5.5.1.4 TREND ANALYSIS FOR JUVENILE AND ADULT STEELHEAD

In their Steelhead Restoration and Management Plan, the California Department of Fish and Game (CDFG) noted the precipitous decline of steelhead populations in most of the coastal streams south of San Francisco Bay.[1] They highlighted the population in the Carmel River as, *"a good example of how fast an anadromous fish population can decline to the point of near extinction"* and attributed population declines throughout the region to *"urbanization and other watershed disturbances, blocked access to headwater spawning and rearing areas, and partial and total dewatering of streams by water diversions and groundwater pumping."*

Past reviews of environmental problems in the Carmel River have led to a general understanding of the principal factors associated with the historical population decline[2] including: 1) Inadequate passage facilities for adults and juveniles at Los Padres Dam; 2) Diversion of surface flows at San Clemente Dam; 3) Subsurface diversion of streamflow which percolates into the Carmel River Aquifer between San Clemente Dam and the Lagoon; 4) Reduction in the number of trees and canopy of the riparian forest downstream of Robles del Rio; 5) Increased erosion of sand and gravel from denuded riverbanks by winter flows; 6) The interruption of streamflow at San Clemente Dam and temporary or seasonally complete blockage of smolt migration past San Clemente Dam in some years when flashboards are raised in the spring; and 7) Deposition of sand in the Lagoon which reduces habitat in it for adults during the winter, for smolts during the spring, and for juveniles during the summer and fall months. Since these reviews, significant progress has been made on correcting many of these problems, but the major problems caused by excessive subsurface diversions of streamflow remain. The purpose of the following sections is to provide a time-series analysis of whether the steelhead population in the Carmel River is recovering from the effects of the 1987-1992 drought and to what extent. This assessment is based on a review of data from historical populations surveys of juvenile steelhead by CDFG and MPWMD, comparisons of the juvenile population to other local and regional streams and on counts of adult steelhead at Los Padres Dam and San Clemente Dam by Cal-Am and MPWMD.

Historical Juvenile Population – As presented in section 5.5.1.2, the CDFG surveyed juvenile steelhead in the reach downstream of Los Padres Dam in 1973 and 1974, and in the reach below San Clemente Dam in 1983 and 1985-87.[3] Lineal population density for the period prior to the 1987-1991 drought averaged 5,878 fish per mile (fpm) and ranged from a low of 3,648 fpm in 1974 to 9,307 fpm in 1986. Population density declined during the drought years of 1987-1991, averaging 683 fpm and dropping to a low of 22 fpm in 1989 (**Table 5.5.1.4-A**). The low population density was indicative of insufficient spawning adults and of juveniles that were trapped in small freshwater refuges during the drought years. Based on captures of resident-type steelhead and observations of fry during the drought, it appears that some of the trapped fish matured in freshwater and spawned without emigrating to the ocean. Others of the trapped fish waited until 1992 to emigrate to the ocean. Following the drought, the juvenile population increased rapidly for the first seven years, averaging 5,890 fish per mile by 1996, but then

[1] McEwan, D. and T. A. Jackson. 1996. Steelhead Restoration and Management Plan for California. Calif. Dept. Fish and Game. Inland Fisheries Division, Sacramento, CA. 234 p.
[2] Kelley and Dettman, 1981; Kelley, Dettman, and Turner, 1982; Snider, 1983; and Dettman and Kelley, 1987; Dettman, 1991; Cramer, S. P., et al., 1995; Bryant, G. J. and J. Lynch, 1996.
[3] Snider 1983, and CDFG office files in Monterey, CA.

decreased slightly to about 4,000 fpm. Since the end of the drought population densities have ranged from about 4,000 to 6,000 fpm, except in two years, 2000 and 2003, when population density averaged 9,700 and 7,700 fpm, respectively. (**Figure 5.5.1.4-A**) Based on available data, it appears that the juvenile population rapidly recovered from low numbers extant during the 1987-91 drought, and now is similar to levels that were common in the 1970's and early 1980's.

Comparison of Juvenile Population to Coastwide, Regional and Local Data -- The density of the juvenile population in the Carmel River can be compared to levels in other steelhead streams in California.

Statewide Comparison: In 1996, the Association of California Water Agencies commissioned a review of the status of steelhead stocks in California, as part of a study to develop recommendations for the National Marine Fisheries Service (NOAA Fisheries) regarding the Service's biological assessment and listing of steelhead under the Endangered Species Act (Cramer *et al*., 1995). This review included a compilation of available data on juvenile steelhead population along the coast of California from the Oregon border, south to Ventura County.[4] Prior to 1987, the density of the juvenile population in the Carmel River was similar to northern California streams, but ranged well below the northern levels during the 1987-91 drought (**Figure 5.5.1.4-B)**. Subsequent to the drought years, the population in the Carmel River increased, but still ranges well below the levels in northern California, where numbers remained relatively consistent during the drought years and post-drought years.[5]

Regional Comparison: Trihey and Associates compiled population survey data from Lagunitas Creek in Marin County during the period from 1970 through 1995.[6] Based on a comparison of selected years, when comparable data is available from the Carmel River, it appears population densities in the Carmel River were once about 50 percent higher than in Lagunitas Creek, but this pattern broke down during the 1987-91 drought. Since the end of the drought, no clear relation was evident, but during two out of those years, population density in the Carmel River exceeded levels in Lagunitas Creek (**Figure 5.5.1.4-C**).

