

**Soquel Demonstration State Forest
Instream Temperature Monitoring 2002
East Branch of Soquel Creek, Fern Gulch Creek and Amaya Creek**

METHODS

Hobo and Stow-Away temperature data loggers (Hobos) were installed at various locations in Soquel Demonstration State Forest (SDSF) in order to continuously monitor stream water and air temperatures throughout the dry season. Hobos recorded temperatures from May 31, 2002 to October 25, 2002.

Locations and Installation

Monitoring locations were chosen based on the following criteria:

- Locations that would demonstrate stream temperature variations of Soquel Creek as it flows through the forest, as well as the temperature of Amaya Creek and Fern Gulch Creek;
- Locations of fish refugia (deeper, shaded areas with cover).

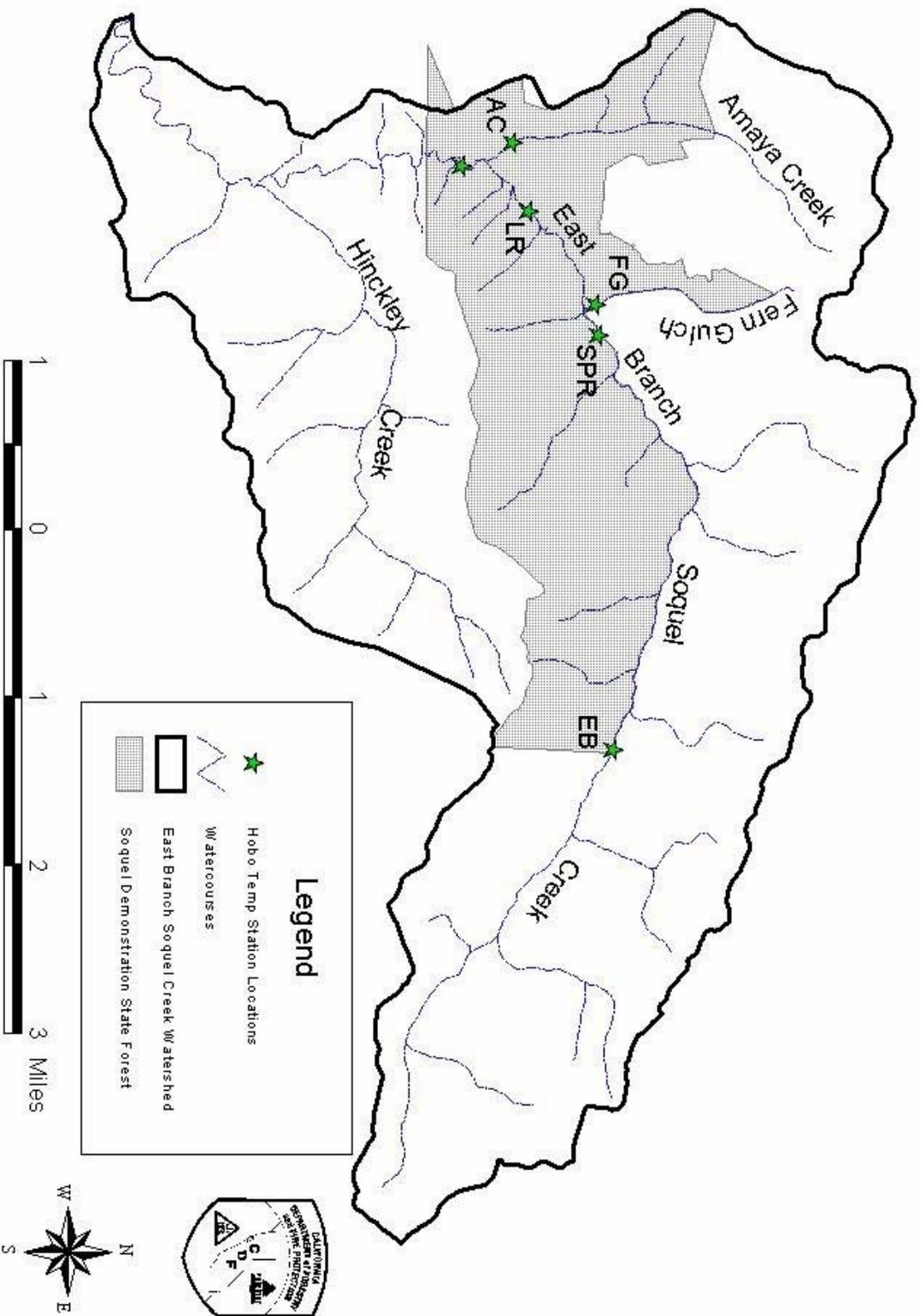
The last criterion was especially important because high water temperatures contribute to lower salmonid survival rates, and fish retreat to these locations to escape warm water temperatures.

