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Sycan River below Sycan Marsh 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

The Sycan River flows 25 miles from headwaters that drain the west side of the south slope of Winter Ridge (elevation 7540') into 24,000 acre Sycan Marsh. Most of the Sycan Marsh was purchased by the Nature Conservancy in 1980 and although their long term goal is to restore the Marsh to wetland, previous management diverted and irrigated the Marsh for pasture and has probably had detrimental impacts to discharges out of the Marsh during low flow months. After flowing 8.6 miles through the Sycan Marsh, the lower Sycan River continues another 37 miles to its confluence with the Sprague River. The lower Sycan River flows 26.4 miles from the outlet of Sycan Marsh to where it leaves the Forest at Coyote Bucket (42°34'N, 121°19'W), forming the boundary between the Winema and Fremont National Forests, draining a watershed of 496 mi^2. Approximately 90% of this stretch of river is under USFS management. In 1988, the Sycan River was designated by Congress as a Wild and Scenic River mainly for its "scenic values". This report covers the development of the fisheries flow recommendations for the Sycan River below Sycan Marsh which is described as Segment 1 of the Wild and Scenic River corridor. The 1992 Environmental Assessment and River Management Plan (USFS 1992) describes the lower Sycan River as mostly flowing through a basalt canyon with areas of steep canyon walls. The floodplain varies from 50 to 150 ft wide with a gradient of about 1%. However, within the Coyote Bucket canyon, the river has a steep sided v-shaped cross section with huge boulders. Here the gradient is about 5%. The 1990 Hankin and Reeves Level II Stream Survey Report names Torrent Springs as a major contributor of flow at the time of the survey, providing about 5 cfs. Flows between the Sycan Marsh and Torrent Springs are intermittent in late summer. The stream survey found mainly glide habitat with few pools throughout the lower Sycan River. The stream survey reports high water temperatures throughout the river, limited large woody debris, low bank stability, and little or no stream canopy. Oregon Department of Fish and Wildlife (ODFW) stocking records indicate that rainbow trout and brook trout were introduced into the lower Sycan River in 1944. Visual and electroshocking efforts by ODFW and USFS in 1979, 1991, and 1992 found sparse populations of trout concentrated near the Torrent Springs and Coyote Bucket sections of the river. Unidentified sucker species were present, and dace and chubs were abundant. Bull trout are found in the uppermost reaches of Long Creek (Light et al. 1996), a tributary to the Sycan Marsh, but do not exist in the lower Sycan River and were not considered in our analysis. Endangered shortnose sucker and Lost River sucker historically may have been present, but were also not included in our analysis. USFS personnel did not collect PHABSIM modeling data for the lower Sycan River but relied on data collected by EA Engineering, Science and Technology of Redmond, Washington, to develop fisheries flow recommendations.

The Physical Habitat Simulation System (PHABSIM) was used to model fish habitat in the stream and to make 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.

Water temperatures were collected at three locations in the lower Sycan River. Temperatures were collected at Coyote Bucket, rivermile (RM) 12, at the downstream most USFS boundary, in 1992 and 1993. In Torrent Springs (RM 26.5) water temperatures were measured from 1995-1996. At the concrete bridge at FS Road 27 (RM 34.5), continuous water temperatures were collected with a datalogger at river elevation 4976' from 1992 to present. The datalogger located at 4976' also recorded continuous water elevation in the river, 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 the Sycan River below Sycan Marsh, 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. Habitat requirements of threatened/endangered and sensitive fish species that currently exist in the stream were given priority over other species.

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

Water temperatures at Torrent Springs were relatively constant at 7.5-9.0°C for the year that measurements were taken (Table 1). The temperatures at Coyote Bucket are not continuous and represent single seasons, but maximum temperatures were above 20°C for four months (Table 1). Additionally, the lower Sycan River was dry at Coyote Bucket by the end of August 1992, the end of July 1994, and by May 1995 (USFS, unpublished data). The monthly average temperatures collected at the concrete bridge at the FS Road 27 crossing, ranged from less than 1°C in winter months to a high of 21.3°C in July 1996 (Table 1). The Sycan River at the concrete bridge also was dry from June 1992 through run-off in 1993 and again from July 1994 through early January 1995 (Figure 1). Maximum water temperatures commonly exceeded 25°C at both the concrete bridge location and the Coyote Bucket location for the years that measurements were taken (Table 1, Figures 2 through 8). These water temperatures are well above the standard for trout of 17.8°C set by the Oregon Department of Environmental Quality (Boyd and Sturdevant 1996).

We used transects that were established by EA Engineering, Science and Technology, Redmond, Washington, under contract to the Bureau of Indian Affairs, at three separate locations at the lower Sycan River to represent fish habitat (Figure 9). The most downstream location was "below Teddy Powers Meadow " (RM 19) with three run habitat cross sections. Upstream of Torrent Springs (RM 26.5), three riffle transects were established. Closest to the outlet of the Sycan Marsh, two riffle and three run habitat transects were established upstream of the concrete bridge at the FS Road 27 crossing (RM 34.5). In September 1990, when the transects were placed, the lower Sycan River was dry at both the Torrent Springs location and the concrete bridge location. Water surface elevations (Figures 10 through 13) were collected at discharges that varied between locations, as well as between the individual transects at a site. Cell velocities were collected once at each transect (Figures 10 through 13). The data from the three locations were combined for PHABSIM model calibration and simulations. The channel widths varied between transects and flows, ranging from narrow, divided channels above Torrent Springs at low flows to a 175' wide channel when flows measured 453 cfs at the concrete bridge transects. Substrate was mainly gravel and silt throughout, with large boulders at the "below Teddy Powers Meadow" site. Generally, the HSI curves ranked velocities of less than 3 ft/s as suitable for redband trout, brown trout, and Klamath largescale sucker (Figures 14 through 16). Depth preferences varied among all species and lifestages, but suitability was optimized for fry and juveniles at depths of 0.5 to 2 ft for all species considered (Figures 14 through 16). Substrate suitability also varied between species and lifestages. Trout prefer small to large gravel for spawning (Figures 14 and 15). Klamath largescale sucker use silt to small gravel for spawning and incubation, with larvae preferring sand substrate (Figure 16).

Redband trout and Klamath largescale sucker, both USFS Region 6 sensitive species and native to the Sycan River, took precedence over brown trout in our flow recommendations. Redband trout spawning period (including incubation) occurs from March to July, whereas brown trout spawn in the fall but egg incubation continues until the following spring (Table 2). Klamath largescale sucker reproduction timing is similar to that of redband trout (Table 2). The period of time that fry occur is similar between species, and juvenile and adult lifestages are present all year for the three species considered (Table 2). Total and optimal fish habitat was simulated for redband trout, brown trout and Klamath largescale sucker from 5 to 600 cfs (Figures 17 and 18).

Most likely due to past land use practices in the Sycan Marsh, discharge in the Sycan River below the marsh typically reaches zero or near zero during the summer; high flows peak at 800 cfs and greater (Figure 1). During 1994, a particularly dry year, run off was short duration and high flows were about 200 cfs. Long-term median monthly discharges ranged from zero in August and September to high flows of nearly 260 cfs in April and May (Table 3). In this instance, the data collected from transects distributed throughout the river were combined to simulate available habitat from below the Sycan Marsh to where the Sycan River leaves USFS management at Coyote Bucket. Using this combined data, PHABSIM modeling suggests that good amounts of total habitat and moderate amounts of quality habitat exist for redband trout adult and juvenile lifestages during most months, but spawning habitat is limited throughout the range of flows simulated (Figures 17 and 18). For Klamath largescale sucker, moderate amounts of total and quality habitat exist for holding behavior and juvenile lifestages, but quality habitat is virtually non-existent for reproduction (Figures 17 and 18). Monthly median discharge was recommended for all months except when fish habitat recommendations exceeded habitat maintenance recommendations (April and May) and when discharge was zero (August and September) (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).

US Forest Service. 1992. Environmental assessment and river management plan: Sycan Wild & Scenic River. Fremont National Forest and Winema National Forest.

