12-8-2009

Ex. 279-US-448

United States Forest Service

Recommended Citation

United States Forest Service, "Ex. 279-US-448" (2009). *Hedden-Nicely Collection, All*. 435.
https://digitalcommons.law.uidaho.edu/all/435

Coyote Creek Instream Flow

Introduction

In 1990 the State of Oregon began the process of adjudicating water rights within the Klamath River Basin for water users with pre-1909 claims to water. The U.S. Forest Service (USFS) manages three forests within the Klamath Basin; the Fremont, Klamath, and Winema National Forests.

The Water Resources Team, situated on the Winema National Forest, was charged with quantifying the instream flow and consumptive water uses of the Forest Service Pacific Northwest and Pacific Southwest Regions within Oregon. Part of that charge involved development of fisheries claims based on the Multiple-Use Sustained-Yield Act of 1960. Flow, channel morphology, and fisheries data were collected, compiled, and analyzed in preparation of the fisheries water rights claims. The fisheries claims took the form of monthly minimum values as determined using two methods. An incremental flow model (PHABSIM) was used to determine recommended minimum monthly fisheries streamflows. Flows necessary to maintain fisheries habitat, i.e. channel maintenance flows, are superimposed upon the PHABSIM derived values. Quantities for these higher, less frequent, channel maintaining flows were determined through analysis of bedload sediment transport relationships.

The following report is a summarization of the steps taken to determine fisheries habitat flow recommendations for the adjudication process. It has been prepared to disseminate data to resource personnel for use in forest management decisions.

Methods

Coyote Creek is a 3rd order stream that lies in the eastern portion of the Klamath Basin, draining 9.9 mi^2 from spring-fed headwaters near Round Butte and discharging into the Sycan Marsh (42°51'N, 121°09'W). Of nearly 10 linear miles of stream, two sections of private property, from above the diversion to river mile (RM) 3.4 and from RM 6.0 to the headwaters, were not surveyed during the 1992 Hankin and Reeves USFS Stream Survey. Presently, resident brook trout are the only trout species that occur in the stream. Stocking records could not be located. Bull trout are no longer present in Coyote Creek (Light et al. 1996), though historically they were present and as recently as 1990 a bull trout x brook trout hybrid was reportedly captured within the USFS boundaries. Redband trout were not captured in electrofishing efforts by either Oregon Department of Fish and Wildlife in 1990 or USFS efforts in 1992, and apparently are no longer present. Other species present but not considered when determining Instream Flow quantification include speckled dace, tui chub, and lamprey. The 1992 USFS Stream Survey results demonstrated a large quantity of large woody debris, a sand- and gravel-dominated streambed, and a gradient of about 3%.

The Physical Habitat Simulation System (PHABSIM) was used to model fish habitat in the stream and to make monthly minimum flow recommendations. The protocol for using PHABSIM is described in detail elsewhere (Milhous et al. 1989) and only a brief overview will be made here. The purpose of PHABSIM is to simulate a relationship between streamflow and physical habitat for various species and lifestages of fish. It consists of overlaying hydraulic simulations that represent the physical properties of the stream channel with Habitat Suitability Index (HSI) curves that represent the biological adequacy of these physical properties for a particular species and lifestage. Combining the physical properties with the suitability curves produces the habitat quantity and quality available for use.

In field measurements, each transect is divided into cells in which depth and velocity are measured over a number of discharges. Cell-by-cell depths and velocities are then simulated over a range of flows using standard hydraulic modeling techniques packaged into the PHABSIM computer software [proper PHABSIM modeling and calibration is technically the most difficult step in analyzing instream flows (Milhous et al. 1989), and is too complicated to discuss here]. Substrate is measured once and assumed to not change over the study period of one field season. It is assumed that the worth of a cell for fish habitat is determined by what the suitability of the depth, velocity, and substrate (represented by HSI curves) would be at a particular discharge. HSI curve values vary from zero (unsuitable) to one (optimal) and were developed for each species and lifestage for the Upper Klamath River Basin by a regional panel of experts using published curves, existing data, and professional judgement. Each cell has an overall suitability derived from the product of the suitability for depth, velocity, and substrate. For example, a cell with a depth suitability of 1.0, velocity suitability of 0.5, and substrate suitability of 0.5 would have an overall suitability of 0.25 (i.e., 1.0 x 0.5 x 0.5 = 0.25). The PHABSIM model uses simulated depths and velocities, and recorded substrate, to determine the overall suitability for each individual cell at a given discharge.

The sum of the surface area of each cell that contains fish habitat, called Weighted Usable Area (WUA), is expressed as units of ft^2/1000 feet of stream length. We produced two quantities of habitat. "Total Weighted Usable Area" is all available habitat, regardless of the overall suitability of each individual cell. Therefore any cell with any suitability (i.e., overall suitability greater than zero) is included in the summation of usable surface area. Cells with overall suitability of 0.75 or greater is included in ">75% Weighted Usable Area". "Total WUA" is therefore defined as the total amount of habitat available for use, whether the quality is high or low, whereas ">75% WUA" is that amount of the total habitat that ranks as optimal habitat.

Continuous water temperature was collected with a datalogger at river elevation 5050' (RM 1.0) from 1992 through 1996. The datalogger also recorded continuous water elevation in the creek, from which a hydrograph was developed for water years 1993-1995 (Figure 1) and 3-year monthly median discharge values were calculated. Using a regional predictive model developed by P. Bakke of the Winema National Forest's Water Resources Team (unpublished data), these 3-year monthly medians were used to predict long-term (30-year) monthly medians for Coyote Creek, providing a starting point from which to recommend monthly values for fish habitat. Based on the amount of discharge present for a particular month, we analyzed how much total and optimal habitat would be available for all lifestages present during that month, and adjusted our flow recommendation to maximize fish habitat. We rarely recommended a minimum flow of more water than is available, according to the long-term monthly prediction. Other anecdotal data (e.g., water temperature, upstream diversions) were also considered when selecting a monthly discharge value.

Sediment movement data were collected, analyzed, and used to determine a habitat maintenance (channel maintenance) discharge. Flows above the habitat maintenance discharge were determined to be those necessary to maintain a functioning stream channel and thereby maintain the fish habitat. For more information on channel maintenance results, see the corresponding channel maintenance folder for this stream. In instances where the PHABSIM-determined fish habitat discharge value exceeded the fish habitat maintenance discharge value, the habitat maintenance value was used as the monthly recommendation. For example, if 20.0 cfs was determined to provide adequate fish habitat for a given month, and flows of 30.0 cfs and greater were determined to be the flows needed for habitat maintenance, then 20.0 cfs would be the minimum fish flow recommendation. All natural flows between 0 and 20.0 cfs would be defined as necessary for fish habitat. When natural flows exceeded 30 cfs, all water would be defined as necessary for maintaining fish habitat. If the fish habitat maintenance value had been 15 cfs, then 15 cfs would be selected as the final flow recommendation value for that month.

Results/Discussion

Monthly average temperatures ranged from 0°C during the winters to a high of 18.5°C in July of 1996 (Table 1, Figures 2 through 7). Maximum temperatures commonly exceeded 20°C during the summer months (Table 1) and reached a high of 28°C in 1992. Generally, temperatures ranged from 12 to 20°C during the summer and remained near zero during all winters (Figures 2 through 7). These temperatures exceed the water temperature standard of 17.8°C for trout set by Oregon Department of Environmental Quality (Boyd and Sturdevant 1996).