Each Hobo was sealed in a clear plastic canister full of clean dry gravel and (except where otherwise indicated) tightly attached to a rock with baling wire, placed in the stream, and covered with cobbles. This method of attachment was used to keep the Hobos submerged throughout the dry season and to hide them to avoid tampering. Included in the canisters were the name of the site and an SDSF business card with "if found please call" written on it. The Hobos were placed in the canisters so that the red light (which indicates it is recording) could be seen from the outside. Red polka dotted flagging was hung at each site to facilitate relocation.

This year canopy readings were made by an ocular estimation at each Hobo site. Hobo locations were the same approximate sites as previous years (see map). Hobo locations were as follows:

East Boundary - on the east branch of Soquel Creek near the boundary between SDSF and Redwood Empire lands. A green sign on Hihn's Mill Road indicates the property boundary. From there, the pink flagging can be followed downhill to the creek. At the creek are two pink flags tied to a tree. Downstream from the pink flags is a slide descending from Highland Way, a car body and a large debris jam (about 75 feet long and 12 feet high). The data logger was placed 115 feet downstream from the two pink flags at the

Hobo Temperature Data Logger Stations Map



upper end of the debris jam in a small pool (about one foot deep) formed by large woody debris. This site had roughly 20% shade canopy. The Hobo was under large woody debris and did not receive any solar radiation.

Spanish Ranch - on the east branch of Soquel Creek at Spanish Ranch Crossing. Approximately 78 feet upstream from the bottom of the electro-fishing station, under the roots of a clump of redwood trees in a pool on the left bank (looking downstream). This site had almost 100% shade canopy and received no direct sunlight.

Spanish Ranch Air - in redwood clump (mentioned above) approximately 12 feet above the creek level.

Longridge Crossing - approximately 500 feet downstream from Longridge Crossing where a redwood log has fallen across Soquel Creek creating a small bridge that is used as a trail crossing. Approximately 10 feet downstream from the fallen redwood log on the left side of a large pool, the Hobo temp was tucked under some downed woody debris, which was marked with red polka dotted flagging. This location has approximately 70% shade canopy. The Hobo received no solar radiation because it is tucked under a log with cobbles placed on top.

Southwest Boundary - east branch of Soquel Creek 965 feet below the bridge crossing. Placed in an undercut bank under the third alder root wad, about 30 feet downstream from where the rock face ends on the right bank. This site is mostly riffle habitat with very little water deeper than ten inches. The shade canopy at this location was estimated at 85% with no solar radiation reaching the Hobo logger.

Fern Gulch Creek - approximately 472 feet upstream from the confluence of Soquel Creek and Fern Gulch Creek. The Hobo temp was placed in a small pool (created by a log across the creek) on the right side beneath the undercut bank, which is marked with red polka dotted flagging. This site had approximately 80% shade canopy and the Hobo received no solar radiation. To reach the confluence, head towards Soquel Creek from Hihn's Mill Road approximately 200 feet west of Sawpit Trail. This spot is marked on Hihn's Mill Road with red polka dotted flagging.

Amaya Creek - approximately 245 feet upstream from the confluence with the east branch of Soquel Creek. Two large redwood slabs form a shallow pool; one slab forms a spillway, and the other forms the overhanging left bank. The Hobo was placed under the latter log and was fully protected from solar radiation. This location had approximately 30% shade canopy.

Interval

All Hobos were "launched" to record for six months, which BoxCar Pro 4.3 automatically sets for a two-hour interval depending on the make of the Hobo temp. Longridge Crossing, East Boundary, and Fern Gulch Creek were automatically set on half-hour interval readings.

