

Preliminary Analysis of  
Daily Maximum Water Temperature  
at Selected USGS Gaging Stations  
in Mendocino County

The U.S. Geological Survey (USGS) collected daily water temperature data at 17 stream gaging in Mendocino County. Most of the water temperature data was collected during the period from 1966 to 1979. The following table lists the USGS stations where daily water temperature was collected.

Station Name	Drainage		Gaging Station Status
	Area Sq-Mi	Period of Temp Record	
* Garcia River near Point Arena	98.5	1964-79	Discontinued
* Navarro River near Navarro	303	66-68,70-79	Active
* Noyo River near Fort Bragg	106	1966-79	Active
Middle Fork of Ten Mile near Fort Bragg	32.9	1965-73	Discontinued
East Fork Russian near Calpella	92.2	1965-79	Active
East Fork Russian near Ukiah	105	53-55,65-68,73-92	Active
Russian River near Hopland	362	1965-79	Active
Russian River near Cloverdale	503	1965-69	Active
Black Butte River near Covelo	162	1964-76	Discontinued
Middle Fork Eel above Black Butte	204	1966-70	Discontinued
Middle Fork Eel below Black Butte	367	1952-67	Discontinued
Middle Fork Eel near Dos Rios	745	1968-84	Active
Elk Creek near Hearst	84.1	1965-73	Discontinued
Eel River above Dos Rios	705	1962-82	Discontinued
* Elder Creek near Branscomb	6.5	1967-79	Active
South Fork of Eel near Branscomb	43.9	1961-70	Discontinued
South Fork of Eel near Leggett	248	1966-79	Active

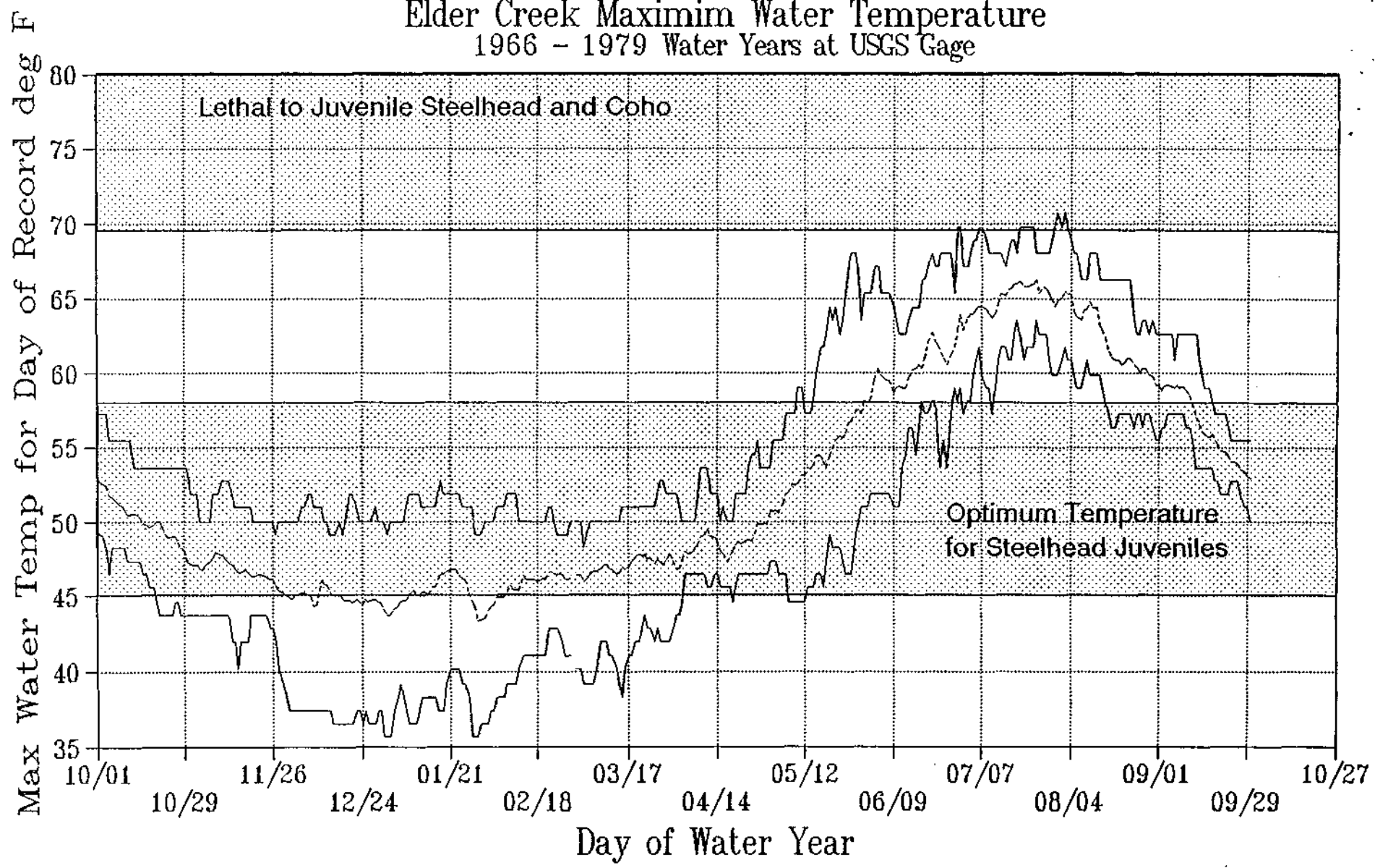
The four stations marked with an asterisk in the above table were selected for the preliminary analysis. Only the daily maximum water temperature record was used in this analysis.

