DISTRIBUTION AND ABUNDANCE OF JUVENILE COHO AND STEELHEAD IN REDWOOD CREEK IN FALL 2001

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ABSTRACT: As expected, juvenile coho were abundant at upstream sites in Redwood Creek in fall 2001. However, overall stream density was substantially reduced because the lower two sample sites, downstream of the Muir Beach well, were reduced to a few isolated, stagnant pools. This was the fourth year since 1992 that a dry or intermittent stream bed affected fish abundance at one or both of the sites downstream of the well. Juvenile steelhead were scarce at 2 of the 3 sites with fish, probably because very low stream flows forced fish into the pools, where the early-emerging and larger coho are able to dominate steelhead.

INTRODUCTION

Both steelhead *(Oncorhynchus mykiss)* and coho *(O. kisutch)* are regularly present in Redwood Creek in Marin County, although their relative abundances vary among years because of differences in spawning and rearing conditions and because of life history peculiarities of coho. Wild southern coho females are exclusively 3 year olds (Shapovalov and Taft 1954). Therefore, the 3 year classes in the 3-year cycle are numerically independent, and each year class may reflect the stochastic effects of floods, droughts or other impacts on previous year classes (Smith 1994A), as well as conditions during the spawning/rearing year. Previous sampling on Redwood Creek has shown strong juvenile coho year classes in two of the year classes (1992/1995/1998 and 1993/1996)(Smith 1996 and Smith 1998B). However, the third year class was very weak in 1988 (Hofstra and Anderson 1989), 1994 and 2000 (Smith 1994B and 2000) and about one-half strength in 1997 (Smith 1997). Similar pronounced and persistent year class variation has been seen in Waddell and Scott creeks in Santa Cruz County and Gazos Creek in San Mateo County (Smith 1994A and Smithl998A).

Summer streamflows in Redwood Creek are also often quite low, with stream bed drying or intermittent flows adversely affecting salmonids in 1988 (Hofstra and Anderson 1989), 1992, 1994 and 1997 (Smith 1997). In October 2001 sites previously sampled on Redwood Creek were resampled. Primary interest was to determine how the lack of spring rain affected summer rearing conditions and absolute and relative abundance of steelhead and coho.

METHODS

Electroshock sampling was conducted on 20 October at two sites regularly sampled on Redwood Creek; one of the sites had been sampled all years 1992-98 and 2000 and the other had been sampled 4 times between 1994 and 2000 (Table 1). Dissolved oxygen levels were determined for the few isolated pools still present at the lower 2 sample sites; the low oxygen levels indicated no salmonids would be present. On 23-24 October the previously sampled (1992-98 and 2000) site near the parking lot of Muir Woods National Monument was sampled by Barren Fong, and his data for previously sampled habitats are included to provide comparisons to previous years. At each site many of the same individual pool, glide and run habitats were sampled as in previous years. Amount of sampled habitat was generally similar to previous years (Table 2). A higher proportion of pools was sampled at sites 3 and 5, reflecting an increase in amount of pool habitat between 1998 and 2000 and the lack of surface flow (riffles and runs) between many of the pools.

Individual habitats or habitat units (i.e. continuous pool/glide sequences) were block-netted and sampled with 2 passes with a backpack electroshocker (Smith-Root Type 7). Salmonids were measured in 5 mm increments (standard length) and released to the habitat from which they were captured. Steelhead young-of-year (YOY) were distinguished from yearlings and older fish by length frequencies at each site. Sampled habitats were habitat typed, and depths and cover rating determined. Densities were estimated from depletion results of the multiple passes.

RESULTS AND DISCUSSION

Habitat Conditions in 2001

Substantial changes in the Redwood Creek channel occurred in 1998 and between 1998 and 2000 (Smith 1998B and Smith 2000), which reduced the amount of riffles and altered many of the pools. However, no channel changes occurred in the relatively mild winter of 2000/2001.

Winter storms ceased early in 2001, and summer stream flows declined quickly and were very low by October. At site 7, near the Pacific Way Bridge, only a single pool remained on 20 October. Water column dissolved oxygen levels at mid day varied between 1.3 and 1.7 mg/1, and no fish were seen. At Site 6, near the Eucalyptus Grove, only 3 shallow (<l/3 m), isolated pools were still present. Water column dissolved oxygen levels at mid day varied between 0.9 and 2.1 mg/l, and no fish were seen.