Four cross sections, 3 glides and 1 pool, were established in 1992 near the datalogger site to represent the fish habitat in the stream reach (Figures 8 and 9). According to the USFS stream survey, riffles made up only 9% of the stream and were not included in the PHABSIM modeling. Water surface elevations and cell velocities (Figures 10 to 13) were collected on four occasions at discharges of 1.3, 2.9, 5.3 (not displayed) and 7.2 cfs, and were used for PHABSIM model calibration and simulations. The glide cross sections were deep (up to 2 feet) with slow velocities (less than 2 ft/s), and substrate was dominated by silt and sand. Depths, velocities, and substrates were similar in the pool cross section. Generally, the HSI curves ranked velocities of less than 3 ft/s as suitable for brook trout (Figure 14), the only species for which habitat was simulated. The suitability of depth varied depending on lifestages, and any substrate was considered suitable for all lifestages except spawning, which generally required small to large gravel to provide suitable habitat (Figure 14).

Total and optimal fish habitat was simulated for brook trout from 1 to 10 cfs (Figure 15). The range of simulation was limited at the low end by reasonable extrapolation from our lowest calibration point of 1.3 cfs, and at the high end by overbank flow conditions, above which we generally did not simulate fish habitat. Brook trout spawn in the fall, but egg incubation continues until the following spring (Table 2) and subsequently was modeled from September to April. Fry were modeled from March to June, and juvenile and adult lifestages are present all year (Table 2).

Discharge in Coyote Creek, during this study, generally ranged from a summer baseflow of less than 1 cfs at the Fremont National Forest boundary to a high of 50 cfs during peak spring runoff (Figure 1). Water year 1994 was a particularly dry year and discharge never exceeded 5 cfs (Figure 1). Long-term median monthly discharges ranged from a low of 0.003 cfs in October to a high of 12.4 during the spring runoff (Table 3). Although flow conditions at the measurement transects are low, there are a series of beaver dams less than 200 yards upstream of our transects that maintain pools throughout the summer. Based on PHABSIM modeling, lower discharges provide more habitat for lifestages other than spawning/incubation, because the transects maintained deep water levels and low velocities even at lower discharges. However, because water temperatures were high during the summer, most flow recommendations were not reduced below the median monthly value. Spawning/incubation habitat was most limited at lower discharges and approached the level of quality habitat present for other lifestages at 7 cfs and higher. Since the flow necessary for maintenance of fish habitat was 4.1 cfs, all months with fish habitat recommendations greater than 4.1 cfs (February through May) were replaced by this fish habitat maintenance recommendation (Table 3). Month by month justification for final fish values also appears in Table 3.

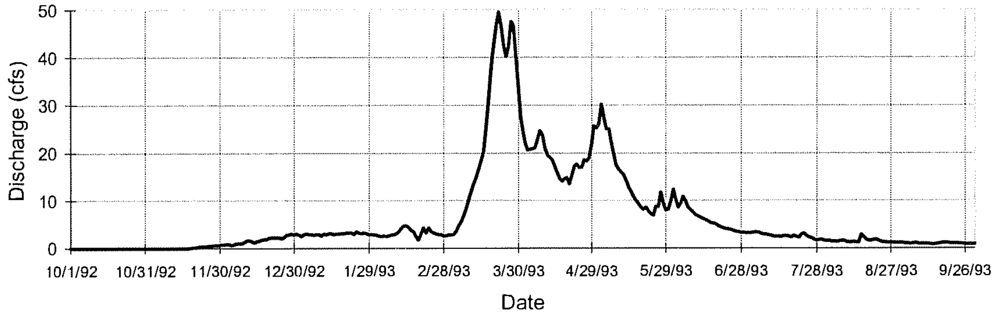
References

Boyd, M., and D. Sturdevant. 1996. The scientific basis for Oregon's stream temperature standard: common questions and straight answers. Oregon Department of Environmental Quality Report.

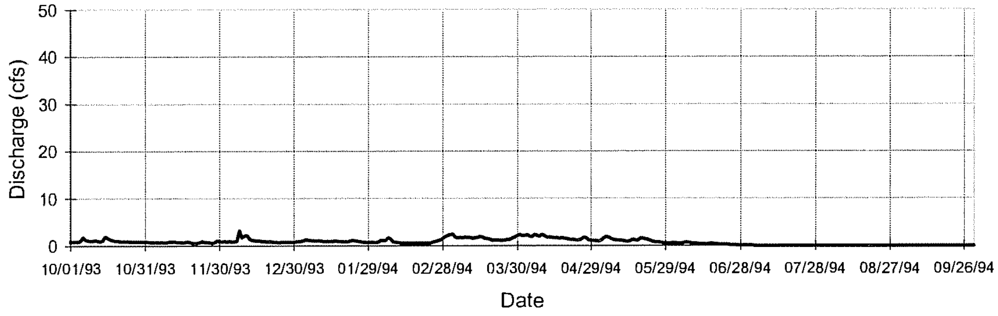
Light, J., L. Herger, and M. Robinson. 1996. Upper Klamath Basin bull trout conservation strategy: Part I, a conceptual framework for recovery. Final report for the Klamath Basin Bull Trout Working Group. 88p.

Milhous, R. T., M. A. Updike, and D. M. Schneider. 1989. Physical habitat simulation system reference manual - version II. Instream Flow Information Paper 26. U.S. Fish & Wildlife Service, Biol. Rep. 89(16).

1993 Daily Mean Hydrograph



1994 Daily Mean Hydrograph



1995 Daily Mean Hydrograph

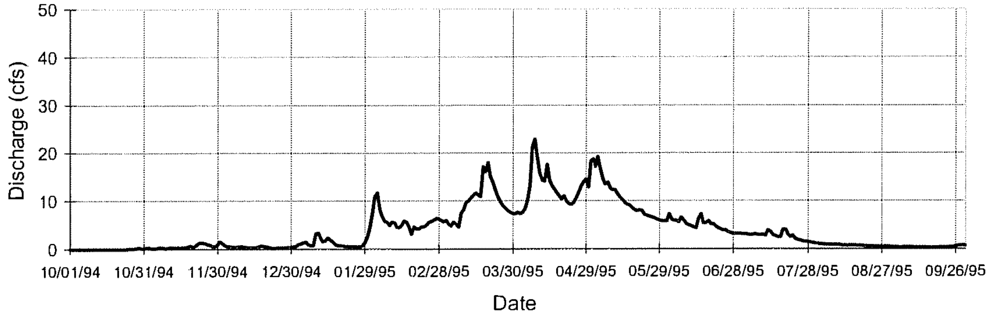


Figure 1. Daily mean discharge for water years 1993-1995 at Coyote Creek.

Table 1. Monthly maximum and mean temperature values at Coyote Creek.