Local Comparison: More locally, D. W. Alley and Associates (2002, 2004) has surveyed steelhead population densities in the San Lorenzo River and Soquel Creek watersheds since 1994.[7] [8] Population density in the main stem portion of the San Lorenzo River, where the

[4] Population data from a wide variety of streams should be compared on a unit area basis to compensate for the effect of stream size.

[5] Data for north coast streams based on Cramer, et al. 1995 (1983-1994); and CDFG 2003 (1995-1999) and includes limited data from the Eel River Basin (1983-1992), the Mattole River Basin (1981,1988-1999) and the Gualala River Basin (1994).

[6] Trihey and Associates. 1995. Abundance of Steelhead and Coho Salmon in the Lagunitas Creek Drainage, Marin County, California. Report to the Marin Municipal Water District, 31 pp.

[7] D. W. Alley and Associates. 2004. Comparison of Juvenile Steelhead Densities, 1997- 2001 and 2003, In the Middle and Upper San Lorenzo River and 4 Tributaries, Santa Cruz County, California; With an Estimate of Juvenile Population Size and an Index of Adult Returns. Report Prepared by D.W. ALLEY & Associates, Aquatic Biology For the Following Agencies; San Lorenzo Valley Water District and the County of Santa Cruz.

[8] D. W. Alley and Associates. 2004. Comparison of Juvenile Steelhead Densities, Population Estimates and Habitat Conditions In Soquel Creek, Santa Cruz County, California; 1997-2003; With an Index of Expected Adult Returns. Report Prepared for the Soquel Creek Water District and County of Santa Cruz Planning Department.

stream is similar in size to the Carmel River, averaged 47 fish per 100 feet (fp100f) of stream over the surveyed years and ranged from an average of 19 fp100f in 2000 to 97 fp100f in 1996. Generally, population density in the Carmel River has exceeded levels in the San Lorenzo River, averaging 99 fp100f over the same time period. Interestingly, the annual pattern of high and low averages was similar in the Carmel and San Lorenzo Rivers prior to 2000, but in following years the population density in the Carmel River has increased to range well above population density in the San Lorenzo River (**Figure 5.5.1.4-D**) This may be due to the biological effects of fine-grained sediment in the San Lorenzo Watershed, where the streambed is chronically affected by excessive erosion and deposition of sand and silt. Average population density in Soquel Creek was lower than in the Carmel River, averaging 26 fp100f during the same period. This difference probably results from a larger stream size, higher baseflow and better substrate conditions in the Carmel River. (**Figure 5.5.1.4-D**).

Population Abundance – Estimates of juvenile population density can be expanded to estimate the abundance of juvenile steelhead in specific reaches, represented by the sampling stations. **Table 5.4.1.4-B** is a compilation and expansion of historical population densities into abundance estimates for seven reaches between Los Padres Dam and the downstream edge of viable habitat near the Narrows. Since 1990, overall estimated abundance averaged 70,500 fish and ranged from 16,000 fish in 1991 to 153,000 fish in 2000 and 2003 (**Figure 5.5.1.4-E**). On average, the population in the reach between the dams averaged 28,700 fish, which represents about 41 percent of the total juvenile population below Los Padres Dam. This abundance is similar to the average abundance estimated by CDFG for 1973 and 1974[9], but is a lower percentage of the total population because habitats downstream of San Clemente Dam are currently maintained by release of stored water from Los Padres Dam. [10] Although the estimated abundance of juvenile fish has increased since 1990, two distinct declines are evident from 1996 to 1999 and following 2000. These declines were probably associated with brief periods of poor to fair substrate conditions affected by high sedimentation rates during and following the 1995 and 1998 floods. During these events high concentrations of fine sediment from Cachagua and Tularcitos Creeks were washed downstream of these tributaries along with sediment from main stem bed and bank erosion, thereby reducing the quality of rearing habitats and number of juvenile steelhead reared during the summer and fall months.

Adult Steelhead Returns -- As described in Section 5.5.1.3, MPWMD has tallied adult steelhead returns at San Clemente Dam since 1993 with the aid of a mechanical/electronic fish

[9] Snider, 1983.

[10] During 1973 and 1974 no streamflow releases were made at San Clemente Dam and habitats below the dam supported only 6,400 juveniles. In contrast, since 1990 the juvenile population below San Clemente Dam has averaged 40,193 fish, or a six-fold increase as compared to 1973 and 1974. The primary factor responsible for this increase has been the restoration of streamflow in the reach upstream of Robinson Canyon. Prior to 1983, no releases were made from San Clemente Dam, but since 1983 the stored water in Los Padres Reservoir has been used to supplement natural runoff during the dry season and to maintain flows below San Clemente Dam. In addition, since 2001, the historical surface diversion from San Clemente Reservoir has been curtailed during the dry season and groundwater pumping from Cal-Am wells in Aquifer Subunits 1, 2 and 3 has been constrained to maximize surface flow in the reach upstream of Robinson Canyon.

counter and tallies prior to 1993 were made visually.[11] At Los Padres Dam, California American Water operates a trap and truck facility to pass adult steelhead over the dam.[12]

San Clemente Dam: Since 1997, the number of adults counted at San Clemente Dam has averaged 604 adults and ranged from a low of 388 fish in 2004 to 861 in 1998, with a clear upward trend during the seven-year immediately following the 1987-1991 drought (**Table 5.5.1.3-A** and **Figure 5.5.1.3-A**). Although the number steadily climbed following this drought, the upward trend appears to have stabilized in the range of 400-800 fish.