At site 5, upstream of the 3rd bridge (and upstream of the Muir Beach well) flow was estimated at only 0.03-0.05 cfs, and riffles and runs connecting the pools were very shallow; flow was subsurface between two of the sample pools. At site 3, upstream of Kent Canyon, portions of the channel bed were dry and surface flow was absent between several pools. No salmonids were captured in the isolated pool, although riffle sculpin *(Cottus gulosus)* were common. Flow between the remaining pools was estimated at 0.03-0.05 cfs, and actually increased at the upstream end of the sample reach between 8:45 and 10.30, as if nighttime pumping upstream had lowered stream flow.

Coho

Coho were common at the 3 upstream sites in 2001, with densities varying between 38 and 50 per 100 feet of sampled stream (Table 1). These densities were similar to the overall stream densities for coho in 1992, 1993, 1995 and 1996 (Table 2), and were also typical for the 3 sites in previous strong coho years (Smith1998B). Overall stream density for coho, however, was substantially reduced because no coho were present at the two (largely dry) sites downstream of the Muir Beach well. The results were similar to 1997 (Table 1), when coho were common upstream, but absent from isolated pools with low dissolved oxygen levels at the lower 2 sites (Smith 1997). In 1994 the lower two sites were also intermittent and lacked coho by October, but coho were scarce even in perennial portions of the stream (Smith 1994B). In 1992 most coho were eliminated by streambed drying by November at site 2, the eucalyptus grove downstream of the well, reducing overall stream density of coho in that year.

Coho at sites 3 and 5 were substantially smaller than in 1996-1998 (Figure 1), reflecting the impact of low spring and summer stream flows on food availability. Coho were also smaller in 1997, another dry year, compared to 1996 and 1996 (Figure 1). However, because coho spawn and fry emerge earlier than steelhead, coho were larger than YOY steelhead in 2001 (Figure 2), as they have been in previous years (Smith 1998B).

Steelhead

Overall YOY steelhead density in 2001 was lower than for all previous sample years (1992-1998, 2000) (Table 2), reflecting both low densities at sites with steelhead and the loss of fish at the two downstream sites (Table 1). Only the uppermost site (site 2 at Muir Woods) had YOY steelhead numbers similar to most previous sample years (Smith 1998B). The loss of most YOY steelhead in 2001 at sites 3 and 5 was probably due to the low summer stream flows, which eliminated almost all habitats except pools. The larger coho present in pools are apparently able to successfully suppress YOY steelhead in competition for scarce food resources. In 1997 dry stream conditions also prevented use of habitats other than pools at site 5 (upstream of the third bridge), and resulted in similarly low YOY steelhead abundance (Smith 1997). In 1994 low summer streamflows resulted in severe reductions in YOY steelhead at sites 2-5 between July and October, although coho showed no apparent decline (Smith 1994B).

The few steelhead YOY present at sites 3 and 5 in 2001 were smaller than in previous years, especially compared to 1995, 1996 and 1998, which were wet years (Figure 3). Fish from 1994 and 1997, which were also relatively dry years, were also smaller than in wet years. The smaller sizes in dry years are presumably because insect abundance and the ability to feed on drifting insects are reduced by low spring and summer stream flows.

Yearling densities at sampled habitats were higher than previous sample years at sites 2 and 3, apparently reflecting good overwinter survival due to the mild conditions. This resulted in overall stream densities that were similar to previous years (Table 2), despite the absence of steelhead at the two downstream sites. Yearling steelhead have a substantial size advantage over YOY coho (Figure 2), and can apparently maintain themselves in pools with coho. In 1994 yearling steelhead did not show the severe density declines between July and October that YOY steelhead did (Smith 1994B). In addition, yearling steelhead are able to feed in early spring, prior to drought year stream flow declines and also prior to emergence of YOY coho or steelhead.

MANAGEMENT IMPLICATIONS

The very low late summer stream flows in Redwood Creek in drier years have significant impacts on both steelhead and coho. Both species grow less, and steelhead can be less abundant, even at reaches that do not go dry or intermittent. In addition, at least one of the two sites downstream of the Muir Beach well has gone dry or intermittent, and lost most or all of it salmonids, in 4 of the last 9 sample years (1992, 1994, 1997 and 2001). These significant impacts could become disastrous during a prolonged drought like that which occurred in 1987-1991.

For coho an additional management concern is the recovery of the one extremely weak year class (2000) in the 3 year cycle. The year class substantially recovered between 1994 and 1997 (Smith 1997), but was extremely weak in 2000, apparently due to poor 1997/1998 overwinter survival of juveniles during El Nino floods (Smith 2000). Year classes as weak as that of 2000 are at risk of being lost, as has occurred for coho year classes in Gazos and Waddell creeks in San Mateo and Santa Cruz counties (Smith 1998A and in preparation). For those streams hatchery-reared females (from adjacent Scott Creek) that return as 2 year olds can potentially fill in lost year classes (Smith 1998A). For Redwood Creek, strays or transfers from Lagunitas Creek might be necessary to restore a lost year class.