Data Analysis

All data were downloaded in BoxCar Pro 4.3 and exported to Excel for graphing and analysis. Temperature measurements taken during transport to and from monitoring sites were eliminated. A rolling seven-day average was calculated and graphed over the raw temperature readings. This number was calculated for each data point as the average temperature for the previous 3.5 days and following 3.5 days. With twelve temperature measurements taken in a 24-hour period (or 48 if the Hobo temp was taking half-hour readings), the resulting number is an average of 84 (or 336) data points. The seven-day rolling average historically has more closely corresponded with fish success than straight temperature readings, because it reflects the duration of high temperatures. All temperature data displayed in the following tables is from absolute data, not from the 7-day rolling average.

RESULTS

Results are shown on graphs in the appendix. These graphs were taken from the data tables, which are too large to be printed but can be viewed on a computer screen. All Hobo data are on the SDSF computer hard drive - C:\FILE CABNET\Hobo Reports\Hobo Temps 2002\2002 Hobo Excel Data.

Data for the Southwest boundary were not recorded and are depicted in each table by N/A. The Southwest boundary Hobo temp was launched with a new battery, but must have experienced an internal malfunction during the four months. In previous years the Hobo temps have not always recorded data for the full four to six months. When reviewing data from prior years, N/A indicates that the Hobo temp did not record the data properly or no data were collected for the site.

DISCUSSION

The highest temperatures were recorded from the middle of July to the middle of August. High temperatures (°F) for each site are shown below in Table 1 for 2001 and 2002.

Table 1. High Temperatures (°F), Date, and Time by Site for 2001 and 2002

Site	High Temp. 2001	Date(s)	Time	High Temp. 2002	Date(s)	Time
East Boundary	64.91	7/03,7/04	15:59	62.85	7/14	15:24
Spanish Ranch	70.82	7/03	17:04	68.73	7/10	17:20
Longridge Crossing	70.39	6/19,6/21,6/29	16:00	61.48	7/(10,11,13,14,17,19,24,25,26,27,28,29,30,31) 8/01	All times of the day
Southwest Boundary	N/A	N/A	N/A	N/A	N/A	N/A
Fern Gulch Creek	61.48	7/03,7/04	13:00	60.80	7/9,7/10,7/12,7/13	15:24 to 19:24
Amaya Creek	68.73	7/03	15:05	66.12	7/10	15:18
Spanish Ranch Air	85.52	7/02	13:00	85.52	7/09,8/10	15:19

Maximum water temperatures were lower in 2002 than 2001. In both 2001 and 2002, temperatures were higher at the Spanish Ranch site. The Longridge Crossing site had the greatest decrease in temperature from 2001 to 2002. Temperature fluctuations throughout the monitoring period were extreme in both the lower and upper portions of the watershed. In the past, the most extreme temperature fluctuations were in the lower portions of the watershed. Table 2 shows the total fluctuation in temperature, from the highest and lowest temperatures recorded for each location, during the entire 2002 measurement period.

Table 2. Temperature Extremes (°F) by Station for 2002

Site	High Temp	Low Temp	Fluctuation
East Boundary	62.85	47.53	15.32
Spanish Ranch	68.73	50	8.73
Longridge Crossing	61.48	53.19	8.29
Southwest Boundary	N/A	N/A	N/A
Fern Gulch Creek	60.8	48.96	11.84
Amaya Creek	66.12	47.76	18.36
Spanish Ranch Air	85.52	43.95	41.57

Table 3 lists by station the most extreme fluctuations in temperature within one day during the 2002 monitoring period. The largest water temperature fluctuation within one day was 8.73°F at the Spanish Ranch location. Spanish Ranch Air temperature fluctuated 31.74°F in one day. Temperature fluctuations were greatest during heat waves from the beginning of July through August, and began to decrease at the end of September.

Table 3. Most Extreme Temperature (°F) Fluctuation within One Day by Station in 2002

Site	Date	High	Low	Difference
East Boundary	9/13/02	55.97	51.08	4.89
Spanish Ranch	7/9/02	67.86	50	8.73
Longridge Crossing	6/5/02	60.8	55.97	4.83
Southwest Boundary	N/A	N/A	N/A	N/A
Fern Gulch Creek	7/9/02	60.8	55.28	5.52
Amaya Creek	7/9/02	65.54	57.25	8.29
Spanish Ranch Air	8/12/02	79.01	47.27	31.74

