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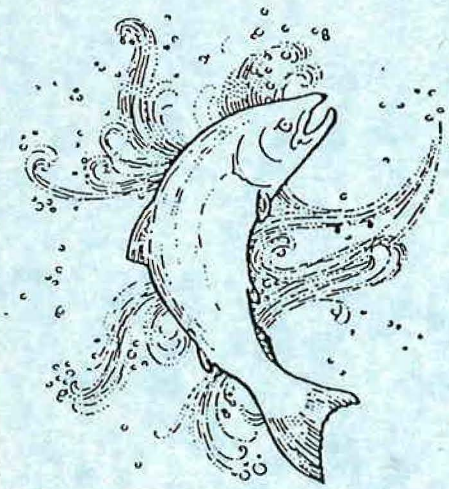

PREDICTING THE EFFECT OF REDUCED STREAMFLOW ON RAINBOW TROUT, BROWN TROUT, AND SCULPIN POPULATIONS IN CHAMOKANE CREEK USING THE INSTREAM FLOW INCREMENTAL METHODOLOGY (IFIM)

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ABSTRACT

An instream flow study was conducted on Chamokane Creek using the Instream Flow Incremental Methodology (IFIM). The purpose of this study was to: (1) determine the optimum flow for brown trout (*Salmo trutta* Linnaeus), rainbow trout (*Salmo gairdneri* Richardson), and sculpins, the majority of which are Piute sculpins (*Cottus beldingi* Eigenmann and Eigenmann); (2) recommend a minimum instream flow regime that would protect brown trout, rainbow trout, and sculpin habitat; and (3) determine the impact that proposed groundwater withdrawals will have on the availability of brown trout, rainbow trout, and sculpin habitat.

The instream flow required to maintain a viable fishery in Chamokane Creek has been part of a lawsuit brought by the United States and the Spokane Tribe of Indians against the State of Washington and all other persons or corporations that might have an interest in the waters of the Chamokane Basin. The court ruled that a minimum flow of 20 CFS, or whatever flow was needed to maintain water temperatures below 20°C (68°F), was adequate to protect the fishery. This decision was made without the necessary data on how such a low flow would impact the fishery.

Chamokane Creek, a third order stream with a drainage area of 466 km^2, has its headwaters in the Huckleberry Mountains north of the Spokane Indian Reservation. The east bank of the stream, over the lower 28.5 km, forms the east boundary of the reservation. The upper 15 km of the stream adjacent to the reservation is largely intermittent. The lower 13 km, from Ford, WA to the Spokane River, is perennial due to the flow of springs. The mean base flow at the USGS gaging station 2.25 km from the mouth is 29.9 CFS.

The lower 13 km (8 mi) of Chamokane Creek has been categorized as a "blue ribbon trout stream" by Scholz *et al.* (1988). They found this section of the stream contained 20633 ± 5638 brown trout and 15945 ± 3633 rainbow trout. Uehara *et al.* (1988) found

the growth and condition of trout in Chamokane Creek were comparable with other quality trout streams.

A scoping study was conducted following the methods of the Instream Flow Group of the U.S. Fish and Wildlife Service. The objectives of the scoping study were to determine what environmental variables would be affected by reduced streamflows, whether the Chamokane Creek channel was in equilibrium, and the selection of evaluation organisms. The DOE calculated the potential impact to the flow of Chamokane Creek at 3.83 CFS; the court recognized an impact of 5.26 CFS. The results of a recently completed aquifer study, however, suggest that the flow reduction will be less than originally believed. The impact of streamflow reductions on water quality and temperature were part of a separate study (O'Laughlin *et al.* 1988a).

The equilibrium condition of the stream channel was evaluated by field observation and by the analysis of USGS rating curve adjustments at the gaging stations on Chamokane Creek. A stream channel is considered to be in equilibrium when there is not a change in the ratio of pools to runs to riffles over time. It was determined that Chamokane Creek is in equilibrium.

The evaluation organisms were selected based upon (1) their economic importance and (2) their importance in the diets of organisms selected in (1). Based upon their economic importance, brown trout and rainbow trout were selected. The most abundant fish in the diet of brown trout were sculpins, so they were included as evaluation species. Macroinvertebrates that were found to be important in the diets of brown trout and rainbow trout were evaluated in a separate study (O'Laughlin *et al.* 1988b).

Study sites were selected based upon the channel structure and flow regime. Segment boundaries were placed wherever there was a 10 percent change in flow, a significant change in slope, a significant change in sediment supply, or a significant change in channel patterns, as recommended by the Instream Flow Group. Five segments were identified and study reaches were selected within each segment that represented the habitat characteristics of the segment. Study reaches were selected randomly following the methods of the Instream Flow Group.

Within each study reach, transects were established at several locations to measure all of the habitat types within the reach. Measurements were made along each transect at a high and low flow. Measurements were made for bed elevation, velocity, substrate, and cover, following the guidelines of the Instream Flow Group. These measurements were entered into a computer file and a hydraulic model (IFG4) was used to simulate the hydraulic conditions at unmeasured flows.

Habitat suitability indices were constructed by measuring habitat utilization for each life stage of the evaluation species. Preference criteria were then constructed from the habitat utilization information taking into account the habitat availability at the time the utilization data was collected.

The preference suitability indices and the information generated by IFG4 were then used in the Physical Habitat Simulation System (PHABSIM) to calculate the Weighted Usable Area (WUA) at incremental stream flows. WUA is the sum of the areas in a stream which have a combination of habitat characteristics that are suitable for the evaluation species based upon the suitability indices constructed for that species.

The model was calibrated according to the procedures of the Instream Flow Group and computer simulations run. WUA was computed for each life stage of each evaluation species over a range of flows from 15 to 150 CFS to get the optimum flow for each evaluation species. Simulations were then run for the median monthly flows under the present regime. These simulations were then repeated after subtracting the 3.83 CFS the DOE calculated would be lost due to groundwater withdrawals. The difference between the WUA's of the two simulations was the amount of habitat that would be lost if the DOE calculations were correct.

Habitat ratios were then calculated for brown trout and rainbow trout. Habitat ratios allowed the comparison of WUA's between life stages of a species based upon their relative requirements for space. This made it possible to determine the life stage at which habitat was limiting. Based upon these ratios, adult habitat was limiting at all flows for both brown trout and rainbow trout.

The optimum flow for brown trout, based upon the adult life stage was 80 CFS. The optimum flow for rainbow trout, also based upon the adult life stage, was 70 CFS. Sculpin habitat was optimized at about 130 CFS. The optimum flow is the flow that maximizes fish habitat. This flow was not based upon the past flow regime and, therefore, is not attainable for most months.

A monthly instream flow recommendation was made using the flow history of the stream and effective habitat times series, following the procedures recommended by the Instream Flow Group. Under the median monthly flow regime, adult habitat was limiting for both brown trout and rainbow trout during the month of August. Since it is the flow of 27.7 CFS in the month of August that limits adult trout populations, the present population level will remain stable if the flow does not drop below 27.7 CFS during any month of the year. The monthly instream flow recommendations for Chamokane Creek can be found in the table below. A minimum flow of 27.7 CFS was recommended for each month except March and April. During these months higher flows are needed to remove sediments that are deposited in the channel during the year. If these sediments are allowed to accumulate, they will fill the interstitial spaces in the spawning gravel, reducing embryo survival. The long-term deposition of sediments could also result in the pools being filled, resulting in a wide, shallow stream channel.

Month	Flow (CFS)	Reason for Recommendation
October	27.7	Adult Habitat
November	27.7	Adult Habitat
December	27.7	Adult Habitat
January	27.7	Adult Habitat
February	27.7	Adult Habitat
March	140	Channel Maintenance
April	151	Channel Maintenance
May	27.7	Adult Habitat
June	27.7	Adult Habitat
July	27.7	Adult Habitat
August	27.7	Adult Habitat
September	27.7	Adult Habitat

The impact analysis revealed that a reduction in Chamokane Creek of 3.83 CFS would result in a loss of about 3.7 percent of the adult brown trout habitat. This translates to a loss of about 52 adult fish. In rainbow trout adults the loss would be about 33 adult fish.

The WUA at the recommended flow of 27.7 CFS was compared with the WUA at the court-ordered flow of 20 CFS, at which 8 percent of the adult brown trout population and 6 percent of the adult rainbow trout population, would be lost. This amounts to 112 brown trout and 62 rainbow trout with a total biomass of about 113 kg (249 lbs). The loss in spawning habitat was calculated at 23 percent for both brown trout and rainbow trout. Based upon the habitat ratios, a 23 percent loss in rainbow trout spawning habitat reduces spawning area to about the minimum required to maintain the population at the present level. Such a loss in spawning habitat is of concern since it reduces the number of spawners, which in turn may reduce genetic variability in the population.

Several management recommendations were made based upon the findings in this and other studies on Chamokane Creek:

(1) It is recommended that the amount of pool habitat be increased. The pool-to-riffle ratio in some sections of Chamokane Creek is low. Habitat improvements can be made that would result in a 1:1 ratio in pool-to-riffle habitat.

(2) It is recommended that grazing be eliminated in the riparian area along Chamokane Creek. Cattle grazing eliminates streamside vegetation, resulting in bank erosion and stream sedimentation.

(3) It is recommended that shrubs be planted along areas of the stream where cattle grazing has resulted in reduced vegetation. This will expedite streambank stabilization.

(4) It is recommended that the Tribe set up a catch and release fishery on Chamokane Creek. The potential exists for the Tribe to profit from anglers' desire to catch wild brown trout in the size range found in Chamokane Creek. A trail system along Chamokane should be constructed with designated access points for guided fishing trips.

(5) The final recommendation is that the Tribe put a large-capacity well in the area of Ford. This well could be used to augment streamflow during years in which the flow can not be maintained at or above the recommended flow.

ACKNOWLEDGEMENTS

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1.0 BACKGROUND

The need for adequate instream flows for fish is a major problem for fisheries managers where water is in high demand for out-of-stream uses. The need for water for hydropower generation, agriculture, industry, and municipal water supplies has resulted in decreased flows for fish and other aquatic life. The problem of providing for the needs of aquatic life has been compounded by the lack of information on the instream flow requirements of these organisms. The U.S. Fish and Wildlife Service developed the Instream Flow Incremental Methodology (IFIM) (Table 1.1) to provide the technical information needed to make management decision on streamflow allocations. This methodology makes it possible to quantify changes in fish and macroinvertebrate habitat as a result of various water management alternatives.

The instream flow needs for fish in Chamokane Creek has been part of a suit brought by the United States and the Spokane Tribe of Indians against the State of Washington and all other persons or corporations that might have an interest in the waters of the Chamokane Basin (U.S. vs. Barbara J. Anderson *et al.* 1979). The U.S. District Court, Eastern District of Washington, ruled that the minimum flow from the falls into lower Chamokane Creek be at least 20 cubic feet per second (CFS) to protect the fishery. (See appendix A for a summary of court rulings dealing with the Chamokane Basin.) This decision was made without the benefit of an assessment of the impact that such a reduction in the flow would have on the fishery in Chamokane Creek. Navarre (1973), who had previously conducted the only fisheries study on Chamokane Creek, recommended a minimum flow of 30 CFS to protect the fishery.

Since the court ruling, the State of Washington has continued to process and approve additional applications for the water of the Chamokane Basin. (See appendix B for a summary of the "Reports of Examination" issued by the Washington Department of Ecology.) This has been done in spite of the fact that the stream flow has been

Table 1.1. List of IFIM manuals and related publications used in designing, conducting, and interpreting instream flow studies.

Bartholow, J.M., and T.J. Waddle. 1986. Introduction to stream network habitat analysis. Instream Flow Information Paper 22. USDI Fish and Wildl. Serv. Biol. Rep. 86(8). 242 pp.
Bayha, K. 1978. Instream flow methodologies for regional and national assessments. Instream Flow Information Paper 7. USDI Fish and Wildl. Serv. FWS/OBS-78/61. 97 pp.
Bovee, K.D. 1978. Probability-of-use criteria for the family Salmonidae. Instream Flow Information Paper 4. USDI Fish and Wildl. Serv. FWS/OBS-78/07. 80 pp.
Bovee, K.D. 1982. A quide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper 12. USDI Fish and Wildl. Serv. FWS/OBS-82/26. 248 pp.
Bovee, K.D. 1986. Development and evaluation of habitat suitability criteria for use in the Instream Flow Incremental Methodology. Instream Flow Information Paper 21. USDI Fish and Wildl. Serv. Biol. Rep. 86(7). 235 pp.
Bovee, K.D. and T. Cochnauer. 1977. Development and evaluation of weighted criteria, probability-of-use curves for instream flow assessments: fisheries. Instream Flow Information Paper 3. USDI Fish and Wildl. Serv. FWS/OBS-77/63. 38 pp.
Bovee, K.D. and R. T. Milhous. 1978. Hydraulic simulation in instream flow studies: theory and techniques. Instream Flow Information Paper 5. USDI Fish and Wildl. Serv. FWS/OBS-78/33. 130 pp.
Milhous, R.T., D.L. Wegner, and T. Waddle. 1984. User's guide to the Physical Habitat Simulation System (PHABSIM). Instream Flow Information Paper 11. USDI Fish and Wildl. Serv. FWS/OBS-81/43 Revised. 475 pp.
Stalnaker, C.B. and J.L. Arnette (eds.). 1976. Methodologies for the determination of stream resource flow requirements: an assessment. USDI Fish and Wildl. Serv. FWS/OBS-76/03. 199 pp.
Theurer, F.D. 1982. Instream water temperature model. Instream Flow Information Paper 16. USDI Fish and Wildl. Serv. FWS/OBS-84/15.
Trihey, E.W. and D.L.Wegner. 1981. Field data collection procedures for use with the Physical Habitat Simulation System of the Instream Flow Group. USDI Fish and Wildl. Serv. Cooperarative Instream Flow Service Group, Fort Collins, CO. 151 pp.
Wassenberg, P.S., S. Olive, J.L. Demott, and C.B. Stalnaker. 1979. Elements in negotiating stream flows associated with federal projects. Instream Flow Information Paper 9. USDI Fish and Wildl. Serv. FWS/OBS-79/03. 41 pp.

below the court-ordered minimum on several occasions, and at or just above the minimum on many occasions over the period of record (USGS 1971, 1972,1973,1974,1978,1983).

In order to determine the relationship between streamflow and fish habitat in Chamokane Creek, a study was conducted using the IFIM. The quantification of fish habitat was accomplished by (1) determining depth, velocity, substrate, and cover preferences for the target species being evaluated (brown trout, rainbow trout, and sculpins), and (2) determining the amount of usable available habitat at incremental streamflows, based upon these preferences. Habitat preference for each species was determined by dividing the utilization of each habitat parameter measured in the field by the availability of that parameter (Bovee 1986). The information was then used to develop habitat suitability curves for each species. These, in turn, were used in the Physical Habitat Simulation System (PHABSIM) (Milhous *et al.* 1984) to calculate the total usable habitat, called Weighted Usable Area (WUA), for that species at incremental streamflows.

The IFIM can be simplified into five steps: (1) scoping; (2) study site selection; (3) data collection; (4) data analysis using simulation models and; (5) determining the recommended minimum instream flow regime and/or impact analysis (Fig. 1.1). The scoping process contains four parts (Fig. 1.2a): (1) defining the problem and the study objectives; (2) describing the study area; (3) determining which environmental variables must be analyzed; and (4) the selection of evaluation species. Evaluation organisms are generally selected because of their economic value or because they are sensitive to environmental fluctuations.

The third step is further subdivided into three questions dealing with overall scope of the project: (1) will streamflow be impacted; (2) will water quality be impacted; and (3) will water temperature be impacted? To obtain answers to these questions individual studies are required. A water quality study was

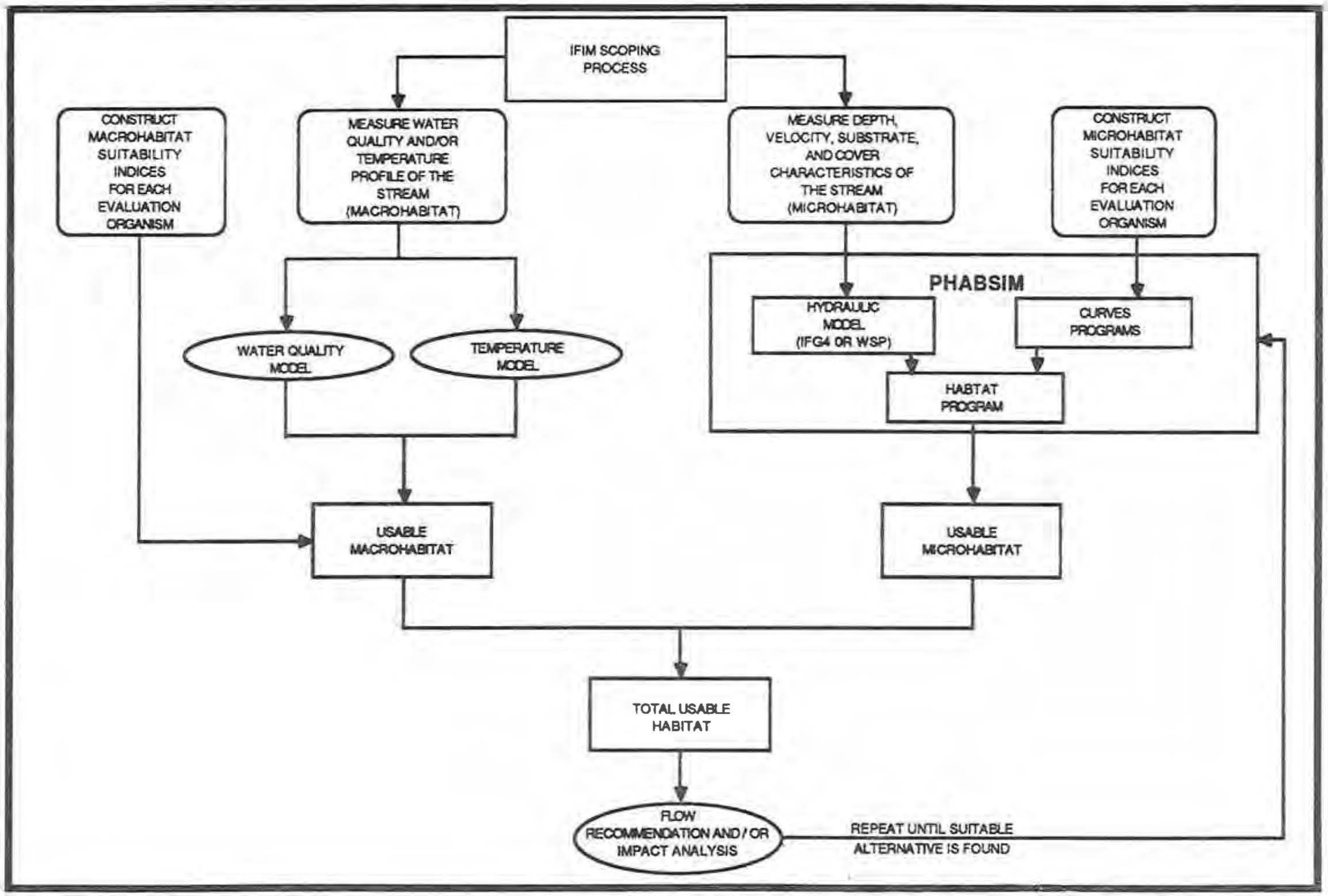


Figure 1.1. Flow chart showing all the components of a study using the IFIM to model macrohabitat and microhabitat.