During the period from 1962 through 1975, visual counts of adult steelhead at San Clemente Dam averaged 780 fish and ranged from a low of 94 fish in 1972 to 1,350 fish in 1965. While not directly comparable to actual counts from the last reporting period, the index from the 1962 to 1975 period was about 30 percent higher than the average count during the last eight years. Based on this information, it appears recent returns of adults have not reached levels that were common prior to the 1976-77 drought.

No adult sea-run steelhead migrated upstream of the dam during the 1987-90 period and this led to low populations of juvenile fish during 1990 and 1991 (see **Figure 5.5.1.4-A**). In turn, these low juvenile populations produced low numbers of sea-run adults in 1994. The returns following 1994 represented improved production of juvenile steelhead from the 1991 and 1992 broods, good to excellent conditions for survival of smolts in 1993, the positive effect of rescue and transport of almost all smolts in 1994, and production of steelhead smolts from the Carmel River steelhead Association steelhead brood stock program. It is important to note the majority of natural juvenile production from the 1991 and 1992 broods may have been due to stream-maturing steelhead, which were rescued as juveniles from the lower river, transported upstream to permanent habitat and matured without migrating to the ocean.

Los Padres Dam: Historically, the number of adults trapped and transported over the dam averages 96 fish, ranging from zero in several years to 558 in 1962. Since 1997, the number of adults trapped at Los Padres Dam has averaged 190 fish and ranged from 105 fish in 2003 to 347 fish in 2001. (**Table 5.5.1.3-A and Figure 5.5.1.3-B**) The 1997-on average is about twice the average count prior to 1997 and indicates a strong increase in returns to Los Padres Dam. The pattern in **Figure 5.5.1.3-B** indicates that the population upstream of Los Padres Dam has crashed at least twice, once from 1970 to 1977 and again from 1988 to 1994. Each time the population has shown a strong recovery, but the most recent increase may be more robust than the short-lived increase immediately following the 1976-1997 drought.

Watershed Basin Between the Dams: In selected years, the number of adults returning to the watershed between the dams can be estimated by subtracting the number of adults at Los

[11] Prior to 1991, counts of adult steelhead passing the dam are available for 1984 and 1975; since 1963, visual counts of fish in the ladder are available for selected years. These visual counts were made by turning off flow through the ladder and counting adult fish in it. As such, the visual counts are an index of the run, and may be biased due to under- or over-counting. Nonetheless, visual counts are valuable as a relative measure of the run prior to 1975 and the counts in 1975, 1984, and since 1991 provide accurate estimates of the run size, not including fish taken by legal and illegal fishing

[12] Records at Los Padres Dam are available for the years 1949-51, 1962, 1963, 1964, 1975-1978, 1982-86 and 1988-present.

Padres Dam from the number counted at San Clemente Dam. Since 1997, the run of adults in this portion of the watershed averaged 414 fish and ranged from 268 to 739 fish (**Figure 5.5.1.4-F**). Although the estimates are spotty prior to 1991, a comparison of returns before and after 1980 indicates that the adult return to this portion of the basin has not recovered to levels that were common prior to 1980. This is in contrast to the relative pattern for reaches upstream of Los Padres Dam where adult returns have increased.

Overall Assessment of Recovery – Ultimately, the success of efforts to restore the steelhead population will be measured by the abundance and persistence of sea-run adults and by their progeny that live in freshwater as juveniles, prior to seaward migration. Estimates of the capacity of the basin to produce adult steelhead have ranged from 3,500 to 4,200 adults, with habitat similar to conditions in 1975 and 1982.[13] [14] These estimates were made assuming steelhead were provided unhampered access to all available spawning and rearing habitats in the basin, had unrestricted access to the ocean during smolt emigration, and could rear during summer months as far downstream as the Narrows. Establishment of a goal of 3,500 adults is reasonable, if the above assumptions were true. However, the first assumption has not been met for many years due to passage problems at Los Padres Dam, so it is unreasonable to expect that 3,500 adult fish would be produced from the basin in the short term. With impaired passage conditions at Los Padres Dam, a more reasonable expectation is for a total return of 2,600 adults, including: 500 fish upstream of Los Padres Dam; 1,200 fish from the basin between the dams; and 800 fish from habitat between the Narrows and San Clemente Dam. These expectations can be used as a benchmark to gage the effectiveness of restoration efforts and long-term recovery of the resource. Currently, a comparison of the adults counted at San Clemente and Los Padres Dams to this benchmark indicates that the existing adult steelhead population is about one-third of the potential adult production. However, the increasing density and abundance of the juvenile population since 1997, the sharp recovery of the juvenile population since the last drought, and the strength of the juvenile population compared to other coast-wide, regional and local streams indicates that the population is resilient, robust, and recovering.