Adult coho returns in winter 2002-2003 and coho juveniles in late summer 2003 should be carefully monitored to determine the status of the year class. Observations of adult coho should pay particular attention to sizes and sexes of the fish, as most fish are likely to be 2-year old males from the relatively strong year 2001 class. Few 3-year old females are likely to be present, and their number will control egg and juvenile production. Genetic samples from carcasses can be checked for evidence of straying from other streams.

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Table 1. Habitats sampled and density estimates (number of fish per 100 feet) by site for juvenile coho and steelhead in October 2001.

Site	Sample Date	Habitat Types Sampled				Length Sampled (feet)	Density		
							Coho	Steelhead	
		Pol	Gld	Run	Rif			0+	1,2+
2. Lower Muir Woods (Mile 2.8)	23-24 Oct*	67	---12---		21	219	38	24	15
3. 0.35 mi > Kent Canyon (mile 2.1)	20 Oct	95	5	0	0	147	50	3	10
5. > 3rd Bridge (mile 1.25)	20 Oct	71	29	0	0	213	47	4	5
6. Downstream of Diversion (mile 0.85)	20 Oct	isolated stagnant pools				190	0	0	0
7. 1st Bridge (mile 0.35)	20 Oct	isolated stagnant pools				187	0	0	0
Totals		78	15	0	7	1077	27	6	6

* Data from Darren Fong

Table 2. Habitats sampled and estimated mean densities (number of fish per 100 feet) for coho and steelhead on Redwood Creek in 1988 (Hofstra and Anderson 1989) and 1992-1998 and 2000.

Number of Sites	Sample Date	Habitat Types Sampled				Length Sampled (feet)	Density		
							Coho	Steelhead	
		Pol	Gld	Run	Rif			0+	1,2+
4 sites*	Oct 88					436+	5	---16---	
4 sites*	Jun-Sep 92	47	40	5	7	1032	45	23	4
4 sites	Jun-Aug 93	48	25	18	9	951	46	56	4
7 sites	Jul 94	58	25	12	6	1287	2	69	14
5 sites*	Oct 94	83	10	4	3	1018	2	34	6
4 sites	Aug 95	41	30	19	10	796	42	97	4
3 sites	Nov 96	51	31	11	7	604	39	33	11
5 sites*	Sep-Oct 97	72	18	9	1	984	23	15	5
5 sites	Oct 98	58	25	15	1	1174	32	47	4
6 sites	Oct 00	71	27	3	0	1077	1.1	39	15
5 Sites*	Oct 01	78	15	0	7	956	27	6	6

*One or both of the sites downstream of the well were intermittent or dry.

Figure 1. Coho standard lengths (mm) at sites 3 and 5 in 1997, 1998 and 2001 and site 3 in 1996.

	1996	1997	1998	2001
40-44				*3
45-49		*5		******18
50-54	1	***16		*********28
55-59	*4	*****27	**13	**************42
60-64	******22	******32	*********49	**********32
65-69	*****17	*****28	**********53	********24
70-74	*****16	*8	*******35	*****16
75-79	*3	1	**11	*5
80-84		1	*5	1
85-89			2	
90-94			1	
95-99		1		

Figure 2. Standard lengths (mm) of steelhead and coho at sites 3 and 5 on Redwood Creek in October 2001.

	Steelhead		Coho
35-39	**		
40-44	**		*3
45-49	**		******18
55-54	**	age 0+	*********28
55-59	*		**************42
60-64	***		********24
65-69			*****16
70-74	*		*5
75-79	*	age 1+	1
80-84	*		
85-89	***		
90-94	*****		
95-99	**		
100-104	**		
105-109	**		
110-114	*		
115-119	*		
120-124			
125-129	*		
130-134			
135-139	*		
140-144	**		
145-149			
150-154			
155-159	**		
205-209	*		

Figure 3. Standard lengths (mm) of young-of-year steelhead at sites 3 and 5 on Redwood Creek in 1994, 1997, 1998 and 2001 and site 5 in 1995 and 1996.

	1994 n = 53	1995 n = 59	1996 n = 36	1997 n = 41	1998 n= 142	2001 n=12
35-39						**2
40-44	***7			*2		**2
45-49	*******14	*2	1	******12	**7	**2
50-54	***7	*****11	1	*****10	******18	**2
55-59	*****10	*******15	****9	****9	************38	*1
60-64	***6	*******14	********16	*2	*********27	***3
65-69	****8	***6	***6	**5	********25	
70-74	1	***6	*2	1	*****16	*1
75-79		*2			**5	
80-84		*2	1		**5	
85-89		1			1	