	Maximum temperature (°C)				
Month	1992	1993	1994	1995	1996
Jan			0.4	0.7	0.6
Feb			0.4	4.5	4.7
Mar	11.1		6.4	6.9	10.7
Apr	16.1	15.3	13.6	11.3	14.7
May	25.3	19.5	15.5	17.2	16.5
Jun	28.1	22.1	18.0	20.6	20.9
Jul		20.1	17.4	21.0	24.9
Aug		22.9		20.8	23.3
Sep		18.3		16.2	17.8
Oct		12.4	6.9	10.3	13.2
Nov	7.0	4.4	5.0	7.6	5.3
Dec		0.8	1.0	5.4	1.7

	Average temperature (°C)				
Month	1992	1993	1994	1995	1996
Jan			0.1	0.5	0.0
Feb			0.0	0.9	0.5
Mar	6.4		1.4	2.8	4.0
Apr	9.2	8.3	6.7	6.1	7.0
May	14.7	12.5	11.1	10.5	10.7
Jun	16.2	14.2	13.5	13.9	15.0
Jul		14.8	14.3	16.9	18.5
Aug		14.8		15.4	16.9
Sep		11.6		12.6	11.5
Oct		7.1	4.9	6.5	7.2
Nov	1.8	1.0	1.4	3.9	3.1
Dec		0.2	0.6	1.2	0.5

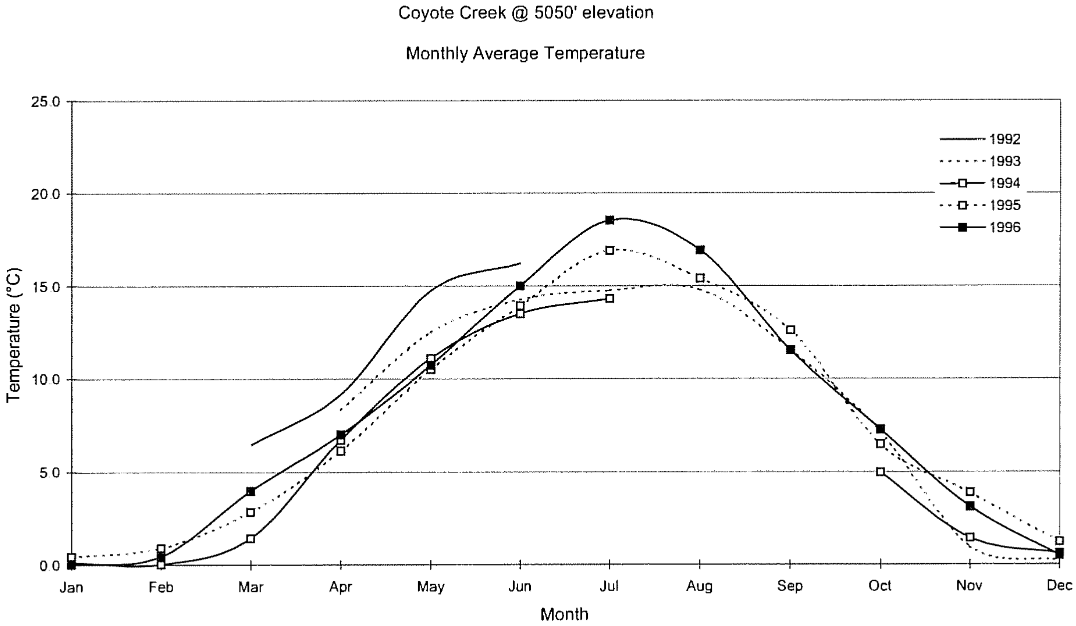


Figure 2. Monthly average temperature at Coyote Creek.

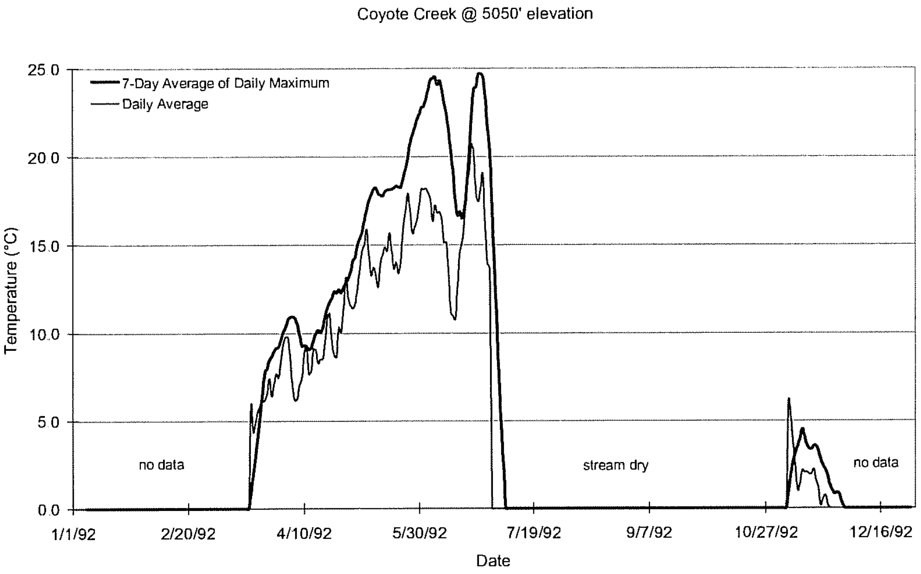


Figure 3. Daily average and 7-day average of the daily maximum temperatures at Coyote Creek in 1992.

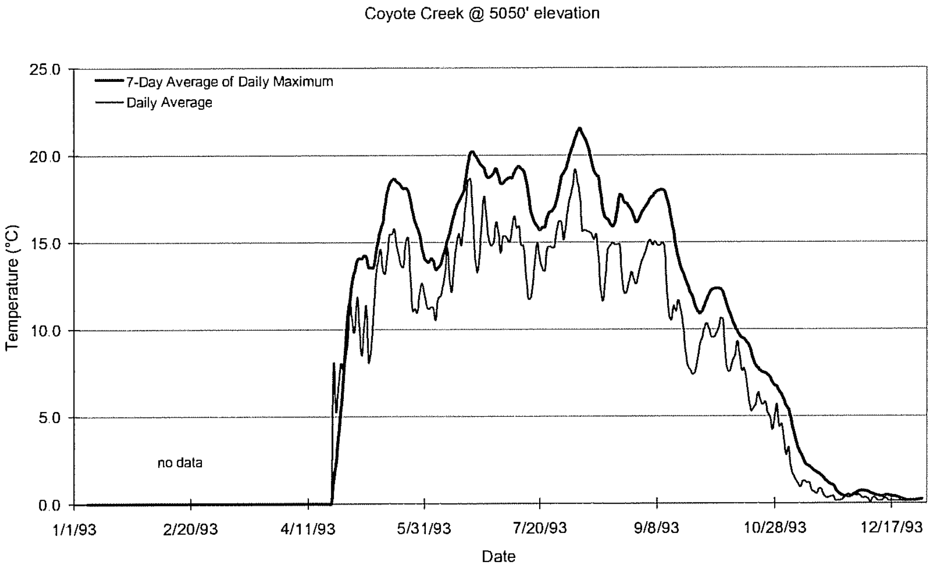


Figure 4. Daily average and 7-day average of the daily maximum temperatures at Coyote Creek in 1993.

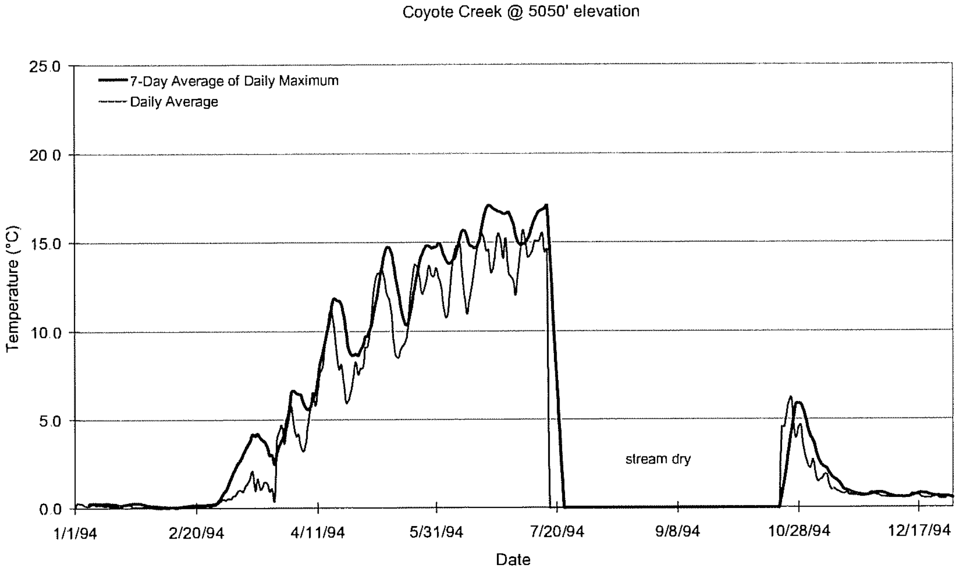


Figure 5. Daily average and 7-day average of the daily maximum temperatures at Coyote Creek in 1994.

