Executive Summary

Environmental and Biological Assessment of Portions of the Carmel River Watershed Monterey County, California

Prepared by Monterey Peninsula Water Management District
Under Contract with Carmel River Watershed Conservancy

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Qualitative and quantitative methods were used to assess several indicators of the health and resiliency of the Carmel River main stem. This report provides a baseline of biologic data compiled in 2003 and early 2004 by the Monterey Peninsula Water Management District (MPWMD) from MPWMD records and other publicly available documents. Data and analysis are presented on stream functionality, riparian vegetation, California red-legged frogs (CRLF), steelhead, large wood, water quality, and insects in the channel bottom known collectively as benthic macroinvertebrates (BMI).

Detailed biologic information is sparse prior to the early 1980's, but data gathered since on steelhead numbers and habitat, channel form, water quality, and riparian vegetation are relatively robust. However, information on CRLF and the BMI community is limited, which makes analysis and observations of trends subject to a degree of uncertainty.

Relatively large data sets exist for the following:

- adult steelhead population counts at San Clemente Dam (first report in 1954, some years missing until an automatic counter was installed in 1992)
- adult steelhead population counts at Los Padres Dam (first report in 1949 and most years since)
- main stem juvenile density (1973, 1974, most years after 1983)
- water quality data at the lagoon, San Clemente Dam, and at Los Padres Dam (1991 to present)
- water temperature data at 11 locations

Less extensive data sets that form a baseline include:

- assessment of riparian functions (2003-2004)
- California red-legged frog sightings, surveys, and habitat mapping (1991 to present)
- distribution of large wood in the main stem (2002 and 2003)
- sampling data for benthic macroinvertebrates (1982 and 2000-2003)

Information about the main stem is regularly updated by MPWMD and there are other public and private agencies also gathering data in the watershed. Data presented in this assessment is from records in the possession of MPWMD and it is possible that more information on the topics presented here exists. Because many organizations and agencies continue to gather

environmental data on the Carmel River Watershed, the information presented here should be considered a first step in understanding and assessing the watershed.

It is apparent that many reaches of the river can provide high quality, productive habitat for steelhead; however, the current steelhead population is below historic numbers for the Carmel River and is well below populations found in Northern California coastal streams. Likely factors contributing to this decline include habitat fragmentation and degradation, introduced non-native predator species, impaired fish passage, and water diversions that alter natural streamflows. Other contributing factors may include water and air pollution and events outside of the watershed such as changes in the ocean going steelhead population. However, the increasing density and abundance of the juvenile population since 1997, the sharp recovery of the juvenile population since the 1987 to 1991 drought, and strength of the juvenile population compared to other coastal, regional, and local streams indicates the population is resilient and recovering.

Another species of concern, California red-legged frogs, has recently begun to be studied intensively after its listing in 1996 as a threatened species under the Federal Endangered Species Act. This species is difficult to investigate and its life cycle and population in the watershed is only just beginning to be understood. Although these frogs are found in many areas within the watershed, it is unclear whether the population is growing, shrinking, or stable. Most of the information gathered about this species is from observations in the Carmel River lagoon, along the main stem, and at San Clemente Reservoir.

Surveys of riparian-wetland areas along the nine-mile reach upstream of Los Padres Reservoir show these areas are the least impacted by human influences and remain naturally sustainable. Between Los Padres Dam and the Narrows, a distance of approximately 15 miles, riparian areas appear to be in reasonably good condition, although channel degradation (incision into sediment deposits) immediately downstream of Los Padres Dam and San Clemente Dam has left the root structures of many streamside trees exposed to scour and erosion. In addition, the paucity of spawning-sized gravels and cobbles in these reaches renders portions of the habitat unsuitable for steelhead spawning in an area that should provide significant opportunity for spawning. Between the Narrows and the Pacific Ocean, a distance of approximately 10 miles, much of the riparian-wetland area is functionally impaired due to water extraction and development adjacent to the streambanks.