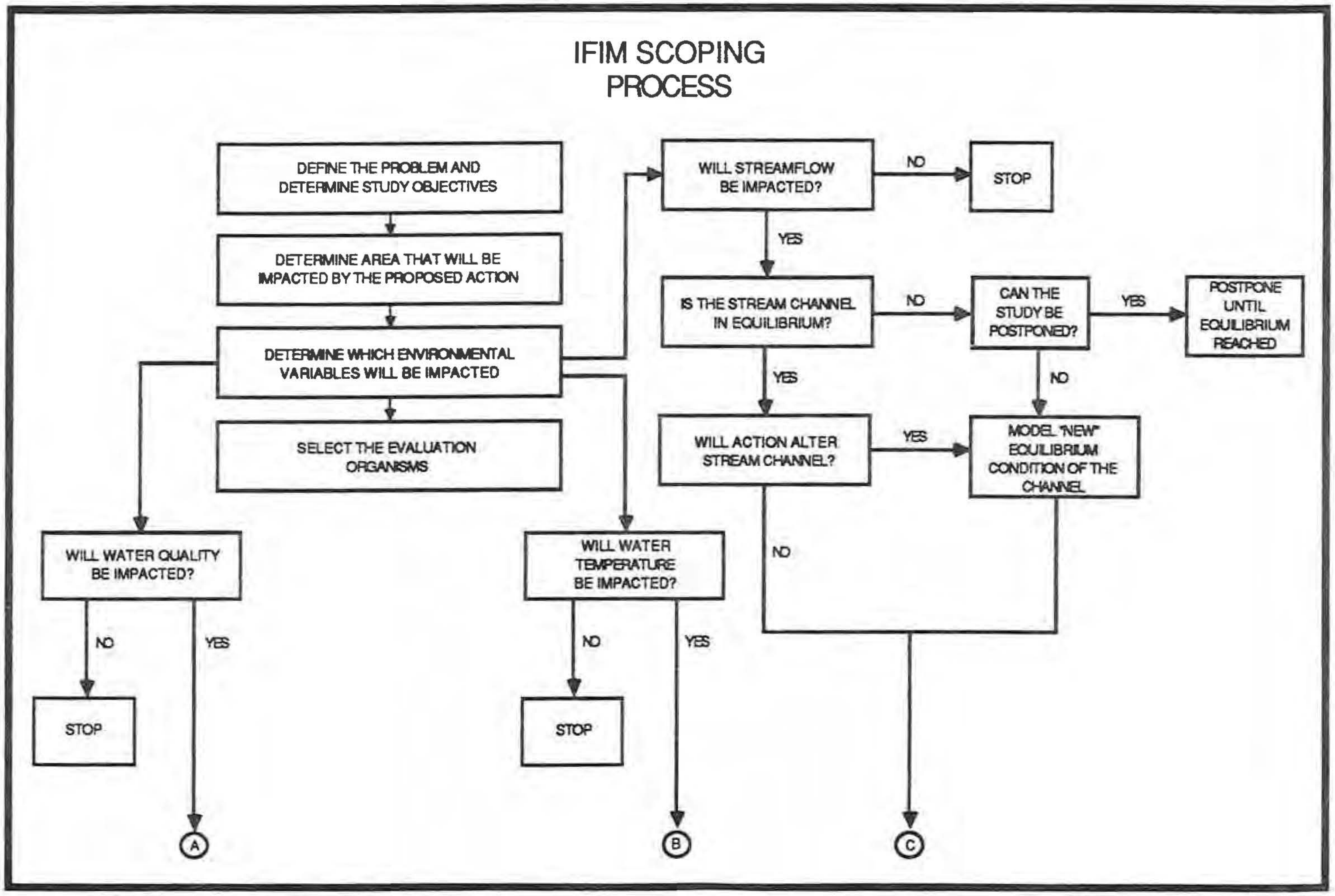


Figure 1.2a. Flow chart of the IFIM scoping process. See Fig. 1.2b. for continuation of A, B, and C.

conducted on Chamokane Creek to determine if water quality is adequate under the present flow regime. Water temperature data collected at the USGS gaging station (USGS 1984,1985,1986) was analyzed to determine if water temperatures are adequate for the growth and survival of salmonids. The water quality and temperature information is contained in a report by O'Laughlin *et al.* (1988a). An aquifer study and water budget analysis has recently been completed by Buchanan *et al.* (1988), which answered the question of what impact water withdrawals will have on the flow regime of Chamokane Creek. Both the DOE's and the court's calculations (Appendix B) indicate that a potential reduction of greater than 10 percent in base flow is likely. The mean base flow of Chamokane Creek is 29.9 CFS, the DOE calculates a reduction of 3.83 CFS, while the court recognizes a reduction of 5.26 CFS. The results of Buchanan *et al.* (1988) indicate that in a "normal" year the proposed withdrawals will have little impact on the flow regime of Chamokane Creek.

Once it was determined whether the streamflow would be impacted, it was necessary to evaluate the equilibrium conditions of the stream channel. All the hydraulic measurements made during the study assumed a persistence in the channel morphology over time (Bovee 1982). If the channel was not in equilibrium, predictions based on past measurements could not be applied to a channel with a different shape.

The second step of the IFIM was the selection of study sites (Fig. 1.2b). If the IFIM water quality or temperature models were used, then macrohabitat study sites would have been selected. The IFIM hydraulic model was being used so microhabitat study sites were selected that were representative of each segment of the stream. Microhabitat study sites were locations on the stream where depth, velocity, substrate, and cover were measured in detail along transects placed to describe the habitat types within the study site. These measurements are made in the third step of the IFIM (Fig. 1.2b). Also at this step, data was collected on the habitat

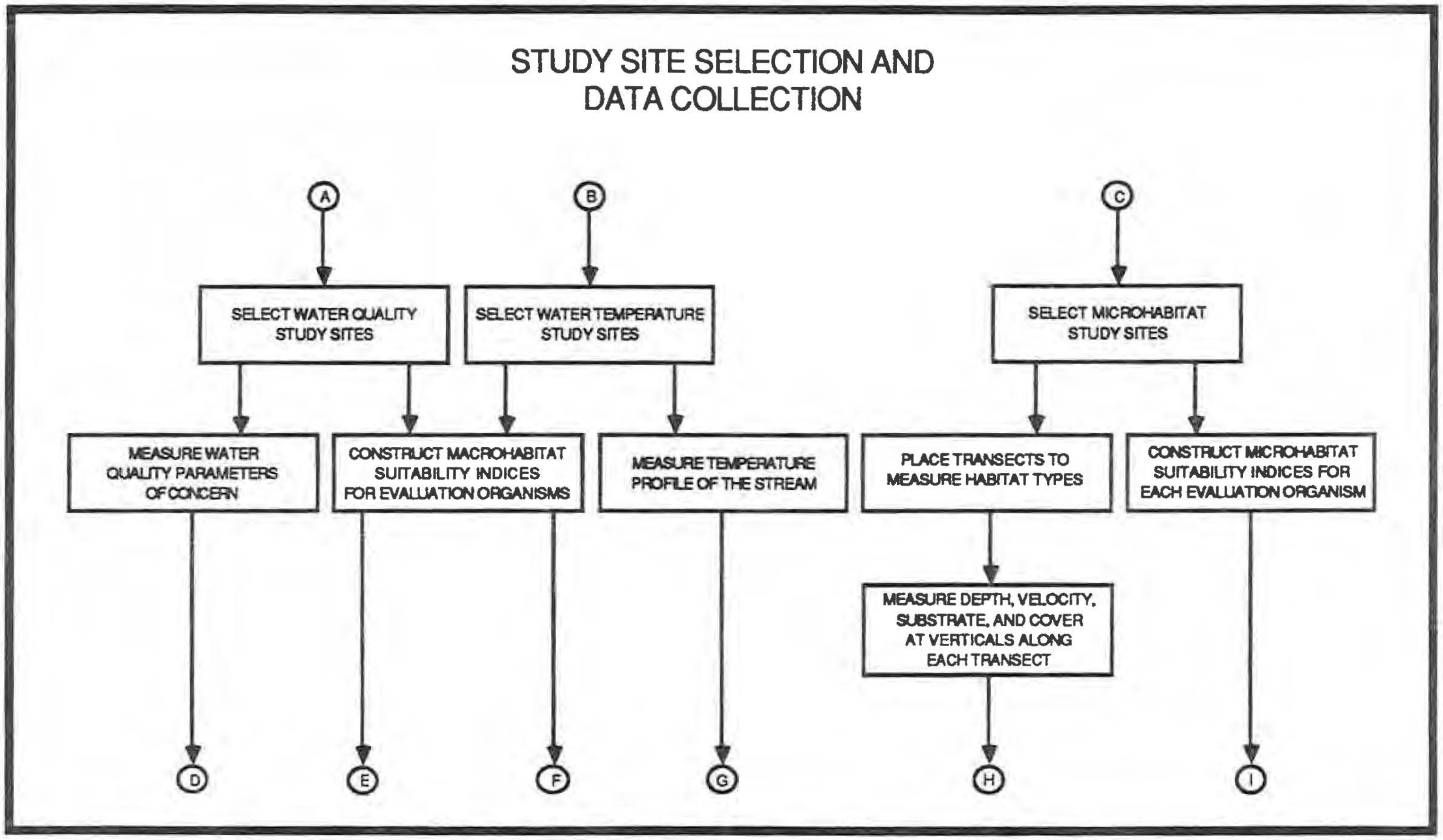


Figure 1.2b. Flow chart showing the steps involved in study site selection and data collection. See Fig. 1.2a. for A, B, and C, and see Fig. 1.2c. for continuation of D through I.

use by each of the evaluation organisms selected in the scoping process.

The fourth step involved computing total habitat availability from the data collected in step 3, using the computer programs that make up PHABSIM (Fig. 1.2c). The PHABSIM system is made up of three units: (1) the hydraulic model; (2) the curves programs; and (3) the HABTAT programs. The computation procedure of the hydraulic model (IFG4) is shown in Fig 1.2c. This is the sequence of events used and the method used in the present study by IFG4 when data is collected at more than one flow (Milhous *et al.* 1984). Simulated discharges are obtained from flow duration curves constructed for the stream. The curve programs were used to write the habitat suitability curves into a format readable by the HABTAT programs. The HABTAT programs then calculated the weighted usable area (WUA) for each study site by summing the weighted usable areas for each cell that was represented by point measurements made along a transect. The WUA for a cell was calculated by multiplying the surface area of the cell by the composite suitability value for the cell (Milhous *et al.* 1984). The composite suitability value of a cell was the product of the habitat suitability indices for the habitat parameters found in that cell. The fifth step involved determining the flows at which habitat was optimized for each evaluation species (Fig. 1.2d) Also at this step, an impact analysis was conducted to determine the amount of habitat that would be lost by the withdrawal of water from the Chamokane Aquifer. Finally, an instream flow regime was recommended that would protect fisheries habitat at its present level.

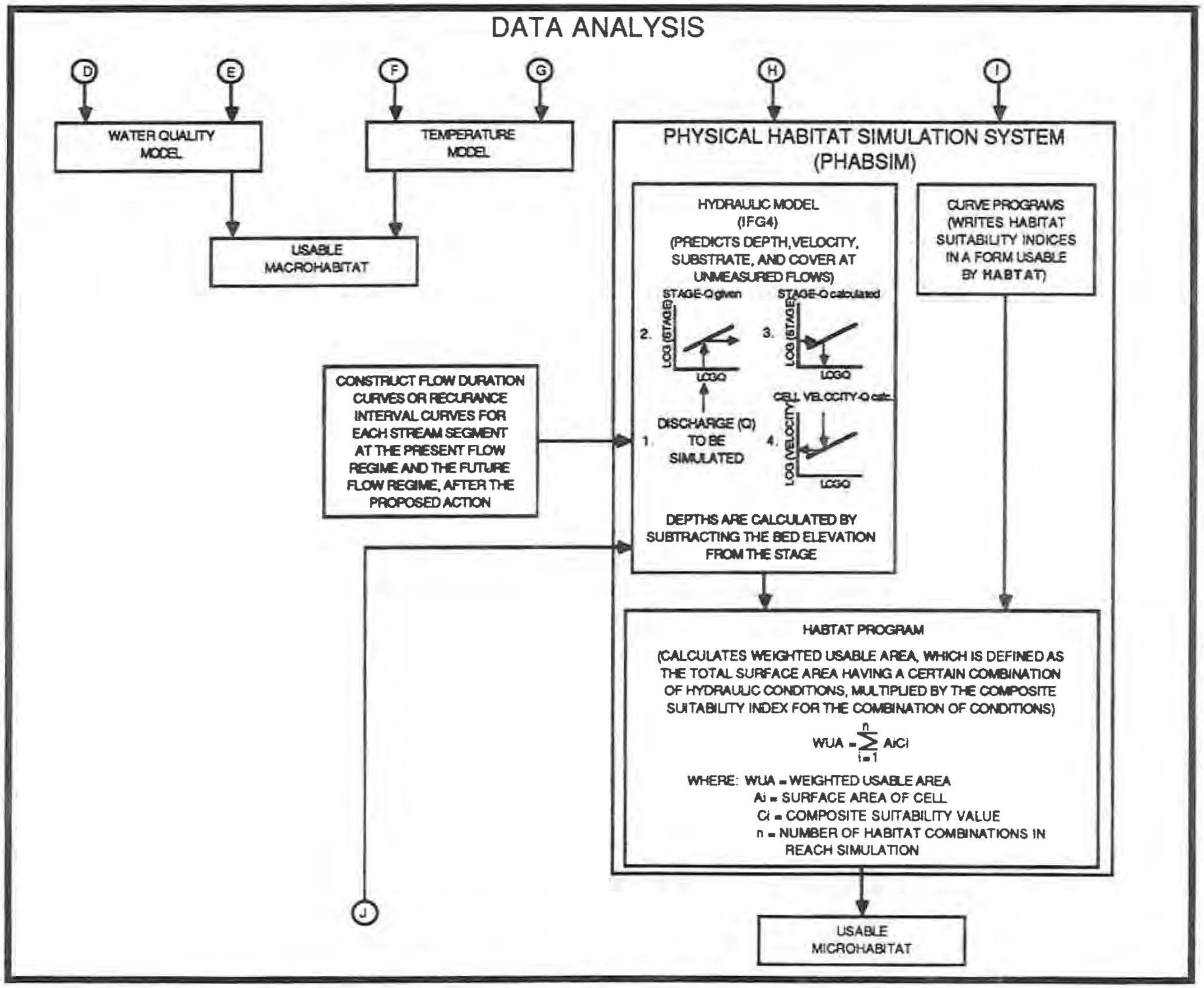


Figure 1.2c. Flow chart showing the steps involved in data analysis. See Fig. 1.2b. for D through I, and Fig. 1.2d. for J.

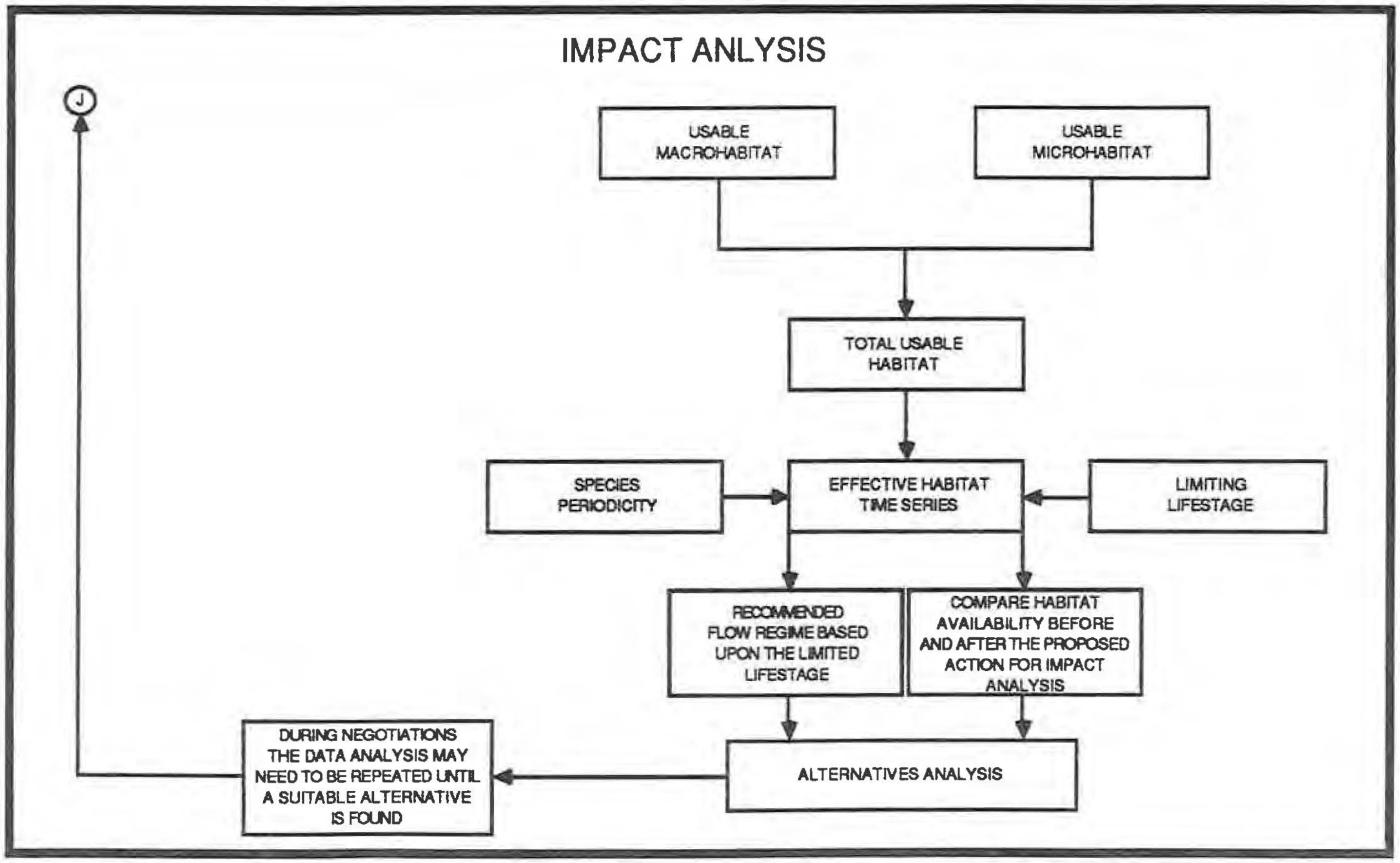


Figure 1.2d. **Flow charts showing the steps involved in recommending an instream flow and/or determining the impact that a proposed action may have on habitat availability. See Fig. 1.2c. for continuation of J.**

2.0 IFIM SCOPING

2.1 INSTREAM FLOW STUDY OBJECTIVES

The objectives of this study were:

(1) to determine the flow which optimizes fish habitat;

(2) to determine the impact that the DOE calculated flow reduction would have on the availability of habitat; and

(3) to recommend a monthly instream flow regime that would protect fish habitat. The optimum flow was the flow that maximized fish habitat. This flow was not based upon the past flow regime and, therefore, is not attainable for most months. The recommended monthly instream flow regime was based upon past monthly flows and can be attained for all but the driest years.

2.2 DESCRIPTION OF THE STUDY AREA

Chamokane Creek (Fig. 2.1) is a third order stream with a drainage area of 466 square kilometers (km^2) (180 square miles (mi^2)). Its headwaters are in the Huckleberry Mountains north of the Spokane Indian Reservation. The east bank of the lower 28.5 km (17.7 mi) of the stream form the east boundary of the reservation. The stream is continuous for 7.25 km (4.5 mi) from the north reservation boundary and then becomes intermittent. For the next 8 km (5 mi) the stream is consistently dry during the summer and fall months. From just north of Ford, Washington, natural springs provide a relatively stable flow in the creek for the lower 13 km (8 mi) to the confluence with the Spokane River.