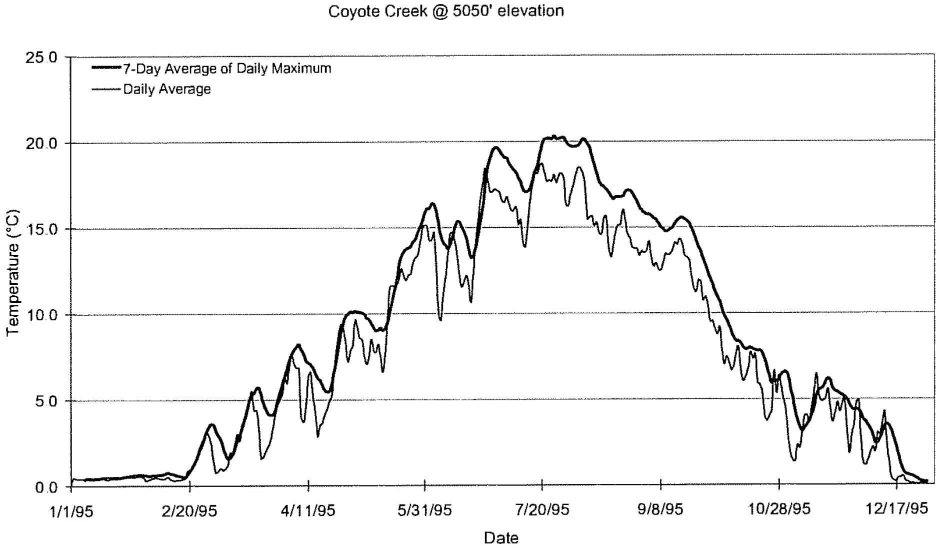


Figure 6. Daily average and 7-day average of the daily maximum temperatures at Coyote Creek in 1995.

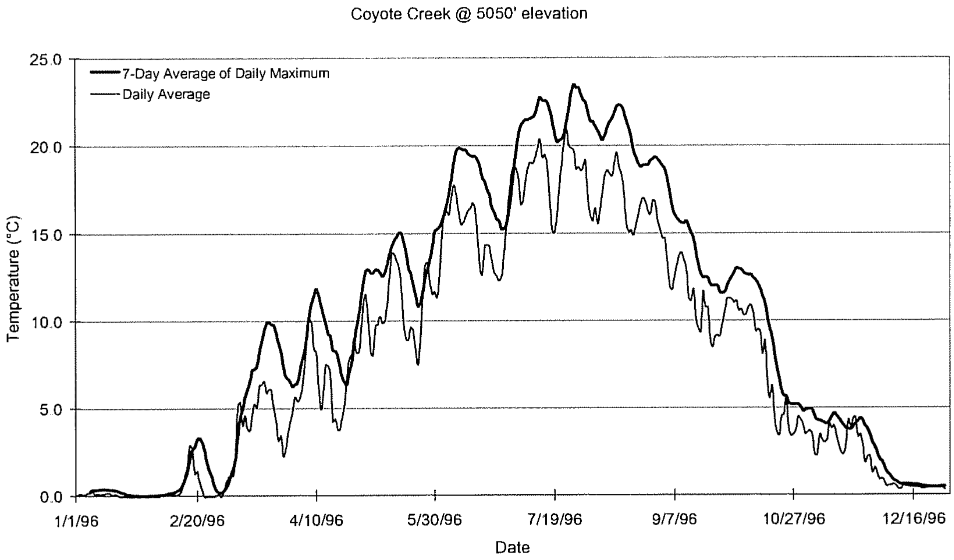


Figure 7. Daily average and 7-day average of the daily maximum temperatures at Coyote Creek in 1996.

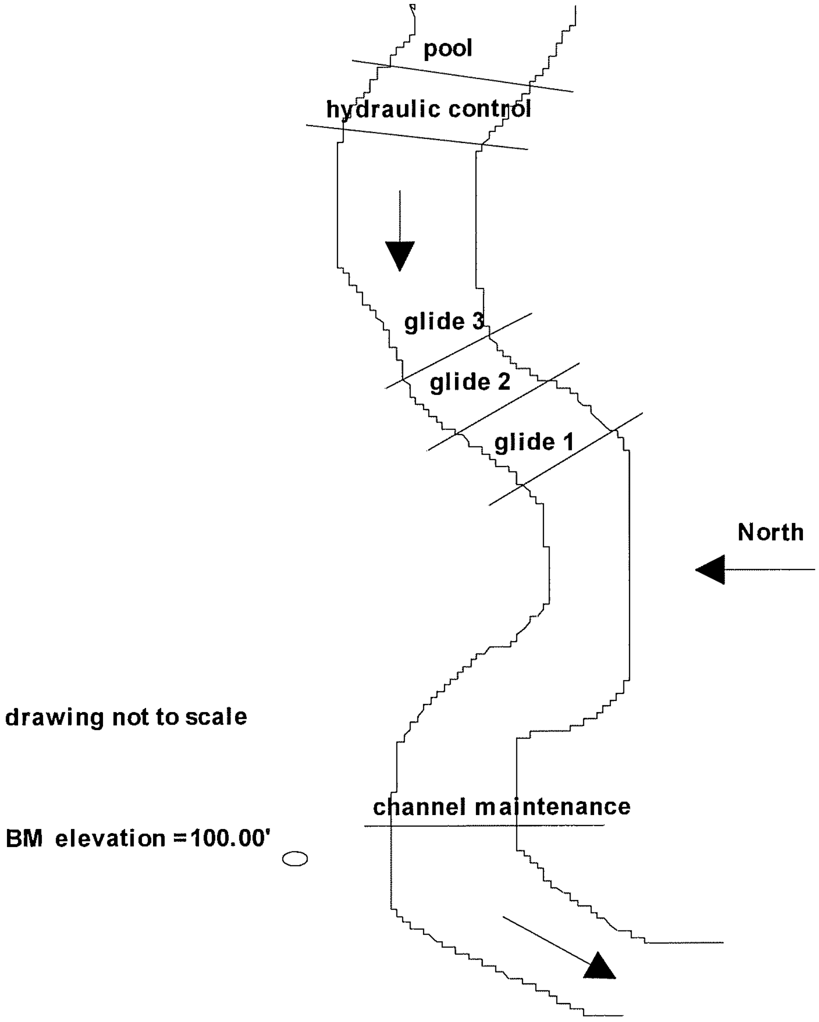


Figure 8. Map of Coyote Creek study site showing the PHABSIM transect layout.

