. In previous studies on many central coast steelhead streams, I have found only more modest declines in steelhead numbers over the late summer, although growth usually stopped and many fish lost considerable weight. Late summer growth halt and weight loss is apparently due to reduction in insect numbers and reduction in the ability of steelhead to feed on drifting insects as flows decline. Severe late summer streamflow reduction in Redwood Creek appears to have not only reduced growth, but also to have starved many of the steelhead, especially YOY. In pools, yearling steelhead, because of their larger size, should be at a competitive advantage over YOY steelhead; this may account for the severe decline of YOY fish compared to yearlings between July and October,

Interestingly, coho density did not decline from July to October. As a pool-adapted fish, coho appear to have high survival in late summer *of* drought years, at least when initial coho densities are low. The results also indicate that coho can successfully compete with steelhead under late summer conditions.

Streamflow conditions in late summer and fall 1994 appear to have been similar to those observed by Hofstra and Anderson (1989) in 1988, with the lower stream sections mostly dry in both years. October steelhead and coho densities at sites 3 and 5 were also very similar between the two years (Table 1). The higher numbers at site 1 in July 1994, compared to October 1988, may be due to the earlier sampling date in 1994. Most importantly, the very weak coho numbers in 1994, compared to 1992 and 1993 (Smith 1994a), are also shown by the 1988 "grandparents" of the 1994 year class. The weak 1994 year class has its origins at least as far back as 1988, and possibly as far back as 1982 or 1976, as suggested by Smith (1994a, 1994b).

Management Implications

The very low coho densities in Redwood Creek in 1988 (Hofstra and Anderson 1989) were similar to those of Waddell Creek in 1988 (Smith 1994b). Waddell Creek apparently lost that year class by 1991, due to a combination of low fish numbers and poor access in 1990-91 (Smith 1994b). Redwood Creek has not lost a coho year class, but 1994 densities were at the same precariously low levels observed in 1988. Since wild coho females are invariably 3-year olds this far south (Shapovalov and Taft 1954), the year class, if it persists, is likely to remain precariously weak. Poor access or a catastrophic drought or flood in 1996-97, or a subsequent year in the three year cycle, could result in the loss of the year class. *If* the strength of the year class is to be rebuilt, augmentation, using hatchery-reared coho, from Redwood Creek broodstock, might be considered for 1997. In addition,

production of 2-year old, hatchery-origin females appears possible, based upon preliminary results on Scott and Waddell creeks, Santa Cruz County, in winter 1994-95; a hatchery rearing effort might be considered for 1998, if the 1997 year class again proves very weak or is extirpated.

Even with agricultural pumping eliminated, pumping by the MBCSD well is apparently sufficient to eliminate most steelhead and salmon from the lower 1 mile of Redwood Creek in severe drought years. Even when isolated pools remain, as in 1992 and 1994, low dissolved oxygen levels eliminate steelhead and salmon; only when surface flow is continuous can substantial numbers of salmon and steelhead survive. In the absence of an alternative domestic water source, significant salmonid losses will continue to occur in severe drought years.

The sharp declines in steelhead YOY densities from July to October in 1994 strongly suggest that between-year comparisons of steelhead densities should be based upon sampling at similar times during the rearing season. Coho and yearling steelhead densities appear to be less sensitive to the date of sampling.

Literature Cited

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Table 1. Density estimates (number of fish per 100 feet) for coho and steelhead collected on Redwood Creek in July and October 1994. Underlined data at each site are direct comparison of same habitats. *Data from 1988 (Hofstra and Anderson 1989) are also included for comparison.

Site		Sample Date	Habitat Types Sampled				Length Sampled	Density		
			Pol	Gld	Run	Rif	(feet)	Coho	Steelhead 0+	Steelhead 1/2+
1.	Upper Muir Woods	26 Jul 94	80%	20%			175	4	40	12
	(Miles 3.3 & 3.6)	*5 Oct 88					233	10	---	18 --
2.	Lower Muir Woods	7 Jul 94	47	32	15	6	256	0	56	15
	(Miles 2.5 & 2.8)		54	46	0	0	35	0	79	9
	< Muir Woods (Mile 2.5)	30 Oct 94	54	46	0	0	35	0	9	9
			75	25	0	0	220	1	14	16
3.	0.35 Mi > Kent Cyn	26 Jul 94	75	13	7	5	179	9	60	9
	(Mile 2.1)		86	0	8	6	148	10	60	9
		30 Oct 94	86	0	8	6	148	10	19	7
		*6 Oct 88					105	11	---	24 --
5.	>3rd Bridge (Mile 1.25)	7 Jul 94	63	10	14	13	136	0	45	14
		30 Oct 94	63	10	14	13	136	0	22	7
			53	25	15	7	177	0	20	8
		*6 Oct 88					98	1	---	23 --
6.	Downstream of Diversions	7 Jul 94	41	36	17	6	231	0	148	9
	(Mile 0.85)	30 Oct 94	isolated pools				231	0	0	0
7.	1st Bridge (Mile 0.35)	8 Jul 94	14	46	30	10	242	0.4	75	4
		30 Oct 94	isolated pools				242	0	6	0.4

Figure 1. Standard lengths of steelhead and coho (C) at Site 5 (Third Bridge) and Site 3 (0.35 mi > Kent Canyon) on Redwood Creek in July and October.

		July		October	
30 - 34	mm	xxxx			
35 - 39		xxxxxxxxxxx			
40 - 44		xxxxxxxxxxxxxxxxxxx		xxxxxxxx	
45 - 49		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx+ 15		xxxxxxxxxxxxxxx	
50 - 54		xxxxxxxxxxxxxxxxxxxxxxxxxx+10		xxxxxxxx	
55 - 59		xxxxxxxxxxxxxxxxxxxxxxx	CCCCCC	xxxxxxxxxxx	C
60 - 64		xxxxxxxxxxxx	CCCC	xxxxxx	C
65 - 69		xxxxx	CCC	xxxxxxxx	CCCC
70 - 74			C	x	CCC
75 - 79			C		CCCC
80 - 84			C	xx	
85 - 89		xxx		x	C
90 - 94		xxxx		xx	
95 - 99		xxxx		xxxx	
100-104		xxxxxxxxxxx		xxxx	
105-109		xx		xx	
110-114		xxx		x	
115-119		xxx		x	
120-124		x		x	
125-129		xx		xx	
130-134		x			
135-139					
140-144					
145-149					
150-154		x			
185-189				x	
190-195				x	
195-199		x		x	
240-244		x			