#### Description of Selected Watersheds

Elder Creek is one of 57 Benchmark Watersheds nationwide. Benchmark Watersheds are small undeveloped basins selected to provide consistent data on hydrology including water quality and flow. Elder Creek is tributary to the South Fork of the Eel River. It lies about six miles north of Branscomb and lies about ten miles from the ocean. It has a drainage area of 6.5 square miles. Most of the Elder Creek watershed is contained in a Nature Conservancy preserve.

The Garcia River is located near Point Arena. The upper watershed is used for timber production and some ranching. There is some agriculture and dairy activity in the lower watershed below the gaging station. The watershed above the gaging station

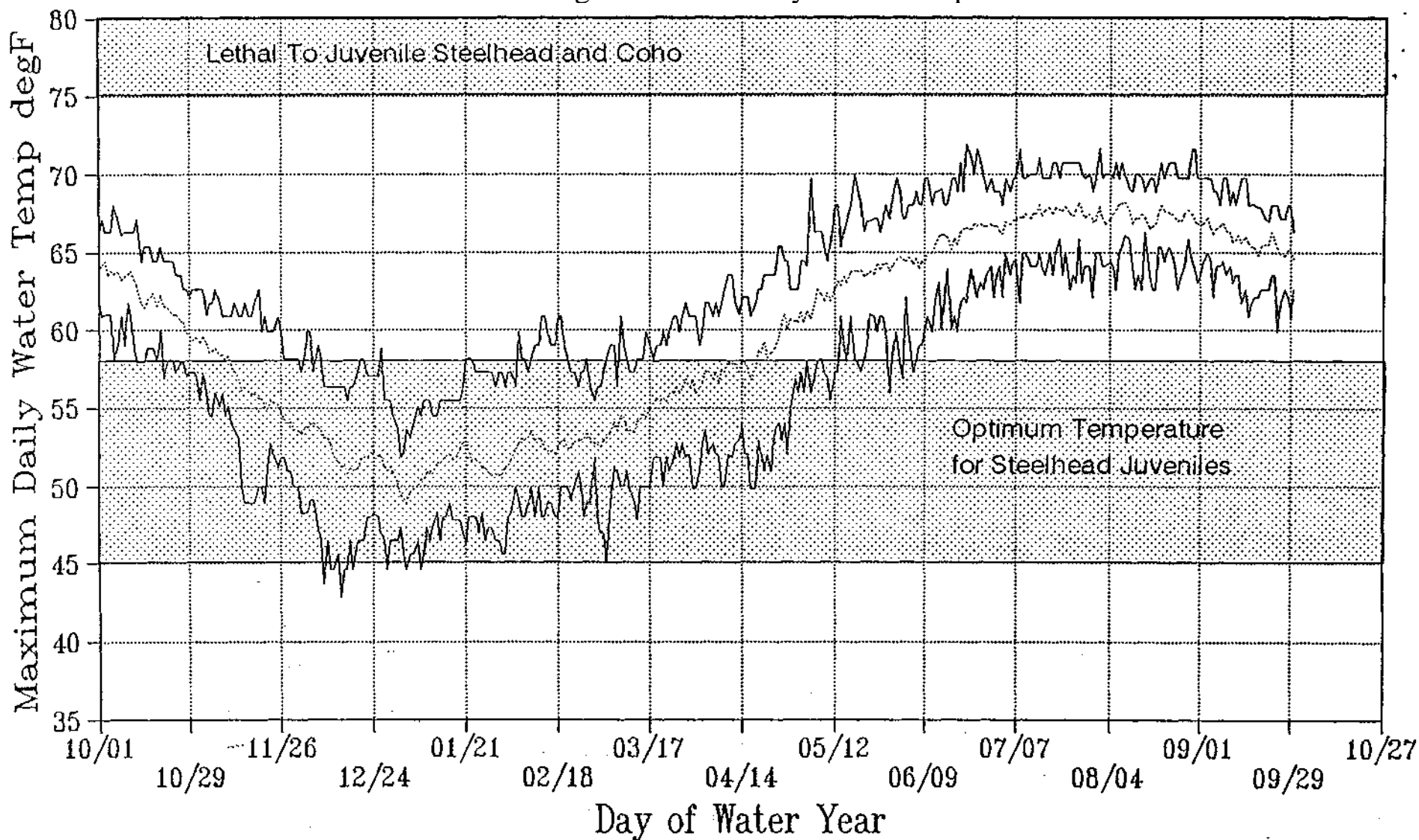
# Elder Creek Maximim Water Temperature 1966 - 1979 Water Years at USGS Gage



—— Greatest Max Temp
- - - - - Avg Max Temp
—— Lowest Max Temp

FIGURE 3

Garcia River at Former USGS Gage Site Max Daily Water Temp: WY1964 - WY1979



— Greatest Max Temp    - - - Mean Max Temp    . . . Lowest Max Temp

(98.5 square miles) is lightly populated. The San Andreas Fault runs under the river for about nine miles. The fault appears to contribute ground water to the river. There is at least one known hot spring in the bed of the river. Studies by Barry Hecht indicate that the summertime discharge per square mile of the Garcia is about twice that of other coastal streams in Mendocino County.

The Noyo River is located near Fort Bragg. The upper watershed is used for timber production with limited ranching. The upper watershed is lightly populated. The drainage area above the gaging station is 106 square miles.

The Navarro River runs along Highway 128 and enters the ocean south of the Town of Mendocino. The communities of Booneville, Philo and Navarro are located in the watershed. The drainage area above the gaging station is 303 square miles. The watershed is used for timber production, orchards and vineyards. The watershed is moderately populated with the majority of the people residing in the Anderson Valley.

The lower portion of Table 2 summarizes the characteristics of the four selected watersheds.

#### Water Temperature Data

Table 2 shows the monthly average of the daily maximum water temperature for the four stations. The period of record is shown for each month. The percent of the time measurements are available for each month is also listed.

Figure 1 is a graph of the monthly average maximum water temperature for the four stations.