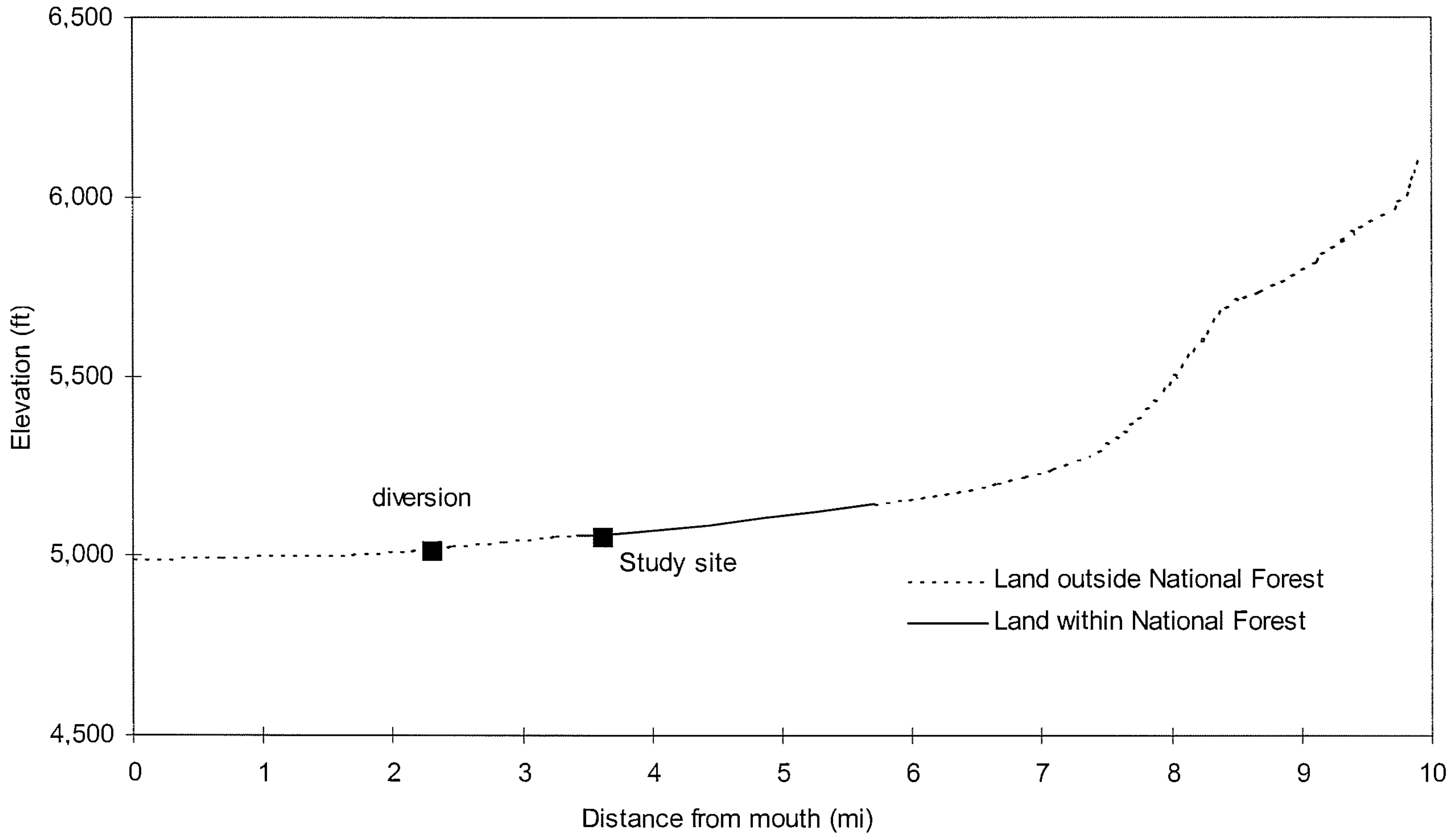


Figure 9. Location of study site at Coyote Creek.

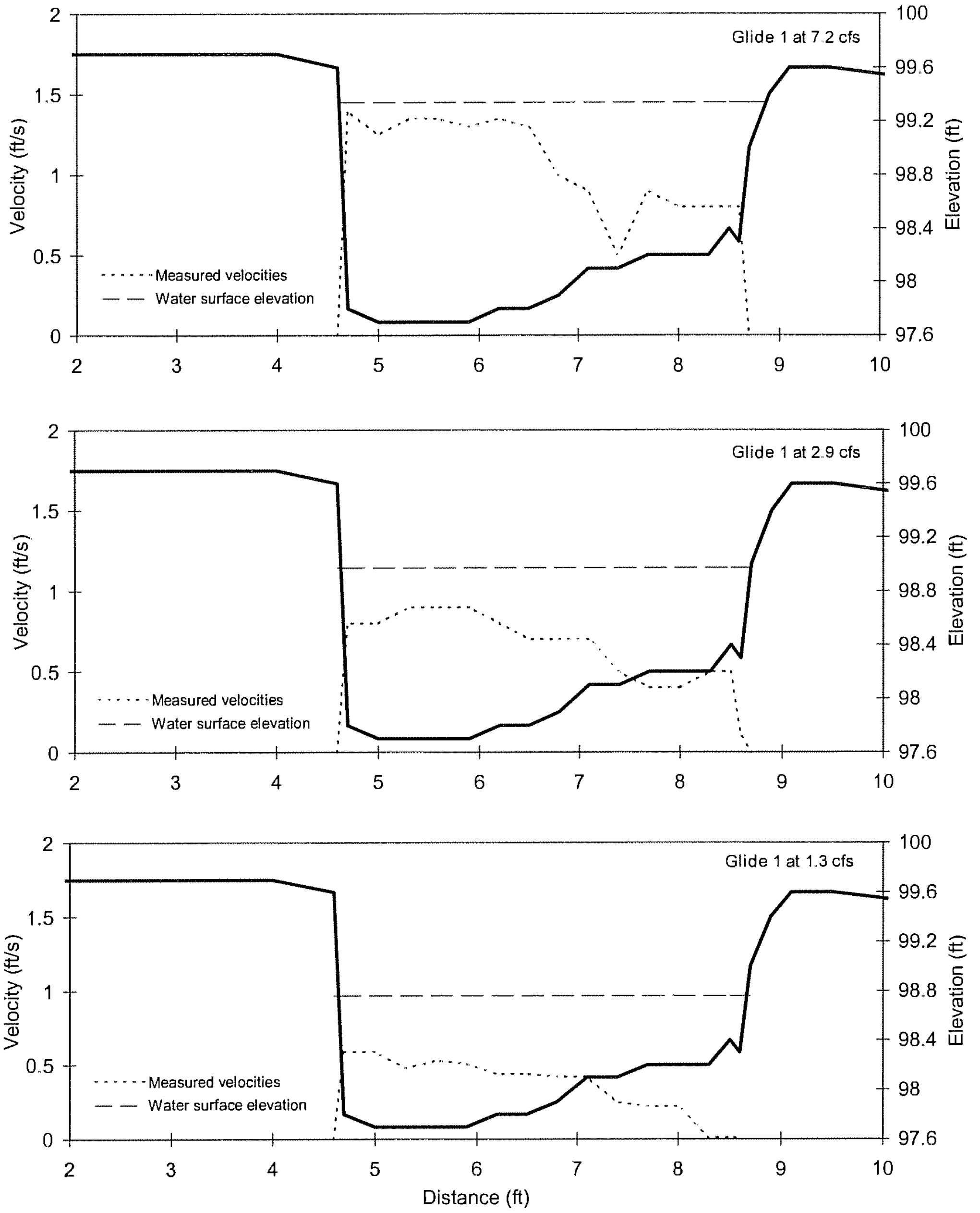


Figure 10. Glide 1 depth and velocities at calibration discharges of 1.3, 2.9, and 7.2 cfs at Coyote Creek.