Although the steelhead population in the Carmel Basin appears to be recovering, a continuing concern remains regarding whether the recovery can persist. Recently, the National Marine Fisheries Service (NOAA Fisheries) assessed and updated the status of listed salmonid species along the western US coast, including the steelhead population in the Carmel River, which is a major portion of the South-Central California ESU.[15] In their assessment of data from the Carmel River they noted a significant positive trend in adult returns over the 1988-2002 period, but opined that the time series was, "too short to infer anything about the underlying dynamical cause of the trend". As discussed in a following section, the persistence of a positive trend most likely depends on the occurrence of flows that are necessary to complete key phases of the steelhead lifecycle, including upstream migration of spawning adults from the ocean and downstream emigration of smolts to the ocean. In turn, the successful completion of these critical life history stages depends largely on the lack of drought periods, especially in the

[13] Snider. W. M. 1983.
[14] Kelley, Dettman, and Rueter. 1987.
[15] National Marine Fisheries Service. Feb 2003. Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead. Draft report prepared by West Coast Salmon Biological Review Team. Northwest Fisheries Science Center and Southwest Fisheries Science Center. 134 pp.

Carmel River where the magnitude of annual water diversions can exceed unimpaired annual runoff. Due to the uncertainty regarding the frequency, magnitude and duration of future droughts, the status of the Carmel River population as well as other streams in the South-Central California ESU continues to be rated at a threatened level, despite the recent positive population trend.

Table 5.5.1.4-A

Density of juvenile steelhead population in the Carmel River, 1973-2003 with a comparison to selected northern California Streams

	Carmel River Lineal Density Indexes [1]			Carmel River Areal Density		North Coast Streams
Year	(no/mi)	(no/100ft)	(no/meter)	(no/sqft)	(no/sqm)	(no/sqm)[2]
1973	6,121	116.4	0.355	0.0486	0.523	
1974	3,648	69.4	0.212	0.0290	0.312	
1983	6,116	116.3	0.355	0.0468	0.503	0.430
1984						0.800
1985	4,966	94.4	0.288	0.0544	0.585	0.550
1986	9,307	177.0	0.540	0.1037	1.116	0.930
1987	5,107	97.1	0.296	0.0492	0.529	0.840
1988						0.810
1989	22	0.4	0.001		0.0003	0.800
1990	733	13.9	0.042	0.005	0.059	0.690
1991	1,294	24.5	0.075	0.014	0.155	0.590
1992	3,098	58.7	0.179	0.034	0.366	0.630
1993	5,075	96.1	0.293	0.050	0.540	1.110
1994	2,713	51.4	0.157	0.025	0.274	0.590
1995	5,281	100.0	0.305	0.050	0.539	0.873
1996	5,890	111.6	0.340	0.040	0.430	1.190
1997	4,359	82.6	0.252	0.031	0.338	0.400
1998	3,901	73.9	0.225	0.024	0.260	0.230
1999	3,403	64.4	0.196	0.026	0.282	0.720
2000	9,680	183.3	0.559	0.063	0.682	
2001	3,716	70.4	0.215	0.027	0.290	
2002	5,734	108.6	0.331	0.047	0.508	
2003	7,738	146.5	0.447	0.062	0.664	
Averages:						
1973, 74, 83, 85-87	5,878	112	0.341	0.0553	0.595	0.710
1989-1991	683	13	0.039	0.0099	0.071	0.693
1992-2003	5,049	96	0.292	0.0401	0.431	0.718

[1] Source: CDFG file reports, Monterey Office and MPWMD files)

[2] Source: 1983-1994 Cramer, et al. 1995; and 1995-1999, CDFG 2003, including limited data from Eel River Basin (1983-1992), Mattole River Basin (1981,1988-1999) and Gualala River Basin (1994).

Table 5.5.1.4-B

Abundance and density indexes of juvenile steelhead population, and length of viable habitat in the mainstem of the Carmel River, between the riverfront and Los Padres Dam, Selected Reaches and Years, 1973 to 2003.

	PROJECTED ANNUAL TOTAL JUVENILE POPULATION										
YEAR	Below San Clemente Dam (Nos.)	San Clemente Reservoir Zone (Nos.)	San Clemente Reservoir to Los Padres Dam (Nos.)	**Overall** (Nos.)	Downstream of San Clemente Dam	San Clemente Reservoir Zone	San Clemente Reservoir to Los Padres Dam	Downstream of San Clemente Dam (Nos./mile)	San Clemente Reservoir Zone (Nos./mile)	San Clemente Reservoir to Los Padres Dam (Nos./mile)	**Overall** (Nos./mile)
1973	8,078		33,396	**41,474**	2.0		5.5	4,039		6,072	5,530
1974	5,316		19,745	**25,061**	2.0		5.5	2,658		3,590	3,342
1983	62,717				9.5			6,595			
1985	15,549				4.2			3,738			
1986	105,913				6.5			16,421			
1987	19,724				4.7			4,215			
1990	9,019		7,254	**16,273**	4.7		5.4	1,927		1,341	1,613
1991	15,295		5,909	**21,204**	8.0		5.4	1,910		1,093	1,580
1992	23,789		14,129	**37,918**	8.0		5.4	2,970		2,613	2,826
1993	43,703		38,737	**82,440**	10.8		5.4	4,043		7,164	5,084
1994	16,177		38,070	**54,248**	8.7		5.4	1,870		7,041	3,859
1995	71,187		21,394	**92,581**	13.8		5.4	5,162		3,957	4,823
1996	58,848		33,234	**92,081**	12.6		5.4	4,659		6,146	5,105
1997	42,134		34,471	**76,605**	11.3		5.4	3,739		6,375	4,593
1998	38,700		26,127	**64,827**	17.5		5.4	2,209		4,832	2,828
1999	38,615		18,740	**57,355**	12.6		5.4	3,057		3,466	3,180
2000	107,173		45,863	**153,036**	13.2		5.4	8,119		8,482	8,225
2001	35,693		20,664	**56,357**	12.8		5.4	2,795		3,822	3,100
2002	52,019	3,161	51,016	**103,035**	11.2	1.4	5.4	4,649	2,274	9,435	6,208
2003	101,980	5,334	51,208	**153,188**	12.6	1.4	5.4	8,113	3,837	9,471	8,521

