Noyo River Temperature Study, 1993

Bradley E. Valentine
CDF Coast-Cascade Region
PO Box 670 Santa Rosa, CA 95401

April 1994

Water temperature as affected by timber harvest is a concern relative to cold-water fisheries. However, as simple as water temperature is to measure, interpretation of the results is complicated. Identifying lethal, stressful, and optimal temperature is easy in laboratory situations, but is more difficult in the field due to diel cycles, groundwater inflow, and lack of climate control. Additionally, the thermal loading of streams can have both positive and negative ramifications, depending on the magnitude of warming and the location along the watercourse. For example, a thermal load induced by canopy removal may be detrimental at the site, but as that water flows downstream it will mix with groundwater inflow and that water which passed the open canopy area on the prior night. This mixed water may be more suitable for fishery production. Also, proximity to coastal influences such as fog and the large cool water mass may ameliorate warming concerns altogether.

During the summer of 1993, I conducted a temperature study of the Noyo River as it flowed through the body of Jackson Demonstration State Forest. The purpose was to evaluate the dynamics of water temperature changes over time and distance in a small, coastal stream.

Methods and Materials

In the lab, maximum recording thermometers were marked with individual identification numbers sites. They were then calibrated to a known thermometer standard by dropping their temperature below 10 **°C** in an cool water bath. As the water warmed, their readings were recorded at known temperatures of 15 and 20 **°C.**

The thermometers were placed in the field on July 2, 1993 and were read on August 4, then again on September 17. At initial placement and at the first reading, the thermometers were reset to a temperature less than 10°C by immersing in a tube of ice-water. Immediately, they were placed prior to any chance for them to return to air temperature. Thermometers for measuring maximum air temperature were placed against the north side of trees in heavily shaded conditions at the up-stream and down-stream most stations. Water temperature thermometers were placed in the thalweg of riffles beneath a large, concealing rock.

The calibration of thermometers showed substantial deviation form the standard. To control for this, thermometers were not exchanged between sites and all data collected was attributable to a specific thermometer. To interpret the results from a given thermometer, its data was adjusted using the average difference between the thermometer and the standard at the calibration temperatures.

The locations of the sampling stations are identified in Table 1 and on Fig. 1. The distances recorded in table 1 are from the downstream end of the reach and were calculated by CDF Region 1's GIS system along the stream course.