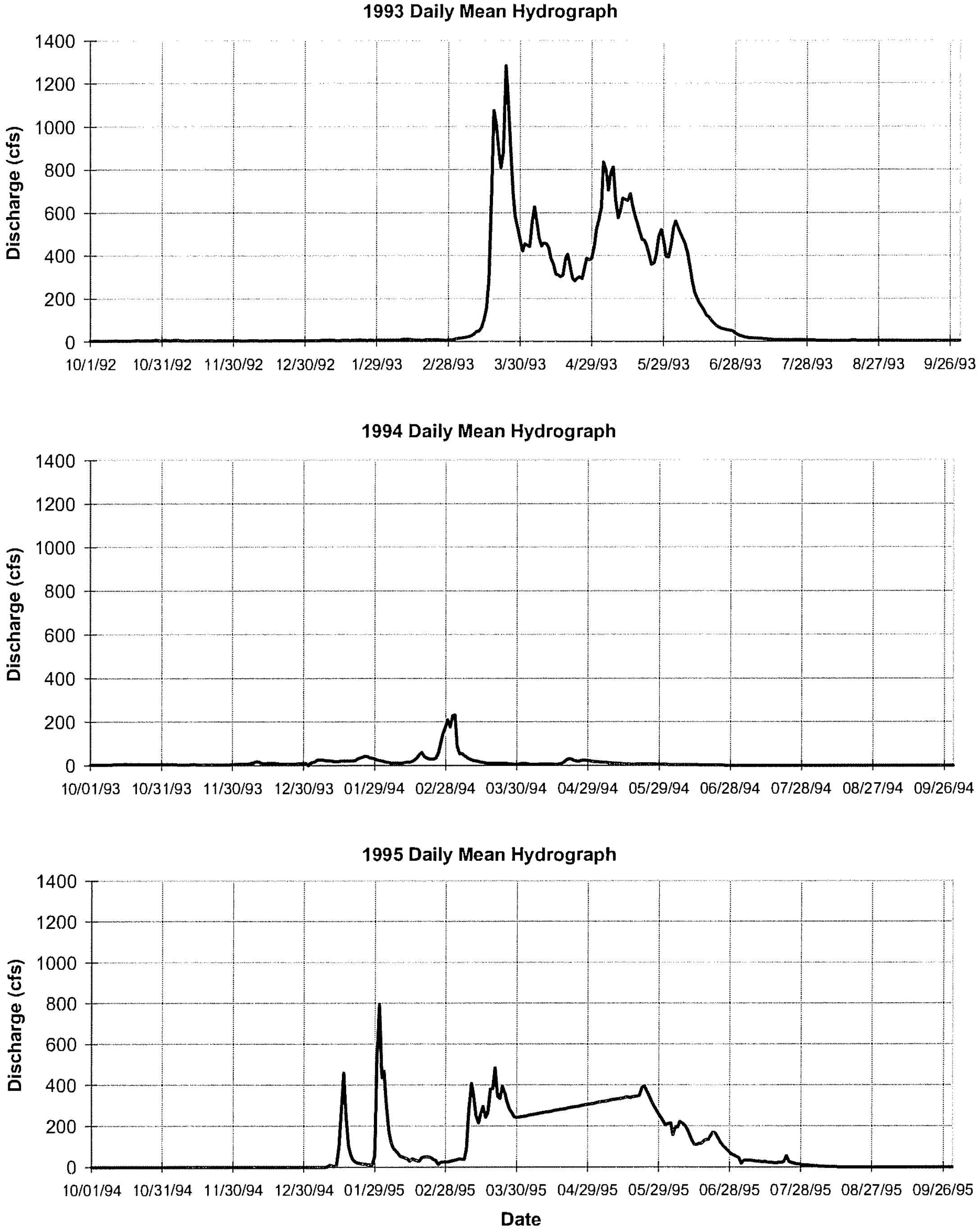


Figure 1. Daily mean discharge for water years 1993-1995 at lower Sycan River.

Table 1. Monthly maximum and mean temperature values at three locations at the Sycan River below Sycan Marsh.

	Maximum temperature (^oC)								
	Coyote Bucket*		Torrent Springs		Concrete Bridge**				
Month	1992	1993	1995	1996	1993	1994	1995	1996	1997
Jan				8.5		1.1	3.8	2.1	2.2
Feb				8.5		0.8	10.0	8.3	3.2
Mar	18.0		8.7	8.7		5.3	11.0	13.2	10.5
Apr	23.7		8.9	8.7	15.9	13.4		17.9	17.9
May	25.3		8.8	8.7	20.9	23.9	23.5	19.9	19.9
Jun			8.8	8.7	22.7	25.1	26.8	25.4	18.5
Jul			9.0		21.9		25.3	25.3	23.7
Aug		28.1	9.0		24.2		23.6	22.4	23.0
Sep		25.4	9.0		20.1		18.0	15.9	20.4
Oct		18.6	8.9		14.2		11.2	15.1	12.2
Nov		8.2	8.8		6.6		9.2	5.7	7.4
Dec			8.7		1.9		6.6	1.4	4.7

	Average temperature (^oC)								
	Coyote Bucket*		Torrent Springs		Concrete Bridge**				
Month	1992	1993	1995	1996	1993	1994	1995	1996	1997
Jan				8.3		1.0	0.1	0.3	1.9
Feb				7.5		0.7	4.2	1.9	2.3
Mar	7.9		8.5	8.5		1.2	4.3	6.1	5.2
Apr	10.7		8.3	8.5	8.8	7.0		8.8	8.3
May	16.0		8.5	8.5	13.2	16.0	17.5	13.1	15.4
Jun			8.5	8.5	15.8	18.2	17.6	19.0	15.4
Jul			8.7		17.2		20.7	21.3	17.7
Aug		17.3	8.7		16.7		16.8	18.1	17.8
Sep		14.4	8.6		13.2		12.6	12.3	14.0
Oct		9.0	8.6		9.0		7.0	7.6	8.9
Nov		0.8	8.4		3.8		4.6	3.2	5.9
Dec			8.3		1.5		1.6	0.1	3.3

*Coyote Bucket dry end of August 1992; end of July 1994; May 1995.

** Concrete Bridge dry June 1992 to April 1993; July 1994 through early January 1995.

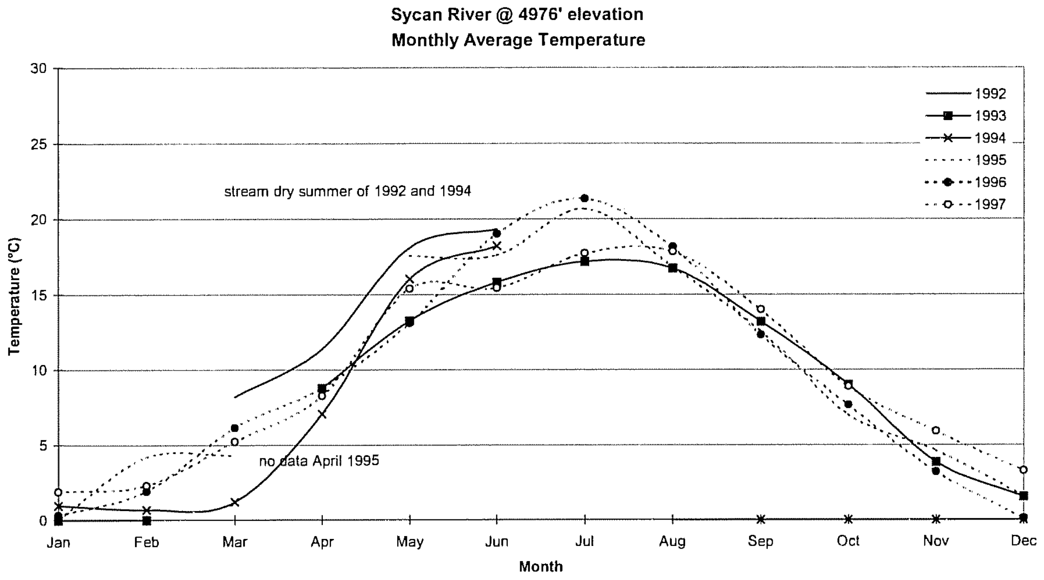


Figure 2. Monthly average temperature at lower Sycan River at concrete bridge.