Figure 5.5.1.4-A

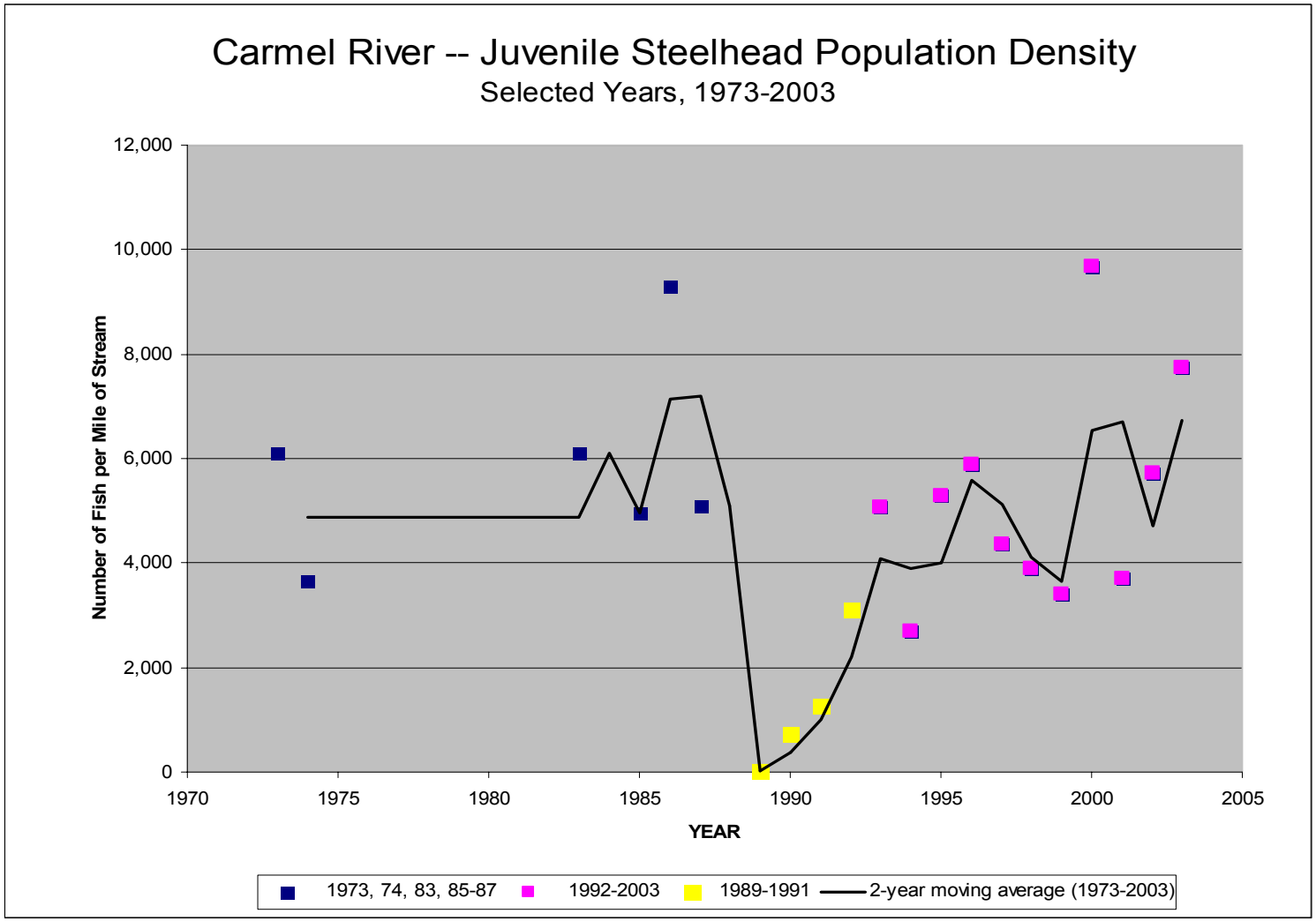
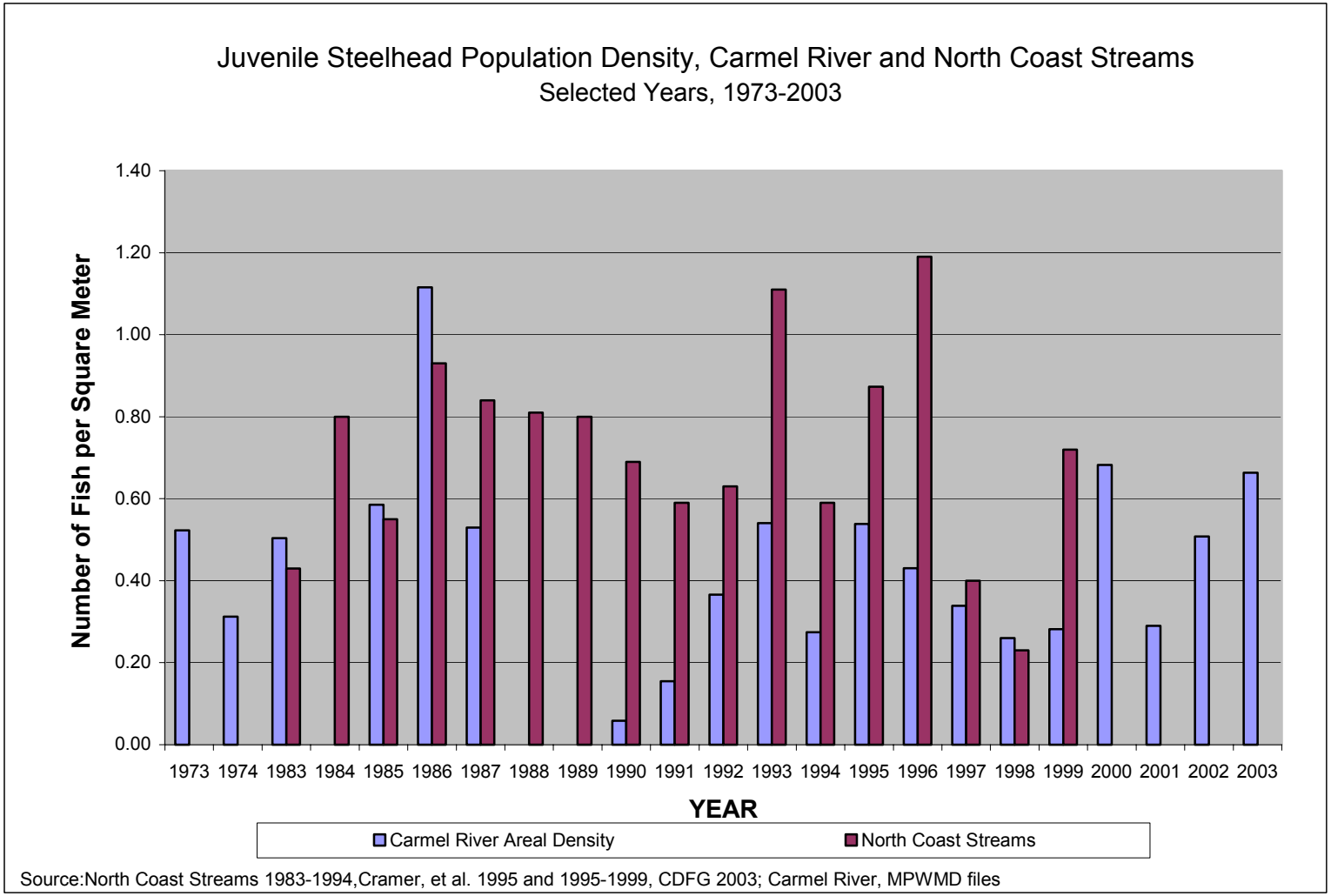