Water temperatures above 70°F make it difficult for coho salmon and steelhead trout to extract oxygen from the water. Optimal rearing temperatures for juveniles are 45-58°F for steelhead and 53-58°F for coho (Resner and Bjornn, 1979). For the sake of comparison, it is interesting to note the number of days recorded at 70°F or higher and 58°F or higher (see Tables 4 and 5, respectively). Since the monitoring period varies from year to year, these tables' comparisons have been adjusted to reflect the same time period in 2001 and 2002. Table 4 shows that in 2002 the Hobos recorded no days with water temperatures above 70°F, while in 2001 there were five days with temperatures over 70°F. Table 5 shows that compared to 2001, there were several more days in 2002 above 58°F at the Spanish Ranch, Longridge Crossing, and Amaya Creek sites. Table 6 presents a comparison of the peak high temperatures from 1997 to the present. The most notable temperature increase is the air temperature for the Spanish Ranch location.

Table 4. Comparison of Number of Days above 70°F by Station for the Same Time Period in 2001 and 2002

Site	No. of Days at or above 70° in 2001	No. of Days at or above 70° in 2002
East Boundary	0	0
Spanish Ranch	2	0
Longridge Crossing	3	0
Southwest Boundary	N/A	N/A
Fern Gulch Creek	0	0
Amaya Creek	0	0
Spanish Ranch Air	80	91

Table 5. Comparison of Number of Days above 58°F by Station for the Same Time Period in 2001 and 2002

Site	No. of Days at or above 58° in 2001	No. of Days at or above 58° in 2002
East Boundary	89	82
Spanish Ranch	117	123
Longridge Crossing	111	121
Southwest Boundary	N/A	N/A
Fern Gulch Creek	66	44
Amaya Creek	99	118
Spanish Ranch Air	98	145

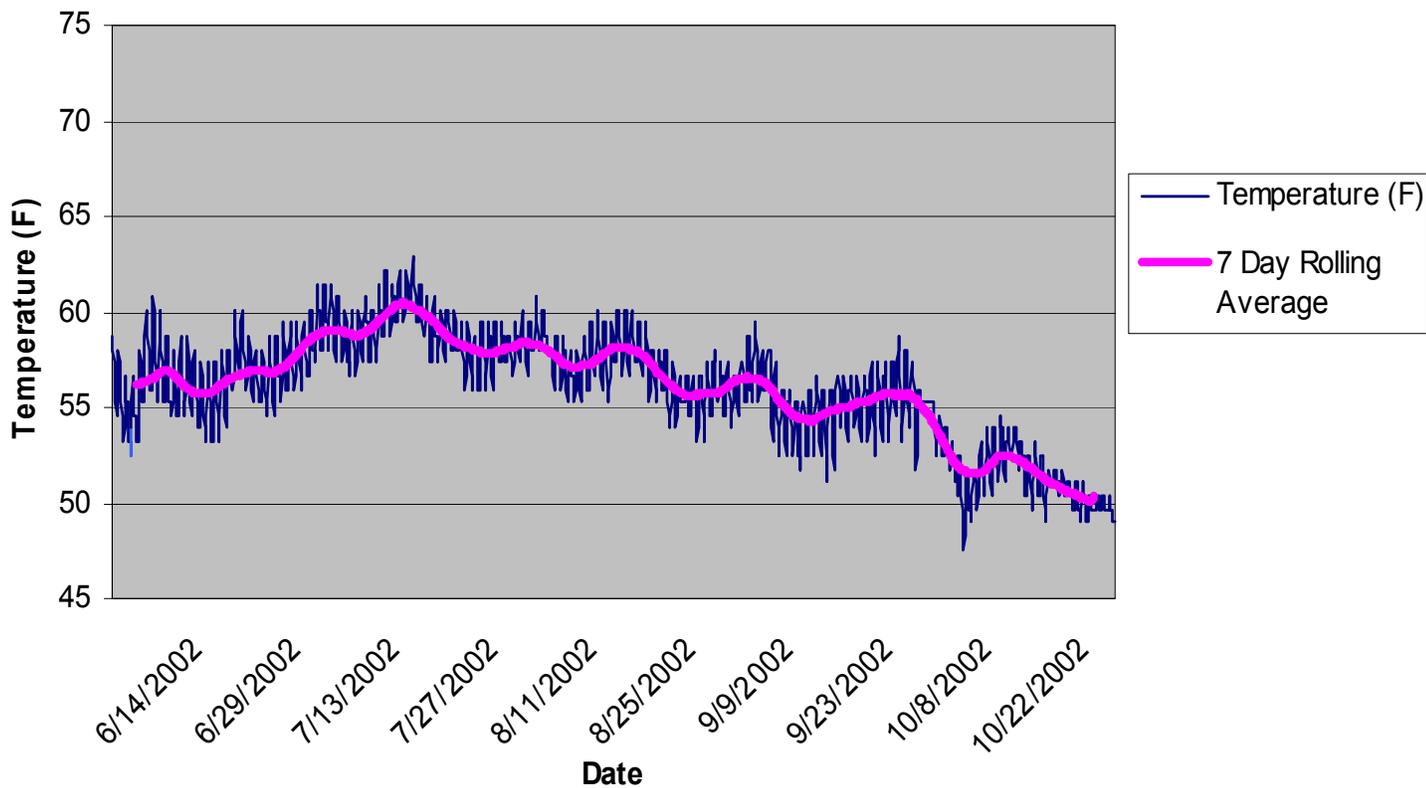
Table 6. Comparisons of Maximum High Temperatures by Site for 1997, 1998, 1999, 2000, 2001 and 2002