According to Richard J. Peone (personal communication), a 40-year resident of the intermittent section of Chamokane Creek, the eight kilometers of stream above Ford dries up annually for several months in the summer and fall. This section is unlikely to provide any usable fish habitat over the long term, so the instream flow

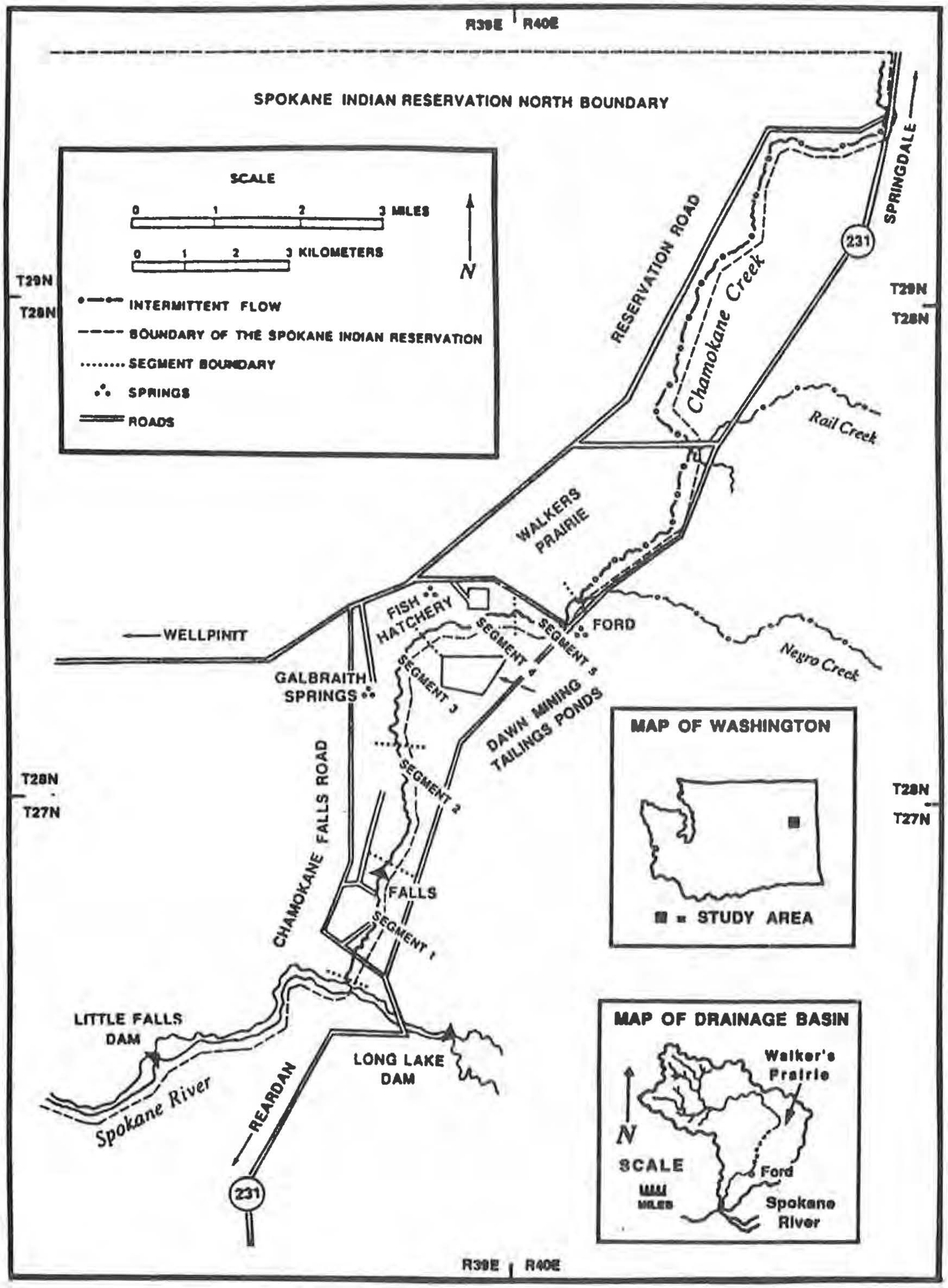


Figure 2.1. Chamokane Creek from the mouth at the confluence with the Spokane River to the north reservation boundary.

study was limited to the 13 km section from the mouth to just north of Ford.

The springs' contribution to the flow of Chamokane Creek makes the stream and the aquifer hydrologically inseparable. Woodward (1971,1973) reports that the return flow springs near Ford yield an average of 1.5 CFS. Galbraith Springs and the Fish Hatchery Springs each yield an average of 7 CFS, and minor springs along Chamokane yield an average of 5 CFS.

United States Geological Survey (USGS 1972,1973,1974,1975, 1976,1977,1978,1983,1984,1985,1986) data from two gaging stations, one below Chamokane Falls and one near the northeastern reservation boundary, show that the flow in Chamokane Creek fluctuates greatly from year to year (Figs. 2.2 and 2.3). Fig. 2.2 shows that the mean annual discharge at the lower gaging station was lowest in 1977 at 26.6 CFS, and highest in 1974 at 141 CFS. Fig. 2.3 shows that the mean annual discharge at the upper gaging station was lowest in 1977 at 3.76 CFS, and highest in 1974 at 105 CFS. Mean monthly flows are generally highest in March and April and lowest from June through January (Figs. 2.4 and 2.5).

Navarre (1974) reported six species of fish in Chamokane Creek, including brown trout (*Salmo trutta* Linnaeus), rainbow trout (*Salmo gairdneri* Richardson), brook trout (*Salvelinus fontinalis* [Mitchill]), largescale sucker (*Catostomus macrocheilus* [Girard]), chiselmouth (*Acrocheilus alutaceus* Agassiz and Pickering), and sculpins (*Cottus* spp.). Scholz (1982,1985) noted that several additional species, speckled dace (*Rhinichthys osculus* [Girard]), northern squawfish (*Ptychocheilus oregonensis* [Richardson]), mountain whitefish (*Prosopium williamsoni* [Girard]), and bridgelip sucker (*Catostomus columbianus* Eigenmann and Eigenmann), also inhabit Chamokane Creek. During field work for this study it was found that redside shiner (*Richardsonius balteatus* [Richardson]), and pumpkinseed (*Lepomis gibbosus* [Linnaeus]) are also residents of Chamokane Creek. It was also determined that two species of

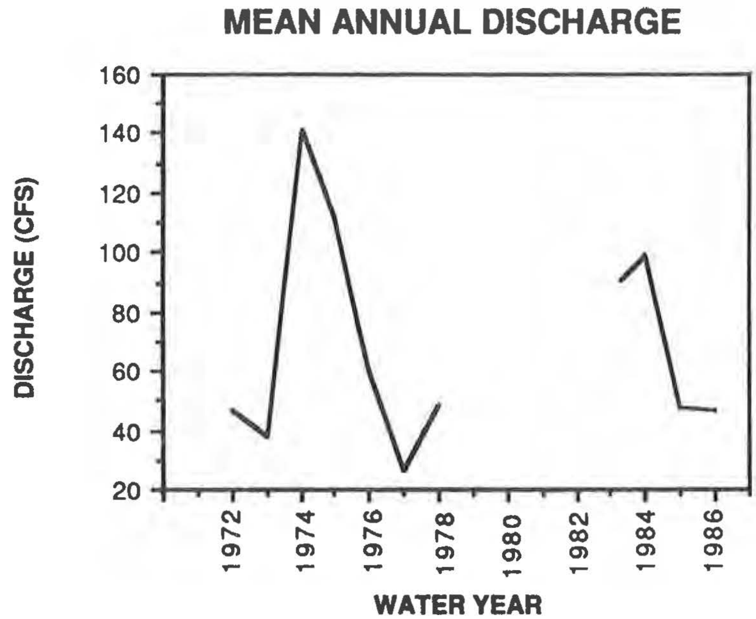


Figure 2.2. Mean annnual discharge of Chamokane Creek at USGS gaging station 12433200, below the falls, for water years 1971-1978 and 1983-1986.

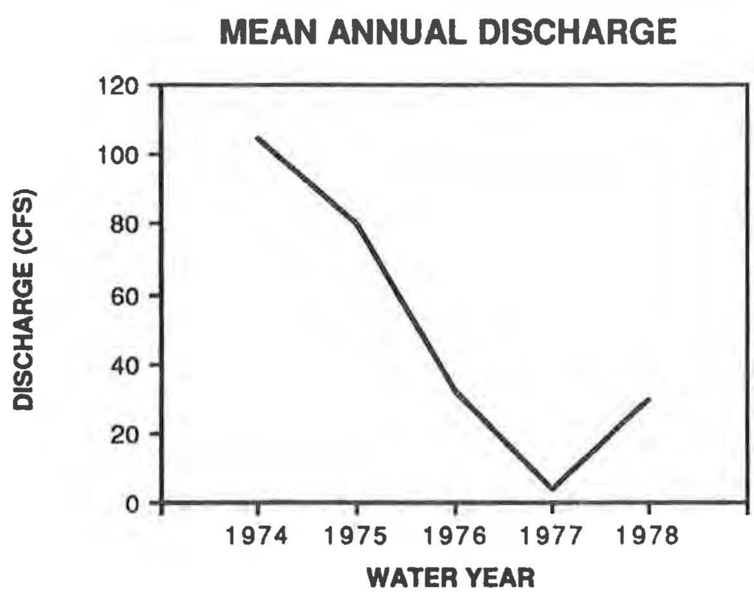


Figure 2.3. Mean annual discharge of Chamokane Creek at USGS gaging station 12433100, near the north-east reservation boundary, for water years 1974-1978.

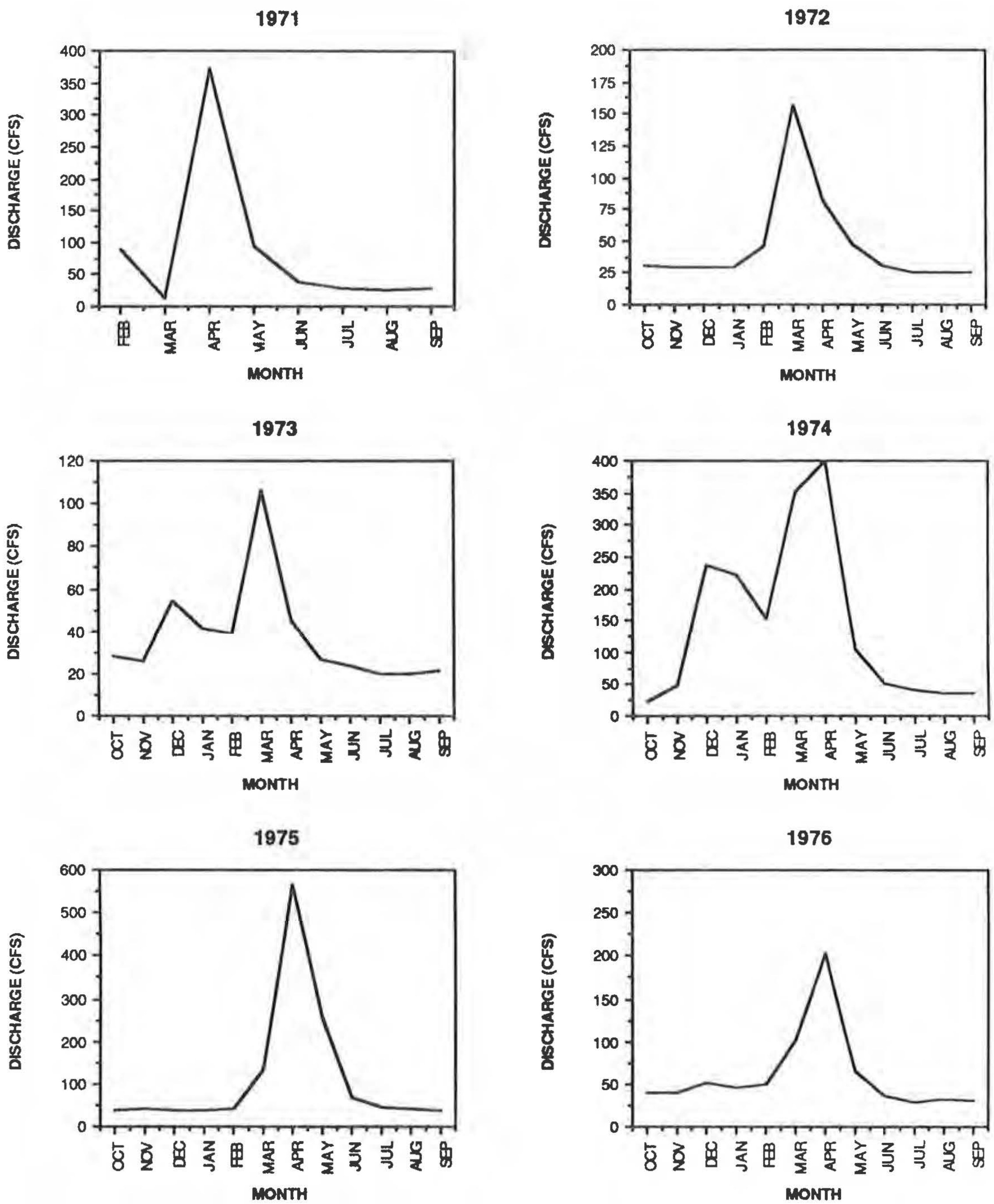


Figure 2.4. Mean monthly flow of Chamokane Creek at USGS gaging station 12433200, below the falls, for water years 1971-1978 and 1983-1986

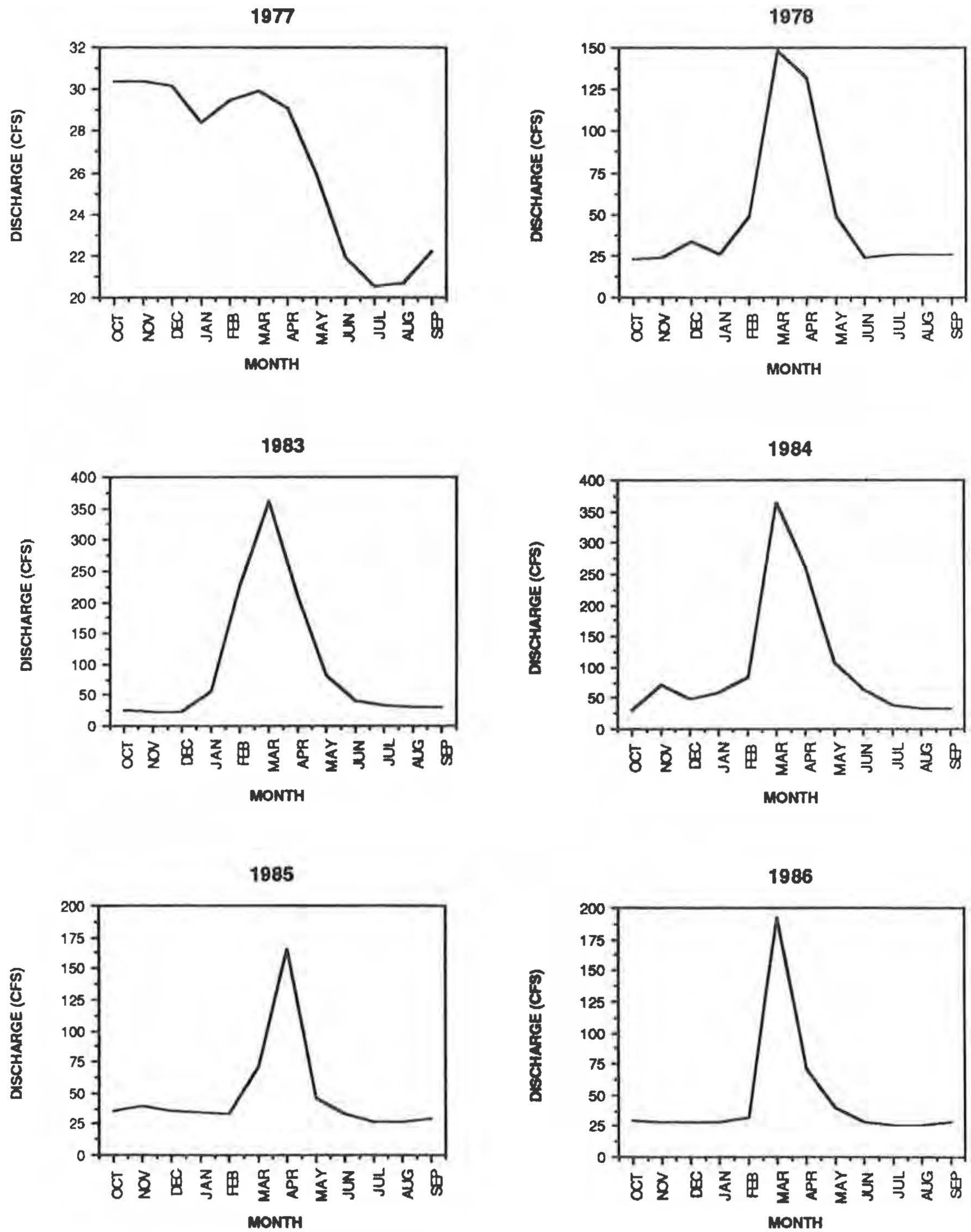


Figure 2.4. (cont.)

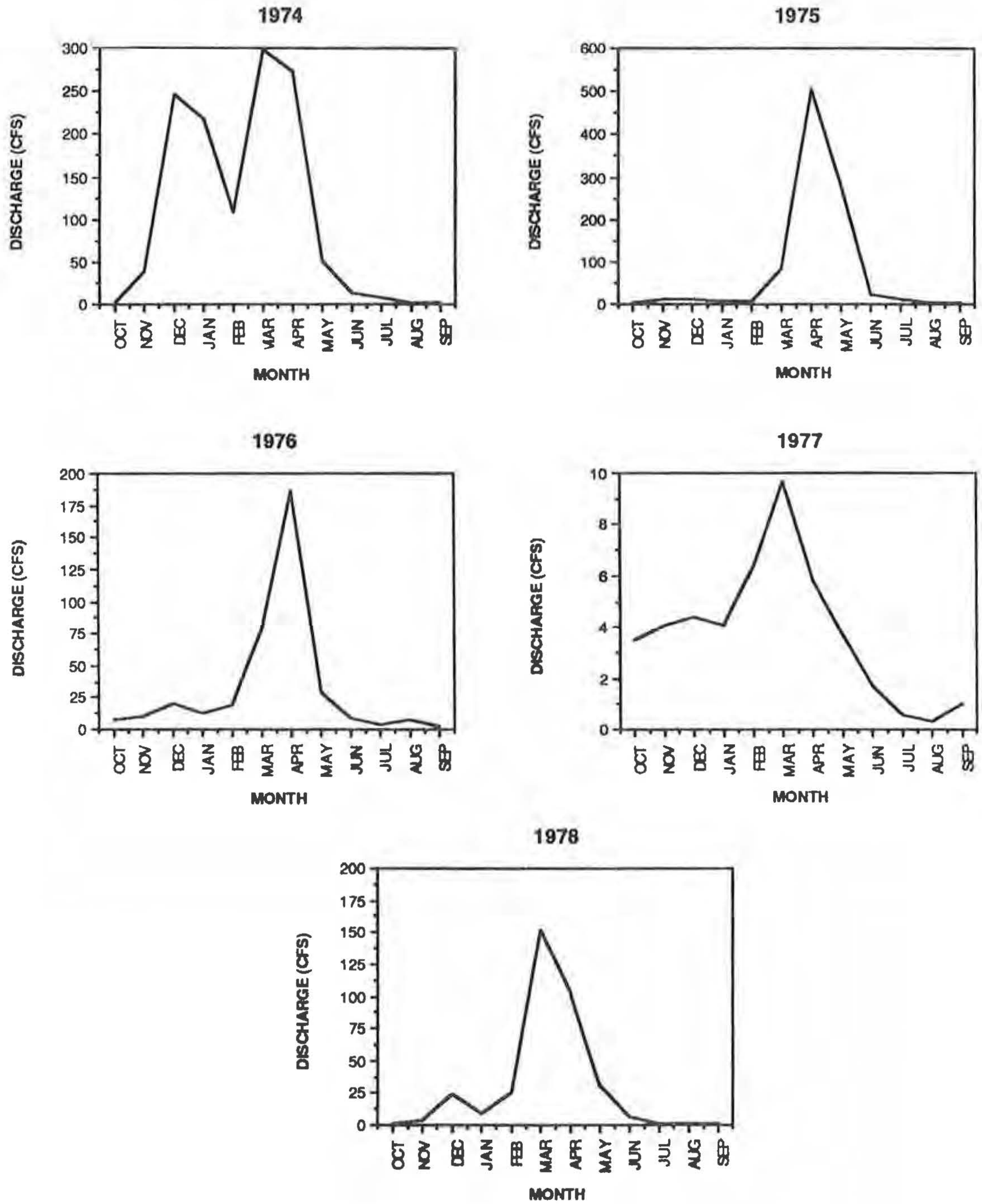


Figure 2.5. Mean monthly flow of Chamokane Creek at USGS gaging station 12433100, near the northeast reservation boundary, for the water years 1974-1978.

sculpins inhabit Chamokane Creek, the Piute sculpin (*Cottus beldingi* Eigenmann and Eigenmann) and the torrent sculpin (*Cottus rhotheus* [Smith]). The Piute sculpin has been listed as a species of special concern in Washington by the American Fisheries Society (Johnson 1987).