Figure 5.5.1.4-B



Source:North Coast Streams 1983-1994,Cramer, et al. 1995 and 1995-1999, CDFG 2003; Carmel River, MPWMD files

Figure 5.5.1.4-C

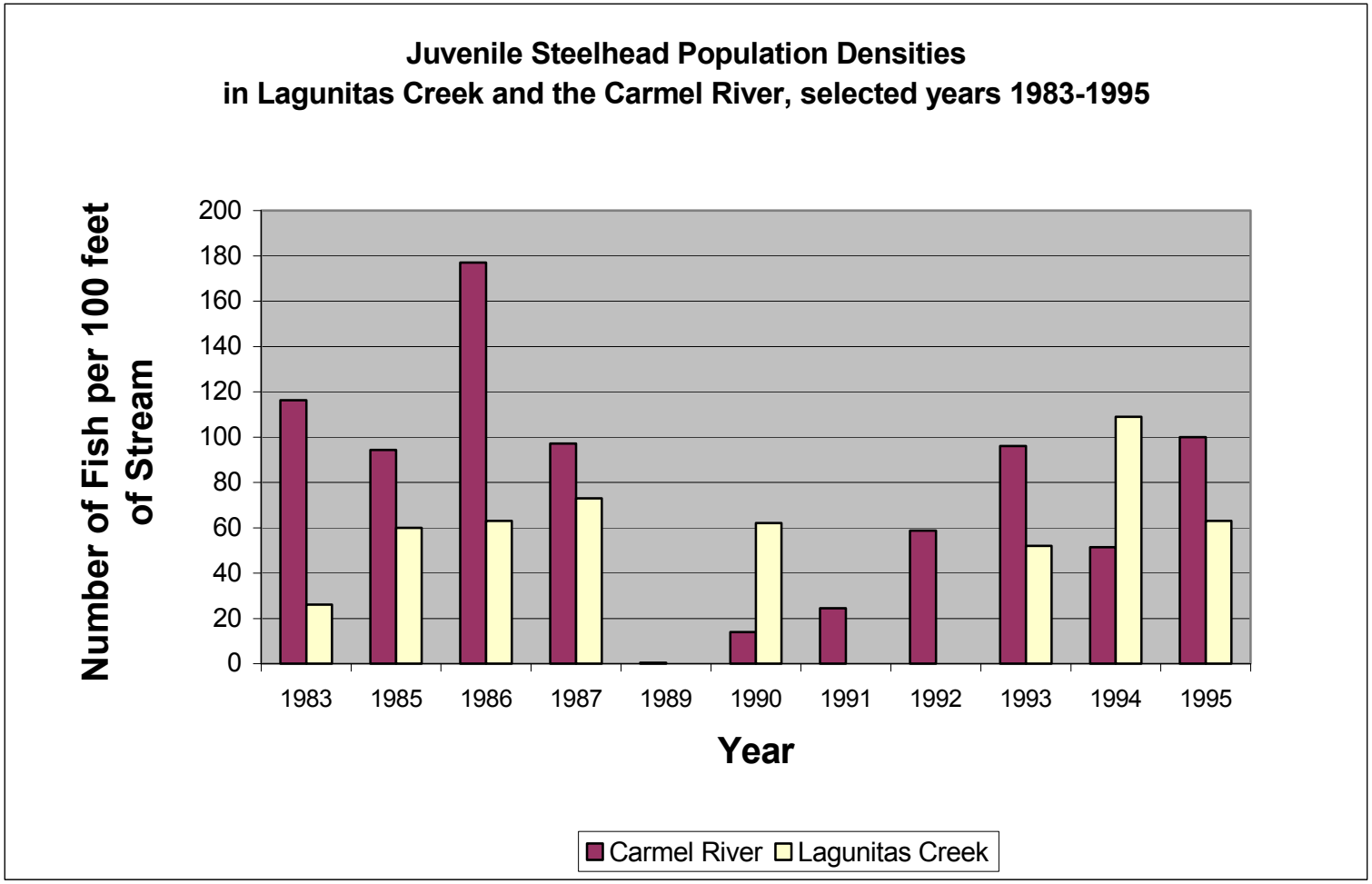
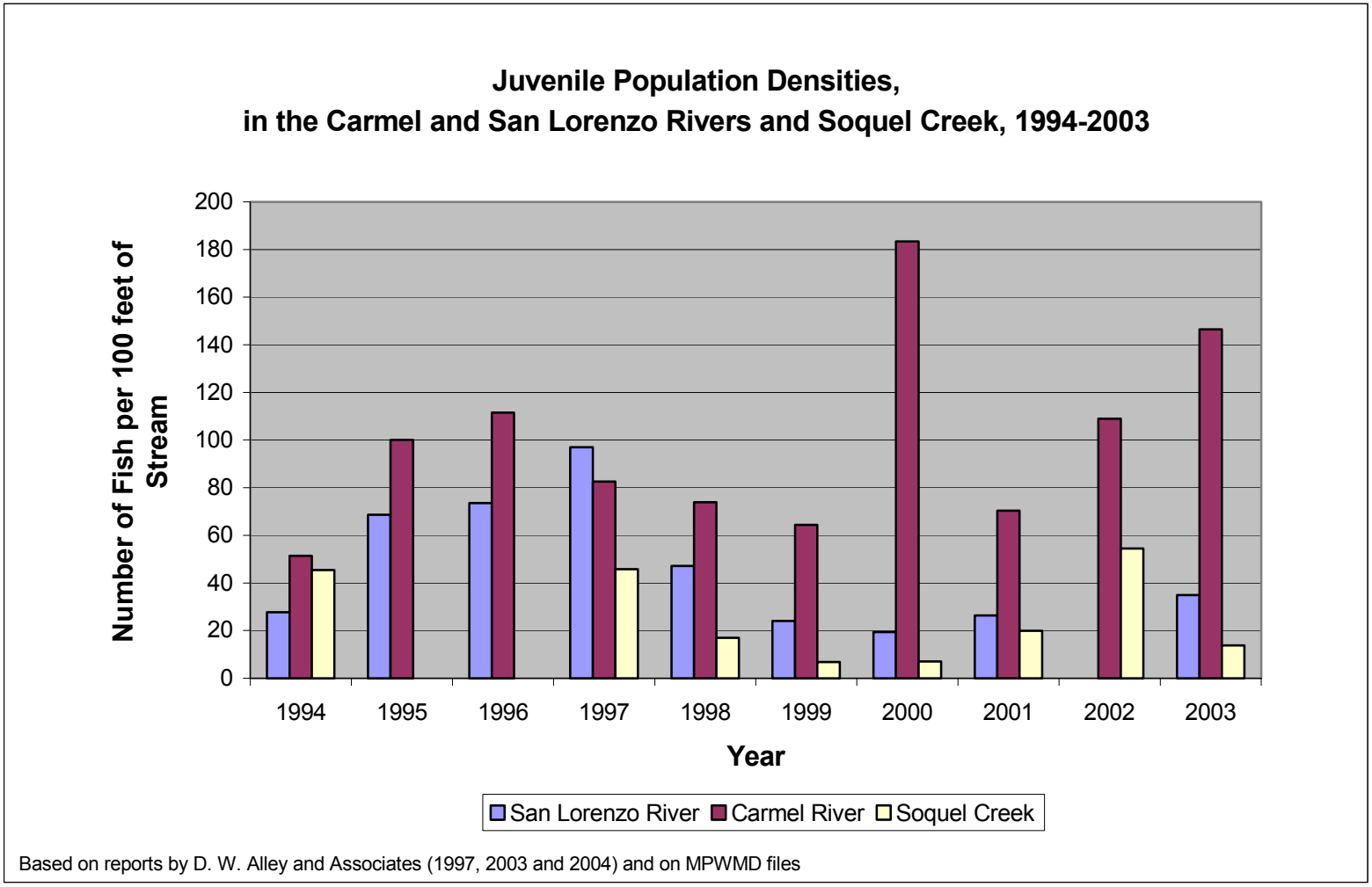