Site	Temperature (F)					
	1997	1998	1999	2000	2001	2002
East Boundary	67.45	67.45	63.68	N/A	64.91	62.85
Spanish Ranch	67.86	70.22	66.41	66.9	70.82	68.73
Longridge Crossing	N/A	N/A	N/A	N/A	70.39	61.48
Southwest Boundary	73.8	76.35	71.28	N/A	N/A	N/A
Fern Gulch Creek	N/A	N/A	N/A	N/A	61.48	60.8
Amaya Creek	66.41	68.44	66.99	62.36	68.73	66.12
Spanish Ranch Air	75.06	79.01	83.55	81.59	85.52	85.52

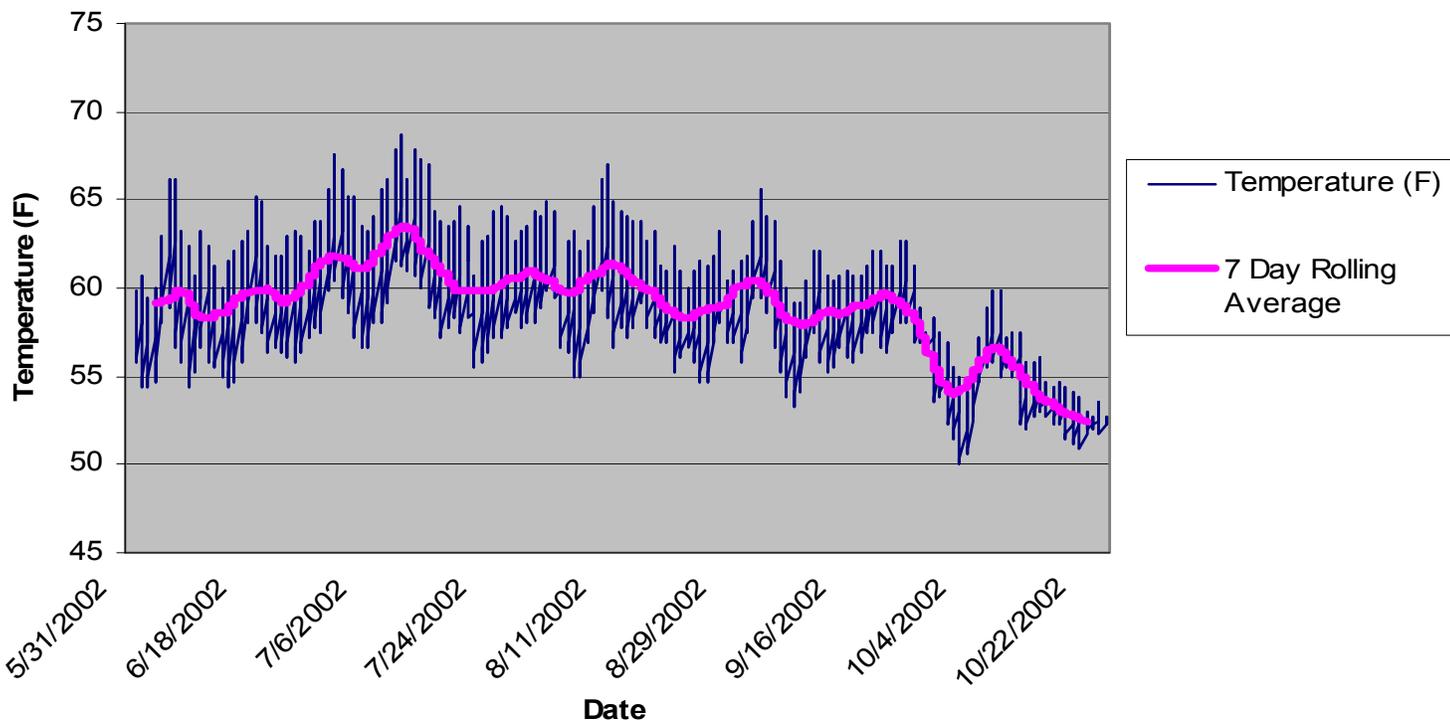
Suggestions for Next Year

Comparisons and trends can best be monitored when methods are repeated closely, particularly matching start and stop dates for monitoring. In 2001 Brad Valentine, Fisheries Biologist for the California Department of Fish and Game, suggested putting the data loggers in June 1 and taking them out in mid to late