The cumulative effect of human influences has resulted in a fragmented environment in the lower 27 miles of the river that requires intensive management efforts. Between Los Padres Dam and the Narrows, flow releases from storage are required in summer to maintain aquatic habitat. The lower 10 miles of the river (downstream of the Narrows), where the impacts from water extraction are concentrated, requires irrigation and maintenance of streamside vegetation, reconstruction of streambanks after high winter flows, annual CRLF and steelhead rescues, habitat enhancement activities, and extensive monitoring. Regulation of water extraction from the basin is in effect under orders from the California State Water Resources Board (Order No. 95-10 and subsequent related orders). A program to mitigate for the effects of water extraction on the main stem is carried out locally by the Monterey Peninsula Water Management District under its Mitigation Program.

Riparian (Streamside) Areas

The proper functioning condition (PFC) method for assessing the condition of riparian-wetland areas, which was developed by the U.S. Bureau of Land Management and U.S. Forest Service for use by land managers, was used to assess 37 sites along the main stem from the Carmel River Lagoon to the headwaters. These assessments, which were carried out during Fall 2003 and Spring 2004, confirm that many reaches are currently functioning properly between the Narrows at approximately River Mile (RM, measured from the ocean) 10 and the headwaters at RM 36. However, several reaches downstream of the Narrows are considered "functional at-risk," meaning that without actions to mitigate for the effects of water diversions, these reaches are at risk of becoming non-functional. A map showing the ratings and locations of these assessments and others performed by the Carmel River Watershed Conservancy in the tributaries is included in Section 5.4. "Assessment of Riparian Functions and Conditions."

Since the mid-1980's, points of water diversion during summer and fall have gradually been shifted downstream into the lower river and groundwater extraction from reaches downstream of the Narrows has been increased. This has increased summer and fall surface flow in the 8.6-mile reach between the Narrows and San Clemente Dam, resulting in an increase in aquatic habitat quality, quantity, and diversity upstream of the Narrows. But increased groundwater extraction downstream of the Narrows may have increased vegetation stress in the lower river, resulting in the loss of streamside vegetation and an increase in bank instability.

Between 1986 and 2001, riparian wooded areas within the streamside corridor downstream of San Clemente Dam have increased from an estimated 299 acres (*McNeish,1986*) to an estimated 438 acres (*Christensen, 2003*). This increase is due to natural recovery after an episode of bank erosion between 1978 and 1986 combined with increased surface flows and restoration work by a variety of groups including private property owners and public agencies.

An inventory of large wood (LW), which is defined as branches and pieces of trunks greater than six inches in diameter and five feet in length, was conducted in the channel bottom in 2002 and 2003 between the Carmel River Lagoon and Stonepine Resort at RM 16 (*Smith and Huntington, 2004*). The study, which documented 471 occurrences of LW, showed a considerable range in the frequency of single pieces and accumulations found in each reach, but the trend shows that frequency decreases in the downstream direction. LW in the lower river tended to be larger and more stable than in upstream reaches, a condition that is to be expected as winter streamflows normally increase in the downstream direction and wash smaller pieces out to the ocean. Almost 30% of wood was fostering pool habitat in the bed. About 70% of LW had no significant impact to lateral channel stability. Less than 4% was found to encourage bank erosion. About 7% of LW had been deliberately placed to enhance aquatic habitat.

In general, higher frequencies of LW were associated with higher densities of steelhead, although there were notable exceptions. In reaches where LW was relative abundant, but steelhead numbers were low, it is likely that the availability of LW was not a limiting factor and that other factors such as substrate condition, food availability, and water quantity and quality were more significant.