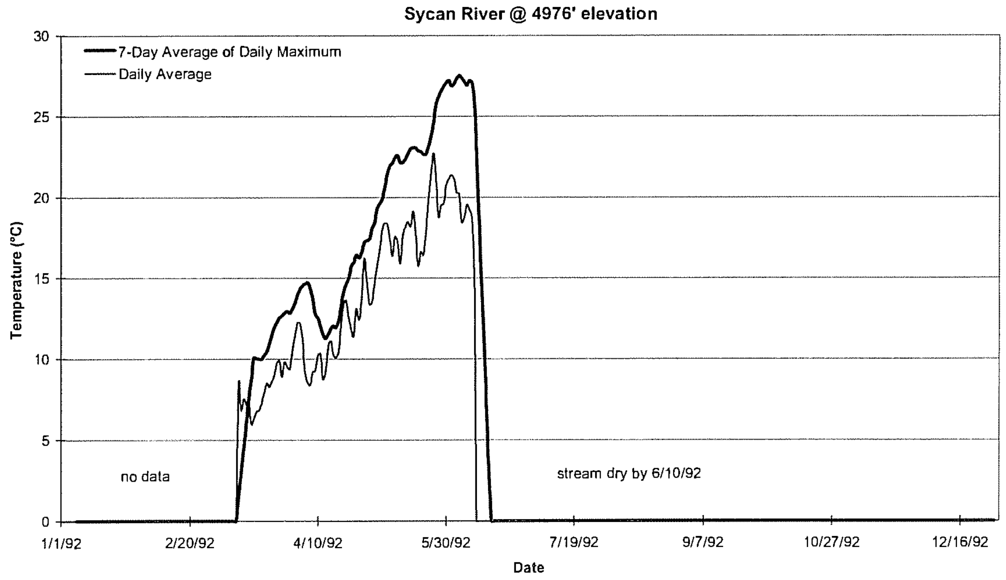


Figure 3. Daily average and 7-day average of the daily maximum temperatures at the lower Sycan River at the concrete bridge in 1992.

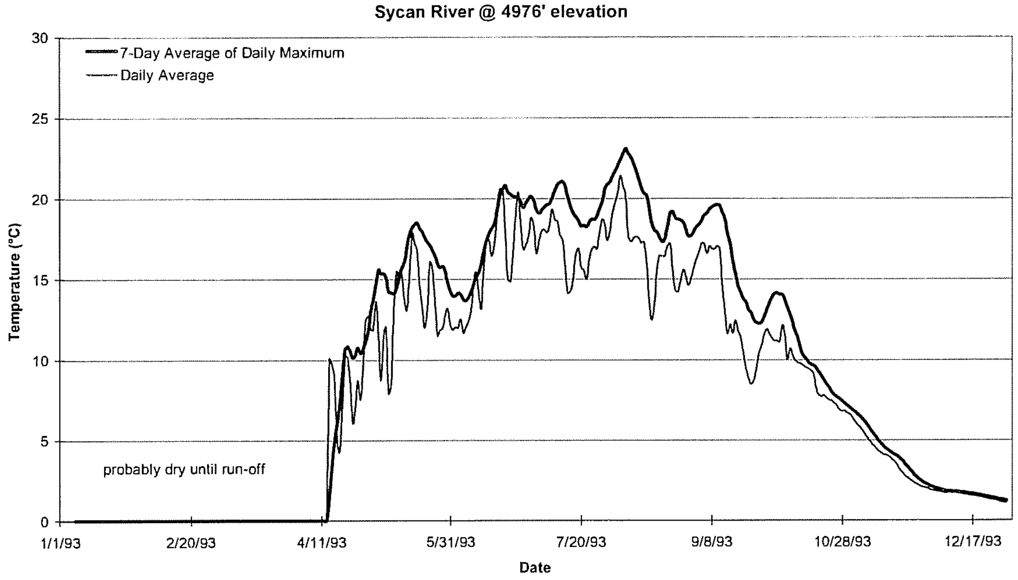


Figure 4. Daily average and 7-day average of the daily maximum temperatures at the lower Sycan River at the concrete bridge in 1993.

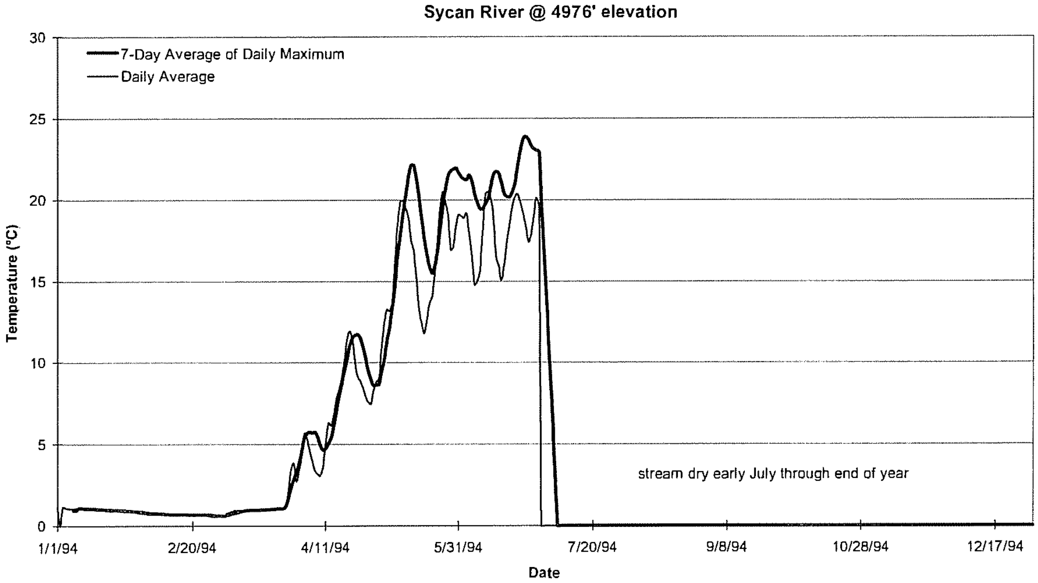


Figure 5. Daily average and 7-day average of the daily maximum temperatures at the lower Sycan River at the concrete bridge in 1994.

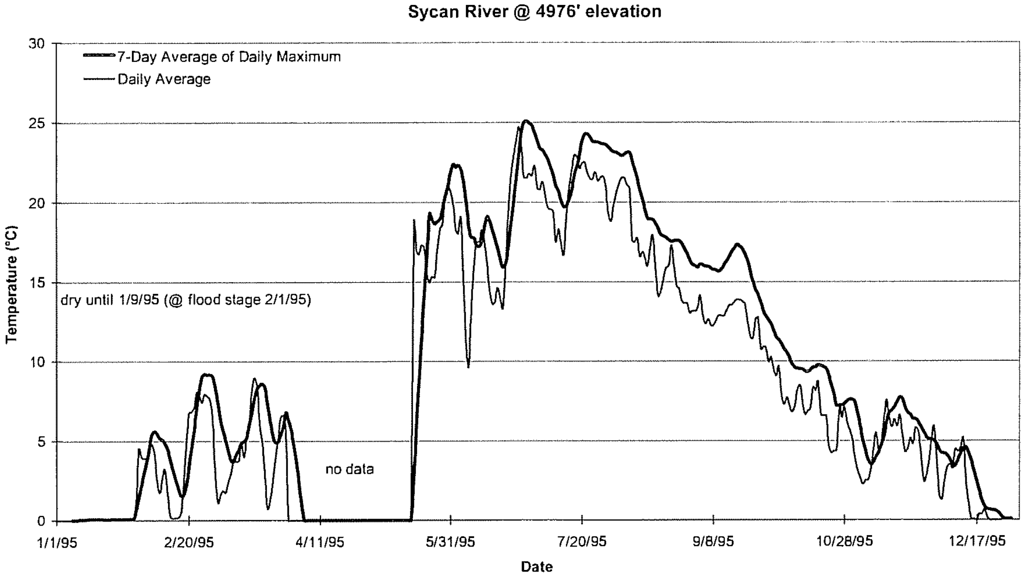


Figure 6. Daily average and 7-day average of the daily maximum temperatures at the lower Sycan River at the concrete bridge in 1995.