October, since water temperatures can be highest as early as June 1. In 2002, the Hobos were placed in the watershed in late May and were not removed until the end of October. In the future, the Hobos will continue to be placed in the watershed during these months. Heavy winter rains can rearrange the monitoring sites and make them hard to find again. Another site can be substituted as long as it has similar habitat type and cover. The winter rainstorms for 2002/2003 have already been very intense. The Longridge Crossing location has been drastically changed. As a result, it may be necessary to find a new Hobo location for this site and possibly for some of the other Hobo sites in May.

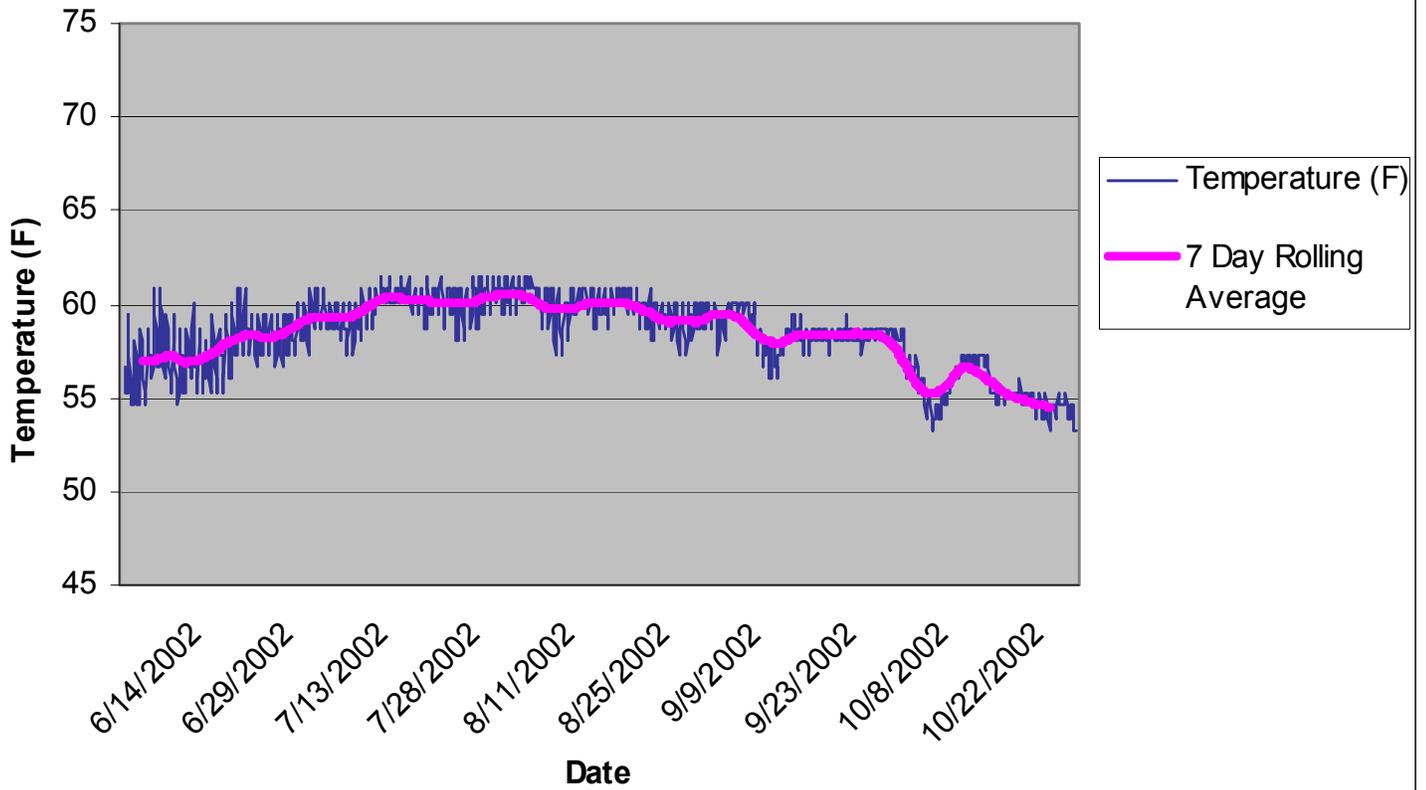
East Boundary Temperatures 5/31/02 to 10/25/02