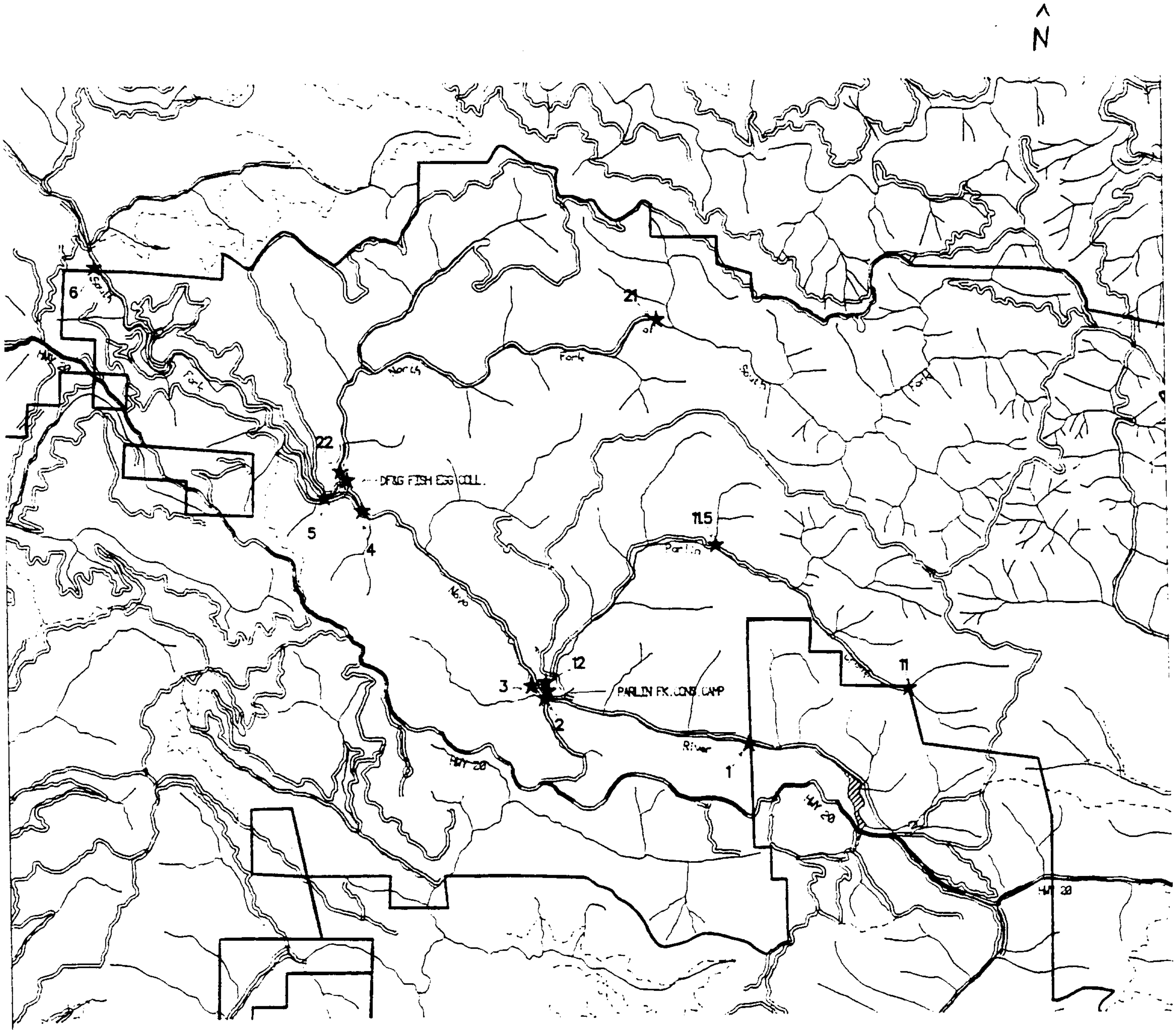

Fig. 1. Temperature measurement stations on Noyo River, Jackson Demonstration State Forest during the summer of 1993. Locations are pinpointed with a star and identified by a number which matches to those in Table 1.

Results and Discussion

Maximum air temperatures were at the inland-most sites (Table 1, Figs. 2 and 3). There, air temperatures were high enough that conduction to the water could elevate temperatures above the mortality limits of coldwater fish. At the downstream end of the study reach, air temperatures were substantially nearer temperatures that would be considered suitable, and heat conduction to the water from the air would be unlikely to have had any immediate mortality impacts.