The riparian corridor between Highway 1 and Schulte Road Bridge remains fragmented and is very thin in some areas (as little as one or two trees wide along the streambank) due to urbanization. In these locations, wildlife mobility is limited by the poor quality and quantity of the riparian corridor. Some streamside areas in the alluvial portion of the river, between the ocean and Carmel Valley Village, continue to come under development pressure as real estate values in Carmel Valley escalate and property owners carve out niches for additional urban living space or seek to stop the natural meanderings of the river. Examples of poor landowner practices include thinning and removing streamside vegetation for view corridors, placing structures adjacent to the stream, and constructing illegal bank protection works.

Steelhead Returns, Spawning, and Juvenile Rearing

The numbers of returning steelhead adults hit a low in the early 1990s, and the run was declared to be nearly extinct by the California Department of Fish and Game (*McEwan and Jackson, 1996*). The number of returning adults has rebounded from the drought years of the early 1990's when only a handful of fish were counted and appears to have stabilized in the range of 400-800 fish. Upstream of Los Padres Dam, adult returns have averaged 190 fish since 1997. Between Los Padres Dam and San Clemente Dam, 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 in the earlier period. Since 1997, the number of adults counted at San Clemente Dam has averaged 604 and ranged from a low of 388 fish in 2004 to a high of 861 fish in 1998, with a clear upward trend during the seven-year period immediately following the 1987-1991 drought. But, the overall population has not reached levels that were common prior to the 1976-77 drought, when the index of adult returns from the 1962 to 1975 period indicates the run was about 30 percent higher than the average in recent years.

Factors limiting the steelhead population include obstructions of fish passage, water diversions from the basin, and degradation of spawning and rearing habitat. The most significant fish passage problems are at the main stem dams and reservoirs, but passage in tributary drainages may also be hindered by poorly designed and constructed culverts. At San Clemente Dam, the fish ladder is outdated and flow across the reservoir sediments if often shallow. Fish mortality occurs as downstream migrants plunge 70 feet over the dam spillway to the pool below. At Los Padres Dam, a trap and truck operation is required for upstream migrants and downstream migrants must slide down a concrete spillway before dropping into the river. Water diversions from the basin reduce flows for adult migration and juvenile rearing. Habitat degradation from within stream channels, loss of riparian vegetation, and reductions in water quality degrade also limit the population.

Estimates based on the amount of suitable habitat available in the basin to produce adult steelhead have ranged from 3,500 to 4,200 adults, with habitat similar to conditions in 1975 and 1982. Comparing the number of adults counted at San Clemente and Los Padres Dams with the capacity of the basin to produce adults indicates that the existing adult steelhead population is about one-third of the potential adult production. Some of the factors that limit the adult population include flow diversions between San Clemente Dam and the Carmel River Lagoon, degraded spawning habitat, fish passage problems at Los Padres Reservoir, sand deposition in the Lagoon, and loss of streamside vegetation.

Most of the tributaries and main stem areas containing spawning habitat have been surveyed, with Chupines and Hitchcock Creeks being notable exceptions. Within surveyed areas, approximately 66.9 miles of stream are accessible to adults in normal and above water years. When no temporary barriers limit upstream migration, adult steelhead spawn in a total of 60.5 miles of stream, including 24.5 miles of the main stem, 30 miles of primary tributaries, and six miles of secondary tributaries. In the remaining 6.4 miles of accessible stream, spawning is limited by water availability in late spring. In dry and some below normal water years, adults probably do not ascend to the uppermost permanent barriers on the primary and secondary tributaries, but utilize the entire 24.5 miles of the main stem up to Los Padres Dam. Those unable to migrate past barriers are forced to spawn below smaller falls and chutes or in the main stem.