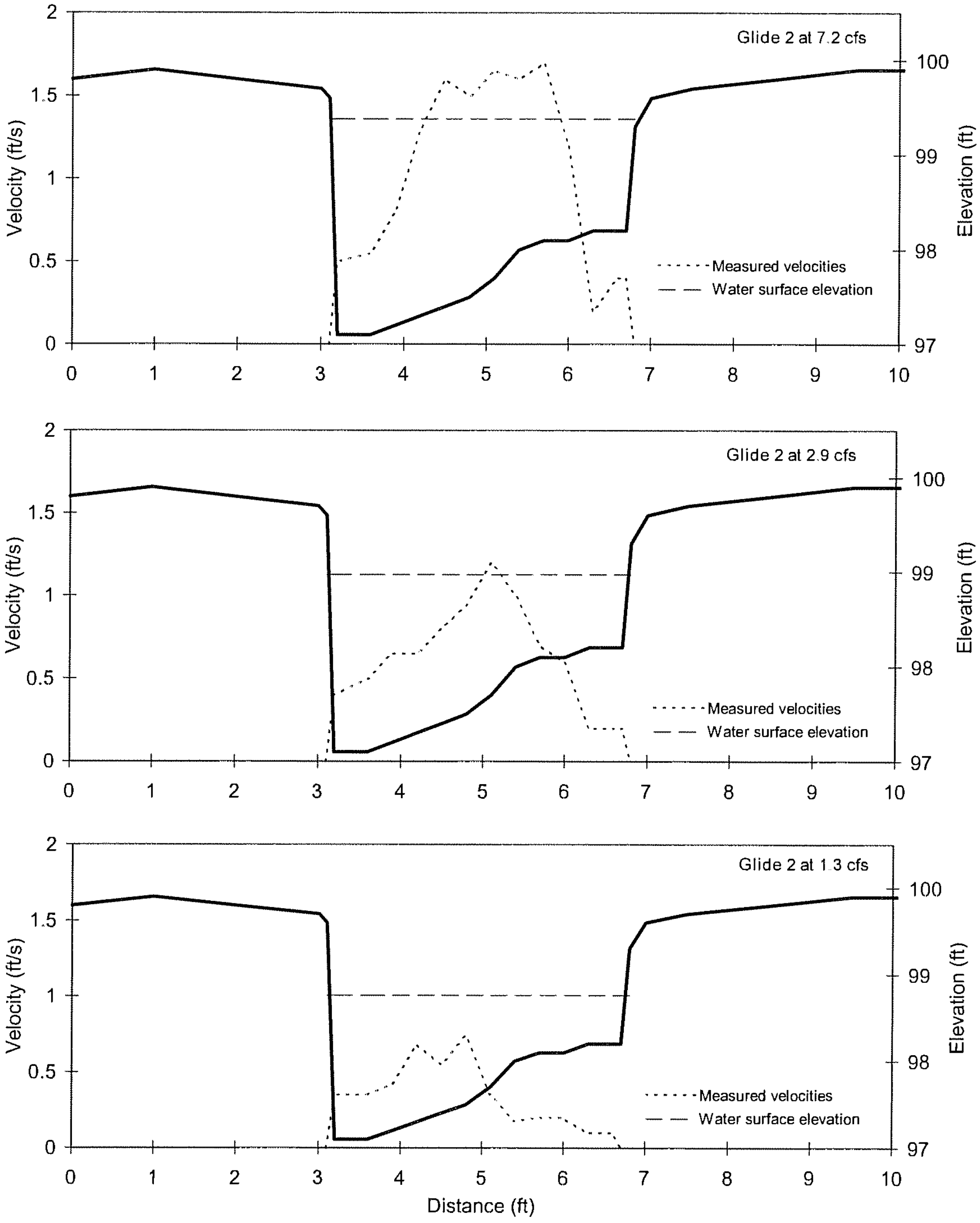


Figure 11. Glide 2 depth and velocities at calibration discharges of 1.3, 2.9, and 7.2 cfs at Coyote Creek.

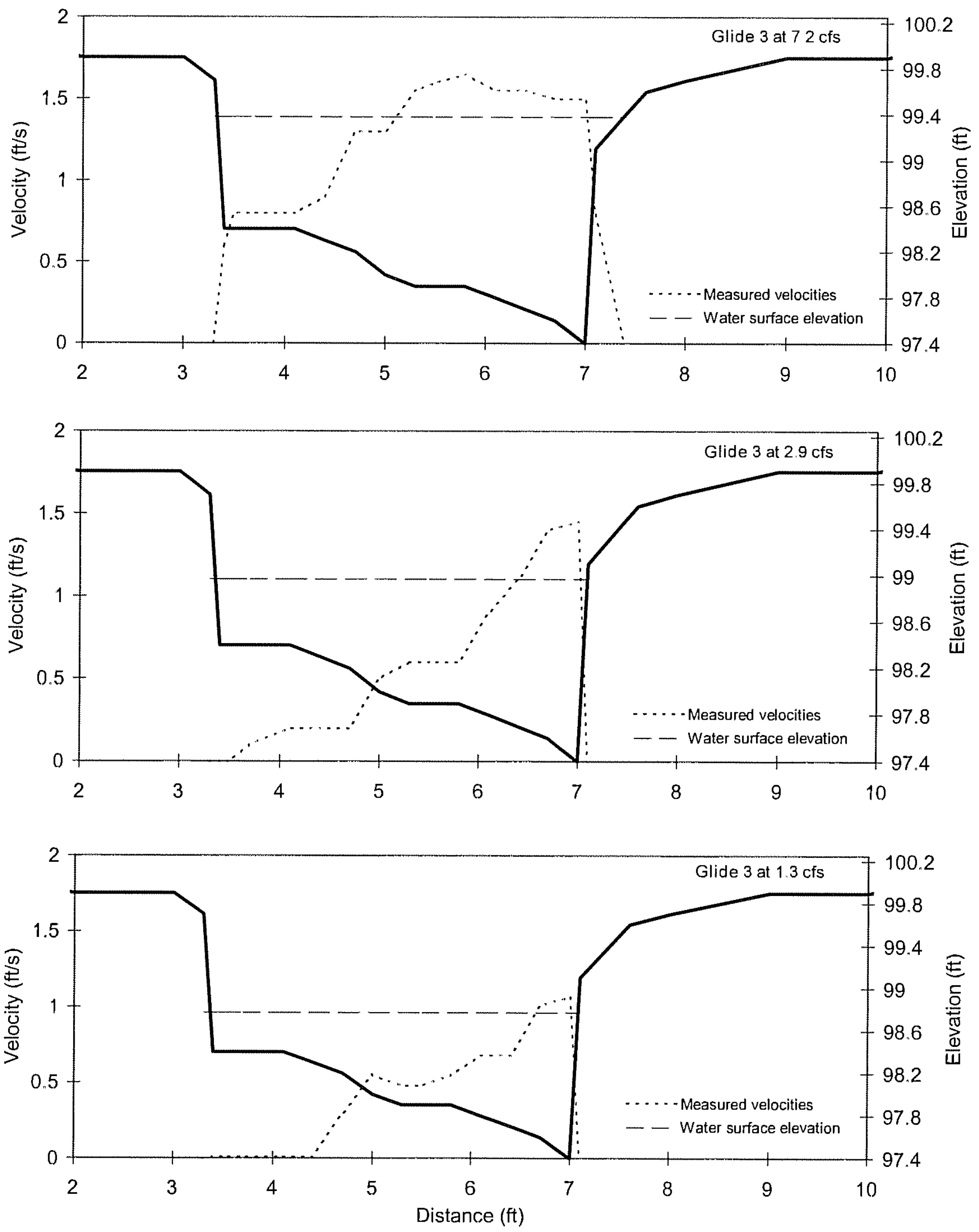


Figure 12. Glide 3 depth and velocities at calibration discharges of 1.3, 2.9, and 7.2 cfs at Coyote Creek.