2.3 AFFECTED ENVIRONMENTAL VARIABLES

The magnitude of change in different environmental variables to disturbances in the system depends upon the nature and degree of the disturbance and how sensitive the variable is to change (Bovee 1982). Table 2.1 shows the generalized environmental changes that can occur due to various land and water uses. From Appendix B it can be seen that the land and water uses in the Chamokane Basin can have far reaching effects on Chamokane Creek. The detailed analysis of all these effects is beyond the scope of this project. However, several will be discussed in the following sections on flow regime, channel equilibrium, water quality, and temperature.

2.3.1 FLOW REGIME

Buchanan *et al.* (1988) have determined that the proposed water withdrawals under consideration by the DOE will have little impact on the flow of Chamokane Creek during "normal" flow years. Buchanan *et al.* (1988) have spent the last year conducting a detailed aquifer study and water budget analysis on the Chamokane Basin. Their model indicates an excess of 6000 acre feet of water. In light of this information, it is believed that the DOE calculated impact on the flow of Chamokane Creek is probably a maximum impact, and will be used in this study for impact analysis.

Dr. Buchanan's findings make it necessary to determine what the minimum flow should be at different times of the year to ensure that in low flow years adequate water is available to maintain the fishery in Chamokane Creek at its present level. During low flow years the amount of water being pumped from the aquifer may need

Table 2.1. Generalized environmental changes associated with a variety of land and water uses (Bovee 1982).

Affected variable	Impoundment	Channelization	Grazing	Silviculture	Surface mining	Agricultural drainage	Ground water extraction	Surface water diversion	Flow augmentation	Urbanization	Irrigation	Hydropeaking
Sediment yield	X		X	X	X	X					X	0
Water yield	0		X	X	0	X	X	X	X	0	X	
Channel morphology	X	X	X	0	0	0		0	0	X	0	X
Substrate character	X	X	X	X	0	0		0	0	X	0	0
Cover	0	X	X	0	0	0	0	0	0	0	X	X
Timing of flow	X	*						0	0	0	X	X
Magnitude of peak flow	X	*	0	0	0	X	0	0	0	X	0	X
Magnitude of base flow	X		0	0	0	X	X	X	X	X	X	X
Thermal regime	X	0	0	0	0	0	X	0	0	0	X	X
Water quality	0		0	0	X	X	0	0	0	X	X	0
Drainage density			0	0	0	X	0			X	X	

X = Dominant influence
0 = Lesser influence
* Channelization can result in shorter detention of flood flows. Consequently, flood events may be of greater magnitude and frequency downstream of the channelized portion. The severity depends on the slope and length of the impacted section.

to be reduced to ensure that the flow does not drop to a level that would result in a loss of available habitat.

2.3.2 WATERSHED AND CHANNEL EQUILIBRIUM IN CHAMOKANE CREEK

Before proceeding with the IFIM data collection process, the equilibrium condition of the channel must be evaluated (Bovee 1982). Microhabitat analysis in the IFIM assumes that the channel structure and dimensions are in a state of dynamic equilibrium (Bovee 1982). Additionally, any predictions of microhabitat availability in the future requires knowledge of the channel shape after the proposed action. So it must be determined if the channel will be affected by the proposed action. It is normal for streams to undergo changes in channel shape due to the movement of riffles and pools, but if the channel is in equilibrium, the channel structure and dimensions will remain in approximately the same proportion over the entire length of the stream.

Chamokane Creek is, for the most part, alluvial in nature, meaning its channel can change shape significantly in response to changes in flow or sediment yield due to the relatively fine materials that make up its channel. If the upstream sediment supply exceeds the ability of the stream to carry that sediment, then the bed elevation will increase (aggradation), leading to a shallow, wide channel. If the stream's ability to carry sediment exceeds the upstream sediment supply then the bed elevation will decrease (degradation), leading to a deep, narrow channel. Channel widening, channel narrowing, and changes in bed elevation are, therefore, good indication of a disequilibrium condition in the stream (Bovee 1982).

2.3.2.1 METHODS USED TO DETRMINE THE STATE OF CHANNEL EQUILIBRIUM

Two days were spent in the field, walking the length of Chamokane Creek from Ford, WA to the mouth at the confluence with the Spokane River. During this period notes were made about the stream channel morphology, substrate, and sediment sources. In addition, as recommended by Bovee (1982), information was obtained from the USGS, Water Resources Division (Spokane, WA), on rating curve adjustments for the two gaging stations that have been maintained on Chamokane Creek. A rating curve correlates gage height to discharge at each gaging station. A new rating curve must be developed if there is a change in bed elevation at the gage.

2.3.2.2 PRESENT STATE OF CHANNEL EQUILIBRIUM

Fig. 2.6 shows the information noted while in the field. It is apparent that there is a great deal of bank cutting along the stream below Ford. Bank cutting on one side of the stream does not indicate channel widening; it may simply indicate normal meander migration. The best indicator of channel widening is bank cutting on both sides of the stream (Bovee 1982). There is no evidence of this occurring along Chamokane Creek. Channel narrowing is more difficult to detect. The most obvious indicator of channel narrowing is when a braided channel reverts to a single, meandering channel. There is no evidence of this occurring on Chamokane.

Tables 2.2 and 2.3 show the rating curve adjustments by the USGS for the years of operation of the two gaging stations on the stream. The period of record is rather short, but does provide insight into the dynamic state of the stream. The up and down adjustment of the curves indicates a normal fill/scour cycle in the stream. A persistent raising or lowering of these curves would indicate a condition of aggradation or degradation that would show disequilibrium of the stream channel. There is no evidence of this

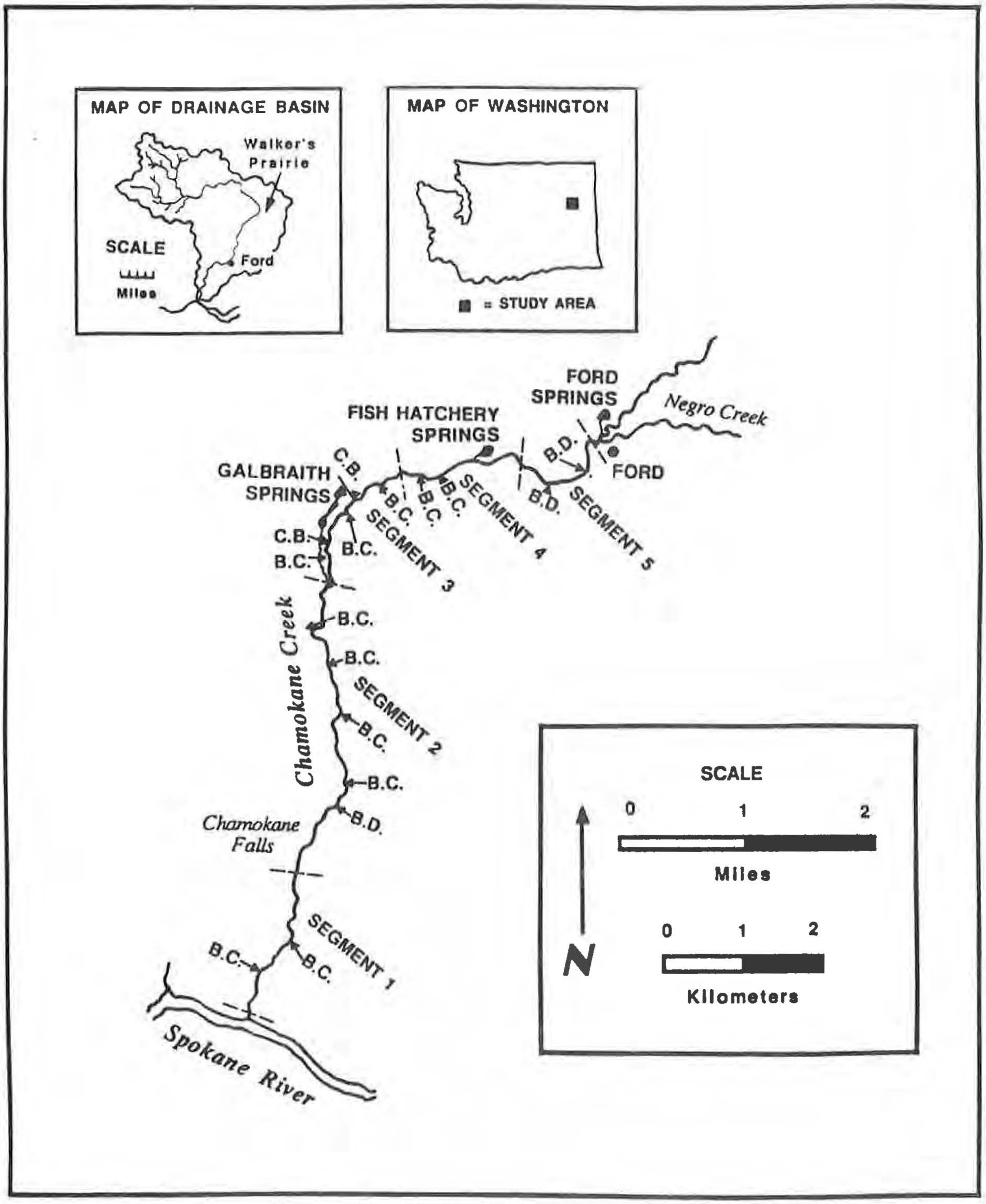


Figure 2.6. Locations of large scale bank cutting (B.C.), beaver dams (B.D.), and large scale channel braiding (C.B.) noted during the initial field visit in December 1985.

Table 2.2. Rating curve adjustment for gaging station 12433100, near the northeast reservation boundary (unpublished data, USGS Water Resources Division, Spokane, WA).

Year	Adjustment (Ft.)
1973	-0.3
1974	-0.0
1975	+0.39
1976	+0.01
1977	No adjustment
1978	No adjustment

Monitoring terminated in September 1978.

Table 2.3. Rating curve adjustment for gaging station 12433200, below Chamokane Falls (unpublished data, USGS Water Resources Division, Spokane, WA).

Year	Adjustment (Ft.)
1972	No adjustment
1973	No adjustment
1974	+0.90
1975	-0.90
1976	No adjustment
1977	No adjustment
1978	No adjustment
Monitoring terminated in September 1978 and resumed in April 1984.	
1984	-0.20
1985	No adjustment
1986	-0.06
1987	+0.06

occurring over the period the USGS has been keeping records. For several of the years of record there was no adjustment in the rating curve. This indicates that the bed elevation remained constant during those years.

Field observations of Chamokane Creek revealed that it contains a great deal of sediment during periods of low flow. This sediment moves at velocities around 2.2 feet/sec., or a discharge of about 77 CFS (Dennis Olson, BIA, Wellpinit Agency, personal communication). Since spring flows have exceeded this level for all but one year that records are available, this sediment is transported out of Chamokane Creek to the Spokane River annually. Other evidence that supports this conclusion is that the stream width would increase if the sediment was continually deposited, causing aggradation. USGS rating curve adjustments indicate that there is not a persistent aggradation of the channel. Field observations made during spring high flows have shown that areas that previously had silt/sand substrates at low flows had gravel/cobble substrates at high flows. All of the evidence presented here leads to the conclusion that the Chamokane Creek channel is in equilibrium.

2.3.3 WATER QUALITY AND TEMPERATURE IN CHAMOKANE CREEK

The following section is a summary based on the information presently available for Chamokane Creek. For a complete discussion see O'Laughlin *et al.* (1988a)

The water quality in Chamokane Creek is adequate at the present time and has been adequate in the past (O'Laughlin *et al.* 1988a). Evidence of good water quality is that Chamokane Creek supports a large fish population (Scholz *et al.* 1988), benthic macroinvertebrate populations are higher than in other streams in the region (O'Laughlin *et al.* 1988b), and that brown trout and rainbow trout feeding and growth in Chamokane Creek are good (Geist *et al.* 1988, Uehara *et al.* 1988).

Potential problems with water quality do exist due to the Dawn Mining Company uranium mill near Ford, land use changes in the basin, and summer water temperatures that exceed the optimum range for salmonids (O'Laughlin *et al.* 1988a). The Dawn Mill is undergoing closure, and while it has not presented a serious problem to water quality in the past, care must be taken during the closure to ensure that it does not present a problem in the future (Scholz and O'Laughlin 1987). A study should be conducted to determine if the fish in Chamokane Creek are accumulating heavy metals. The uranium concentration is known to be increasing in a seep area near Chamokane Creek (O'Laughlin *et al.*1988a), so it is possible that uranium is entering the food chain. Changes in land use in the basin also have the potential to impact the water quality of Chamokane Creek. The majority of the applications for water (Appendix B) include water for domestic use, livestock, and agriculture. Domestic sewage and livestock wastes have the potential to increase pollution in the aquifer and creek by groundwater infiltration and surface runoff (O'Laughlin *et al.* 1988a). Agriculture can introduce chemical pollutants such as fertilizers and pesticides (O'Laughlin *et al.* 1988a) and could result in increased sediment yield (Ursic and Dendy 1965, Sartz 1973).

Temperature was a key issue in the legal proceedings concerning Chamokane Creek. The court ruled that temperatures should not exceed 20°C (68°F) for optimum growth and survival of salmonids (Appendix A). Temperature, however, is not considered to be a serious problem at the present time since temperatures have never approached the upper lethal limit for brown trout or rainbow trout (O'Laughlin *et al.* 1988a). While maximum temperatures have exceeded 20°C (68°F) on 139 out of 268 days during June, July, and August in 1984, 1985, and 1986, mean daily temperatures have never exceeded and were usually well below 20°C (68°F) (O'Laughlin *et al.* 1988a). Additional evidence that temperature has not been a problem is that growth of Chamokane Creek brown trout and rainbow trout is good (Uehara *et al.* 1988). The high abundance of food may mitigate the higher temperatures in that the trout are able to increase feeding in response to higher metabolic rates, so their growth remains positive under temperatures in which growth would stop, or be negative, if food was not readily abundant (Uehara *et al.* 1988).

2.4 SELECTION OF EVALUATION ORGANISMS

It is not feasible, economically or logistically, to study every species within a community. For this reason, a few evaluation organisms are selected for study. The evaluation organisms should reflect the environmental constraints on the community as a whole. Indicator species may be selected as evaluation organisms because they are sensitive to environmental change. It is assumed that as long as conditions remain adequate for the indicator species, conditions are also adequate for the rest of the community.

Bovee (1982), recommends that major game, sport, or commercial species be included as evaluation organisms. Since most sport species are predators, they may be limited by the availability of their prey. Because of this, important prey species should be included as evaluation organisms (see O'Laughlin *et al.* 1988b). The habitat evaluation procedures (U.S. Fish and Wildlife Service 1980) uses a ranking system for the selection of evaluation organisms based upon: (1) the economic importance of a species; (2) the species' vulnerability to change in the environment; and (3) the amount of information that is available for that species.

Bovee (1982) recommends that periodicity charts be constructed for each fish species selected as an evaluation organism. The periodicity chart describes the changes in habitat use over time for each life stage of a species. This helps to ensure that field data collections are conducted at the proper times and that microhabitat availability is calculated when it is required by a particular life stage of an evaluation organism.

The distribution and relative abundance of fish in Chamokane Creek from the mouth to Ford was determined by electrofishing using a Smith-Root portable backpack electroshocker. Observations were made in November, 1985 (Scholz 1985), and monthly from February through October, 1986, while conducting field work for the various tasks in this project. These data were used to determine the sport species in Chamokane Creek. Periodicity charts for brown trout and rainbow trout were constructed from field observation and by consulting Calhoun (1966), Carlander (1969), Scott and Crossman (1972), Wydoski and Whitney (1979), and Raleigh *et al.* (1984,1986).

Table 2.4 is a list of fish species showing their distribution and relative abundance. Brown trout and rainbow trout were the only sport species present in adequate numbers to provide a fishery in Chamokane Creek. Brown trout and rainbow trout impart an economic significance to Chamokane Creek and, therefore, were included as evaluation organisms.

Sculpins were the most abundant genera of fish present in Chamokane Creek (Table 2.4). Stomach analysis indicated that sculpins were the second most important food item for brown trout based upon the index of relative importance computed by Geist *et al.* (1988), and for that reason were included as evaluation organisms. The two sculpin species present in Chamokane Creek were combined and studied as a group since it was impossible to identify them to species in the partially digested form.

Periodicity charts for brown trout and rainbow trout can be found in Figs. 2.7 and 2.8. These charts display the approximate times that different microhabitats are used by each species. A periodicity chart for sculpins was not included since they were divided into only two life stages, adult and subadult, and these microhabitats are required year-round.

The checklist of scoping activities provided by Bovee (1982) is provided in Appendix C.

Table 2.4. Species of fish known to occur in Chamokane Creek and their relative abundance by segment.

Segment	1	2	3	4	5
Family Salmonidae					
Brown Trout (*Salmo trutta*)	2	4	4	4	3
Rainbow Trout (*Salmo gairdneri*)	1	4	4	4	4
Brook Trout (*Salvelinus fontinalis*)	0	0	1	1	2
Mountain Whitefish (*Prosopium willlansoni*)	2	0	0	0	0
Family Cyprinidae					
Redside shiner (*Richardsonius baleatus*)	1	2	3	4	5
Speckled dace (*Rhinichthys osculus*)	1	2	2	2	2
Northern squawfish (*Ptychochellus oregonensis*)	2	0	0	0	0
Chiselmouth (*Acrochellus alutaceus*)	1	0	0	0	0
Family Cottidae					
Piute sculpin (*Cottus beldingi*)	4	5	5	5	5
Torrent sculpin (*Cottus rhotheus*)	1	2	2	2	2
Family Catostamidae					
Bridgelip sucker (*Catostomus columbianus*)	2	1	1	2	2
Largescale sucker (*Catostomus macrochellus*)	4	0	0	0	0
Family Centrarchidae					
Pumpkinseed (*Lepomis gibbosus*)	1	1	1	1	2

0 Not present
1 Rare
2 Occasional
3 Frequent
4 Abundant
5 Very abundant

SPECIES: BROWN TROUT

SYSTEM: CHAMOKANE CREEK

Microhabitat Usage	Month J F M A M J J A S O N D
Adults	
Resting	[----------------------------------]
Spawning	[---] (O–N)
Nest protection	[---] (O–N)
Fry	[-----] (M–J)
Y-O-Y	[----------] (J–A) [----------------] (J–D)
Juvenile	[----------------------------------]
Feeding	
Aquatic source	
Adult	[----------------------------------]
Juvenile	[----------------------------------]
Fry	[------] (M–J)
Y-O-Y	[----------] (J–A) [----------------] (J–D)
Terrestrial source	[----------------] (M–S)
Adult	[----------------] (M–S)
Juvenile	

Figure 2.7. Periodicity chart for brown trout showing the times various microhabitats are required.