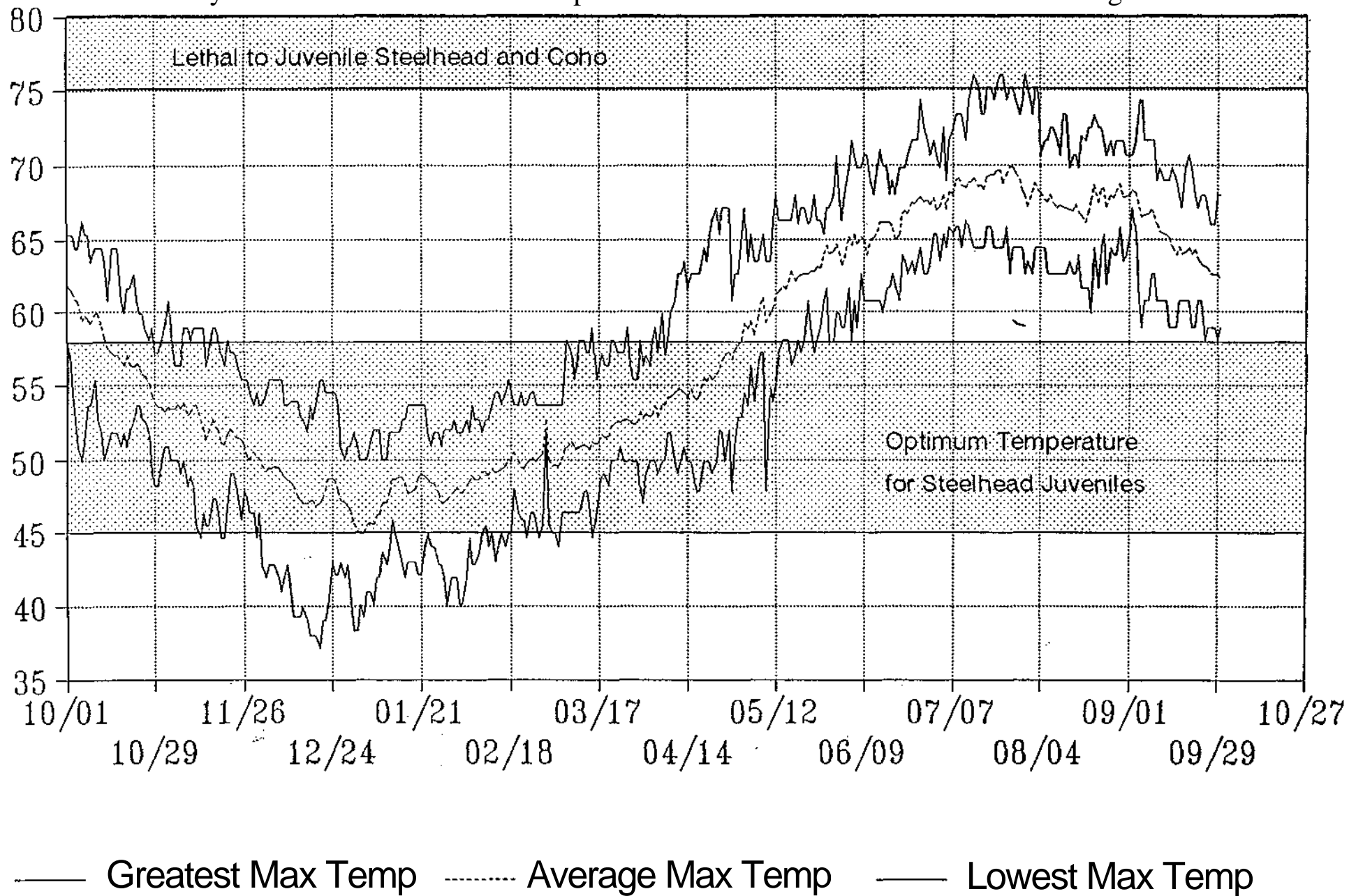
Throughout the year Elder Creek has the lowest monthly average maximum water temperature of the four stations. The monthly average maximum water temperature varies from 44.8 degrees F in December to 65 degrees F in July for a range of 20.2 degrees F.