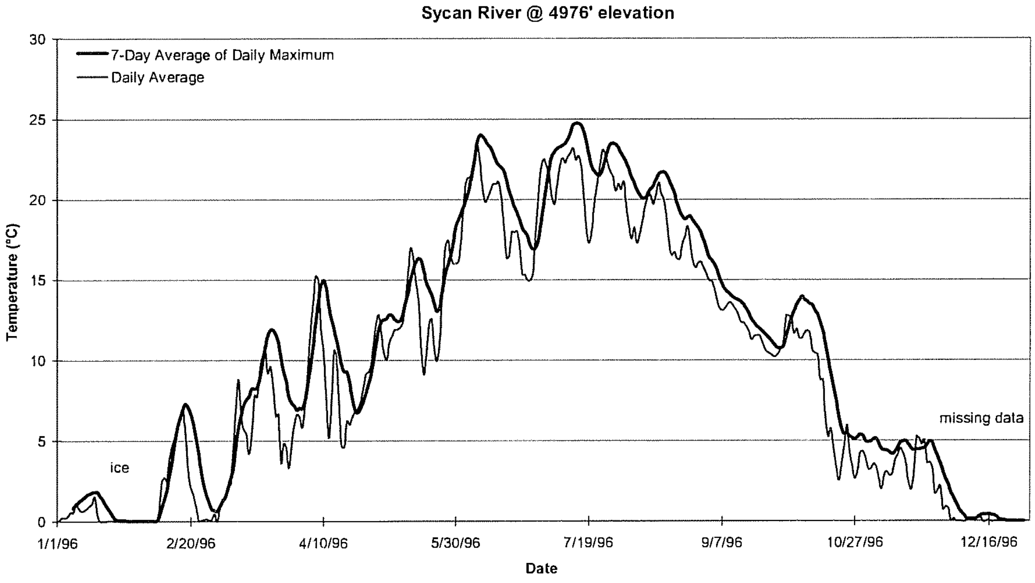


Figure 7. Daily average and 7-day average of the daily maximum temperatures at the lower Sycan River at the concrete bridge in 1996.

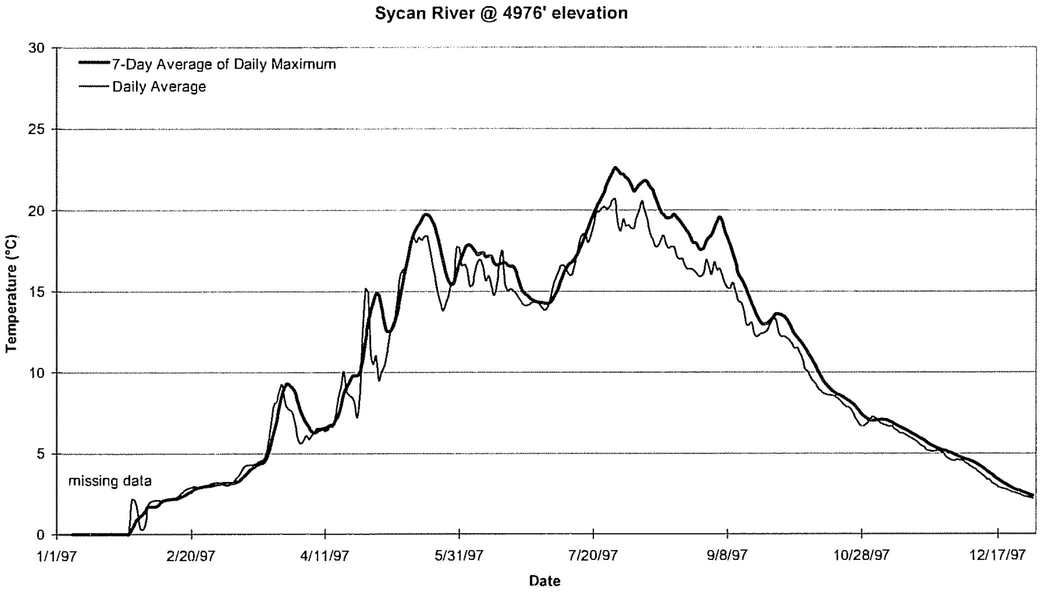


Figure 8. Daily average and 7-day average of the daily maximum temperatures at the lower Sycan River at the concrete bridge in 1997.

Figure 9. Map of lower Sycan River showing the vicinity of the sampling areas.

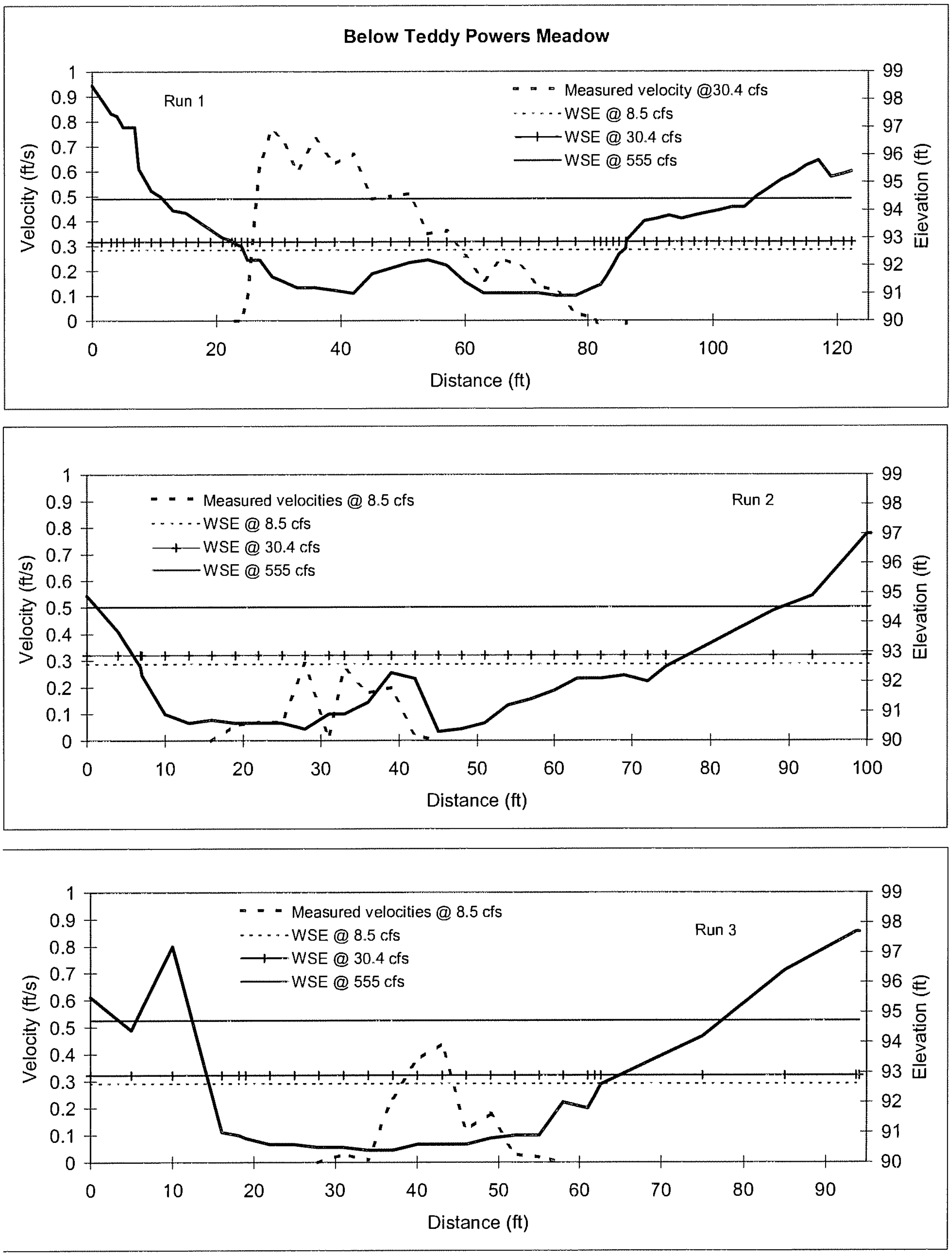


Figure 10. Three run habitat transects at lower Sycan River below Teddy Powers Meadow.