SPECIES: RAINBOW TROUT

SYSTEM: CHAMOKANE CREEK

Microhabitat Usage	J	F	M	A	M	J	J	A	S	O	N	D
Adults												
Resting	[	-	-	-	-	-	-	-	-	-	-	]
Spawning			[	-	]							
Nest protection			[	-	]							
Fry						[	-	]				
Y-O-Y	[	-	-	-	-	]		[	-	-	-	]
Juvenile	[	-	-	-	-	-	-	-	-	-	-	]
Feeding												
Aquatic source												
Adult	[	-	-	-	-	-	-	-	-	-	-	]
Juvenile	[	-	-	-	-	-	-	-	-	-	-	]
Y-O-Y	[	-	-	-	-	]		[	-	-	-	]
Fry						[	-	]				
Terrestrial source												
Adult				[	-	-	-	-	-	]		
Juvenile				[	-	-	-	-	-	]		

Figure 2.8. Periodicity chart for rainbow trout showing the times various microhabitats are required.

3.0 STUDY SITE SELECTION

3.1 ESTABLISHING SEGMENT BOUNDARIES

A stream segment is a length of stream that is characterized by homogeneity of channel structure and flow regime (Bovee 1982). Since it is normal for streams to have longitudinal variation in channel size, channel shape, and flow regime, more than one segment is usually required to describe the entire study area.

Segment boundaries were placed wherever it was determined that Chamokane Creek underwent a significant change in water supply. Bovee (1982) recommends that segment boundaries be placed wherever accretion or depletion changes the base flow of the stream by more than 10 percent at the point of confluence. The percent contribution of Galbraith Springs and the Fish Hatchery Springs were estimated at the time of scoping. The contribution of a smaller unnamed spring near the post mill was measured using the float method (Chow 1954) in December, 1985.

A segment boundary was placed at the confluence of Galbraith Springs and Chamokane Creek. Galbraith Springs contributes about 7.0 CFS to the flow of the stream (Woodward 1971 and 1973, Scholz *et al.* 1986). Additional springs in this area appproximately double the flow of Chamokane Creek from about 14 CFS to 27 CFS. A second segment boundary was placed at a small unnamed spring near the post mill, approximately 2.1 km (1.3 mi) above Galbraith Springs. The spring contributed 13 percent to the flow of Chamokane Creek during the initial site evaluation work in December, 1985. Several springs enter Chamokane from the hatchery to 0.5 km (0.3 mi) upstream. Since these springs are proximate to each other, one segment boundary was placed at the uppermost spring to account for the contribution of all the springs. These springs, in combination, account for about 9.5 CFS of the base flow of about 12 CFS at that point. The forth segment boundary was placed above Ford. This segment boundary is located where the return flow springs give the stream a year-round flow below the intermittent section of the stream.

Bovee (1982) recommended that segment boundaries be placed wherever slope changes significantly. The longitudinal profile of Chamokane Creek from the mouth to Ford (Fig. 3.1) was constructed using a USGS 7.5 minute topographic map and a map wheel. The slope is fairly uniform except for the abrupt change at the falls. Chamokane has an average gradient of 0.83 percent above the falls and 0.89 percent below the falls. A segment boundary was placed at Chamokane Falls due to it being a passage barrier to fish.

Bovee (1982) also recommended that segment boundaries be placed wherever sediment supply changes significantly. Figure 2.6 (Section 2.3.2) shows the major point sources of sediment within the study area. These bank cuts introduce sediment throughout the lower 9.7 km (6.0 mi) of the study area at high flows. However, these bank cuts are probably not the primary source of sediment deposited in the study area. During periods of high flow, large amounts of sediment are transported into the study area from upstream sources. This results in the sediment supply being fairly constant throughout the study area, so an additional boundary was not warranted.

Bovee (1982) recommended that segment boundaries be placed wherever sinuosity changes by more than 25 percent. Sinuosity was determined by taking the ratio between channel length and valley length (Leopold *et al.* 1964). Table 3.1 displays the sinuosities calculated for the lower 12.9 km (8.0 mi) of Chamokane Creek at 1.6 km (1.0 mi) increments. The only change exceeding 25 percent is from 11.3 km (7.0 mi) to 12.9 km (8.0 mi). A segment boundary had already been placed at the 11.3 km (7.0 mi) mark due to the springs near the fish hatchery, so an additional segment boundary was not warranted.

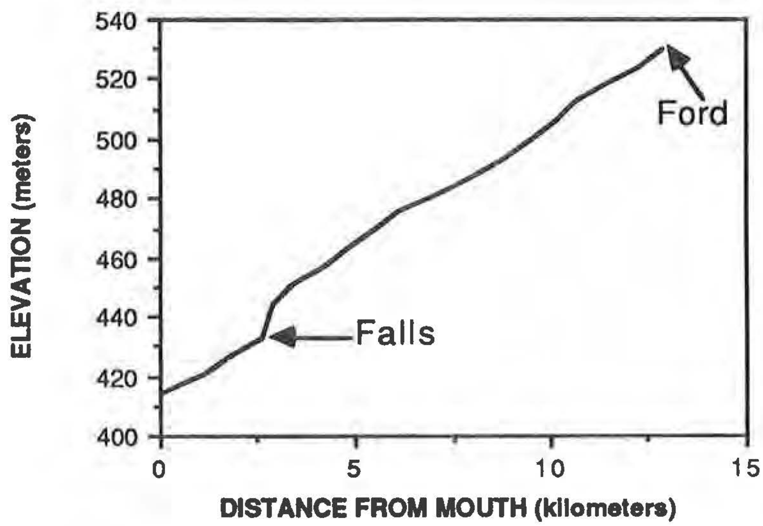


Figure 3.1. Longitudinal profile of Chamokane Creek from the mouth to just north of Ford, WA.

Table 3.1. Sinuosities calculated for Chamokane Creek at 1.6 km (1.0 mi) intervals.

Interval (km)	Sinuosity	% Change
0-1.6	1.11	- -
1.6-3.2	1.11	0
3.2-4.8	1.18	6
4.8-6.4	1.43	21
6.4-8.0	1.21	15
8.0-9.7	1.25	3
9.7-11.3	1.21	3
11.3-12.9	1.66	37

Figure 3.2 shows the locations of the segment boundaries. Table 3.2 gives a written description of the location of each segment boundary.

3.2 SELECTION OF STUDY REACHES

A study reach, or microhabitat study site, was the location, within a segment, where the hydraulic and habitat characteristics for that segment were measured. Since the study reach was used to represent the characteristics of the entire stream segment, it had to be representative of the entire stream segment (Bovee 1982).

Bovee (1982) recommended selecting reaches randomly. By this method, the probability of selecting a reach "typical" of the segment is greater than the probability of selecting an "atypical" reach. Our method for selecting study reaches followed Bovee's (1982) suggestion.

(1) In selecting representative reaches, the average width of each segment was determined by taking random width measurements for each segment. The average width was then multiplied by 10. This first step was recommended by Bovee (1982) since all of the habitat types will usually be included in a length of stream that is 10 times longer than its average width.

(2) The boundaries of all potential reaches were marked on a topographic map at the distance specified in the first step. All reaches having bridge crossings were eliminated because stream characteristics in these areas may not be typical due to altered flow patterns (Bovee 1982).

(3) Each potential reach was sequentially numbered and a random numbers table was used to select three reaches within each segment.

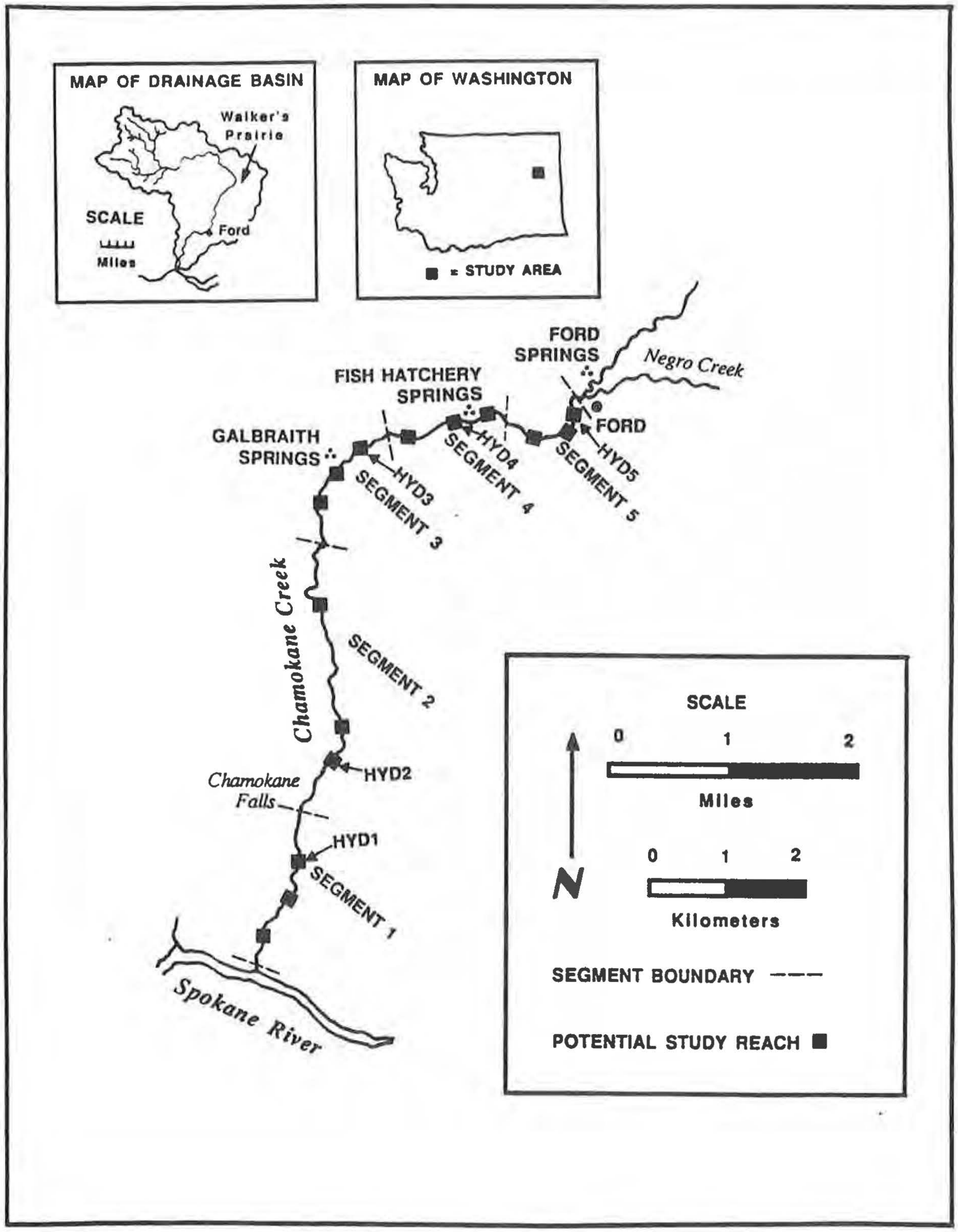


Figure 3.2. Locations of segment boundaries and potential study reaches. Selected study reaches are designated by HYD#.

Table 3.2. Locations of segment boundaries and microhabitat (hydraulic) study sites.

SEGMENT NUMBER	STUDY SITE	LOCATION
1		From mouth at N.E.1/4 of Sec. 15, T. 27 N., R. 39 E., at stream kilometer 0 to Chamokane Falls in the S.W. 1/4 of Sec. 2, T. 27 N., R. 39 E., at stream kilometer 2.7.
	HYD1	N.W. 1/4 of Sec. 11, T. 27 N., R. 39 E., at stream kilometer 1.6.
2		From segment 1 upper boundary to the N.E. 1/4 of Sec. 26, T. 28 N., R. 39 E., at stream kilometer 7.6.
	HYD2	N.E. 1/4 of Sec. 2, T. 27 N., R. 39 E., at stream kilometer 3.4.
3		From segment 2 upper boundary to the S.W.1/4 of Sec. 24, T. 28 N., R. 39 E., at stream kilometer 9.7.
	HYD3	S.E. 1/4 of Sec. 23, T. 28 N., R. 39 E., at stream kilometer 9.0.
4		From segment 3 upper boundary to the S.W. 1/4 of Sec. 19, T. 28 N., R. 40 E., at stream kilometer 11.3.
	HYD4	S.E. 1/4 of Sec. 24, T. 28 N., R. 39 E., at stream kilometer 10.5.
5		From segment 4 upper boundary to the S.E. 1/4 of Sec. 19, T. 28 N., R. 40 E., at stream kilometer 12.9.
	HYD5	S.E. 1/4 of Sec. 19, T. 28 N., R. 40 E., at stream kilometer 12.6.

(4) Each selected reach was inspected in the field. If all three candidate reaches were similar and typical of their respective segments, considerations such as access, logistics, and landowner permission were used in the ultimate selection.

Figure 3.2 displays the location of the three reaches randomly selected for consideration as the study reach. Table 3.2 gives a written description of the locations of the final study reaches. Appendix D contains the checklist for establishing study areas provided by Bovee (1982).

4.0 DESCRIPTION OF THE PRESENT STATE OF CHAMOKANE CREEK

4.1 BACKGROUND

Describing the present state of Chamokane Creek involved measuring the available microhabitat. Microhabitat included the channel structural characteristics (*i.e.*, proportions of riffles, runs, and pools, the distribution of cover and substrate, and the shape and slope of the channel) and the hydraulic characteristics (*i.e.*, water depth and velocity). These measurements were made at each of the study reaches, and utilized in the hydraulic model (IFG4) to simulate the hydraulic characteristics of the reach at unmeasured flows.

It was also necessary to determine the flow regime of the stream under current conditions. Bovee (1982) recommended using a time series, or summary time series, of discharges that have occurred over the period of record. These hydrographs were constructed for each stream segment and were utilized to determine the range of flows to be simulated.

4.2 FIELD MEASUREMENTS OF MICROHABITAT

At each study reach a benchmark was established as a reference point to be used throughout the study. Considerations involved in the placement of each benchmark were ease of relocation and permanence. The benchmark consisted of a 75 cm (30 in) length of rebar driven into the ground.

Transects were then established within each study reach. Transects, or cross-sections, were the locations within each reach where the microhabitat was measured. Transects were first placed at each hydraulic control (Bovee and Milhous 1978). A hydraulic control was any point where there was a change in the slope of the water surface (*i.e.*, the transition from a pool to a riffle). Additional transects were then placed so that major habitat types could be sampled (*i.e.*, pools, runs, and riffles missed in the initial transect placement). Headstakes, consisting of 75 cm (30 in) lengths of rebar driven flush with the ground, were placed at the ends of each transect. Wooden stakes were placed just outside of the headstakes to aid in relocation and for the attachment of a measuring tape.

Channel structural characteristics were measured during the collection of high flow data in March and April, 1986. First, headstake and bed elevations were measured using a TOPCON Geodetic Total Station (GTS-2B) and following the standard surveying techniques outlined by Bovee and Milhous (1978) and Moffit and Bouchard (1982). All elevations within a reach were referenced to the benchmark that was arbitrarily set at 100 feet (Bovee and Milhous 1978). Bed elevations were taken along each transect from headstake to headstake to get a cross-sectional profile of the channel (Appendix E). Ten to twenty measurements were made along each transect as recommended by Bovee and Milhous (1978).

Second, substrate was classified by visual inspection (Table 4.1) at each point, or vertical, that the bed elevations were measured. This scale is similar to that used by Bovee and Cochnauer (1977) except plant detritus, mud, clay, and silt were combined into one category and cobble was divided into "small" and "large" categories. A mixture of two substrate types was categorized according to the relative percentage of each type. For instance, a substrate code of 3.6 represents a mixture containing 40 percent gravel and 60 percent small cobble.

Third, cover was characterized (Table 4.2). Object cover consisted of any obstruction to flow that would afford velocity cover for a fish. This type of cover was broken into "large" and "small" based upon the size of the object. Instream overhead cover was any object that provided shade cover for fish. Finally, the distances between transects were measured along the right and left

Table 4.1. Scale used to categorize substrates in Chamokane Creek.

Substrate Code	Description	Size (mm)
1	Silt	<0.062
2	Sand	0.062-2.0
3	Gravel	2.0-64.0
4	Small Cobble	64.0-128.0
5	Large Cobble	128.0-256.0
6	Boulder	>256
7	Bedrock	

Table 4.2. Covers codes used to categorize cover in Chamokane Creek.

Cover Code	Description	
1	No cover	
2	Small object	
3	Large object	> 60 cm in length and > 15 cm diameter or > 30 cm diameter
4	Overhead	< 45 cm from water surface
5	Combination of object and overhead	

banks using a fiberglass tape. The measurements made at each vertical were applied to a cell with a width equal to half the distance to the adjacent verticals along the same transect, and a length equal to half the distance to the adjacent upstream and downstream transects.

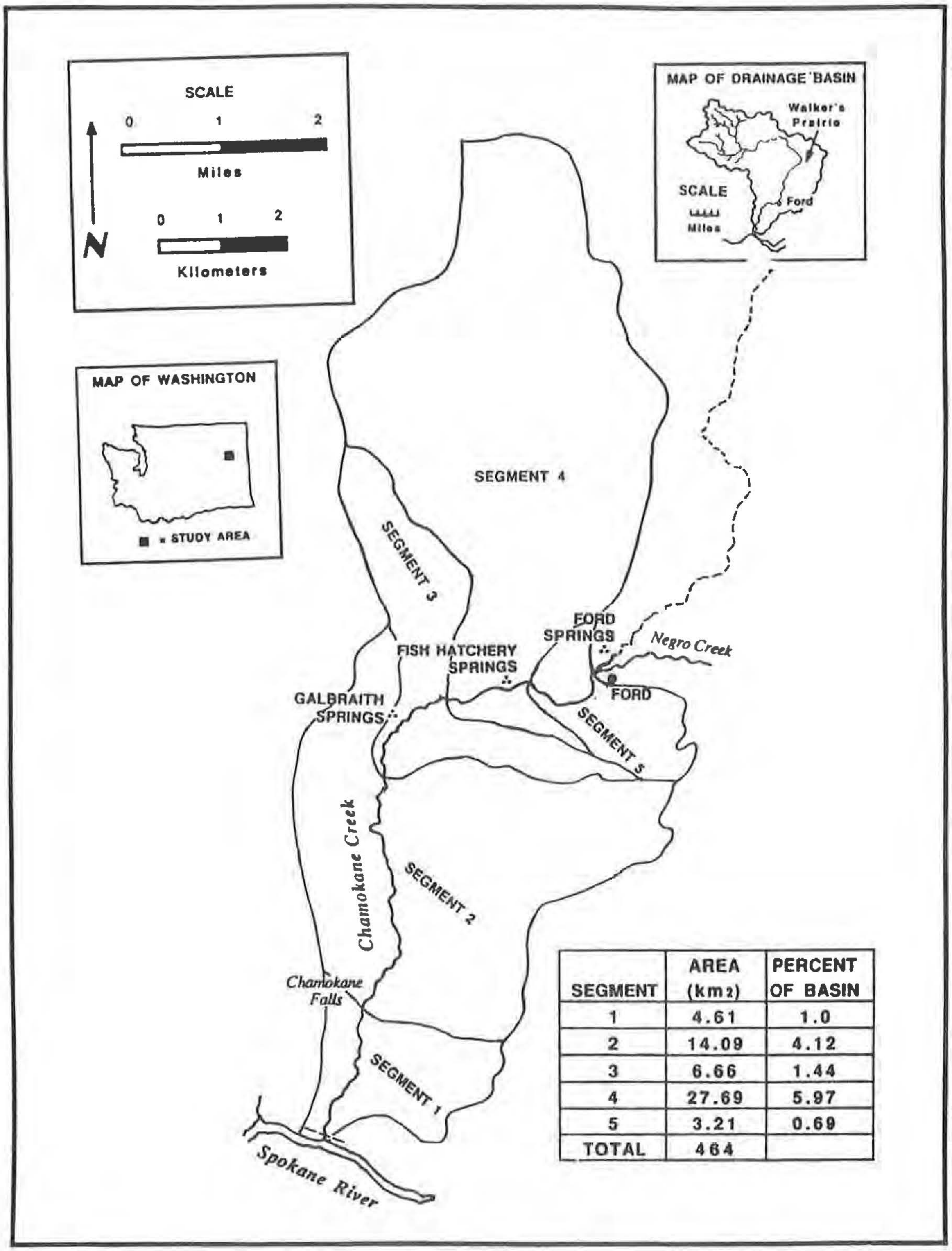
Hydraulic characteristics were measured during the high flow data collection in March and April, 1986 and the low flow data collection in September, 1986. First, water surface elevations were measured on both sides of the stream at each transect. If the water surface elevations from each side were not equal, then they were averaged for the transect (Bovee and Milhous 1978). Second, velocity measurements were made at each vertical along each transect. Velocity measurements were made using either Price AA or Price pygmy current meters and following the methods outlined by Bovee and Milhous (1978) and Buchanan and Somers (1980). Finally, a discharge measurement was made at each study reach while collecting the hydraulic data. Discharge measurements were made following the guidelines of Buchanan and Somers (1980). The microhabitat data collected at each transect can be found in Appendix F.