The Garcia River water temperature data exhibits the effects of ground water inflow. The Garcia shows less variation in water temperature than the other three stations. The monthly average maximum water temperature varies from 51 degrees F in January to 67.3 degrees F in July and August for a range of 16.3 degrees F.

The monthly average maximum water temperature of the Noyo varies from 47.4 degrees F in January to 68.6 degrees F in July for a range of 21.2 degrees F.

FIGURE 4

Noyo River Maximum Water Temperature 1966 - 1979 Water Year at USGS Gage



The Navarro River monthly average maximum water temperature varies from 47 degrees F in January to 72.4 degrees in July for a range of 24.7 degrees F.

Figures 2-5 show the maximum daily water temperature for the period of record for each day of the water year. For example, each point on the graph for Elder Creek (Figure 2) represents the most extreme water temperature recorded during the 13 years of record for that day of the water year. Figures 2-5 also show the lowest maximum water temperature for each day of the water year. Thus, Figures 2-5 show the envelope enclosing all the recorded maximum daily water temperatures for the period of record.

### Impacts on Salmonid Habitat

"Water temperature affects all metabolic and reproductive activities of fish, including such critical functions as growth, swimming, and the ability to capture and assimilate food (Tebo 1974)".

The above quote is the opening statement in Roger A. Barnhart's report on steelhead entitled,

"Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) - Steelhead" U.S. Fish and Wildlife Service, Biological Report 82(11.60). U.S. Army Corps of Engineers, TR EL-82-4, June 1986.

Barnhart notes that Steelhead have difficulty in extracting oxygen when water temperatures are greater than 21 degrees C (69.8 degrees F). He states that a productive steelhead stream should have summer water temperatures between 10 and 15 degrees C (50 -59 degrees F) with an upper limit of 20 degrees C (68 degrees F).

Thomas J. Hassler reviewed the water temperature requirements of Coho salmon in his report entitled,

"Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) - Coho Salmon". U.S. Fish and Wildlife Service, Biological Report 82(11.70). U.S. Army Corps of Engineers, TR EL-82-4, August 1987.

Hassler's Table 2 (p. 12) lists the water temperature requires for Coho salmon. I have added the water temperature requirements for Steelhead from Barnhart's paper to Hassler's Table 2 in the following table.

Water Temperature	Hassler Coho (deg C)	Barnhart Steelhead (deg C)
Adult migration upstream	7.2 - 15.6	
Spawning	4.4 - 9.4	4 - 13
Incubation	4.4 - 13.3	
Upper Lethal	25.8	21 - 23.9
Preferred Range	11.8 - 14.6	7.2 - 14.5

Converting to degrees F the above preferred range for Coho is 53 to 58 degrees F, and the upper lethal temperature is 78.4 degrees F. The preferred range for steelhead translates to 45 to 58 degrees F, and the upper lethal temperature for steelhead is 69.8 to 75 degrees F.

The graphs for Elder Creek (Figure 2) and the Garcia River (figure 3) show that the recorded water temperatures never exceeded 72 degrees F. Thus, for the period of record, no water temperatures that could be lethal to steelhead or Coho were recorded at the Elder Creek or Garcia River stations.

Figure 4 shows that during the month of July water temperatures lethal to juvenile steelhead and Coho were observed during the period of record at the Noyo station.

The ground water input from the San Andreas fault appears to play an important role in moderating the water temperature in the lower Garcia River. The Garcia watershed is nearly the size of the Noyo and they have similar land use, but, only the Noyo station recorded days with water temperatures in the lethal range.

Figure 5 shows that during the months of June through mid-September water temperatures lethal to juvenile steelhead and Coho were observed during the period of record at the Navarro station. The extended period of possible lethal temperatures for juveniles indicates that, during the period of record, the Navarro River was probably subject to cumulative impacts on water temperature from canopy removal during timber operations and summer water diversions.

