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Yoncalla Creek Dye Study

8/26-8/28/99

Abstract

Fluorescent dye was placed in a small, pool dominated, stream under low flow conditions (0.18 ft^3/sec) to measure the average velocity of the stream over a distance of about 2000 feet. Water samples were collected at frequent time intervals at two downstream locations. A Turner III fluorometer was used to measure the relative concentration of the dye in the samples. The maximum value of the concentration curve was used to determine the average transport velocity of the dye material, which was 51 feet per hour over the 2060 feet distance. A 42% decrease in the peak concentration was observed for the 31 hour time period between the measured peaks.

Background

Travel time in temperature models.

When considering seasonal maximum stream temperatures during the low flow period, the effect of the immediate local environment on the stream temperature may be of interest. Since all of the heat transfer modes are time dependent, the amount of time a quantity of water spends in a particular environment will influence the extent that local environment affects the stream temperature.

In computer stream temperature models the travel time factor is often derived from an average velocity calculated from the Manning equation or estimated from flow measurements. During extreme low flow conditions, application of the Manning equation to small channels may become problematic in systems dominated by deep pools connected by shallow riffle reaches because it is difficult to determine appropriate values for Manning's "n", wetted perimeter, width and slope.

Measuring travel time directly can also produce errors. Floating objects don't always simulate the flow of the sub-surface water. Velocity measurements from flow meters typically are taken in a higher velocity portion of the stream because they do not operate in quiet water. Factors such as average cross section and accounting for reverse circulation and dispersion can add to the errors.

Fluorometric dye studies are the preferred method because they can simulate the actual travel path of the heated water and the concentration measurements define the shape of the heated mass which can be timed as it moves downstream (See references). Figure 7 shows typical results.

This study was conducted to supplement the stream temperature data that was being collected for the Umpqua Basin Stream Temperature Characterization project for the Umpqua Basin Watershed Council..

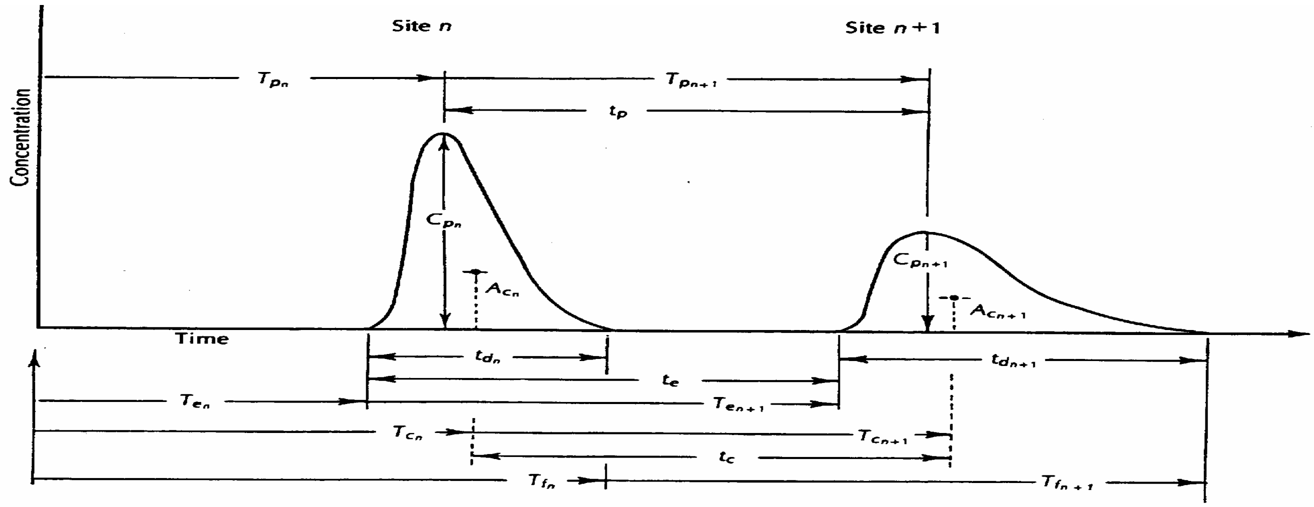
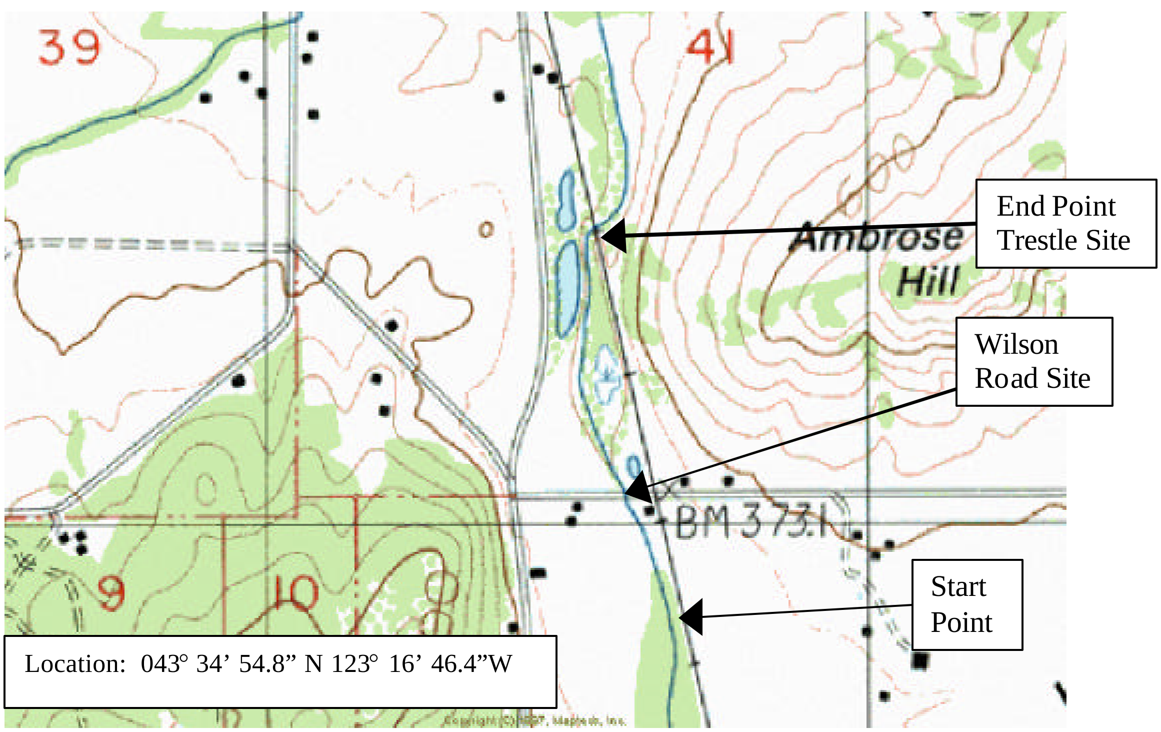