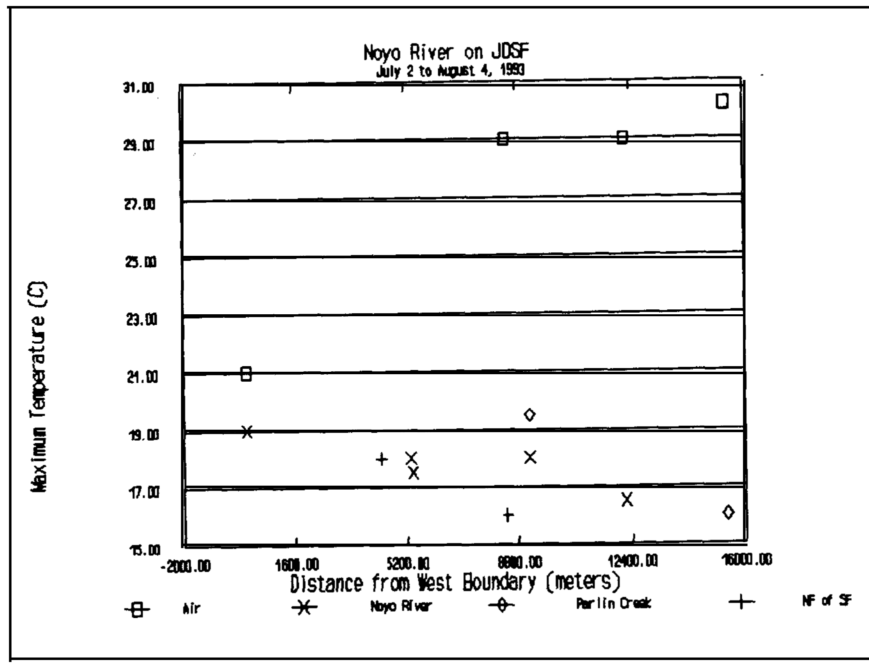

Fig. 2. Water temperatures in the Noyo River on. JDSE, 2 July, to A August 1994.

Maximum water temperatures ranged from 16.2 to 21 °C and warmed in a downstream direction (Table 1, Figs. 2 and 3). All these temperatures are greater than the preferred temperatures for salmonids, but are well below those considered lethal (Bjornn and Reiser 1991). In fact, they are in the range which Bjorn and Reiser (1991) consider optimal when measured in terms of "performance." One temperature at the mouth of Parlin Fork was in excess of 20 °C and is high enough to raise concern.

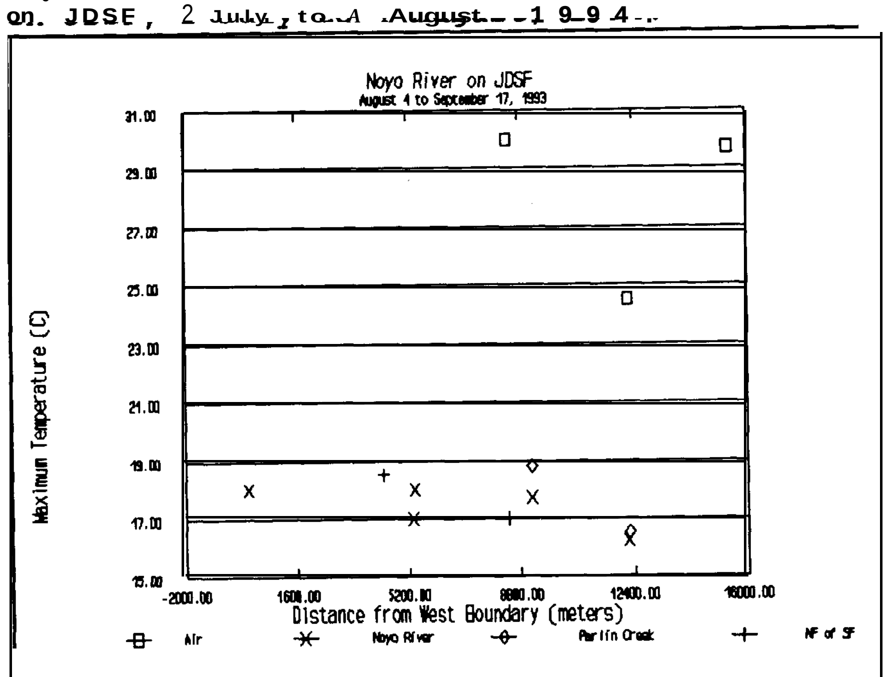

Fig. 3. Water temperatures in the Noyo River on JDSF, 4 August to 17 September, 1994.

The information shows the influence of the coastal location of the study area on air temperature. The cooler air temperature near the coast is representative of the maximum warming potential and is probably unrelated to fog. The maximum recording thermometers registered the greatest temperature achieved during the reporting period. Even though early burn-off of fog can limit the maximum air temperature, there were undoubtedly days during the period which were substantially clear. To the extent that the 1993 summer temperatures are representative of those in other years, the extent of warming of water at the downstream limits of the study is probably limited by the cool air temperature; i.e., heat gained by the water is likely to be reradiated or conducted to the air. However, air temperatures at more inland locations can impart substantial heat loads to the water.