It is estimated that the spawning habitat in the main stem can support approximately 2,400 nests, equivalent to a run of 4,800 adults or about 193 spawners per mile of stream. However, 50% of this habitat is located upstream of Los Padres Dam, where disproportionately low returns of adults to Los Padres Dam indicate that spawning habitat upstream of Los Padres Dam has not been fully utilized for many years and that the amount of spawning habitat upstream of the reservoir is most likely not the primary limiting factor. This condition was first noted by CDFG in the 1950's shortly after completion of the Los Padres Dam. Spawning areas influenced by the armoring effect of the main stem dams are estimated to have 25% of the habitat per mile found in similar areas upstream of Los Padres Reservoir. Armoring refers to the coarsening of the channel bottom over time as gravel and cobble is stripped out by high flows with no new gravel and cobble able to pass the dams to replace lost materials. This effect is dramatic in the reaches from Los Padres Dam to the confluence with Cachagua Creek and from San Clemente Dam to the confluence with Tularcitos Creek. In these reaches, much of the channel bottom is covered with boulders and sand, with little spawning sized material visible. Armoring lessens in the downstream direction due to inputs of gravel and cobbles from tributaries and main stem bed and bank erosion.

In most years, 49 to 53 miles of rearing habitat are available in the watershed with approximately one-half in the main stem and the remainder in primary and secondary tributaries. The length of viable habitat is somewhat dependent on flow levels downstream of San Clemente Dam and on the amount of diversion of subsurface flow (i.e., the volume of water pumped from wells). It is estimated that this rearing habitat can support up to 245,000 young-of-the-year steelhead. Similar to spawning habitat, an estimated 42% of juvenile rearing habitat is located above Los Padres Reservoir, where fish densities appear to be much lower than in other areas of the river.

For areas downstream of Los Padres Dam, juvenile density per mile of stream remains 72% of the density found in previous Carmel River studies by CDFG carried out between 1973 and 1986. The juvenile population rapidly recovered from low numbers extant during the 1987-92 drought, and now is similar to levels that were common in the 1970's and early 1980's. Based on annual adult counts and fall population surveys, it is likely that the current juvenile population in the main stem is between 89,000 and 94,000 fish (for comparison, the mean estimate for the entire watershed for 1973 and 1974 was 94,500 fish). It should be noted that the perennial portion of the river may have been shorter in previous surveys, due primarily to water extraction practices. The current population of fish in the tributaries is unknown. For comparison purposes, the main stem juvenile population is 19% of that found in northern coastal streams on a per unit area basis.

In addition to the factors limiting the adult population, juveniles are limited by the amount and quality of rearing habitat, which is directly linked to surface flow and channel conditions. Projects recommended to improve adult and juvenile populations include:

- water supply augmentation for the Monterey Peninsula in order to increase streamflow in the Carmel River
- management of fine-grained sediment entering and moving through stream channels
- passage of coarse-grained sediment around main stem dams
- modification of fish passage barriers
- introduction of large wood into stream channels
- enhancement of habitat insect production
- increase summer/fall Lagoon water levels
- management of water quality (temperature and chemical content) of releases from Los Padres Reservoir

California red-legged frogs (CRLF)

The listing of CRLF in 1996 as a threatened species by the U.S. Fish and Wildlife Service (USFWS) has triggered additional scrutiny of water extraction and land management practices in Carmel Valley and has required development projects to undergo extensive investigations and monitoring for CRLF. Carmel Valley is one of the few remaining locations in California with a significant CRLF population. These frogs, which are the largest native frogs in North America, are found throughout the main stem. Most habitat and animal surveys and sightings of CRLF have been confined to the main stem and Carmel River Lagoon. There have been few surveys in the remainder of the watershed, with the exception of the Santa Lucia Preserve. At the Preserve, surveys of ponds in Potrero, Robinson Canyon, Las Garzas, San Clemente, and Hitchcock Creeks were conducted each spring between 2000 and 2003. All life stages (egg masses, larvae, and adults) have been found in these tributary drainages, but not each year and the trend appears to show fewer sightings each year; however, it is not known if these surveys are directly comparable from year to year.