4.3 DEVELOPMENT OF FLOW DURATION CURVES

Flow duration curves (Bovee 1982) were constructed for each month of the year using mean daily discharges recorded at the USGS gaging station below the falls. The flows at the gaging station represented the flow regime at segments 1 and 2 since the gage is located near the division of these segments and there is no significant inflow or outflow below the gage in segment 1. Less than one percent of the total area of the basin lies below the gage, so runoff was considered to be negligible. Flow duration curves were developed by: (1) constructing an array of flow intervals from high to low; (2) tallying the mean daily flows for the period of record in each of the flow increments; (3) dividing the frequency within each flow increment by the total number of days in the period of record to get the percent of time the increment is represented; (4) summing the percent of occurence cumulatively, from high to low flows; and (5) plotting the flow versus the cumulative frequency. The flow duration curves can be found in Appendix G.

In order to determine what the flow would be in segments 3, 4, and 5 for a given flow at the USGS gaging station, a conversion equation for each segment was developed. This was accomplished by first drawing, on a USGS 15 minute topographic map, the area that would provide runoff to each segment based upon the topography (Fig. 4.1). The area of each segment was measured using a polar planimeter and divided by the total area of the basin. This technique of calculating the proportion of runoff at each segment assumed that runoff was equal throughout the basin. Olson (1986) calculated the mean base flow of Chamokane Creek, at the USGS gage, at 29.9 CFS, flows above this base flow were assumed to contain runoff. In order to determine the runoff contribution to flow at each segment above segment 2, the proportion of runoff occurring below the segment was subtracted (excluding segment 1, since that runoff was not included in the flow at the gage) from the total. For example, if the flow at the USGS gage was 40 CFS, then 10.1 CFS was assumed to be runoff. Since segment 2 contains 4.1 percent of the area, then 4.1 percent of the runoff was assumed to occur in that segment. The contribution of runoff to the flow of segment 3 was then 100 percent minus 4.1 percent, or 95.9 percent of total runoff. Therefore, the runoff contribution to the flow of segment 3 was 10.1 times 0.959, or 9.7 CFS.

Second, the relationship between the base flow of each segment was determined by making a discharge measurement at each study reach on Feb. 26, 1987. The runoff component of the discharge at each segment was subtracted, giving the base flow of each segment. By dividing the base flow of segments 3, 4, and 5 by 29.9, a conversion factor was obtained for each segment at base flow or below. The assumption here was that the proportion of flow provided by the springs and seeps, which results in a change in flow



SEGMENT	AREA (km^2)	PERCENT OF BASIN
1	4.61	1.0
2	14.09	4.12
3	6.66	1.44
4	27.69	5.97
5	3.21	0.69
TOTAL	464	

Figure 4.1. Areas of the Chamokane Basin that contribute runoff to each of the study segments.

between segments, was constant. Table 4.3 shows the calculations used to determine the flow for segments 3, 4, and 5.

Table 4.3. Calculations used to convert the flows at the gaging station to the flows in segments 3,4, and 5.

A. Base Flow Calculations			
Segment	Measured Flow (CFS)	Runoff[1]	Base Flow
1	31.0	1.1	29.9
2	31.0	1.1	29.9
3	16.7	1.1	15.6
4	14.7	1.0	13.7
5	2.7	1.0	1.7

B. Calculation of Flow	
Segment	
1	Same as flow at gage
2	Same as flow at gage
3	(15.6/29.9) X Flow at gage
4	(13.7/29.9) X Flow at gage
5	(1.7/29.9) X Flow at gage

C. Calculation of Flow During Periods of Runoff	
Segment	
1	Same as flow at gage
2	Same as flow at gage
3	(0.522 X 29.9) + (Runoff [1] X 0.959)
4	(0.458 X 29.9) + (Runoff [1] X 0.944)
5	(0.057 X 29.9) + (Runoff [1] X0.885)

[1] Defined as any flow exceeding the base flow (29.9 CFS) at gage. The runoff component of the flows in A was determined by multiplying 1.1 times the percent of the basin in or above that segment, as in the right portion of the equations for segments 3,4, and 5 in part C.

5.0 HABITAT SUITABILITY INDICES FOR BROWN TROUT, RAINBOW TROUT, AND SCULPINS IN CHAMOKANE CREEK

5.1 BACKGROUND

Habitat suitability indices provided the criteria utilized in the PHABSIM system for calculating the Weighted Usable Area (WUA) for an evaluation organism. Suitability indices were constructed for the microhabitat variables of depth, velocity, substrate, and cover for each life stage of each evaluation organism. The habitat suitability information was presented as a curve, with the optimum range for a particular variable assigned a weighting factor of one. Increments outside of the optimum range were assigned decreasing weighting factors, with a weighting factor of zero representing unsuitable habitat. This technique assumes that individuals of a species will select areas of the stream containing the most favorable combination of habitat variables (*i.e.,* velocity, depth, substrate, and cover) and will utilize areas with less favorable conditions with decreasing frequency.

Three types of suitability criteria are generally used in IFIM applications (Bovee 1986). Category I criteria are developed from professional judgment. This type of criteria should only be used when there is a lack of empirical data to construct curves. Category II, or utilization, criteria are based upon microhabitat measurements made wherever an evaluation organism is located. Category III, or preference, criteria are constructed by adjusting the utilization criteria for habitat availability.

The use of preference criteria is favored over the other types of criteria since it is based upon empirical evidence, not dependant upon habitat availability, and resolves many of the problems of dependence of habitat variables. Moyle and Baltz (1985) criticized the use of utilization criteria because the curves are biased by the availability of habitat types at the time and place of data collection.

availability of habitat types at the time and place of data collection. Voos (1981), Orth and Maughan (1982), and Mathur *et al.* (1985) criticized the multiplication of suitability weighting factors from utilization criteria because the assumption of independence is not valid for depth and velocity. Voos (1981), however, concluded that the use of preference criteria eliminated many of the problems of interactions between variables, since the same physical relationships are present in utilization and availablity data bases. When utilization is divided by availability to get preference, the correlation cross-products cancel out (Bovee 1986).

5.2 FIELD MEASUREMENTS FOR HABITAT UTILIZATION IN CHAMOKANE CREEK

Habitat utilization information was collected for five life stages (adult, juvenile, young-of-the-year, fry, and spawning/egg incubation) of brown trout and rainbow trout, and for two life stages (adult and sub-adult) of sculpins. Habitat utilization indices were developed based upon the velocity, depth, substrate, and cover measured wherever a life stage of an evaluation species was located.

Generally, two crews were used to collect habitat utilization data. The first crew used a pulsed DC backpack electrofisher (Smith-Root, Type VII or Model 12) to capture fish. Extreme caution was used when approaching an area to be shocked to reduce the movement of fish from their original location. Spot electrofishing was employed so that a fish would not be captured after moving from its selected habitat. A numbered buoy was placed at the spot a member of an evaluation species was located, not necessarily where it was captured. If the original location of a captured fish was not determined, it was not included in the data base. The length, species, and buoy number were recorded. Fish were then released downstream to prevent recapture.

At each buoy, the second crew measured the depth using a wading rod, and mean column velocity at 0.6 of the depth, if the depth was 0.75 m (2.5 ft) or less, using a Price pygmy meter. If the water depth exceeded 0.75 m (2.5 ft) then mean column velocity was averaged from the velocities measured at 0.2 and 0.8 of the total depth (Bovee and Milhous 1978, Buchanan and Somers 1980). Substrate and cover were categorized as described in section 4.2.

Spawning habitat data for brown trout and rainbow trout was collected by walking the stream and taking measurements wherever a redd was located. A redd consisted of a single nest (Greeley 1932) and was identified by the "cleaned" substrate and characteristic shape. Velocity and depth measurements were made immediately in front of the redd and substrate was classified in the undisturbed area immediately around the nest. Spawning criteria were assumed to apply to the egg indcubation life stage (Raleigh *et al.* 1986). Since adults select depth, velocities, and substrates suitable for spawning, it is logical to assume that these parameters also meet the requirements for egg incubation.

Brown trout and rainbow trout were divided into life stages based upon age as determined by scale analysis (Lux 1971, Jearld 1983), and length frequency distributions following the methods of Anderson and Gutreuter (1983). The O+ age class was divided into fry ($\leq$49 mm total length, TL) and young-of-the-year (50-118 mm TL). Brown trout juveniles ranged from 119 to 345 mm TL (ages 1+, 2+, and 3+), while rainbow trout juveniles ranged from 119 to 265 mm TL (ages 1+ and 2+). Brown trout adults were greater than 345 mm TL (4+ and older) while rainbow trout adults were greater than 265 mm TL (3+ and older). The age at maturation typical for brown trout (Carlander 1969, Wydoski and Whitney 1979) and rainbow trout (Wydoski and Whitney 1979) was used to determine the age classes to be included in the adult life stage. Sculpins were grouped into subadult ($\leq$ 47 mm TL) and adult ($\geq$ 48 mm TL) based on a length frequency distribution (Anderson and Gutreuter 1983).

Utilization data was then arranged from the lowest measured value to the highest at increments of 9.15 cm/s (0.3 ft/s) for velocity, 9.15 cm (0.3 ft) for depth, one substrate code (0.3 substrate code for spawning), and one cover code. A tally was then made of the total number of each life stage of each evaluation species to utilize each increment. The number of individuals within each increment was then divided by the total number of individuals at that life stage to get the relative frequency at each increment.

5.3 CONVERSION OF UTILIZATION INFORMATION TO PREFERENCE

Once the utilization information was collected it was necessary to make adjustments for the availability of habitat at the time the utilization data was collected. This resulted in true preference criteria which shows what habitat each life stage of each evaluation species was selecting, independent of what was available. The collection of availability information every time utilization data was collected would be extremely labor intensive. Since habitat availability measurements were already made for each segment for use in the PHABSIM program, the model was used to generate habitat availability information.

Availability data was obtained by running the IFG4 and HABTAT programs for each segment at the flows in which utilization data was collected (see section 6). By running the HABTAT programs with option 4 set to 1 (see Milhous *et al.* 1984), the output file contained all of the computational details for each cell of each transect. Included in this output are the depth, velocity, substrate (or cover), and surface area for each cell at the flow simulated. A FORTRAN program (Appendix H) was written to read this information and write it to a file containing the area available at each increment for the segment and flow simulated.

Since habitat availability was dependant upon the stream segment in which the fish were captured, and the flow at the time of capture, weighted averages were used to calculate habitat availability for each life stage. The number of fish captured in a particular segment at a particular flow was divided by the total number of fish captured in that life stage, to get a proportion. The proportion was then multiplied by the area at each increment of each habitat parameter. The areas at each increment were then summed for each habitat parameter, giving a weighted average of habitat availability for each life stage. Relative habitat availability was then calculated by dividing the area available at each increment by the total area available.

Preference ratios for velocity, depth, and spawning substrate were calculated by dividing the relative utilization at an increment by the relative availability at that increment. The preference ratios were then normalized by dividing all ratios by the highest ratio. This sometimes resulted in an irregular curve that was smoothed by connecting the high points (Raleigh *et al.* 1986). This technique, in a few of the cases, resulted in an upturned tail at the end of the distribution; these were artifacts of the data and were ignored and the curves smoothed to zero (Bovee 1986).

Cover and substrate (other than spawning) preference criteria were constructed using histogram analysis (Bovee 1986). This technique was used since there were only five cover and seven substrate types, making the curve fitting methods impractical. Additionally, since there were so few increments, the variation present in data sets with a large number of increments was not present, making smoothing techniques unnecessary. Preference histograms were constructed by dividing relative utilization by relative availability and normalized by dividing through by the largest ratio. After constructing utilization and preference criteria, comparisons were made with the criteria of previous researchers.

5.4 HABITAT UTILIZATION AND PREFERENCE CRITERIA FOR DIFFERENT LIFE HISTORY STAGES OF BROWN TROUT

Habitat parameters were measured for 62 adult brown trout from April through December, 1986 (Appendix I, Table I.1). Fig. 5.1 shows the utilization and preference criteria developed from this data. Adult brown trout utilized velocities ranging from 0.0 to 70.1 cm/s with an optimum of 0.0 to 21.3 cm. They showed a preference for velocities of 21.3 cm/s. Utilized depths ranged from 18.3 to 137.2 cm with an optimum of 67.1 cm. The depth preferred by adult brown trout was 67.1 cm. Substrates of 1.0 to 5.0 were utilized, with the optimum at 4.0. After adjusting for availability, adult brown trout preferred substrate type 1.0. The optimum cover, for both utilization and preference, was cover type 5.

Measurements were made for 197 brown trout juveniles between April and October, 1986 (Appendix I, Table I.2). Fig. 5.2 shows that juvenile brown trout utilized velocities of 0.0 to 109.7 cm/s with the optimum at 12.2 cm/s. Preferred velocity was 21.3 cm/s. Utilized depths ranged from 9.1 to 115.8 cm. Juvenile brown trout preferred depths of 67.1. Utilized substrates ranged from 1.0 to 7.0 with the optimum at 4.0. Preferred substrate for juvenile brown trout was 1.0. Cover type 5 was optimum for both utilization and preference.

Habitat parameters were measured for 151 young-of-the-year (YOY) brown trout from April through October, 1986 (Appendix I, Table I.3). YOY brown trout utilized velocities from 0.0 to 103.6 cm/s, with an optimum of 0.0 (Fig. 5.3). The preferred velocity was 39.6 cm/s. Utilized depths ranged from 9.1 to 88.4 cm with the optimum at 39.6 cm. YOY brown trout preferred a depth of 39.6 cm. Substrates utilized ranged from 1.0 to 5.0 with the optimum at 4.0. The preferred substrate for YOY brown trout was 2.0. The optimum cover type was 4 for both utilization and preference.

Eighty-six brown trout fry were captured in May, 1986 (Appendix I, Table I.4). Fig. 5.4 shows that brown trout fry utilized velocities from 0.0 to 33.5 cm/s with an optimum at 12.2 cm/s. The preferred velocity was 21.3 cm/s. Depths utilized by brown trout fry were from 6.1 to 54.9 cm with an optimum of 12.2 cm. They also showed a preference for depths of 12.2 cm. Utilized substrates ranged from 1.0 to 5.0 with the optimum at 4.0. Brown trout fry preferred substrates of 2.0. Brown trout fry utilized cover type 1 with the greatest frequency, while cover type 5 was not utilized and cover type 2 was preferred.

Habitat measurements were made for 140 brown trout redds in late October and early November 1986 (Appendix I, Table I.5). Brown trout spawners utilized velocities ranging from 9.1 to 94.5 cm/s with the optimum at 39.6 cm/s (Fig. 5.5). The preferred velocity was 67.1 cm/s. Depths utilized by brown trout spawners ranged from 9.1 to 42.7 cm. The optimum and the preferred depth for spawning was 21.3 cm. Substrates utilized for spawning ranged from 2.4 to 4.2, with the optimum at 3.5. The preferred substrate was also 3.5.

5.5 HABITAT UTILIZATION AND PREFERENCE CRITERIA FOR DIFFERENT LIFE HISTORY STAGES OF RAINBOW TROUT

Fifty-seven rainbow trout adults were captured from April through December, 1986 (Appendix J, Table J.1). Rainbow trout adults utilized velocities ranging from 0.0 to 64.0 cm/s, with the optimum at 12.2 cm/s (Fig. 5.6). The preferred velocity was 21.3 cm/s. Utilized depths ranged from 15.2 to 140.2 cm with the optimum at 67.1 cm. The depths preferred by adult rainbow trout ranged from 67.1 to 94.5 cm. Substrate utilization ranged from 1.0 to 7.0 with the optimum at 4.0. The preferred substrate was 1.0. Cover type 5 was the optimum for both utilization and preference.

Habitat measurements were made for 89 rainbow trout juveniles from April through December, 1986 (Appendix J, Table J.2).