Figure 7. Schematic of dye concentration versus time showing dispersion during time-of-travel study. The X-axis also may be interpreted as proceeding downstream from left to right. Thus the magnitude of the concentration becomes attenuated through time (and space). Travel time is measured from peak concentration to peak concentration. Reproduced from Hubbard et al. (1981).

Yoncalla Creek Site

Yoncalla Ck, a tributary of Elk Creek, which enters the lower Umpqua near Elkton, has a 60 sq mile watershed. Much of the main channel is low gradient as it flows through the alluvium in the central Yoncalla valley.

Map 1. The project site.



The study area was about 4.9 miles from the source ridgeline. Two sampling locations were used as shown in Map 1. The Wilson Rd bridge site was about 700 feet below the injection point and the Trestle site was 2060 feet below the injection point.

Study Methodology

The study was conducted between 8/26/99 and 8/28/99 over a 77 hour time period. Stream flow was measured by the direct capture method at 0.18 CFS. 250 ml of rhodamine B fluorescent dye was used for the study. Water samples were collected at the two downstream sites over the three-day period. The relative dye concentration of the samples was measured using a Turner II fluorometer. The streamflow was determined using a calibrated bucket and a flume to capture and measure the flow. Stream distance was estimated by counting the railroad ties and applying an average spacing value. The channel slope was estimated using a hand-held clinometer. The drainage area and distance to the ridge was determined using Terrain Navigator® mapping software. A videotape of the study was made which shows the method used, the stream characteristics and how the dye moved downstream with the passage of time.

Results

Table 1 and Chart 1 show the results of the study:

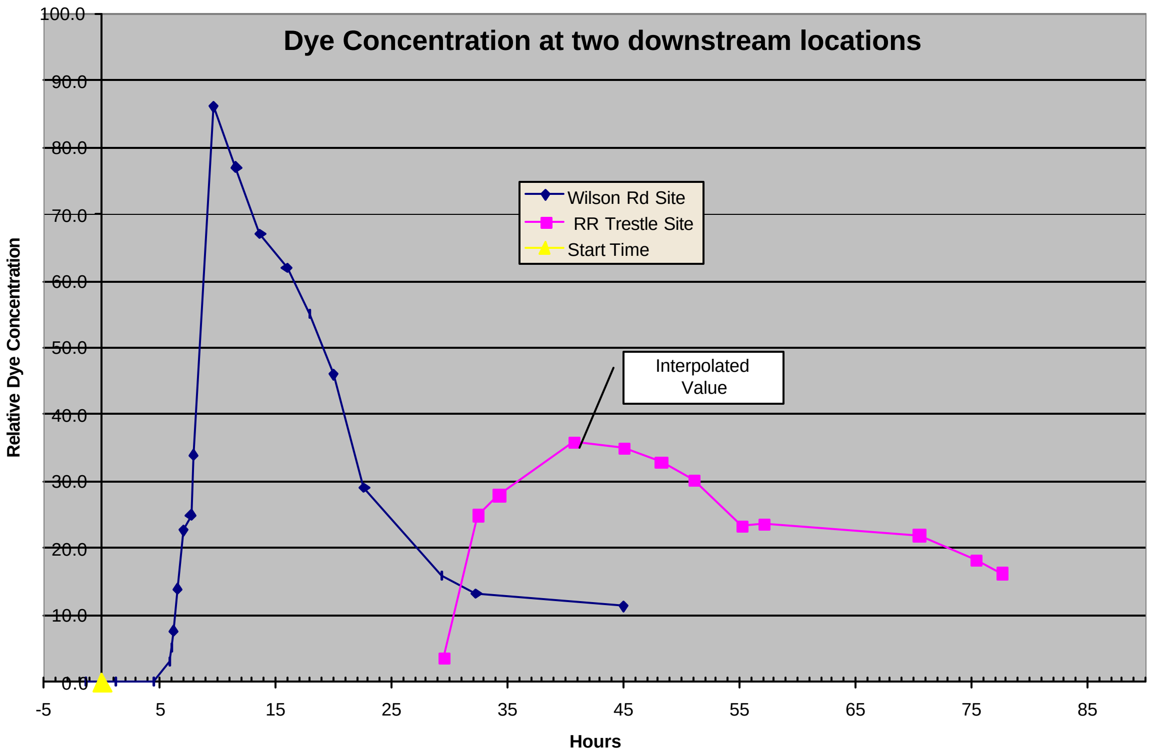


Chart 1: Relative concentration pattern for the two sites.

Table 1	Between Start & Wilson	Between Wilson & Trestle	Between Start & Trestle
Distance (ft)	696.67	1363.33	2060.00
Peak Travel Time (hours)	9.65	31.05	40.7
Average Velocity (ft/hr)	72.19	43.98	50.68
Average Velocity (ft/sec)	0.020	0.012	0.014
Average Velocity (mph)	.0137	.0083	.0096

Discussion:

This study represents only one sample of low flow stream conditions in the Umpqua Basin. This particular stream reach appeared to have a relatively high amount of water storage that could be considered above average. However, this condition should not be considered exceptional, especially in areas with beaver activity. The results indicate that ponded areas such as found at this site can effectively slow the movement of the dye molecules. The implication to stream heating is that this type of condition would allow water flowing through the reach to become fully acclimatized to the local environment. This would have the effect of isolating the upstream thermal influences.

Sampling Results:

Wilson Rd Site

Bottle #	Dale / Time	Relative Concentration	Cummulative Time (HR)
1	8/26/99 9:00	0.1	-1.35
32	8/26/99 11:35	0.1	1.23
99	8/26/99 14:47	0.1	4.43
6	8/26/99 16:09	3.0	5.80
A1	8/26/99 16:22	5.2	6.02
9	8/26/99 16:35	7.7	6.23
42	8/26/99 16:55	14.0	6.57
70	8/26/99 17:22	22.7	7.02
12	8/26/99 18:01	25.0	7.67
33	8/26/99 18:15	34.0	7.90
34	8/26/99 20:00	86.0	9.65
26	8/26/99 21:58	77.0	11.62
35	8/27/99 0:02	67.0	13.68
45	8/27/99 2:18	62.0	15.95
46	8/27/99 4:18	55.0	17.95
36	8/27/99 6:18	46.0	19.95
49	8/27/99 9:00	29.0	22.65
35	8/27/99 15:42	16.0	29.35
60	8/27/99 18:40	13.3	32.32
2	8/28/99 7:20	11.3	44.98

RR Trestle Site

Bottle #	Date/Time	Relative Concentration	Cummulative Time (HR)
54	8/27/99 15:51	3.6	29.50
29	8/27/99 18:48	25.0	32.45
4	8/27/99 20:33	28.0	34.20
Estimated	8/28/99 3:00	36.0	40.65
50	8/28/99 7:20	35.0	44.98
38	8/28/99 10:32	33.0	48.18
52	8/28/99 13:20	30.3	50.98
58	8/28/99 17:30	23.3	55.15
53	8/28/99 19:28	23.7	57.12
63	8/29/99 8:49	22.0	70.47
37	8/29/99 13:42	18.3	75.35
59	8/29/99 16:00	16.3	77.65

Further details of the field data is contained on the Excel workbook "Yoncalla Ck Dye Study.xls."

A video of this project is available for viewing. It provides information about the flow measurements, site conditions and views of how the dye progressed downstream. The following pictures are clips taken from the project video.

Figure 1 View of Yoncalla Creek from Wilson Rd Bridge looking upstream into a pool area prior to testing.

Figure 2 Leading edge of dye as it moves downstream near the injection point.

Figure 3. Leading edge of the dye at a point upstream from Wilson Rd on 8/26.

Figure 4. Leading edge of dye at a point between Wilson Rd and the Trestle site on 8/27.

Figure 5. Upstream from Trestle on 8/27. No dye arrival at this time.

Figure 6. Same location, 24 hours later. Dye has arrive

Figure 7 Flume used to measure the flow, which was 0.18 ft^3 per second. The view is the downstream side at Wilson Rd. The stream was blocked and allowed to backfill. A hole was dug at the downstream end of the flume to accept the bucket. A stopwatch was used to time the filling of the bucket.

Figure 8. Taking a flow measurement.

Figure 9. Turner Flurometer used to measure relative concentration of the dye.

This project was conducted in cooperation with the Umpqua National Forest.

References:

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