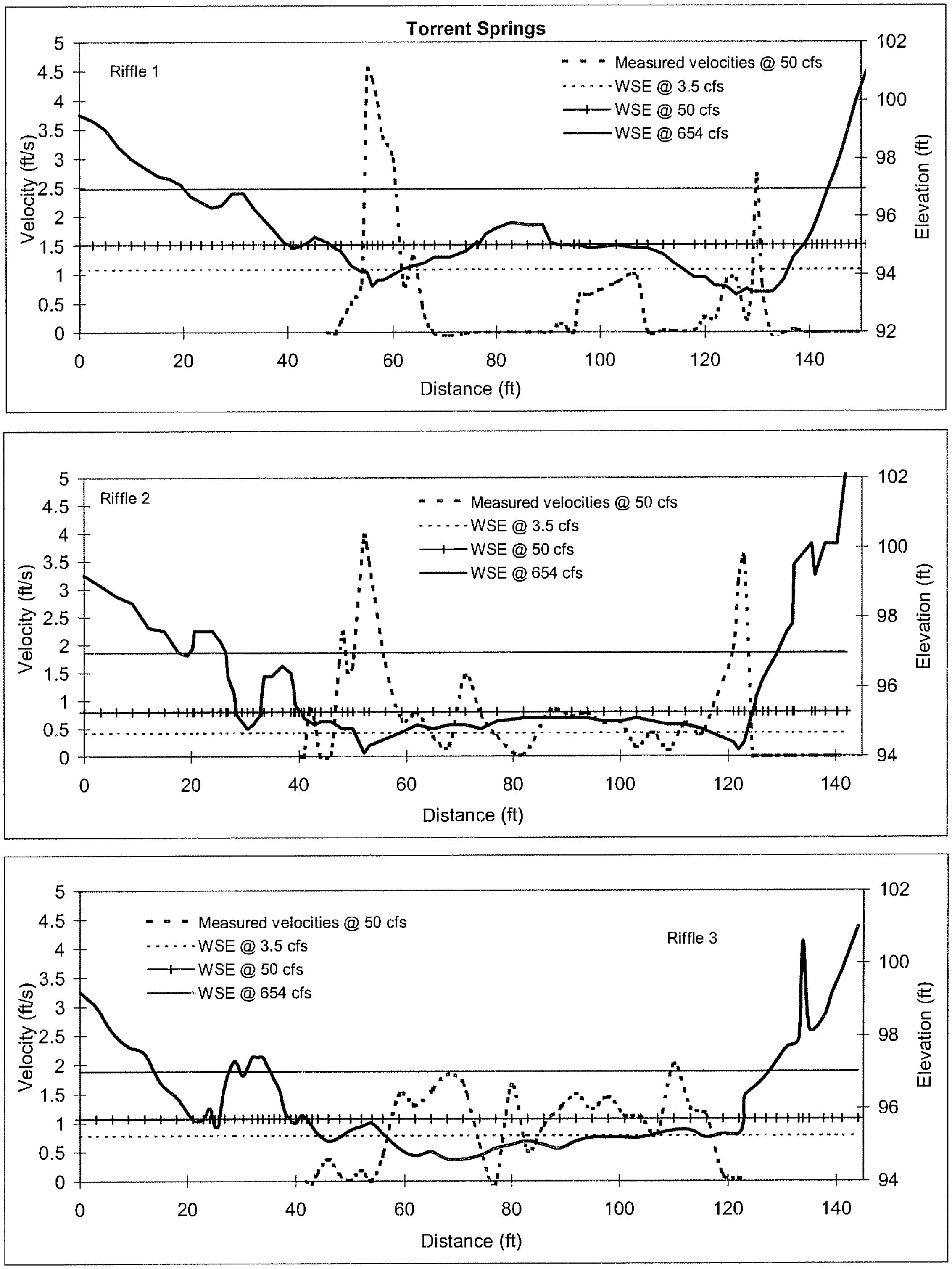


Figure 11. Three riffle transects at lower Sycan River near Torrent Springs.

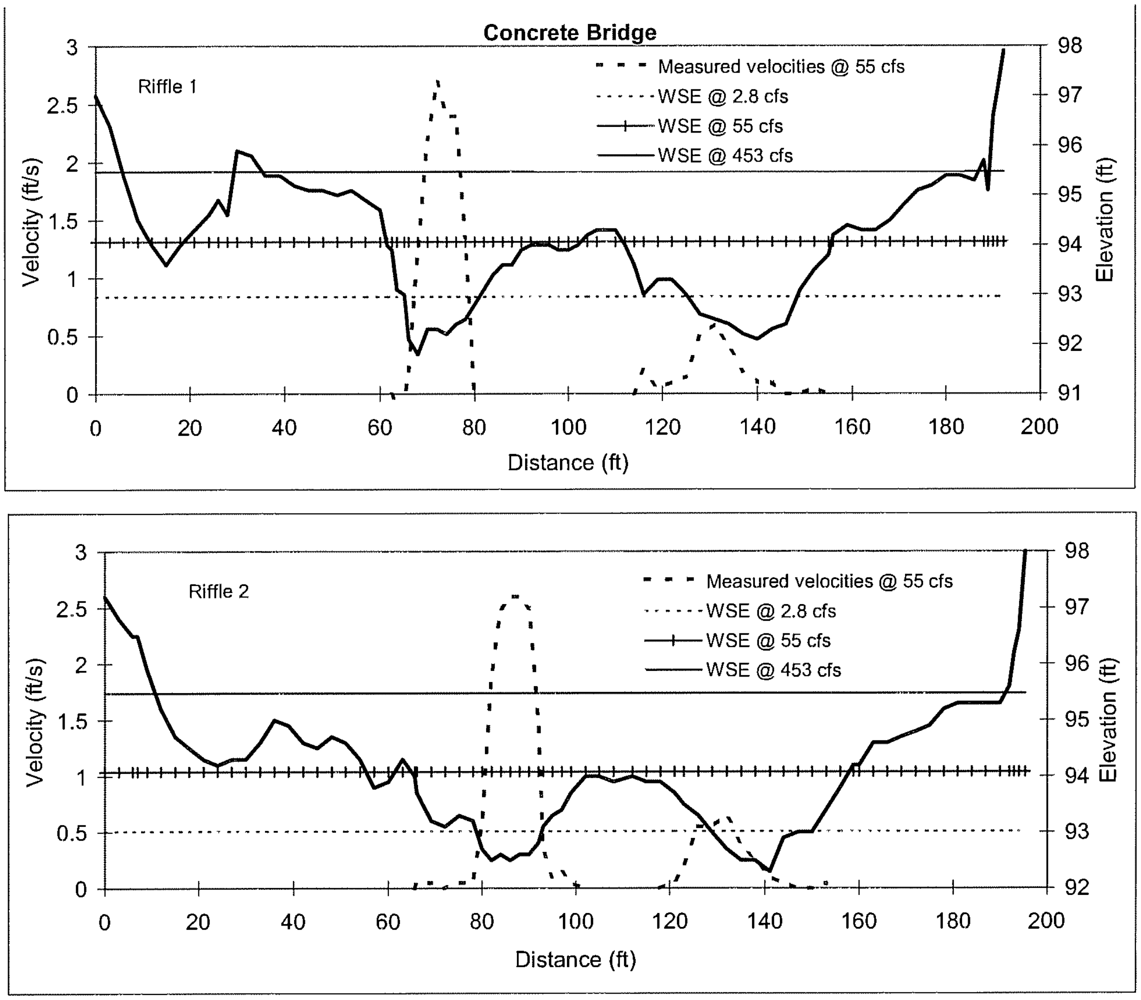


Figure 12. Two riffle transects at Sycan River near FS Road 27 Concrete Bridge.