The data shows that water warms downstream in an asymptotic pattern. This is as expected, where in gaining stream reaches cool groundwater emerges and flows downstream. Temperature gain is positively related to the difference between its temperature and that of the air surrounding it. An asymptote is achieved when the average water temperature matches the local air temperature, a factor primarily of local climate and secondarily of shading. Removal of canopy will greatly influence the rate at which the asymptotic temperature is approached. Shade may less affect the asymptotic temperature itself, especially in larger streams. In a watercourse where asymptotic temperature has been reached, shade's role is primarily in reducing the amplitude of temperature fluctuations; i.e., between shaded and unshaded streams, the mean temperatures would be similar but the maximum and minimum temperatures would be less in the shaded than the unshaded stream.

None of the water temperatures recorded in this study are cause for real concern. Despite the fact that 20° C is the point at which suitability drops markedly to a lethal temperature of 25-26 °C (see Bjornn and Reiser 1991), the temperatures recorded in this report were maximum temperatures only. Minimum temperatures were not recorded, but would provide prolonged periods at or near temperatures (12-14 °C) reported to be optimal (Bjornn and Reiser 1991). In fact, Reeves et al. (1989) did not consider summer water temperature to be limiting unless "minimum summer temperature exceeds 20° C for 2 weeks or more during summer low flow."

Further, temperatures recorded in 1993 are unlikely to be a concern because they were recorded from riffles, a location which integrates water temperature variation in the flow and water column. Temperatures in deeper pools and locations of groundwater inflow would be cooler than the "average" represented by the riffle locations.

This study did not evaluate shade canopy over the stream. Although shade appeared to be adequate, certain locations may be excessively open. I did not attempt to ascertain if the high temperature noted on Parlin Creek near the mouth was the result of canopy opening immediately upstream, or due to some other cause.

References Cited

Bjornn, T.C., and D.W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. Amer. Fish. Soc. Spec. Publ. 19:83-138.

Reeves, G.H., F.H. Everest, and T.E. Nickelson. 1989. Identification of Physical Habitats Limiting the Production of Coho Salmon in Western Oregon and Washington. USDA For. Serv. Gen. Tech. Rpt. PNW-245. 18 pp.

Table 1. Temperature of the Noyo River and tributaries during the summer of 1993. Maximum recording thermometers were deployed on July 4, 1993.

Field ID No.[a]	Water or Air	Distance Upstream (m)[b]	Temperature (°C) Aug 04	Temperature (°C) Sept 17	Location
1	A	12230	28.5	24.5	Noyo at upstream JDSF boundary
1	W	12230	17.5	16.2	Noyo at upstream JDSF boundary
2	W	9180	19.5	17.7	Noyo upstream of Parlin Creek
3	W	9160	18.5	c	Noyo downstream of Parlin Creek
4	W	5400	18.5	18	Noyo upstream of NF of South Fork
5	W	5340	18	17	Noyo down of NF of South Fork
6	A	20	21.5	d	Noyo at downstream JDSF boundary
6	W	20	19	18	Noyo at downstream JDSF boundary
11	A	15410	31.7	29.7	Upper Parlin Creek
11	W	15410		e	Upper Parlin Creek
11.5	W	12240	f	16.5	Mid-Parlin Creek
12	W	9175	21	18.8	Parlin upstream of Noyo
21	A	8440	30	30	Upper NF of South Fork Noyo River
21	W	8440	17	17	Upper NF of South Fork Noyo River
22	W	4370	18.5	18.5	NF of South Fork upstream of Noyo River

a Field ID Number corresponds to those on the map.

b Distance upstream of the JDSF private land boundary upstream of Kass Creek.

c Thermometer missing.

d Thermometer misread.

e Stream became intermittent during period. Thermometer moved downstream to Station 11.5.

f Station not established during period.