Limiting factors for this species includes the introduction of non-native species such as bullfrogs, crayfish, bass, and mosquito fish, habitat fragmentation and degradation due to urbanization, and

water extraction practices. Upstream of Los Padres Reservoir, the only known limiting factor for CRLF is the presence of bullfrogs. Limiting factors increase downstream of Los Padres Dam, with the highest number of limiting factors found between Carmel Valley Village and the Lagoon. The number of potential reproductive sites along the main stem varies from year to year and depends on hydrologic conditions. Main stem habitat surveys in 2002 and 2003 showed 67 and 54 potential reproductive sites, respectively, with the majority concentrated around San Clemente Reservoir and in the alluvial reach between the Lagoon and Carmel Valley Village. Actual reproduction occurred in 37% of the sites in 2002 and 52% of the sites in 2003 (*Reis, 2003*).

A recovery plan, which was published by USFWS in 2002, makes detailed recommendations for recovery and sets out five requirements for delisting of the species, including maintenance of a stable population. A minimum of 15 years of data would be needed, which would require a significant monitoring program to document population status.

Water Quality Conditions in the Main Stem and Lagoon

Water temperature has been measured at a total of 11 locations including the Lagoon (two sites), the Narrows, Garland Park, Sleepy Hollow weir, San Clemente Reservoir (three sites), San Clemente Creek, and Los Padres Reservoir (two sites). One of the Lagoon sites has been discontinued due to vandalism.

Chemical and physical data on surface water quality, including temperature, dissolved oxygen (DO), carbon dioxide (CO_2), pH, and specific conductance have been collected since 1991 immediately downstream of Los Padres and San Clemente Dams and at the Carmel River Lagoon. Beginning in 1996, continuous recording temperature sensors were placed at these locations and at two additional locations – Garland Park and the Sleepy Hollow Rearing Facility.

In general, DO, CO_2, and pH levels in the main stem have met Central Coast Basin Plan objectives set by the California Regional Water Quality Control Board. However, average daily water temperature during the late summer and fall commonly exceeds the range for optimum steelhead growth (50-60°F). Monitoring stations in the flowing portions of the river (i.e., excluding the Lagoon and main stem reservoirs) shown that water temperature during these months remains in a stressful range and can reach levels that threaten aquatic life (above 70°F). Linear trend analysis of data from the eight-year period between 1996 and 2004 at the Garland Park station, where water temperature annually exceeds 70°F, shows a slight downward trend in maximum daily water temperature. This may be due to the recovery of the riparian zone upstream and the shade it provides along the river. Water temperature in winter and spring is frequently in the range that is considered optimum for steelhead growth.

Turbidity in the main stem is normally low, except during winter when storm runoff events can elevate turbidity for several days during and after a storm event. Very wet years, such as in 1998, can cause extensive landslides and bank erosion, which can increase turbidity in the main stem for up to several months. More recently, in the reach immediately downstream of the San Clemente Dam, it appears that fine sediment released from the reservoir during drawdown operations has increased turbidity at the Sleepy Hollow weir.

Water quality in the Lagoon typically declines during late summer and fall as freshwater inflows cease and ocean waves start to overtop the sandbar at the mouth of the river. Water temperature often exceeds 70°F, which is above Central Coast Basin Plan guidelines. DO levels also periodically drop below guidelines (not less than 7.0 mg/L), probably due to a combination of increasing water temperature and decomposition of marine organic material washed into the lagoon by high ocean waves.

Benthic Macroinvertebrate Community

The community of insects living in the river bottom, which are called benthic macroinvertebrates (BMI), is an important food source for steelhead and an indicator of water quality. But the study of this community as an indicator of a stream's health is relatively new. For the Carmel River, a limited amount of information is available. In fall of 2000, MPWMD established four sites on the Carmel River to conduct the Carmel River Bioassessment Program (CRBP).