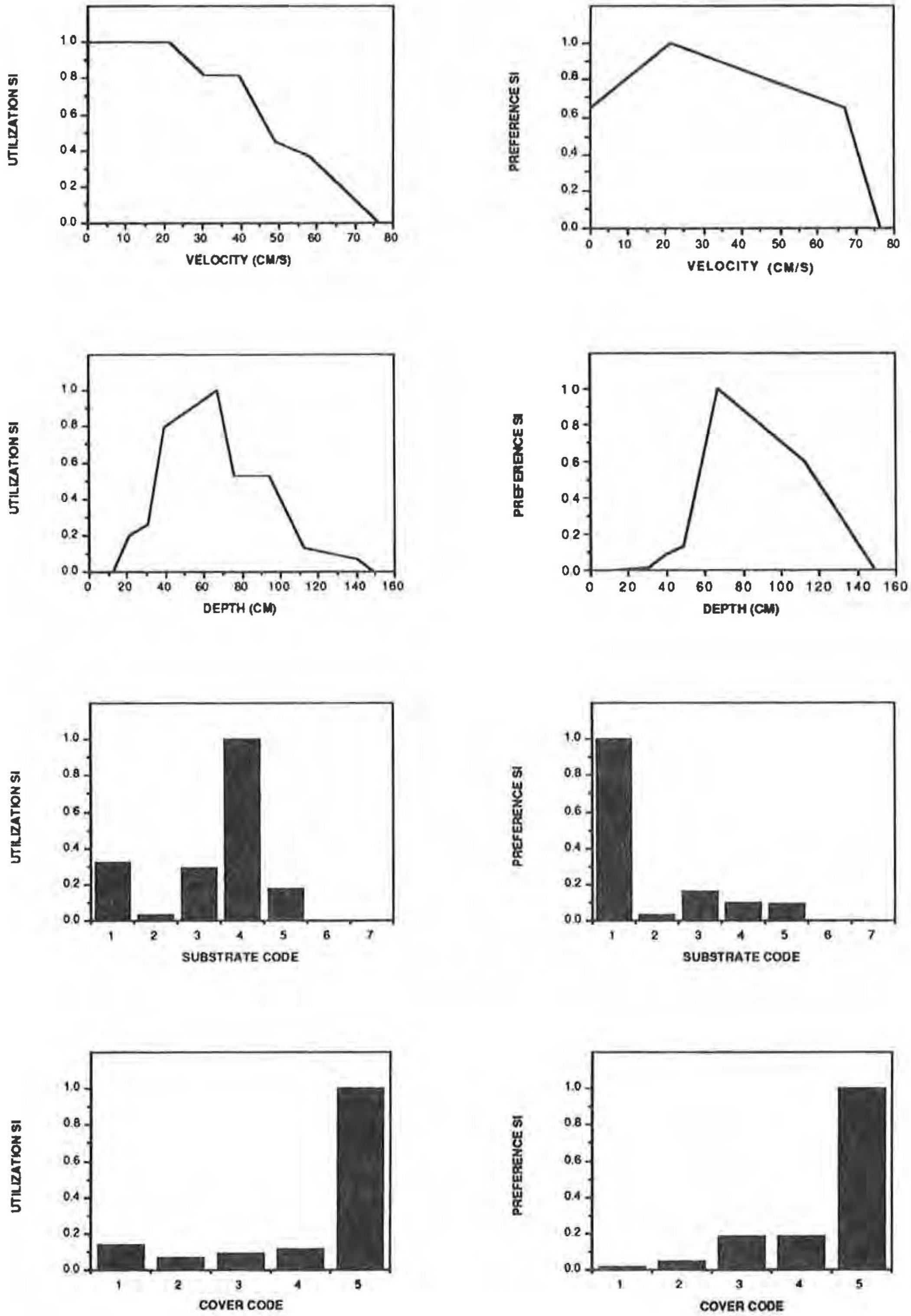


Figure 5.1. Utilization and preference suitability indices for brown trout adults. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

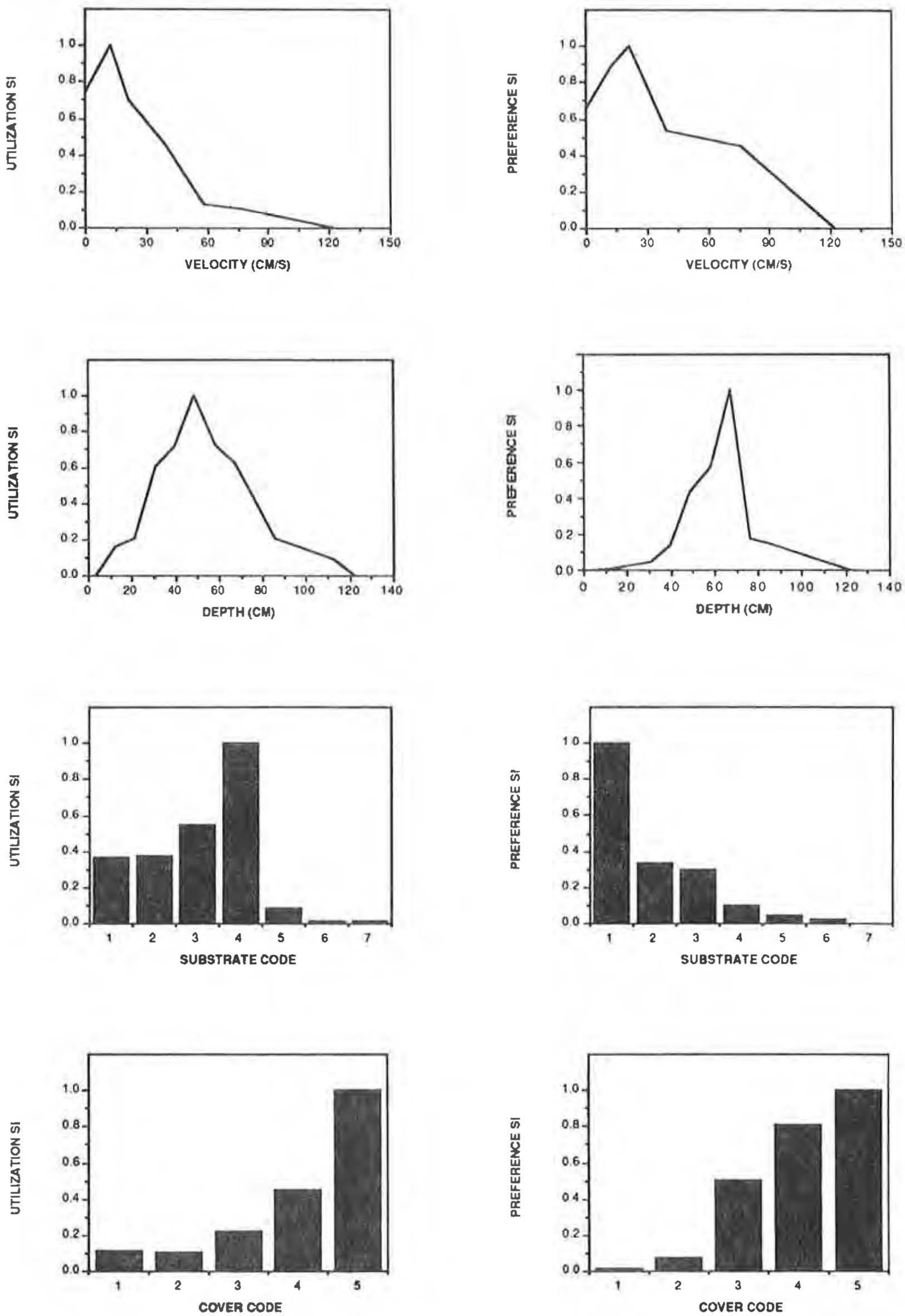


Figure 5.2. Utilization and preference suitability indices for brown trout juveniles. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

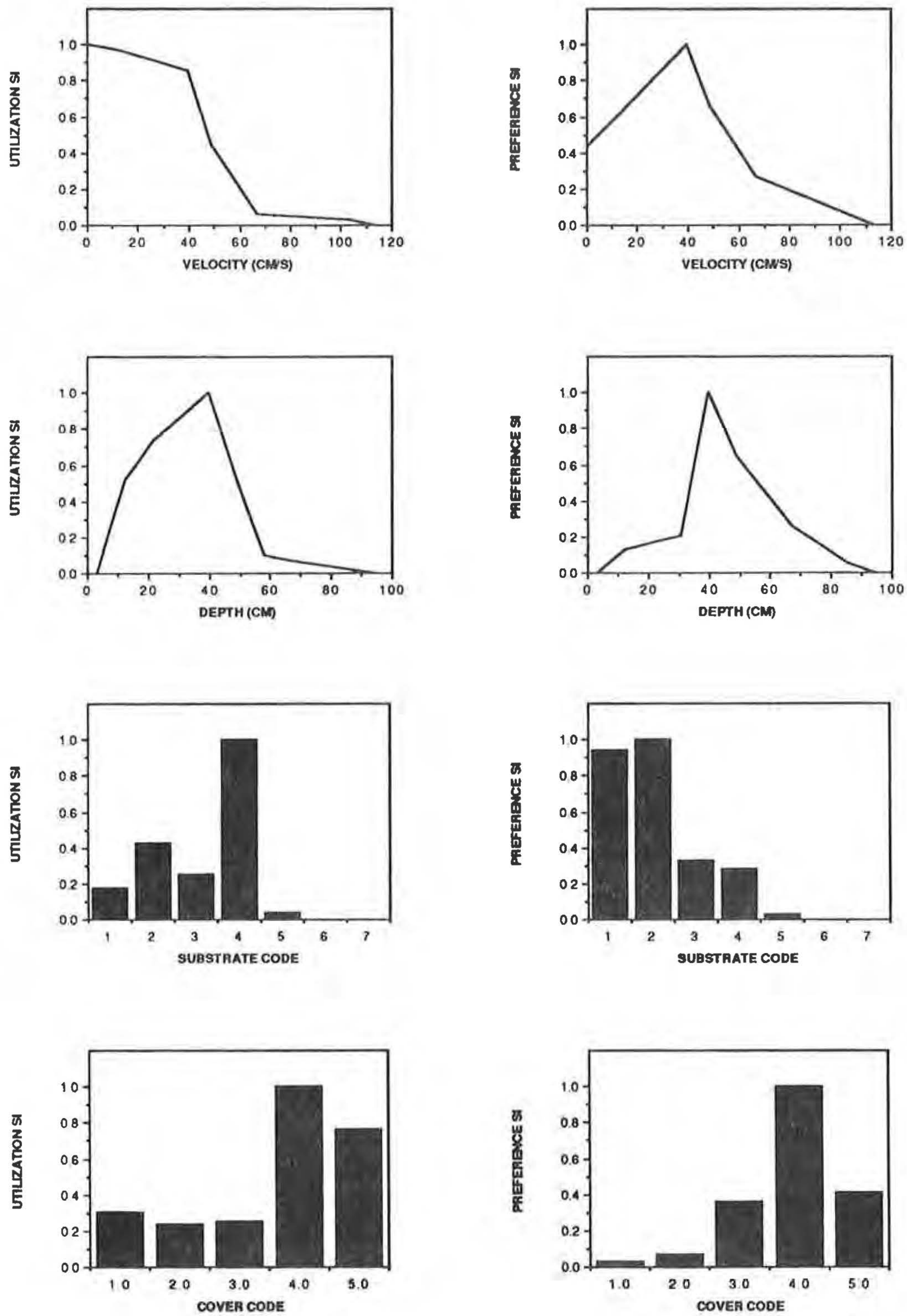


Figure 5.3. Utilization and preference suitability indices for brown trout young-of-the-year. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

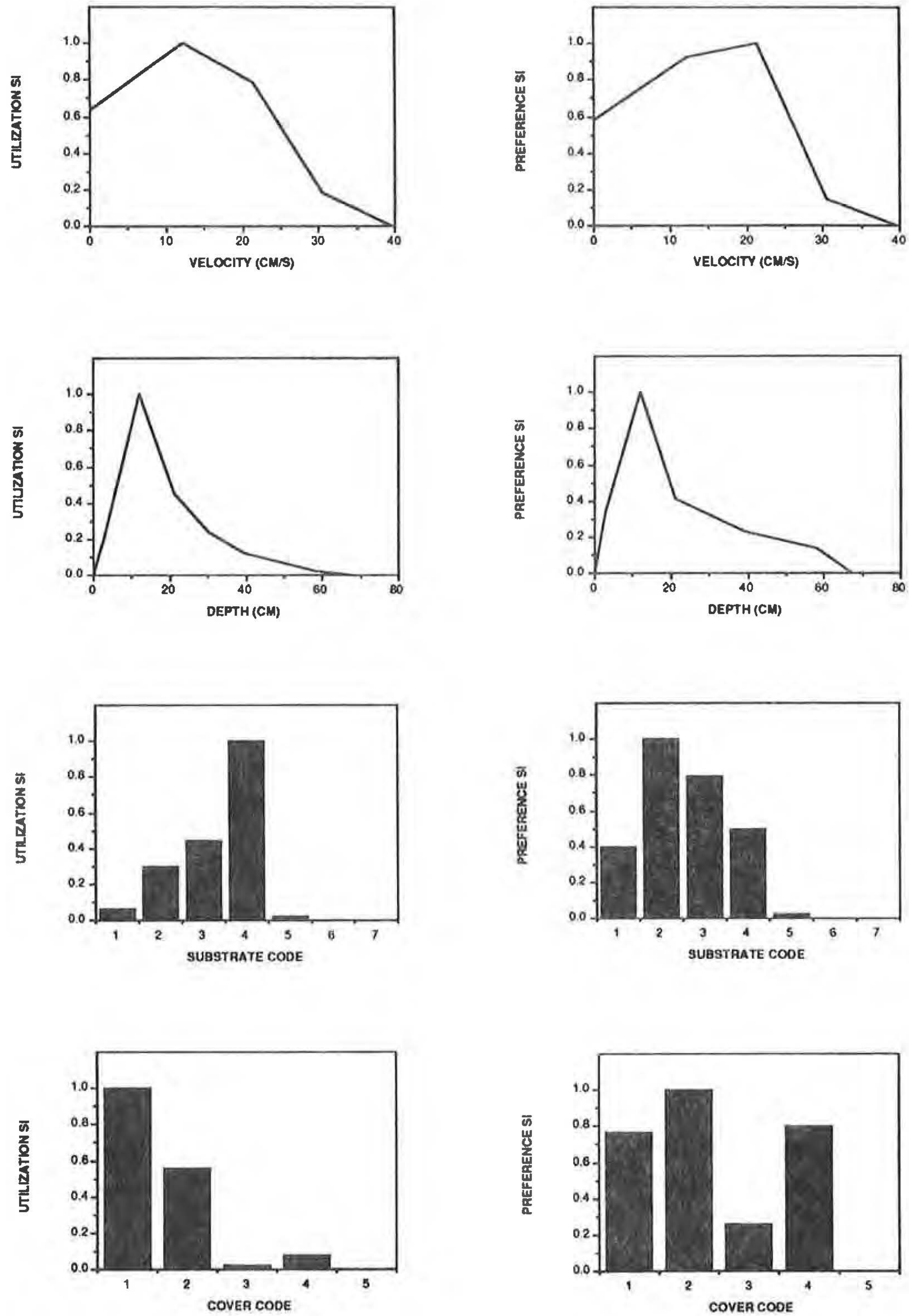


Figure 5.4. Utilization and preference suitability indices for brown trout fry. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

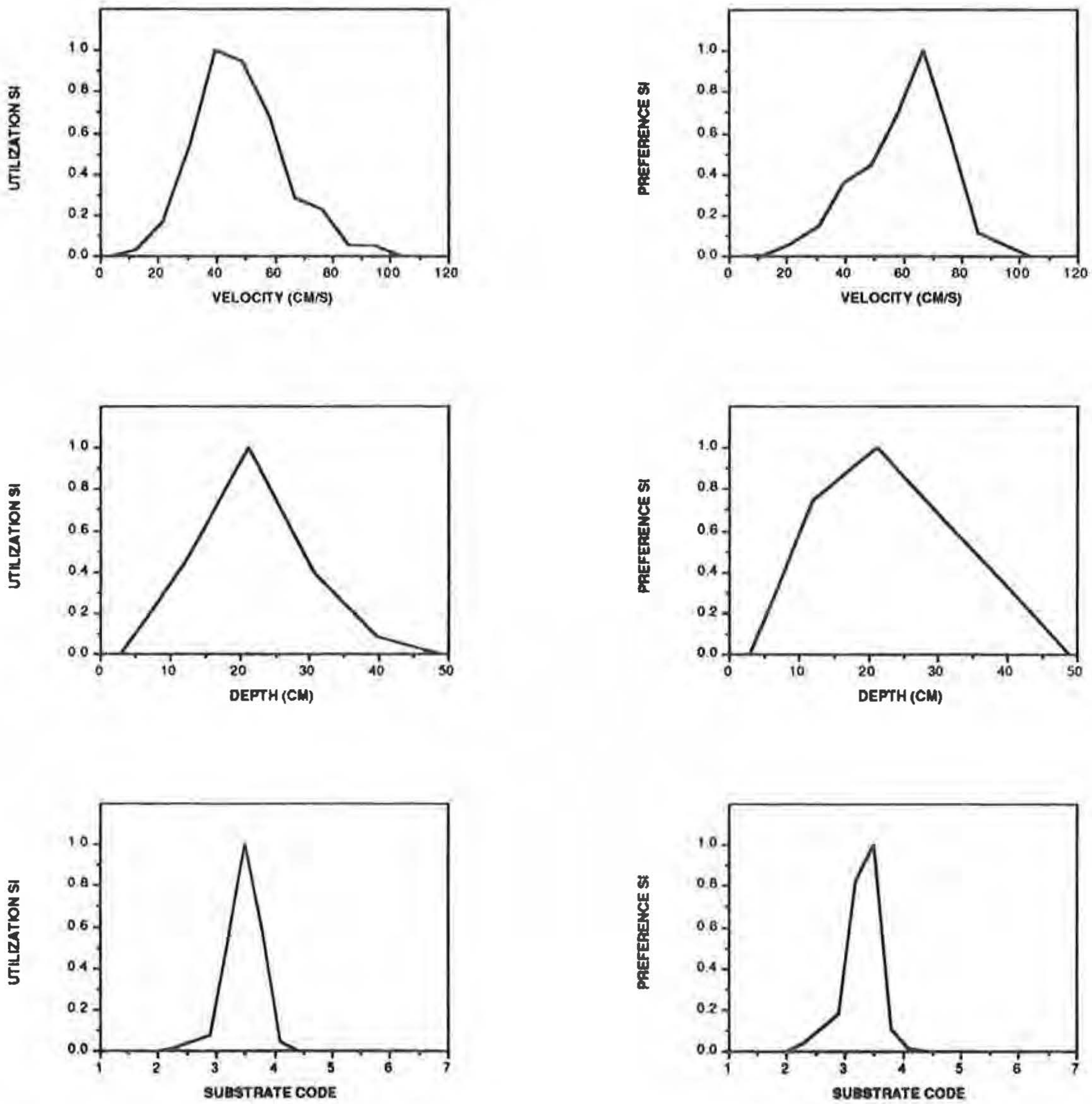


Figure 5.5. Utilization and preference suitability indices for brown trout spawning. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock.

Fig. 5.7 shows that rainbow trout juveniles utilized velocities ranging from 0.0 to 97.5 cm/s, with an optimum of 0.0 cm/s. The preferred velocity was 57.9 cm/s. Depths utilized by rainbow trout juveniles were from 21.3 to 121.9 cm, with the optimum from 33.5 to 61.0 cm. The preferred depth was 57.9 cm. Utilized substrates ranged from 1.0 to 5.0, with the optimum at 4.0. Rainbow trout juveniles preferred substrates of 1.0. The optimum cover type for utilization was 5, and the preferred cover type was 4.

Sixty-five young-of-the-year (YOY) rainbow trout were captured from April through December, 1986 (Appendix J, Table J.3). Rainbow trout YOY utilized velocities ranging from 0.0 to 73.2 cm/s, with the optimum at 0.0 cm/s (Fig. 5.8). The preferred velocity was also 0.0 cm/s. Utilized depths were from 15.2 to 106.7 cm with an optimum of 21.3 cm and a preferred depth of 48.8 to 57.9 cm. Substrates utilized by rainbow trout YOY ranged from 1.0 to 7.0. The optimum was 4.0 with a preferred substrate of 1.0. The optimum cover type was 5, while the preferred cover type was 4.

Habitat measurements were made for 207 rainbow trout fry in June, 1987 (Appendix J, Table J.4). Fig. 5.9 shows that rainbow trout fry utilized velocities from 0.0 to 39.6 cm/s with the optimum at 0.0 cm/s. The preferred velocity was also 0.0 cm/s. Utilized depths ranged from 9.1 to 39.6 cm. The optimum depth for utilization was 21.3 cm while the preferred depth was 30.5 cm. The range of substrates utilized by rainbow trout fry was 1.0 to 4.0, with the optimum and preferred substrate at 1.0. Cover type 4 was the optimum for both utilization and preference while cover type 3 was not utilized.

Twenty-two rainbow trout redds were examined in April, 1987 (Appendix J, Table J.5). Rainbow trout spawners utilized velocities ranging from 15.2 to 82.3 cm/s with the optimum at 48.8 cm/s (Fig. 5.10). After adjusting for habitat availability, the preferred velocities were from 48.8 to 67.1 cm/s. Depths utilized by rainbow trout spawners ranged from 12.2 to 30.5 cm with the optimum at

21.3 cm. The preferred depth was also 21.3 cm. Utilized substrates ranged from 2.9 to 3.7 with the optimum and preferred substrate at 3.2.

5.6 HABITAT UTILIZATION AND PREFERENCE CRITERIA FOR DIFFERENT LIFE STAGES OF SCULPINS

The criteria developed for sculpins were essentially Piute sculpin curves, since about 94.1 percent of all sculpins in Chamokane Creek are Piute sculpins (Scholz *et al.* 1988). Habitat parameters were measured for 261 adult sculpins from April through August, 1986 (Appendix K, Table K.1). Adult sculpins utilized velocities from 0.0 to 149.4 cm/s with the optimum at 30.5 cm/s (Fig 5.11). They preferred velocities of 85.3 cm/s. Depths utilized by adult sculpins ranged from 9.1 to 94.5 cm. The optimum depth was 30.5 cm for utilization, with the preferred depth at 48.8 cm. Substrates utilized by adult sculpins ranged from 1.0 to 6.0 with the optimum at 4.0. The preferred substrate was 1.0. Adult sculpins utilized cover type 1 most frequently, but showed a preference for cover type 4.

