

**1996-1997 WATER TEMPERATURE MONITORING  
SONOMA CREEK WATERSHED**

**Draft**

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## Executive Summary

This report provides the results of the Sonoma Creek watershed 1996 and 1997 water temperature monitoring program conducted by the Sonoma Ecology Center, Technical Advisory Committee. A description of the monitoring program objectives, methods, results, implications for potential restoration activities, and recommendations for future monitoring activities are discussed. The main purpose of the monitoring program is to identify if summer water temperatures are limiting the once productive steelhead fishery which existed in the watershed. This information, in conjunction with other data evaluating watershed conditions, can be used to assist with identifying potential riparian and aquatic habitat improvement or restoration opportunities.

In the upper watershed, five stream reaches were monitored in 1996 and two stream reaches were monitored in 1997. The results for the reaches which were monitored indicate that:

- ▶ summer water temperatures are probably suitable for rearing steelhead, and are not likely limiting the fishery
- ▶ water temperatures are not optimal, therefore there is reason to investigate opportunities such as riparian re-vegetation, to improve shading and decrease summer temperatures to improve habitat conditions
- ▶ there were few large differences in temperatures at any of the sites monitored, however, Calabazas Creek, Graham Creek, and Sonoma Creek at Sugar Loaf Ridge State Park had the lowest average daily and lowest maximum temperatures, as well as the smallest fluctuation in daily temperatures
- ▶ average daily temperatures, and maximum temperatures were only slightly greater in Asbury Creek, Sonoma Creek at Glen Ellen, and Sonoma Creek at Kenwood sites, although Asbury Creek also exhibited fairly large diurnal temperature fluctuations (about 8 F).
- ▶ mainstem Sonoma Creek at the Developmental Center monitoring site had the highest average daily temperatures and the highest maximum temperatures of the monitored sites

It is important to continue, and if possible, to expand the temperature monitoring program. To-date, thermal monitors have never been installed prior to mid-July. Thus, temperatures during the months of June and early July are unknown, and may be higher than those which have been recorded for the mid-to-late summer months so far. There are also many other tributaries and segments of mainstem Sonoma Creek which should be monitored. The monitoring could take place over a period of several years to provide a good database which is characteristic of the range of temperatures that can be expected.

The temperature monitoring program could also be developed as an excellent educational opportunity for community-based involvement in watershed protection and enhancement issues. With some guidance and over-sight, local residents and schools could assist in many of the temperature monitoring tasks. It is highly recommended that opportunities for greater community involvement be explored by the SEC.

## **Introduction**

The Sonoma Ecology Center, Technical Advisory Committee (TAC) directs and supports activities which foster a comprehensive understanding of the historic and present condition of the Sonoma Valley watershed in order to facilitate wise stewardship. These activities include developing scientifically based plans for the restoration of salmonid fish populations, preservation and restoration of riparian corridors, and the preservation and protection of the quality and quantity of water. The monitoring of surface water temperatures during the low-flow summer period is a critical element in understanding how and where salmonid fish populations may be restored. The TAC initiated water temperature monitoring activities in 1996, and continued the monitoring in 1997. This report provides a description of the monitoring program, results, and implications for potential future restoration activities.

## **Purpose and Objectives**

Water temperature is an important component of fish habitat conditions. If water temperatures are too high, which may occur during the summer low-flow season in coastal California streams, conditions for the survival of steelhead may be impaired, and their distribution in the watershed may be restricted only to those locations where temperatures are suitable. There are no known comprehensive temperature studies which have been conducted on Sonoma Creek or its tributaries, although historically a few “spot” temperature measurements have been collected. The objectives of this water temperature monitoring program are to:

- (1) collect baseline summer water temperature data for Sonoma Creek and its tributaries
- (2) identify where water temperatures may be suitable for steelhead rearing
- (3) determine if summer water temperatures are limiting the steelhead fishery, and if so, where
- (4) in locations where water temperatures may be limiting, determine what the underlying causes (e.g., lack of surface flow, loss of riparian habitat, shallow pool depths, etc.) may be, and develop a plan for enhancement or restoration

In addition to these objectives, the temperature monitoring program may also provide future opportunities for educational involvement through the local schools, the adopt-a-watershed curriculum, or other community programs. Many of the temperature monitoring tasks could be supported by, and perhaps turned over to students, requiring only limited supervision and guidance.