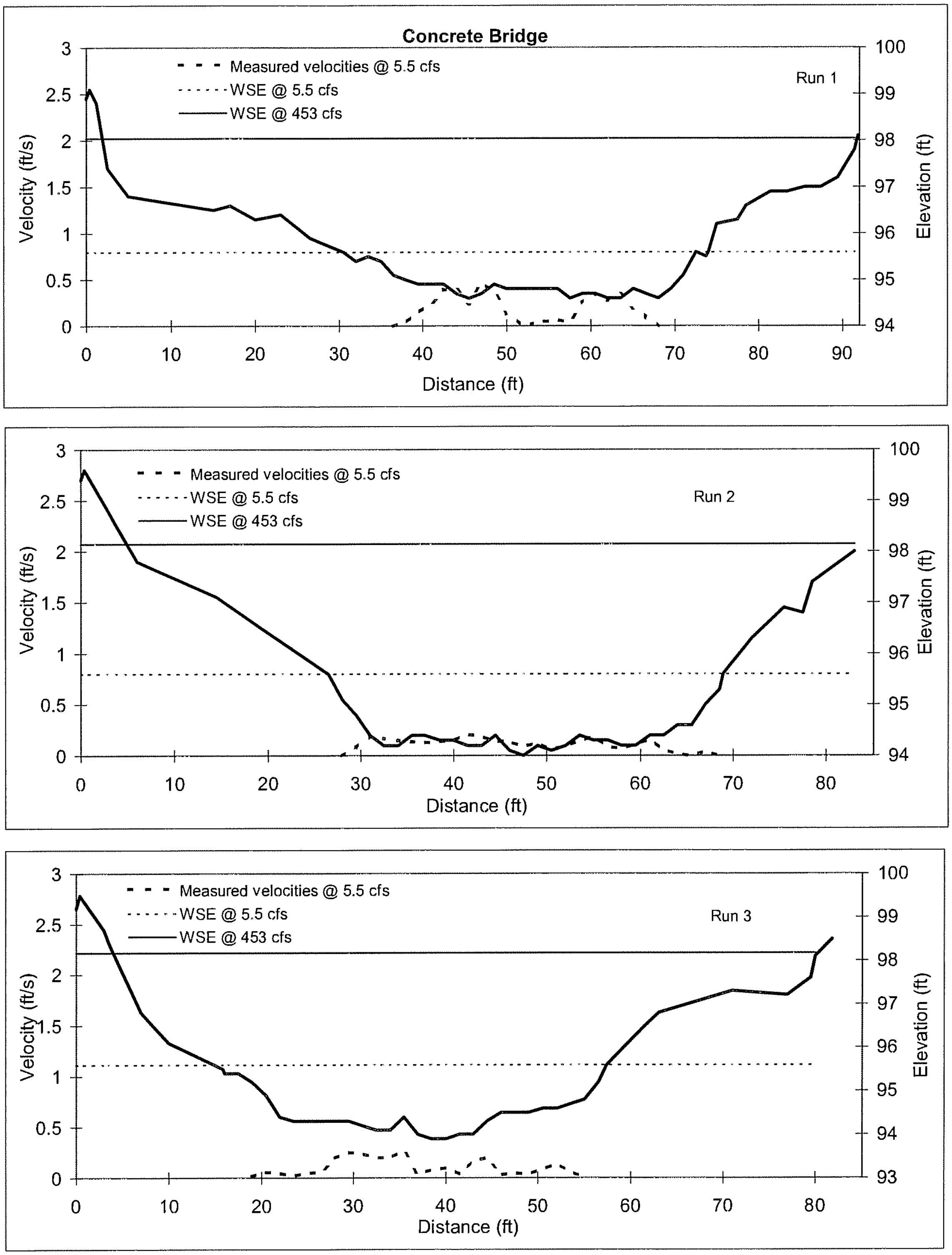


Figure 13. Three run habitat transects at Sycan River near FS Road 27 Concrete Bridge.

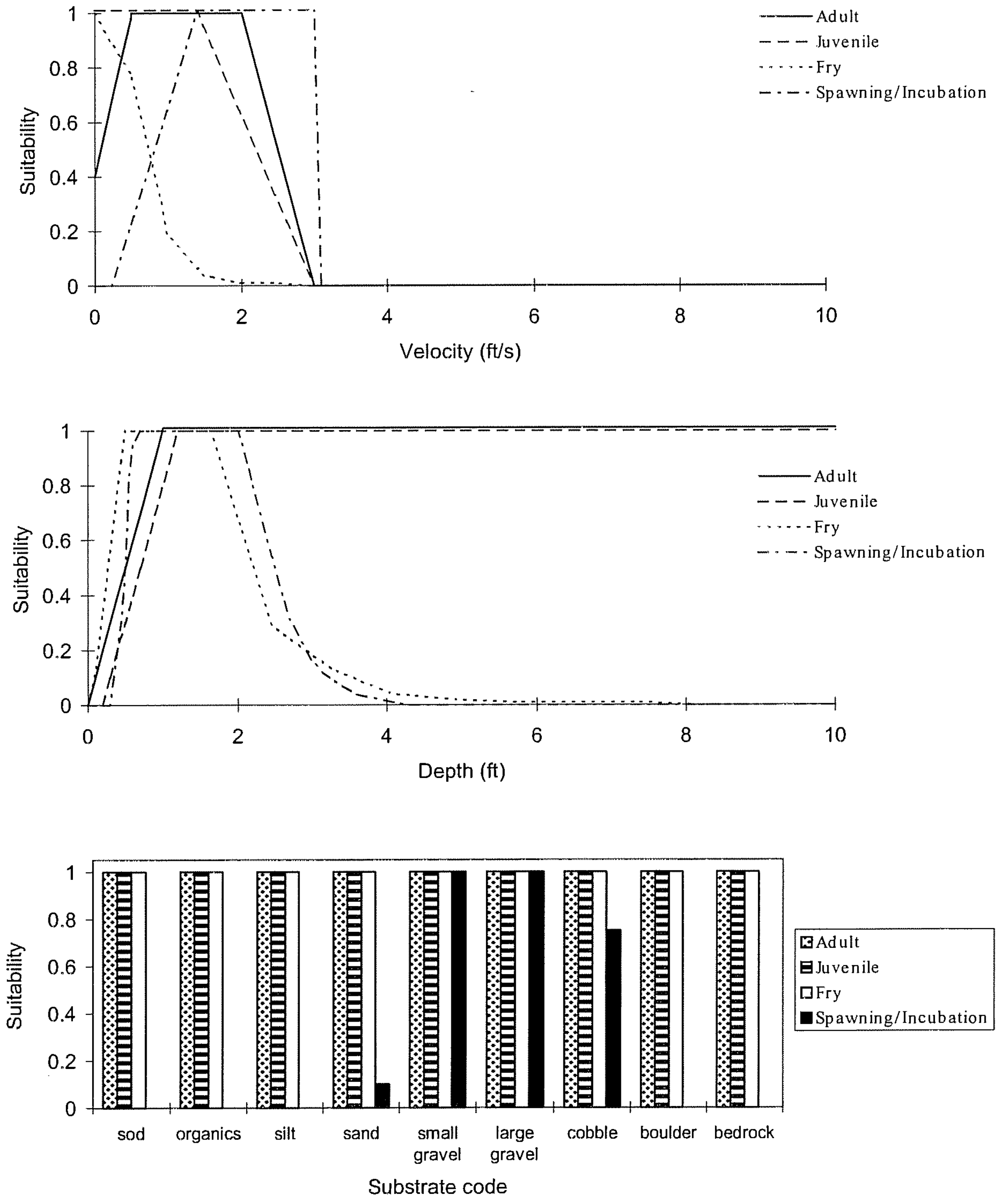


Figure 14. Habitat suitability Index (HSI) curves used for redband trout.