The water temperature record ends in 1979. The State Forest Practice Rules were adopted in 1972. Therefore, it is possible that the forest practice rules have improved the situation. However, without actual data it is not possible to know if the rules have had any impact on water temperature.

Summer water diversion is another land use practice that can lead to elevated water temperatures. In May of 1991 I demonstrated that the annual minimum flow at the Navarro gaging station was declining with time after accounting for changes in

precipitation (see attached letter). The analysis of minimum streamflow used data up to 1988. The water use in the Navarro watershed has not declined with time. In fact, there are presently ten applications pending to divert water on file with the Division of Water Rights.

Therefore, I conclude that there is a strong possibility that the Navarro River continues to be sensitive to cumulative effects in regard to summertime water temperatures.



TABLE 2

Data Derived from Maximum Daily Water Temperature Records Collected by the USGS

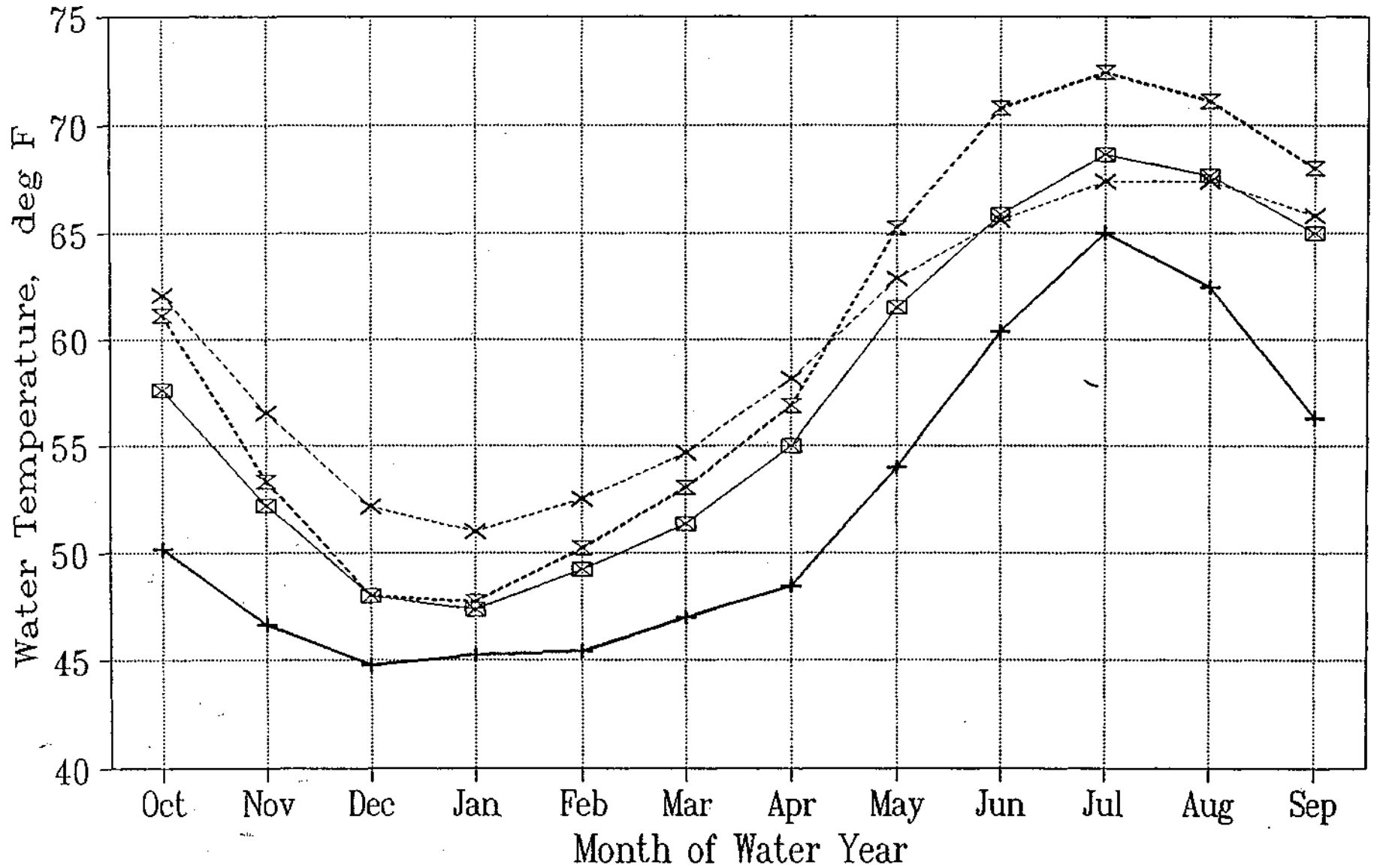
Water Temperature in degree F

	Elder Creek			Garcia River			Noyo River			Navarro River		
	Monthly Average Maximum Record	Period Record	%of Period Covered	Monthly Average Maximum Record	Period Record	%of Period Covered	Monthly Average Maximum Record	Period Record	%of Period Covered	Monthly Average Maximum Record	Period Record	%of Period Covered