## **Methods**

Thermal monitors were installed at six locations (in 5 different streams reaches -- Graham Creek was monitored at two nearby sites) in 1996, and in two locations in 1997. We selected locations which are in the upper portion of the Sonoma Creek watershed (upstream from the Sonoma Valley Regional Park), which is generally believed to encompass the primary rearing habitat for steelhead (other tributaries and mainstem Sonoma Creek reaches downstream from this area may also provide suitable rearing habitat). The monitoring locations for 1996 and 1997 are listed in Table 1.

**Table 1. 1996 and 1997 Water Temperature Monitoring Locations**

<b>Year</b>	<b>Location</b>	<b>Notes</b>
1996	Sonoma Ck. at Sugarloaf State Park	near horse company; partial record which began in Adobe Canyon, but was moved in late August to Sugarloaf
1996	Sonoma Ck. near Kenwood	upstr. from Morton's Resort
1996	Calabazas Ck.	0.5 mi. upstr. from Hwy. 12
1996	Graham Ck.	0.45 mi. upstr. from confl. w/ Sonoma Ck.
1996	Graham Ck.	immediately upstr. from Sonoma Ck. (Sept.1-Oct.10)
1996	Sonoma Ck. in Glen Ellen	0.5 mi. upstr. of Arnold Dr. bridge crossing in town
1997	Sonoma Ck. at Developmental Center	downstr. from Arnold Dr. bridge crossing at State Hospital
1997	Asbury Ck. at Jack London Village	immediately upstr. from confl. w/Sonoma Ck, at concrete culvert outlet crossing under Arnold Dr.

The monitors used are Hobo (Onset Corporation) data loggers that can be used to record and download water temperature data to computerized programs. The thermal monitors were set to “wake-up” and take a temperature reading at intervals of approximately one-hour during their period of installation. The monitors were installed during the the summer season, typically about mid-July, and were removed in late October.

We selected deeper pool habitats (usually 2 to 3 feet deep), preferably in shadier sections of the stream where available, for the monitoring sites. In this way, the data collected indicates the coolest, and therefore the best temperatures available, for steelhead rearing in the general area or stream reach which was monitored.

## **Results**

For each site, graphs of the 1997 water temperature data are provided in Appendix A, and the 1996 water temperature graphs are provided in Appendix B<sup>1</sup>.

At all sites in both years, the coolest temperatures were approximately 56 F and the warmest temperatures were approximately 72 F. The warmest temperatures always occurred between July and mid-August. By late August to early September water temperatures consistently begin a general cooling trend.

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<sup>1</sup> Note that on some of the temperature graphs there is an initial warm “spike” that may be well above 70-75 F. These spikes occur because the monitors must be turned on using a computer. Therefore, they begin reading indoor air temperatures at the site where they are switched on, and continue to record ambient air temperatures until they are transported to the stream site and installed in the channel.

Inspection of the graphs indicate that average temperatures were very similar at 5 sites; Asbury Creek, Graham Creek, Calbazaras Creek, Sonoma Creek at Sugarloaf, and Sonoma Creek at Kenwood; over the 1996 and 1997 monitoring periods. During the warmer portion of the season, July to mid-August, average temperatures typically ranged between 61-67 F at these sites. For brief periods (several hours) maximum temperatures were occasionally higher than this range, although temperatures were never greater than 69 F, except for a few days in Asbury Creek (71 F) and for a few days in Sonoma Creek at Kenwood (70 F). After mid-August temperatures at these 5 sites typically ranged between 58-63 F.

Temperatures were slightly warmer during the July to mid-August period in Sonoma Creek at Glen Ellen and at the Sonoma Creek Developmental Center monitoring site. Temperatures were typically between 65-68 F at the Glen Ellen site, and 68-69 F at the Developmental Center site. There were many days in 1997 when maximum temperatures equalled or occasionally exceeded 70 F in the Sonoma Creek reach at the Developmental Center. Sonoma Creek at Glen Ellen in 1996 had a few days when temperatures reached 70 F.

Inspection of the graphs also indicates that temperatures have a typical diurnal (change between day and night) range of about 5-7 F. The diurnal range was most moderated (smallest difference between night and day temperatures) on Calbazaras Creek, Graham Creek, Sonoma Creek at Kenwood, Sonoma Creek at Glen Ellen, and Sonoma Creek at Sugarloaf. The diurnal range at these five sites was usually about 4-5 F. On Asbury Creek and Sonoma Creek at the Developmental Center, the diurnal range is greater, up to 7 or 8 F on some days.