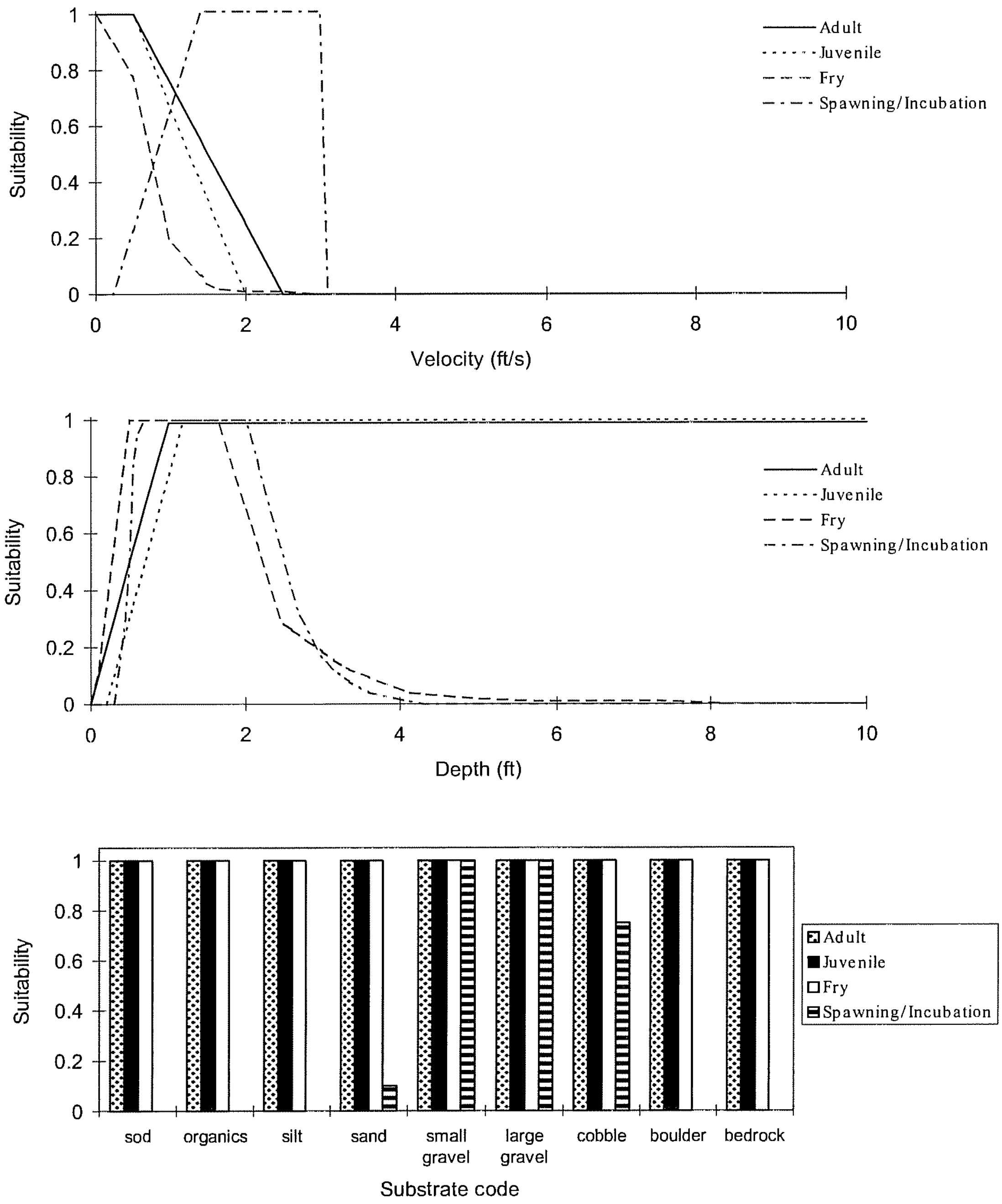


Figure 15. Habitat Suitability Index (HSI) curves used for brown trout.

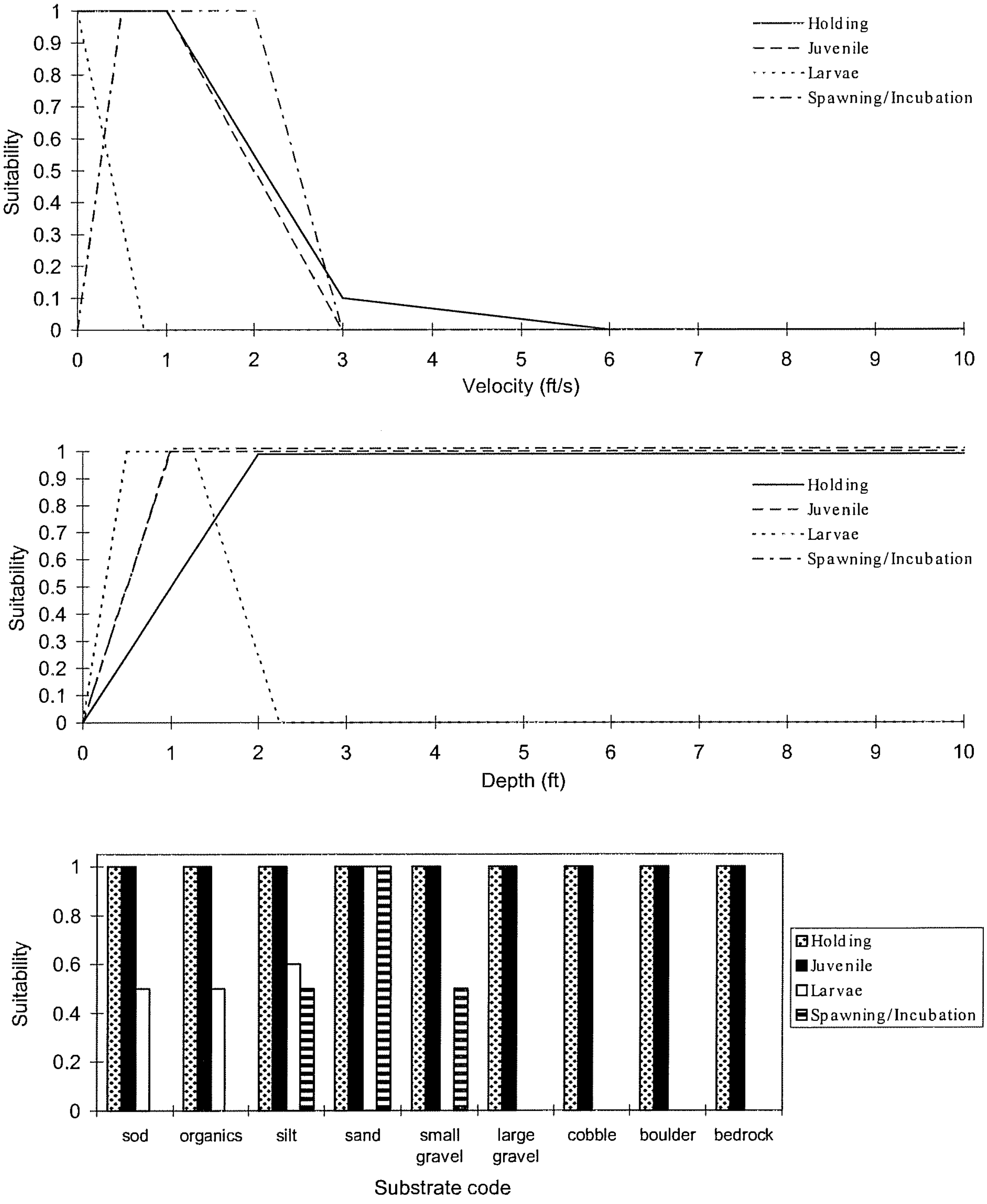
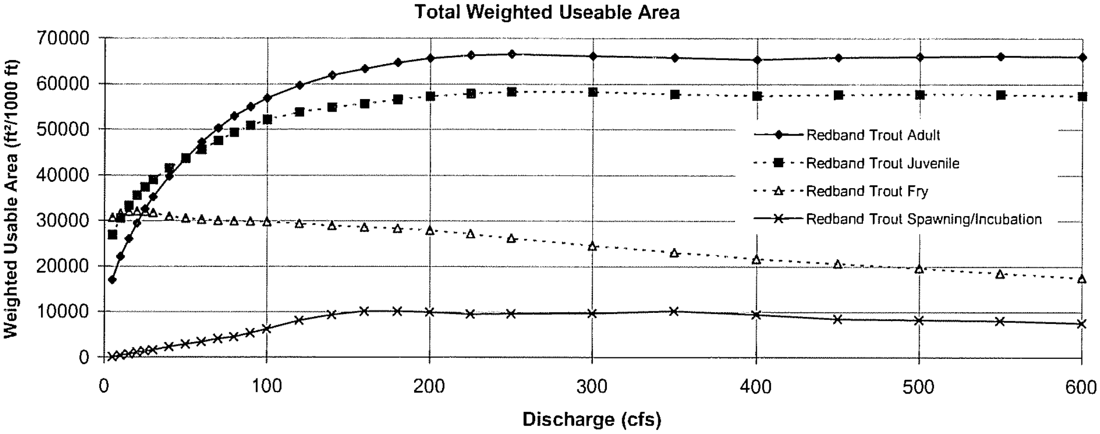
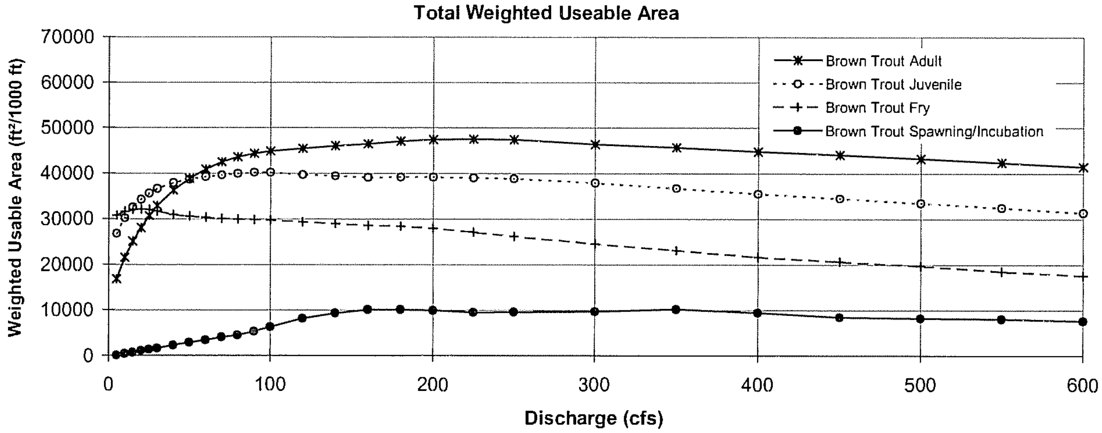


Figure 16. Habitat Suitability Index (HSI) curves used for Klamath largescale sucker.