October	50.1	1966-79	97.31	62.1	1964-79	91.73	57.6	1967-79	85.11	61.1	1966-68.70-79	61.79
November	46.6	1966-79	99.72	56.5	1964-79	93.75	52.2	1967-79	86.67	53.4	1966-68,70-79	64.36
December	44.8	1966-79	86.83	52.2	1964-79	94.56	48.0	1966-79	86.18	48.0	1966-68.70-79	66.25
January	45.2	1966-79	94.62	51.0	1964-78	96.56	47.4	1966-79	80.41	47.7	1966-68,70-79	59.31
February	45.5	1966-79	78.16	52.5	1964-78	80.00	49.3	1966-79	74.63	50.3	1966-68.70-79	53.32
March	47.0	1966-79	77.42	54.7	1964-78	96.34	51.4	1966-78	86.35	53.1	1966-68.70-78	77.69
April	48.5	1966-79	80.56	58.2	1964-78	99.78	55.0	1966-78	95.13	56.9	1966-68.70-78	75.00
May	54.0	1966-78	82.40	62.8	1964-78	95.70	61.5	1966-78	92.56	65.2	1966-68.70-78	73.66
June	60.3	1966-78	81.52	65.6	1964-78	93.33	65.8	1966-78	88.72	70.7	1966-68,70-78	70.83
July	65.0	1966-78	86.51	67.3	1964-78	90.75	68.6	1966-78	96.03	72.4	1966-68.70-78	70.97
August	62.4	1966-78	96.67	67.3	1964-78	85.59	67.6	1966-78	84.12	71.1	1966-68.70-78	75.81
September	56.3	1966-78	95.76	65.8	1964-78	94.89	65.0	1966-78	81.28	68.0	1966-68,70-78	88.89

	Elder Creek	Garcia River	Noyo River	Navarro River
Drainage Area	6.5 Sq-Mi	98.5 Sq-Mi	106 Sq-M	303 Sq-Mi
Gage Datum	1391 ft amsl	55.31 ft amsl	11.73 ft amsl	4.79 ft amsl
Land Use	Hydro Benchmark Watershed	Timber & Ranching	Timber & Ranching	Timber & Agriculture
Other	Protected Watershed	Ground Water contribution from San Andreas Fault Relatively High Summer Flows	Moderate Population in Anderson Valley	Statistically Significant Decline in Minimum Flows *»