From inspection of the 1996 data, there appears to be only a small warming trend, perhaps 2-3 F along mainstem Sonoma Creek between Sugarloaf State Park and the downstream site at Kenwood. Temperatures further downstream at the mainstem Sonoma Creek site in Glen Ellen are perhaps a little cooler than those at Kenwood, and are very similar to temperatures at SugarLoaf Ridge State Park. The 1997 data for Sonoma Creek at the Developmental Center appears to indicate that temperatures continue to warm slightly in the downstream direction. This is reasonable, given that Sonoma Creek begins to flow in a wider channel downstream of the Kenwood reach. Wider channels usually have greater solar input due to less canopy cover, and therefore warmer water temperatures. However, other factors including spingflow and groundwater upwelling, condition and extent of the riparian canopy, color and size of bed materials, and streamflow quantity, can influence temperatures at any given site.

The general interpretation of warming water temperatures between SugarLoaf State Park and the Developmental Center monitoring site should be cautiously considered. The Developmental Center data is from a different year (1997), than either the Kenwood, Glen Ellen, or SugarLoaf State Park data (1996), and therefore, they are not strictly comparable. The relatively small temperature differences between the four mainstem sites may be more a function of micro-habitat conditions existing at the monitoring installation site rather than a trend in temperature conditions which are truly representative of difference between stream reaches. For example, the pool depth at which the monitor is installed can influence water temperatures. Continued monitoring over several years, and a denser network of temperature monitoring sites, could assist in discerning if the apparent warming trend in the downstream direction is truly representative of typical changes in temperature in the downstream direction. However, because the temperature changes are not

very great, this is not a particularly important issue in regards to understanding how the fishery may be affected.

The water temperature data indicates slightly cooler tributary water temperatures than the nearby reaches of mainstem Sonoma Creek. In 1997, Asbury Creek had water temperatures which were about 3-4 F cooler than Sonoma Creek at the Developmental Center. It is interesting to note that the diurnal range of temperatures is greater on Asbury Creek than Sonoma Creek at the Developmental Center during the same periods of time. The reason for this is unknown. In 1996, Calbazas Creek and Graham Creek usually had slightly cooler temperatures than the nearby Sonoma Creek monitoring site in Glen Ellen.

### **Discussion and Implications for Fish Habitat Restoration**

Overall, summer water temperatures are probably suitable for rearing steelhead at all locations which were monitored in 1996 and 1997. Preferred temperature ranges for juvenile steelhead range between 55 F and 61 F (Rich, 1987). Different optimal temperature ranges have been indicated by other researchers and agencies. For example, Department of Fish & Game (Flosi and Reynolds, 1994), indicate a preferred temperature range of 45-58 F for juvenile steelhead. The critical thermal maximum (CTM, temperature at which a fish loses equilibrium and dies) for steelhead is 84.9 F (Lee and Rinne, 1980). Juvenile steelhead can typically tolerate warmer water temperatures than coho salmon (Moyle, 1976). Optimal temperatures for coho rearing are about 57 F (Moyle, 1976) and the CTM is about 84.6 F. Warmer average water temperatures, and large diurnal temperature fluctuations, require more abundant food resources for fish survival because of the resultant increase in their metabolic rate (Brett, 1971; Fausch, 1984).

Steelhead are known to exist in streams with much higher average temperatures than in either Sonoma Creek or the tributary sites which were monitored. For comparison, Appendix C provides 1995 and 1996 temperature graphs from Soda Creek, a stream located in Mendocino County which is tributary to Anderson Creek in the Navarro River watershed. This stream is considered to have temperatures which are marginal for steelhead habitat. However, steelhead are known to rear in Soda Creek. Note that average temperatures in July 1995 were about 68 F and in July 1996 were about 70 F. Maximum daily temperatures were consistently above 70 F in July 1996 and occasionally above 75 F. These maximum temperatures exceed typical maximum temperatures at all Sonoma Creek watershed monitoring sites. Also, the diurnal temperature range, as much as 15 F in June 1996, is much greater than at any of the monitoring sites in the Sonoma Creek watershed.

Thus, it appears that although summer water temperatures are not optimal for juvenile steelhead rearing, they are not a critical factor which is limiting the steelhead fishery at any of the sites which have been monitored thus far. It appears that summer water temperatures are suitable for steelhead rearing as far downstream as the Regional Park and Developmental Center reach of Sonoma Creek. How much further downstream temperatures may remain suitable is unknown at this time, but should be determined by continued monitoring. Identifying opportunities for providing increased shading to reduce summer water temperatures is, at least preliminarily, not a critical factor which will "restore" steelhead habitat. Efforts to restore steelhead populations should probably concentrate investigations related to other habitat conditions which may be limiting the fishery, perhaps improving spawning habitat.