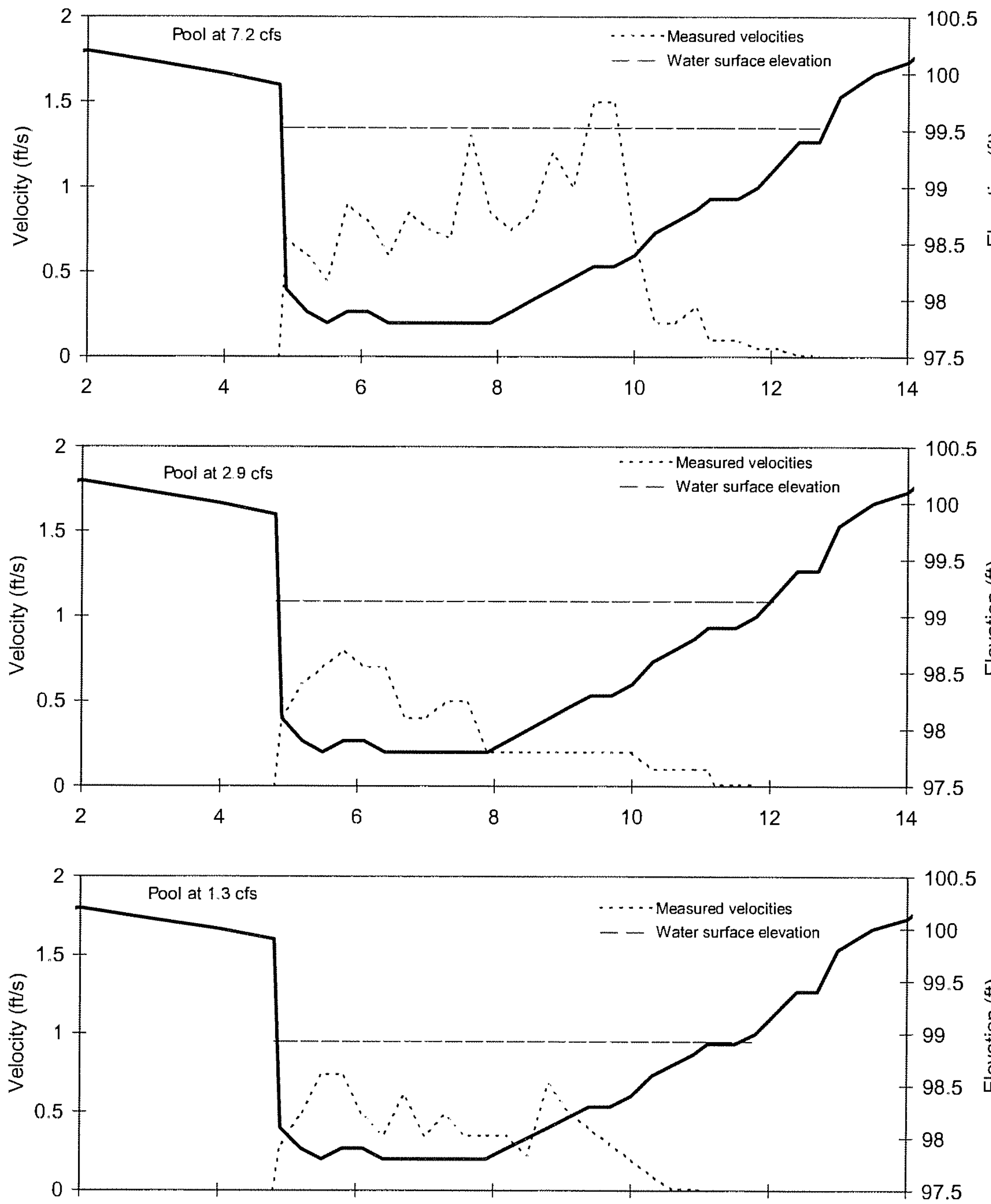


Figure 13. Pool depth and velocities at calibration discharges of 1.3, 2.9, and 7.2 cfs at Coyote Creek.

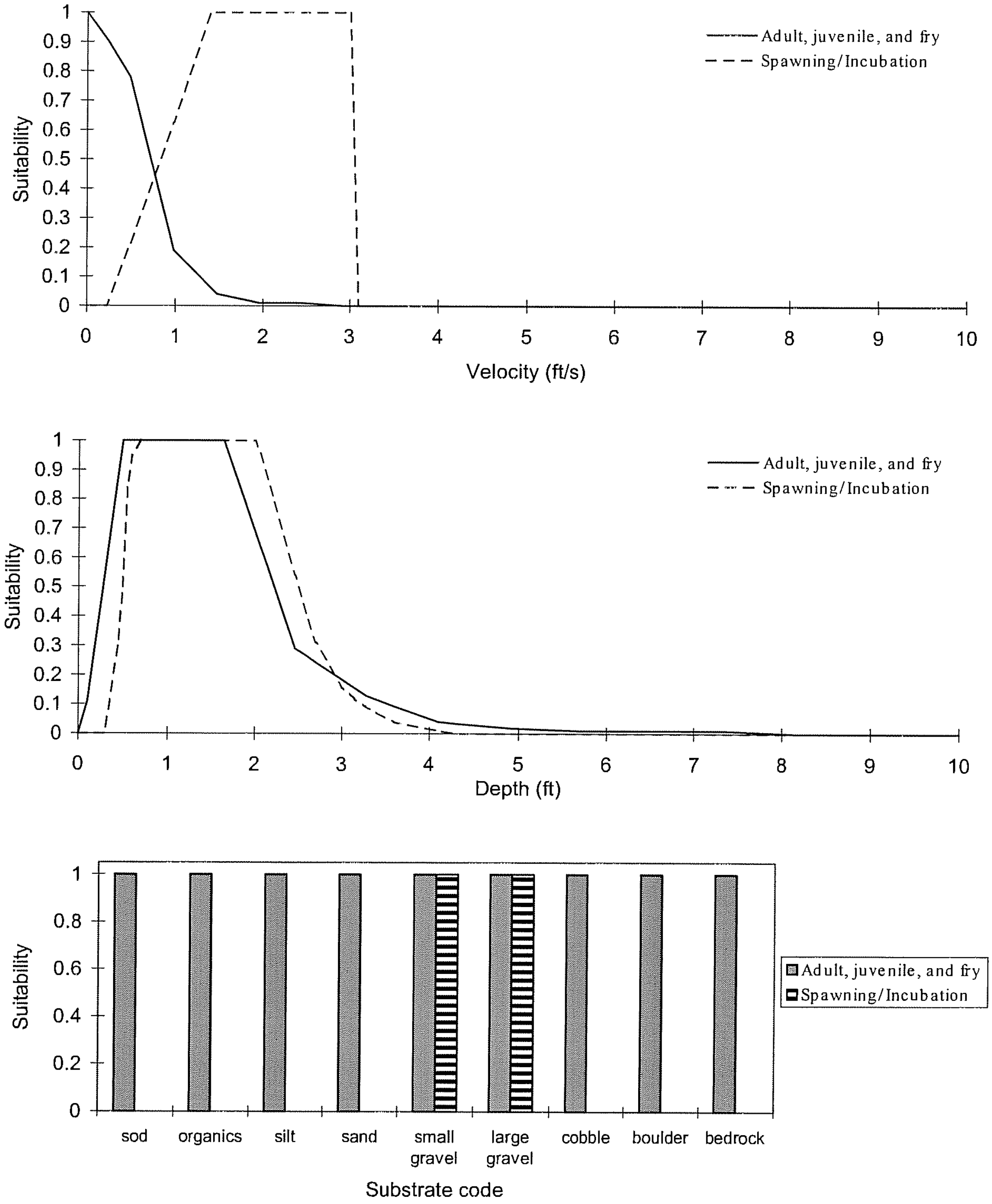
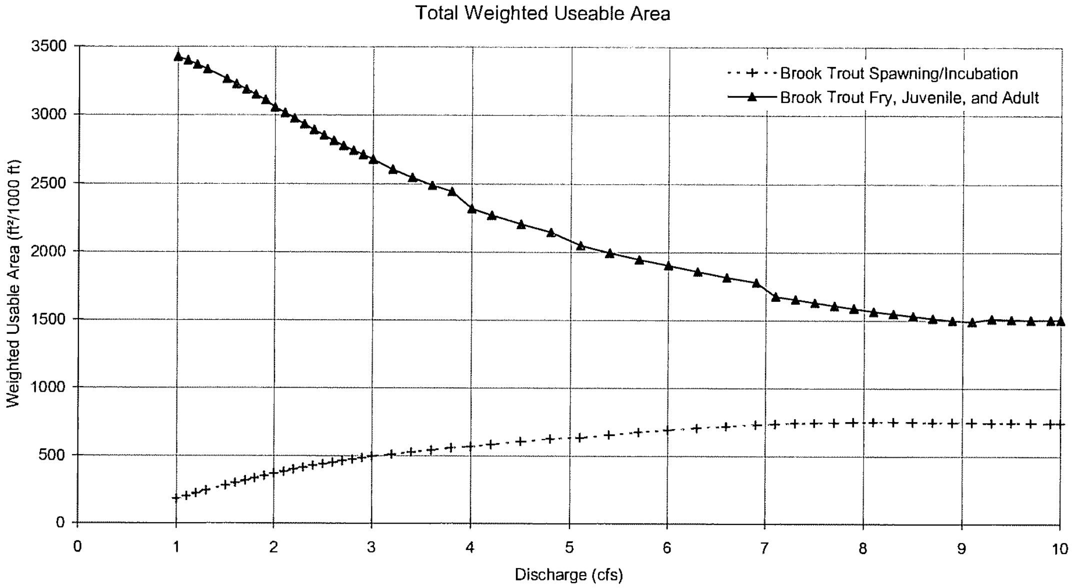