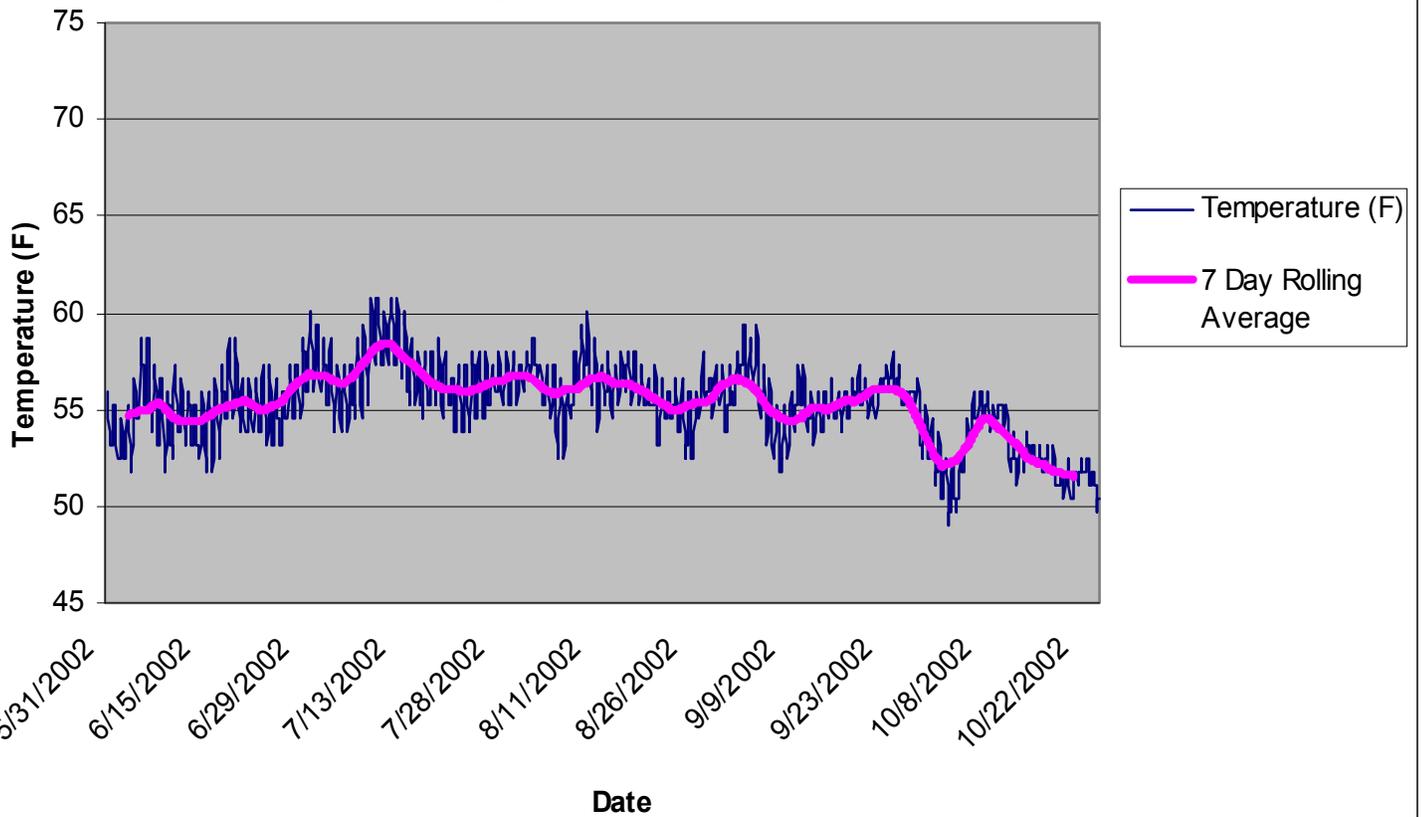
Spanish Ranch Temperatures 5/31/02 to 10/25/02