Although stream temperatures do not appear to be a factor which is limiting the steelhead fishery at the sites which have been monitored, opportunities which may arise for re-vegetating or improving the riparian

corridor should always be considered. Temperatures are not optimal, and if reduced, could improve habitat conditions. There are also other benefits to riparian habitat improvement which go beyond providing shade and cooler water temperatures. These benefits may include increased streambank stability, decreased potential for sedimentation, increased input of large woody debris to improve habitat diversity, and increased habitat for avian species. Such benefits should not be overlooked when considering the relative value and cost-effectiveness of riparian restoration activities.

### **Future Temperature Monitoring Program Efforts**

It is important that the temperature monitoring program efforts continue, at least for several years. The results provided thus far are only preliminary, based on two years of data in a limited portion of the watershed. Although the results indicate that temperatures are at least suitable for steelhead rearing, the monitoring program should continue in order to:

- (1) provide temperature data in the months of June and through mid-July
- (2) determine the downstream extent of suitable temperatures for rearing on mainstem Sonoma Creek
- (3) identify which tributaries that have not been monitored provide suitable, or not suitable, temperatures for rearing
- (4) determine the annual variability of temperatures that occur from year to year over the typical range of summer streamflow conditions (drought years, wet years, average years)
- (5) provide comprehensive baseline data on temperature regimes, and identify if there are sites subject to unsuitable temperature conditions due to water extraction
- (6) confirm the results which have been obtained at the sites monitored thus far

Unfortunately, we have not been able to schedule our time to install thermal monitors earlier in the summer season and thereby collect temperature data for the months of June to mid-July. This leaves a significant hole in our database, because water temperatures can be quite warm during this early summer period. Soda Creek (Appendix C), has some of its highest temperatures in June and July. Whether or not higher temperatures may similarly occur in the Sonoma Creek watershed during the earlier part of the summer season cannot be determined unless we begin the monitoring in June.

During the next monitoring season, data should be collected at some points further downstream from the mainstem Sonoma Creek site at the Developmental Center. Temperatures may be suitable for rearing steelhead some distance downstream. Alternatively, temperatures may be unsuitable, but could be improved to provide rearing habitat. Temperature data from sites further downstream are needed to make these determinations. Similarly, many tributaries have not been monitored, but may provide opportunities for either restoration or conservation of existing conditions to protect steelhead habitat. Therefore, new tributaries should continue to be selected for thermal monitoring.

As the monitoring program goes forward, it is advisable to re-monitor at previous sites so that we can determine how temperatures may change from year to year at the same site, given different streamflow conditions. At the present time, we have had at least one average and probably one wet streamflow year. By re-monitoring some of the same sites where data was collected in 1996 and 1997, we can determine how temperatures may fluctuate as annual streamflow conditions vary. This will also provide some continuity for interpreting data between different years. Unfortunately, none of the sites monitored in 1997 were the



same as those monitored in 1996. In addition, some continuity and overlap of monitoring sites over several years will increase the confidence we have in our data and in the interpretation of results.

As residential development and land-uses for vineyards and other agricultural activities continues in Sonoma Valley, it may become increasingly important to have baseline data which indicates the range of stream temperatures for a given stream reach. Extraction of surface water for irrigation, and pumping of water from wells, can have an influence not only on water quantity, but also on temperature. A thermal monitoring program provides an “early warning system” to detect undue changes in stream temperatures that may adversely affect the fishery.

It is recommended that new thermal data loggers be purchased in order to carry out the temperature monitoring program. At present, the SEC has only two thermal data loggers. At least 4 or 5 additional data loggers should be purchased to proceed with the program to achieve the objectives described above in a reasonable period of time. Since thermal data loggers are occasionally washed-out or are vandalized, purchase of more than 4 or 5 monitors would provide some “insurance” for completing a monitoring program in perhaps the next five years.

The SEC should consider opportunities to allow local residents or schools to participate in the monitoring program. There is ample room for student educational opportunities including installing data loggers, downloading and graphing data, preparing reports, and interpreting the results. Assistance and guidance from an instructor, professional biologist, hydrologist, Department of Fish & Game personnel, or other knowledgeable individuals would be required. If a student or citizen-based monitoring program, with limited professional guidance cannot be enacted, SEC may alternatively consider obtaining grant funding specifically for a comprehensive temperature monitoring program. Grant funding could be used to provide professional assistance with the implementation, data interpretation and reporting tasks.

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**APPENDIX A: 1997 TEMPERATURE GRAPHS**

**APPENDIX B: 1996 TEMPERATURE GRAPHS**

**APPENDIX C: 1995 & 1996 SODA CREEK TEMPERATURE GRAPHS**