Figure 14. Habitat Suitability Index (HSI) curves used for brook trout.



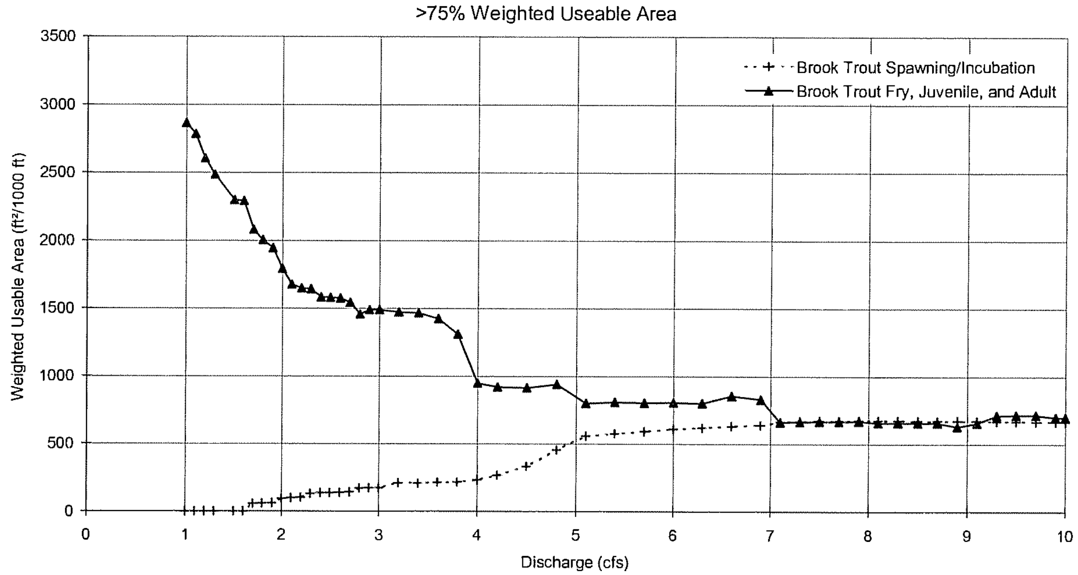


Figure 15. Total and optimal (>75% suitability) weighted usable area vs. discharge for brook trout in Coyote Creek.

Table 2. Periodicity chart for brook trout in Coyote Creek.

Species / Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Brook Trout Spawning/Incubation	X	X	X	X					X	X	X	X
Brook Trout Fry			X	X	X	X						
Brook Trout Juvenile	X	X	X	X	X	X	X	X	X	X	X	X
Brook Trout Adult	X	X	X	X	X	X	X	X	X	X	X	X

Table 3. Summary of rationale for final fish flow recommendations at Coyote Creek.

Stream: Coyote Creek | Species present: Brook trout

Selection crew: T. Smith, K. Meyer

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Long Term Median Discharge	1.8	5.4	9.8	12.4	7.5	3.8	1.4	0.5	0.3	0.0	0.8	1.2
Fish Habitat Recommendation	1.8	5.4	7.0	7.0	7.5	3.8	1.4	0.5	0.3	0.6	0.8	1.2
Habitat Maintenance Recommendation	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Final Fish Recommendation	1.8	4.1	4.1	4.1	4.1	3.8	1.4	0.5	0.3	0.6	0.8	1.2

Comments:	because of our lowest calibration point of 1.3 cfs and because of overbank conditions at about 10 cfs, we are constrained to model between these extremes
Jan	brook trout spawning/incubation is low and drops even lower below 1.8 cfs: other habitat is already good; therefore recommend monthly median.
Feb	below 5.1 cfs, quality incubation habitat drops below 80% of the maximum total available habitat and total incubation habitat is nearly below 80%; other lifestages experience increased habitat at lower flows due to deep water and slow velocity; since incubation in the most limited, recommend median monthly.
Mar	10 cfs is at optimal habitat quantity and quality, and curves are balanced down to 7 cfs; recommend 7.0 cfs
Apr	cannot model higher flow because of overbank conditions; otherwise, same as March and recommend 7.0 cfs
May	available habitat increases with lower flows but significant gains in habitat are not experienced until flow is drastically reduced from median monthly, & by then temperatures could become a problem (temps. >20°C have been documented); therefore recommend monthly median
Jun	same as May; recommend monthly median
Jul	habitat is good for all lifestages and increases at even lower discharges, but there is potential for lethal temperatures since they already exceed 20°C; recommend monthly median
Aug	cannot model this low due to our lowest calibration flow of 1.3 cfs, but flow is already extremely low and temperatures could become a problem; therefore recommend monthly median
Sep	cannot model this low due to our lowest calibration flow of 1.3 cfs, but flow is already extremely low and temperatures could become a problem; also, spawning habitat is already extremely low and dropping as flows drop; therefore recommend monthly median
Oct	the IFIM transects appear to be in a losing reach, because there is more water upstream behind beaver dams; recommend average Sep and Nov median monthly, which is 0.6 cfs
Nov	same as Sep, recommend monthly median
Dec	same as Sep, recommend monthly median