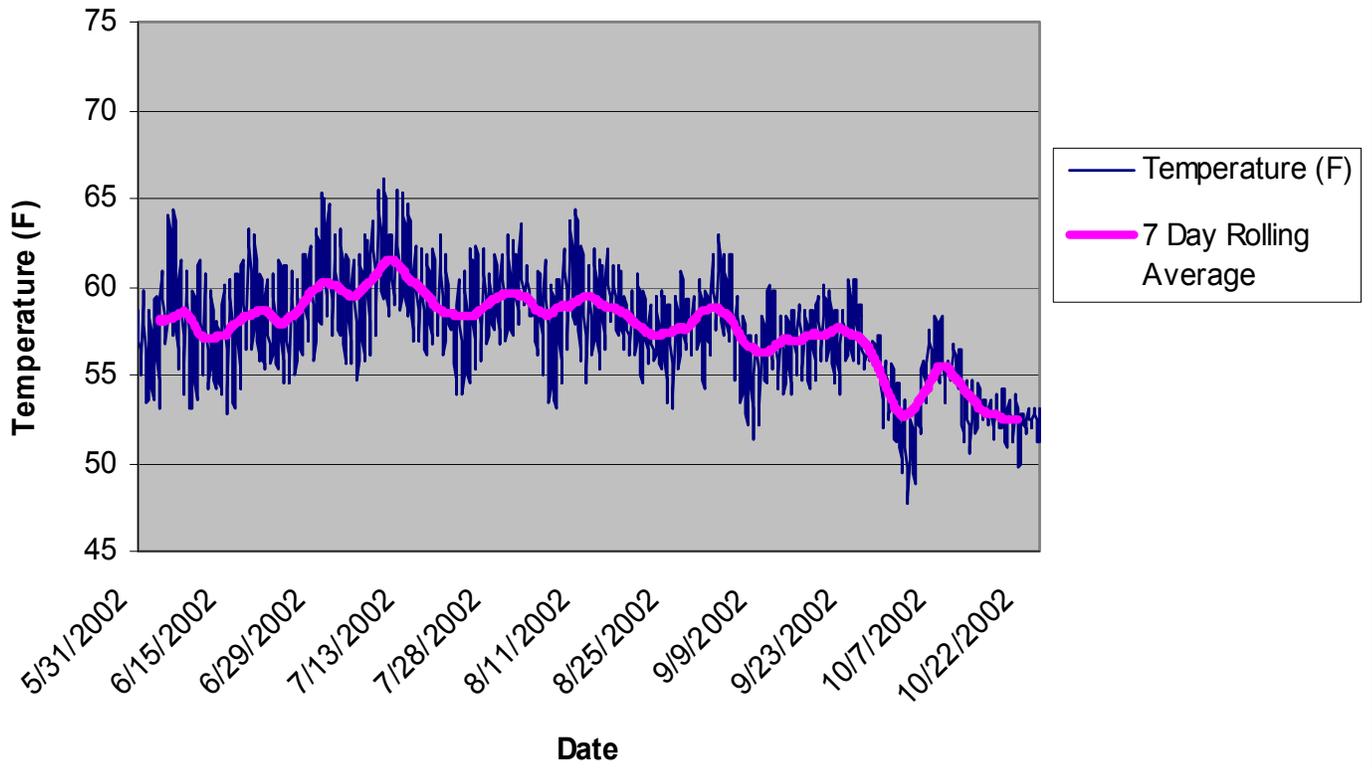
Long Ridge Crossing Temperatures 5/31/02 to 10/25/02



Fern Gulch Temperatures 5/31/02 to 10/25/02



Amaya Creek Temperatures 5/31/02 to 10/25/02



Spanish Ranch Air Temperatures 5/31/02 to 10/25/02