FIGURE 1

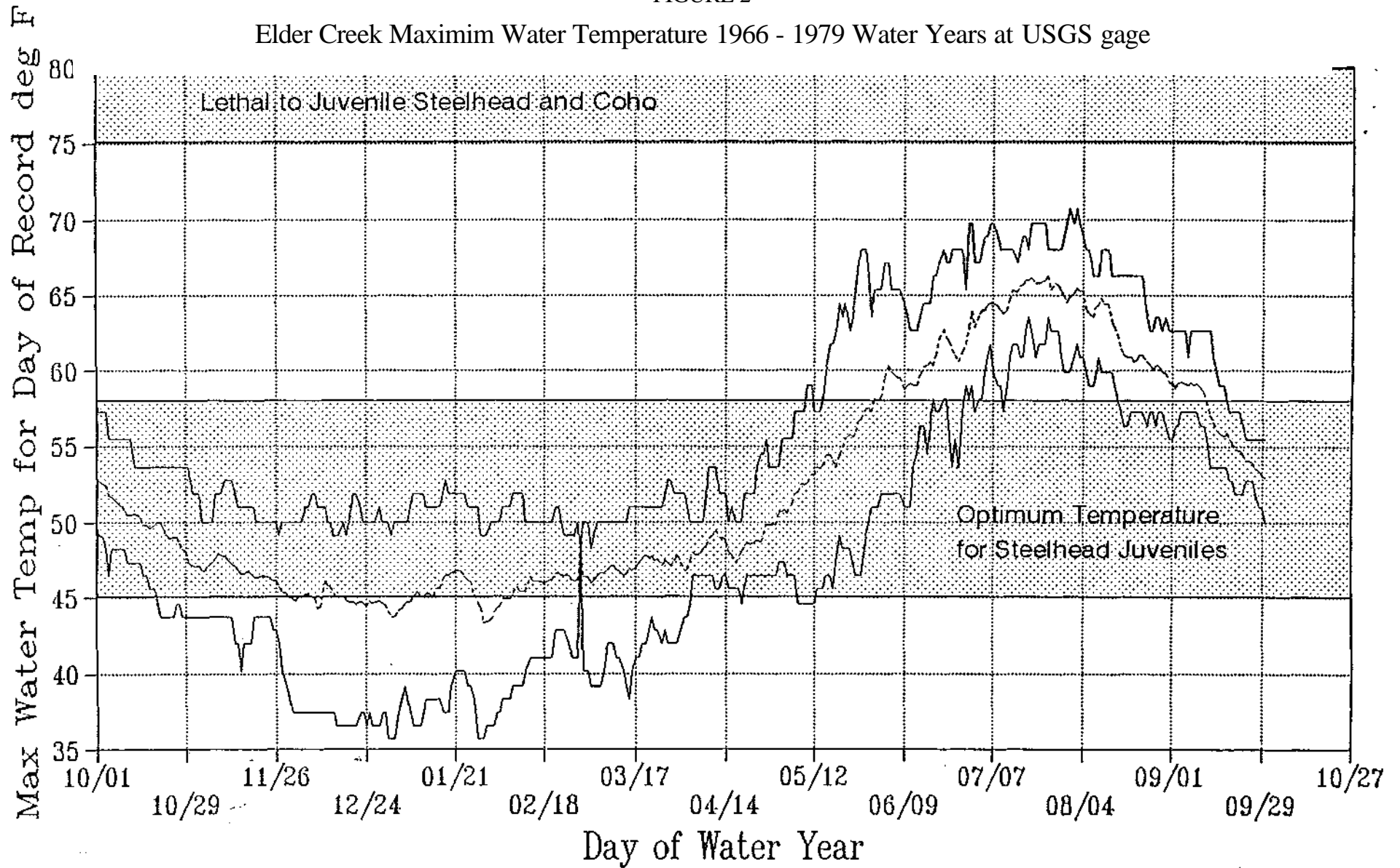
### Monthly Average Maximum Water Temp for WY1964 to WY1979 at USGS Stations



—+— Elder Creek    -·-x-·- Garcia River    -□- Noyo River    -·-x-·- Navarro River

FIGURE 2

Elder Creek Maximim Water Temperature 1966 - 1979 Water Years at USGS gage



—— Greatest Max Temp

..... Avg Max Temp

—— Lowest Max Temp