Table 2. Periodicity chart for redband trout, brown trout, and Klamath largescale sucker in the lower Sycan River.

Species/Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Redband Trout Adult	X	X	X	X	X	X	X	X	X	X	X	X
Redband Trout Juvenile	X	X	X	X	X	X	X	X	X	X	X	X
Redband Trout Fry				X	X	X	X	X	X			
Redband Trout Spawning/Incubation			X	X	X	X	X					
Brown Trout Adult	X	X	X	X	X	X	X	X	X	X	X	X
Brown Trout Juvenile	X	X	X	X	X	X	X	X	X	X	X	X
Brown Trout Fry			X	X	X	X						
Brown Trout Spawning/Incubation	X	X	X	X						X	X	X
Klamath Largescale Sucker Spawning/Incubation			X	X	X	X						
Klamath Largescale Sucker Fry			X	X	X	X	X					
Klamath Largescale Sucker Juvenile	X	X	X	X	X	X	X	X	X	X	X	X
Klamath Largescale Sucker Holding	X	X	X	X	X	X	X	X	X	X	X	X





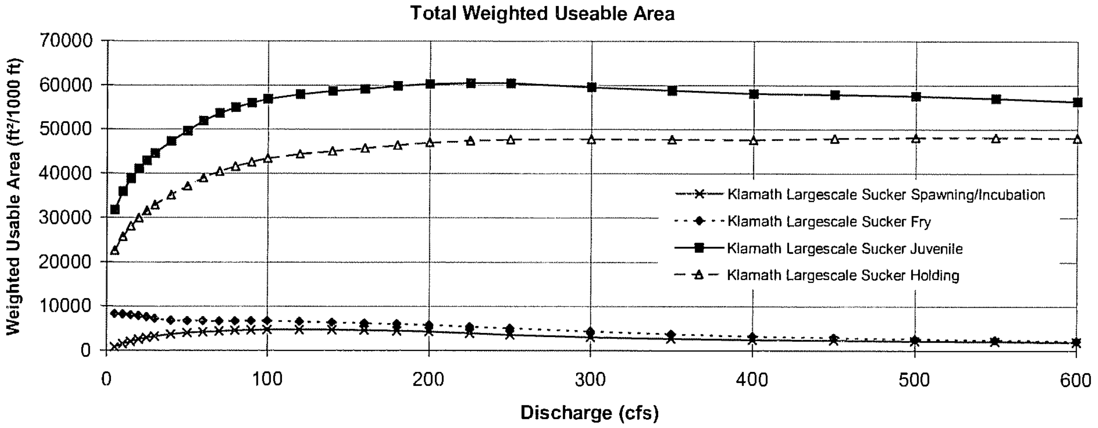


Figure 17. Total weighted useable area vs. discharge for redband trout, brown trout, and Klamath largescale sucker in the lower Sycan River.

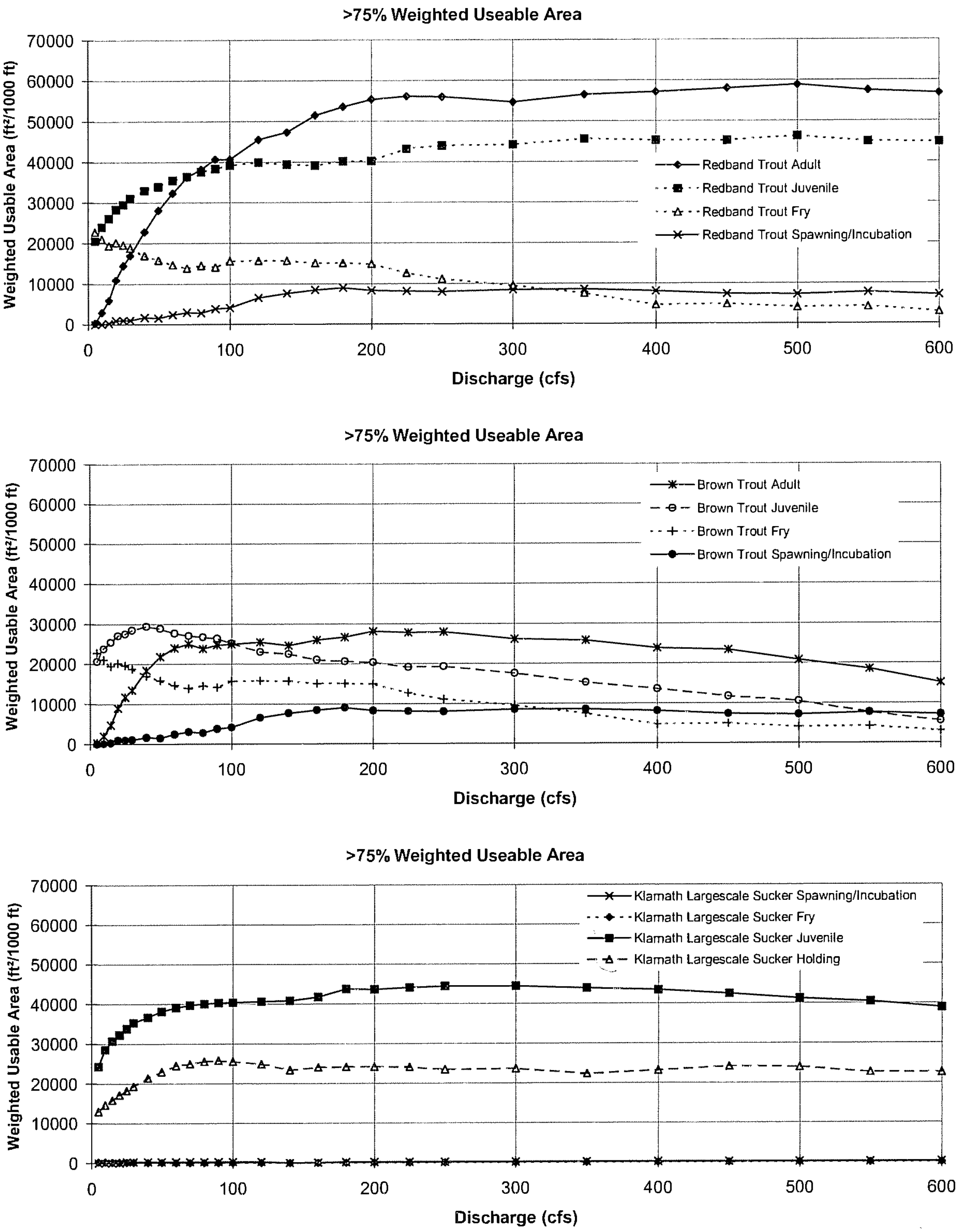


Figure 18. Optimal weighted useable area vs. discharge for redband trout, brown trout, and Klamath largescale sucker in the lower Sycan River.

*used EA data for flow recomm.

Table 3. Summary of rationale for final fish flow recommendations at lower Sycan River.

Stream: Sycan River below Sycan Marsh

Species present: Redband trout, brown trout, Klamath largescale sucker

Selection crew: K. Meyer, T. Smith

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Long Term Median Discharge	17	33	61	254	264	70	5.8	0	0	6.9	6.1	6.6
Fish Habitat Recommendation	17	33	61	230	230	70	5.8	5.8	5.8	6.9	6.1	6.6
Fish Habitat Maintenance Recommendation	287	287	287	287	287	287	287	287	287	287	287	287
Final Fish Recommendation	17	33	61	230	230	70	5.8	5.8	5.8	6.9	6.1	6.6

Comments:

Jan	All habitat availability is low and drops at lower flows; recommend median monthly.
Feb	Same as January; recommend median monthly.
Mar	Redband trout spawning is already well below 80% of optimal available habitat and continues to drop at lower flows; recommend median monthly.
Apr	Total habitat for redband adults and juveniles is nearly maximized at 230 cfs, as is Klamath largescale sucker juvenile and holding habitat; redband fry habitat gained is not as great as other losses; this relationship is similar for quality habitat; recommend 230 cfs.
May	Same as April; recommend 230 cfs.
Jun	Same as March; recommend monthly median.
Jul	Same as January; recommend median monthly.
Aug	Because the estimated streamflow is zero, we recommend the monthly value for July (5.8 cfs).
Sep	Because the estimated streamflow is zero, we recommend the monthly value for July (5.8 cfs).
Oct	Same as January; recommend median monthly.
Nov	Same as January; recommend median monthly.
Dec	Same as January; recommend median monthly.