Recommendations

There are several short-term actions (i.e., over the next five to ten years) that the Carmel River Watershed Council may wish to consider that would improve Carmel River habitat quantity and quality including:

- expand the existing program of periodic injections of spawning-sized gravels and cobbles downstream of Los Padres and San Clemente Dams to a level that restores the channel bottom to a condition similar to areas upstream of Los Padres Reservoir;
- implement riparian corridor restoration projects that will establish permanent CRLF habitat;
- actively promote stewardship concepts and projects among river front property owners through peer-to-peer groups and multi-media outreach (newspaper, television, internet, mailings, etc.).

Additional activities that could improve management of the riparian corridor include:

- decrease the sampling frequency for BMI to once per year and add BMI sampling locations upstream of Los Padres Reservoir, at the Pine Creek confluence with the main stem, in a sandy reach in the lower river, and at the Carmel River Lagoon;
- develop a data collection program to document the CRLF population within the watershed;
- investigate whether control or eradication of non-native aquatic species (especially bullfrogs) is feasible;
- develop a database of documents pertaining to the riparian corridor such as reports, environmental analyses, biological opinions, and regulations.

Below are several recommendations that would help ensure a long-term increase of habitat quantity and quality in the main stem of the Carmel River and could help shift the environment

to a more naturally sustainable condition. However, these activities have one or more physical, financial, institutional, or social constraints to resolve:

- investigate means to reduce summer heating of the river as it passes through reservoir areas;
- increase the use of steelhead spawning and rearing habitat upstream of Los Padres Reservoir;
- implement a dredging program or other method to pass bedload (sand, gravel, and cobble) from the upper watershed around Los Padres and San Clemente Reservoirs
- expand riparian forest areas in the alluvial reach between Carmel Valley Village and the Lagoon to increase habitat areas and allow for natural meandering;
- remove San Clemente Dam and the accumulated fine sediments from within the reservoir area and reestablish spawning areas within the channel bottom;
- consider the feasibility of approximating an unimpaired flow condition downstream of Los Padres Dam during the summer low flow season (i.e., a surface flow in the river equivalent to the flow that would occur in the absence of surface and groundwater diversions).

Future Water Supply Projects and Los Padres Reservoir Sedimentation

In 1995, California American Water (Cal-Am) was ordered by the California State Water Resources Control Board (State Board) to reduce its water extraction from Carmel Valley by 20% and to implement actions to end unlawful diversions either by obtaining additional water rights or by obtaining replacement water from other sources. The portion of Cal-Am's water use representing unlawful diversions at the time of the State Board's order was 10,730 acre-feet per year. This is currently a topic of study by Cal-Am and several public agencies, but no definitive timeline for completion of a water supply project or combination of projects is currently available. Initially, any new water supplies for the Monterey Peninsula would likely reduce diversions of water from the Carmel Valley during the dry season thereby increasing flow to the lower river, which would benefit riparian vegetation and aquatic species. However, Cal-Am has no program to maintain surface storage capacity at Los Padres Reservoir, which is currently about 50% filled in with sediment, or at San Clemente Reservoir, currently about 90% filled in with sediment. The progressive loss of surface storage in the future due to sedimentation of the reservoirs will reduce the volume of stored water available to augment dry season flows and dry season releases to the lower river will need to be reduced as a result.

New water supplies would reduce diversions from Carmel Valley and help reduce the dependency on dry season flow releases from storage to maintain flow to the lower river. But as Los Padres Reservoir fills with sediment and summer releases are reduced, existing legal water diversions by Cal-Am and other water right holders could result in dry season river conditions that are similar to current conditions (i.e., intermittent flow in some years between Carmel Valley Village and the Narrows and a dry riverbed downstream of the Narrows in many years).

It is estimated that unless sediment is removed, within 40 to 50 years Los Padres Reservoir will be 100% silted in and have virtually no surface storage capacity. However, the sedimentation rate at Los Padres Reservoir is not uniform over time and significant storage loss can occur in a

single winter season. The planning and implementation of a program or project(s) to cope with the inevitable sedimentation of Los Padres Reservoir and reduced dry season flows could take several years.

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