Figure 5.5.1.4-D



Based on reports by D. W. Alley and Associates (1997, 2003 and 2004) and on MPWMD files

Figure 5.5.1.4-E

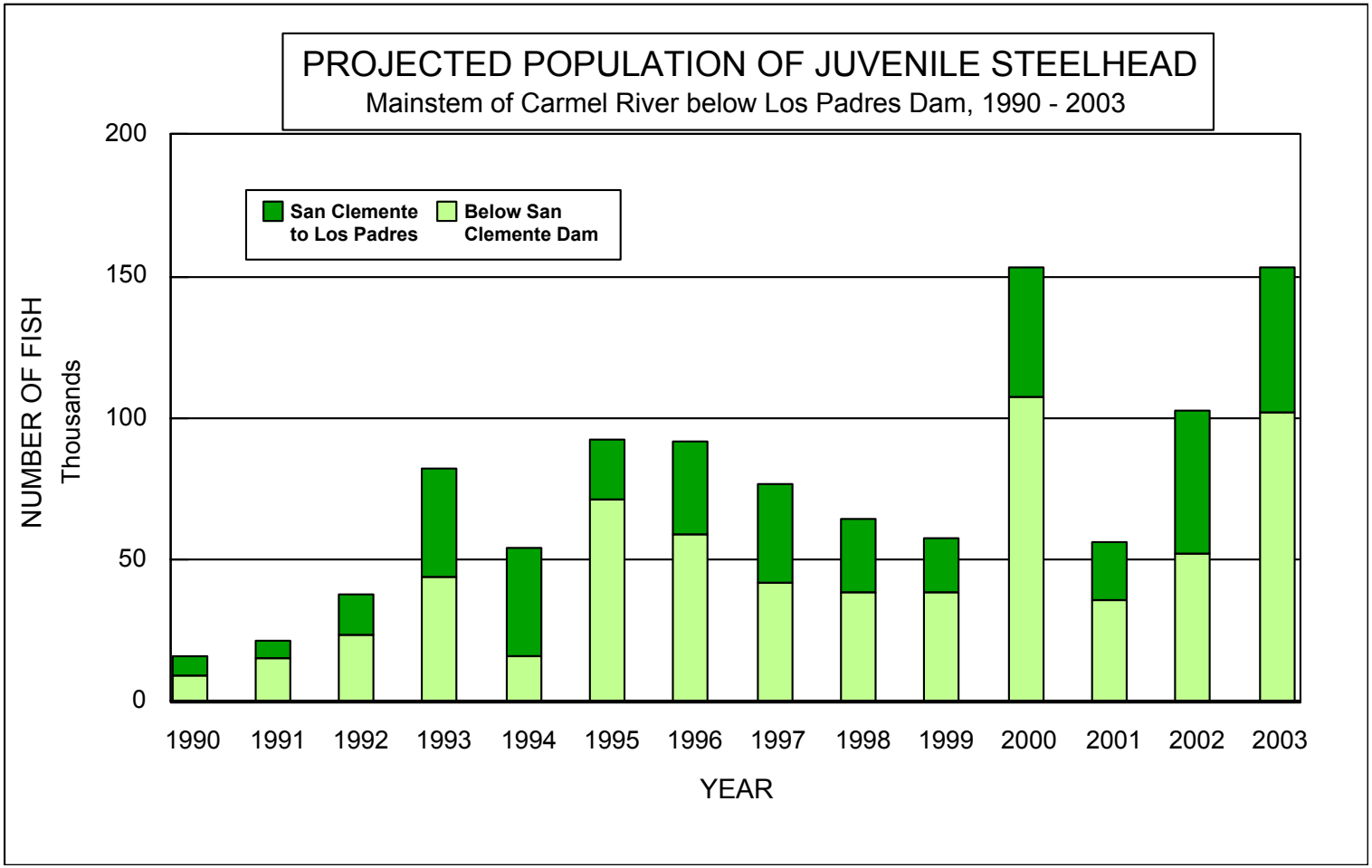


Figure 5.5.1.4-F