Habitat measurements were made for 296 sub-adult sculpins from April through August, 1986 (Appendix K, Table K.2). Fig. 5.12 shows that sub-adult sculpins utilized velocities ranging from 0.0 to 91.4 cm/s, with an optimum of 21.3 cm/s. The preferred velocity was 67.1 cm/s. Utilized depths were from 6.1 to 88.4 cm. The optimum depth for utilization was 21.3 cm, while the preferred depth was 67.1 cm. Substrates utilized by sub-adult sculpins were from 1.0 to 5.0, with the optimum at 4.0. The preferred substrate was 1.0. The cover type most frequently utilized was 1, but the preferred cover type was 4.

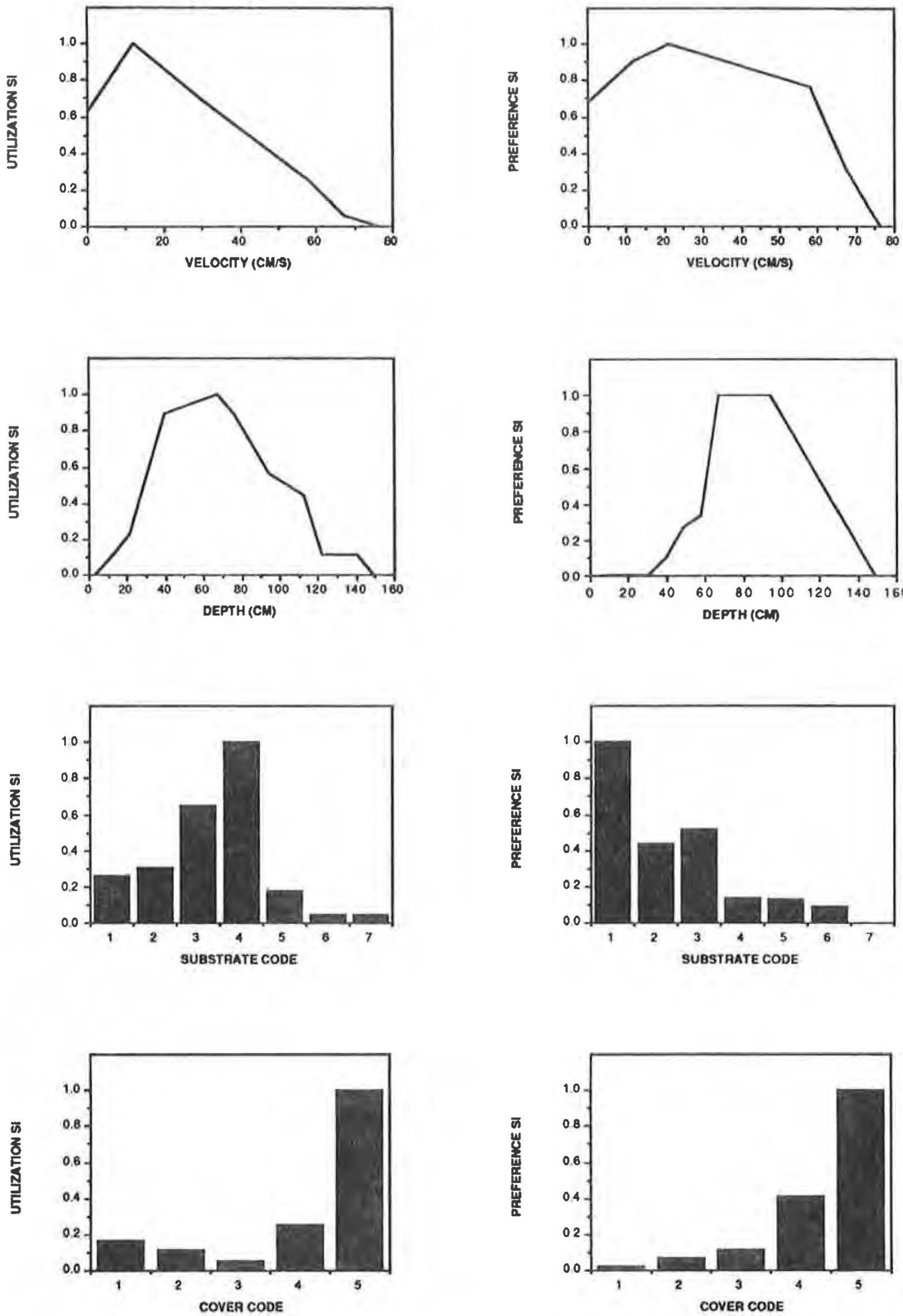


Figure 5.6. Utilization and preference suitability indices for rainbow trout adults. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

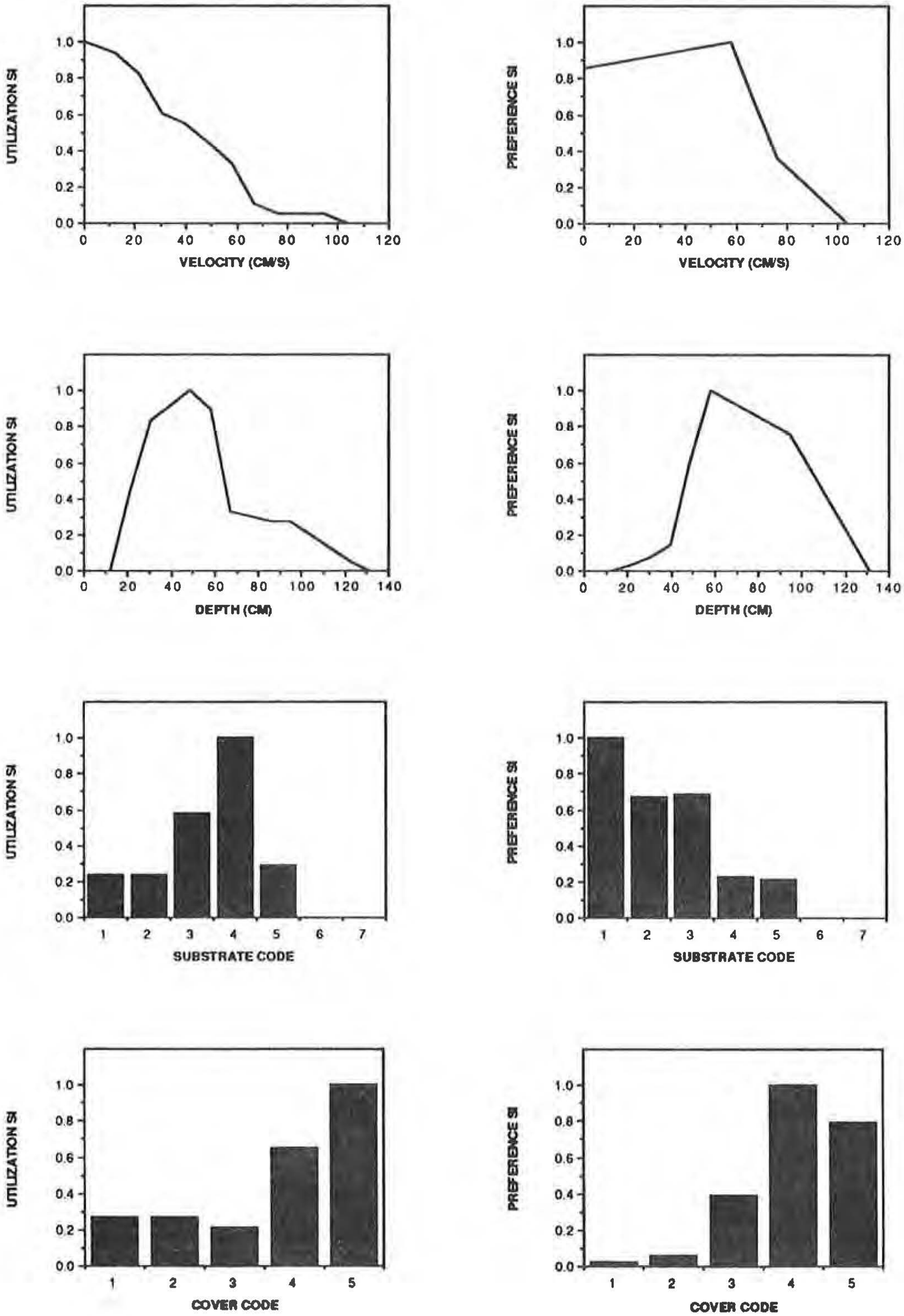


Figure 5.7. Utilization and preference suitability indices for rainbow trout juveniles. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

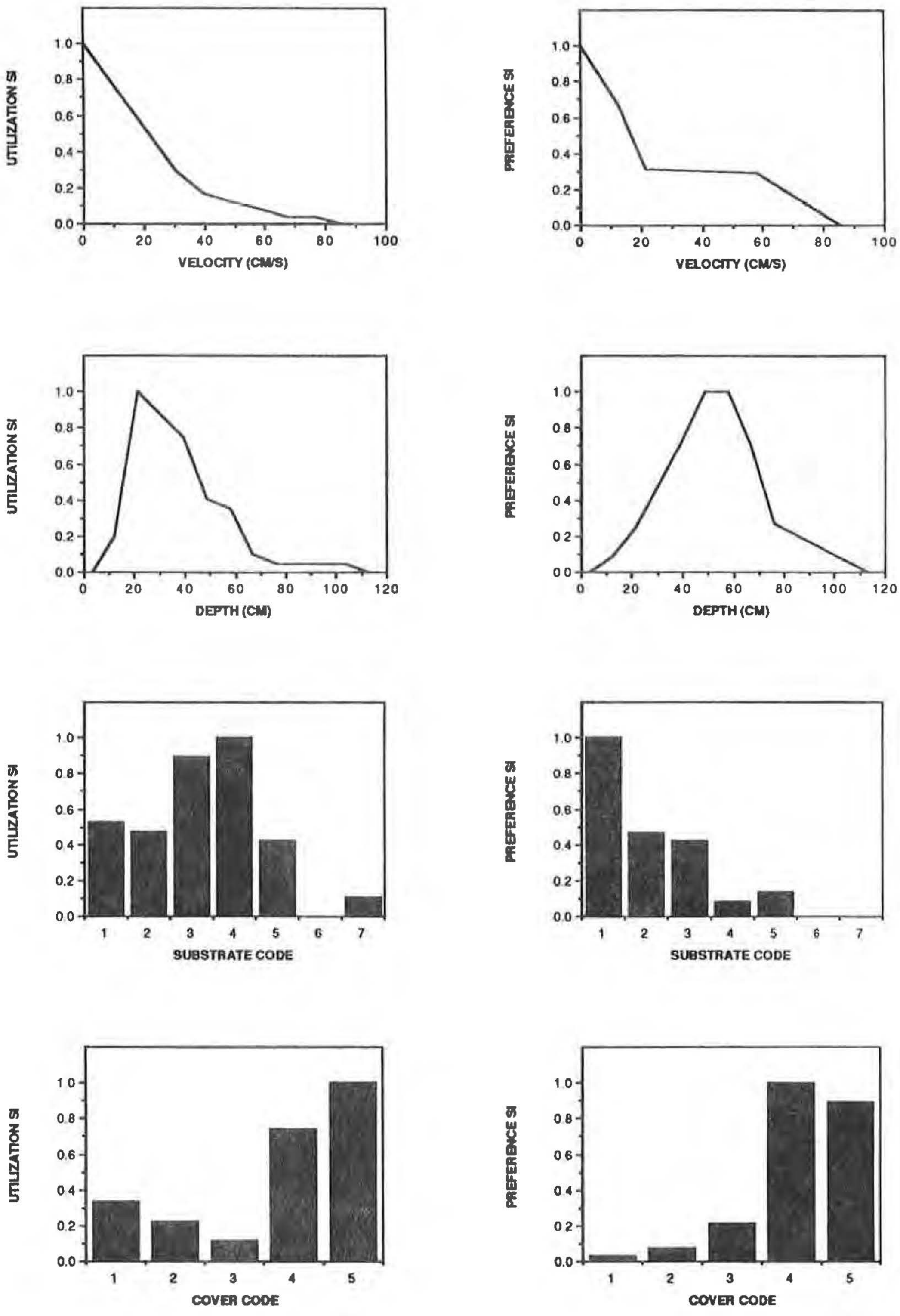


Figure 5.8. Utilization and preference suitability indices for rainbow trout young-of-the-year. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

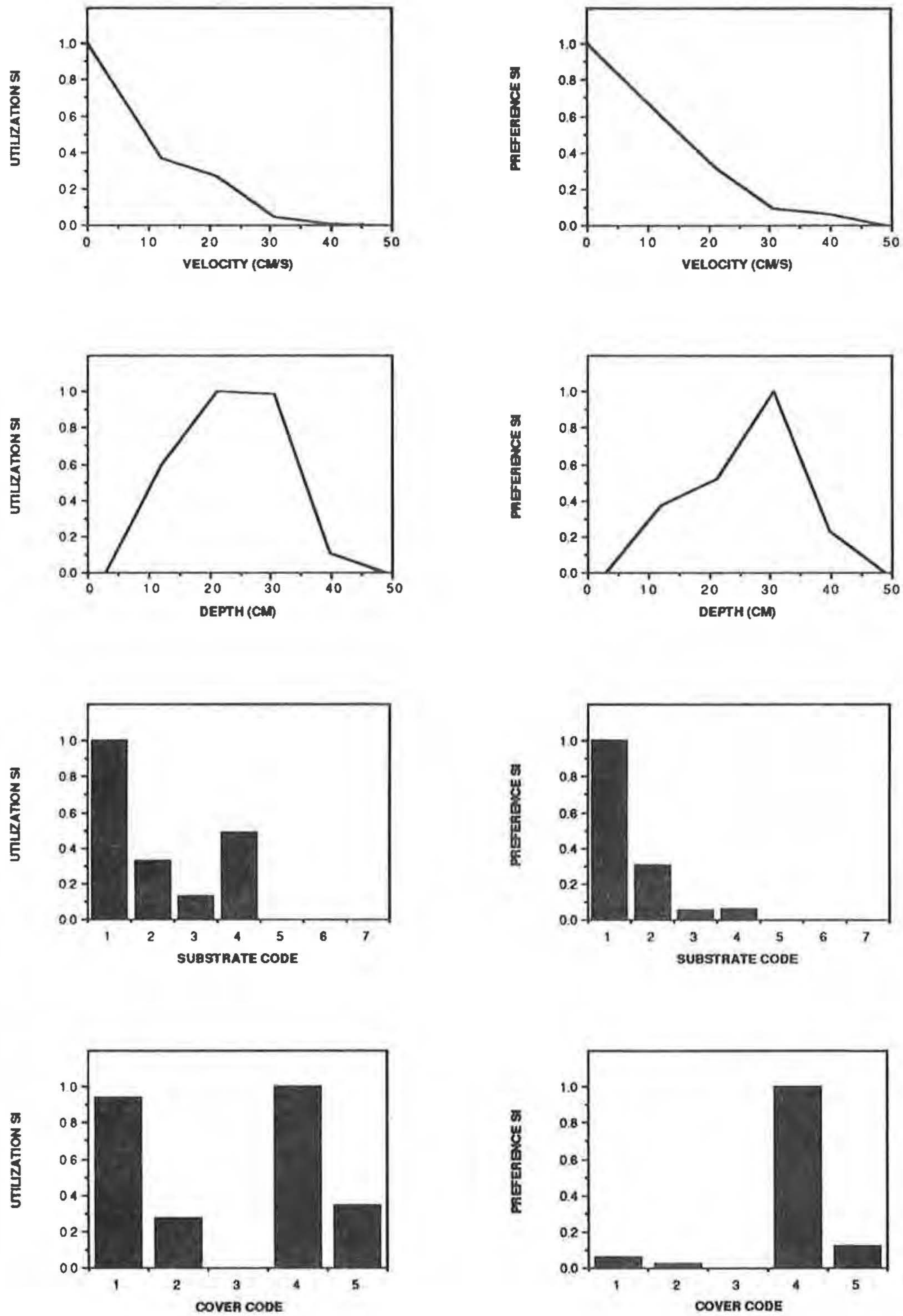


Figure 5.9. Utilization and preference suitability indices for rainbow trout fry. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

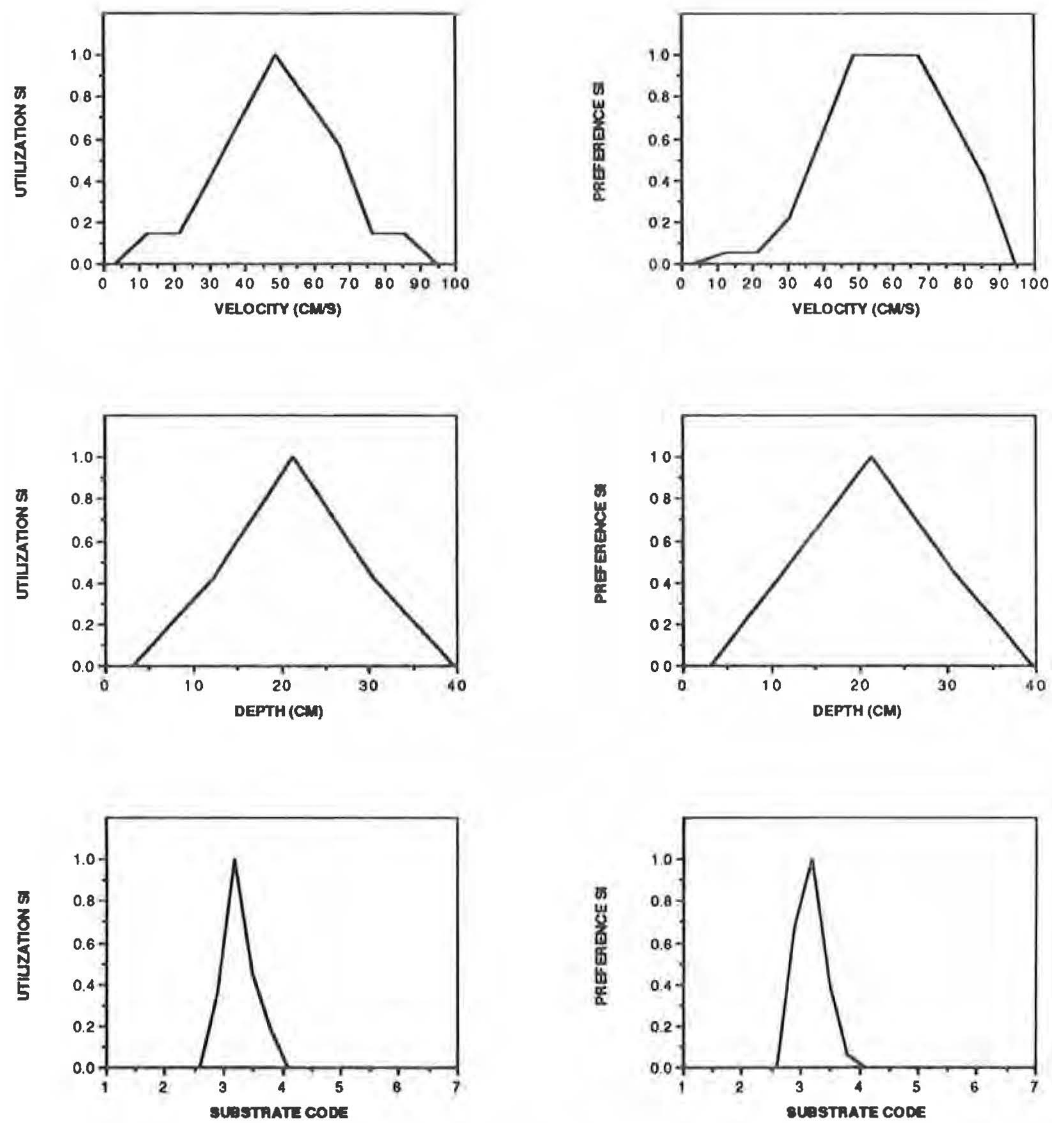


Figure 5.10. Utilization and preference suitability indices for rainbow trout spawning. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock.

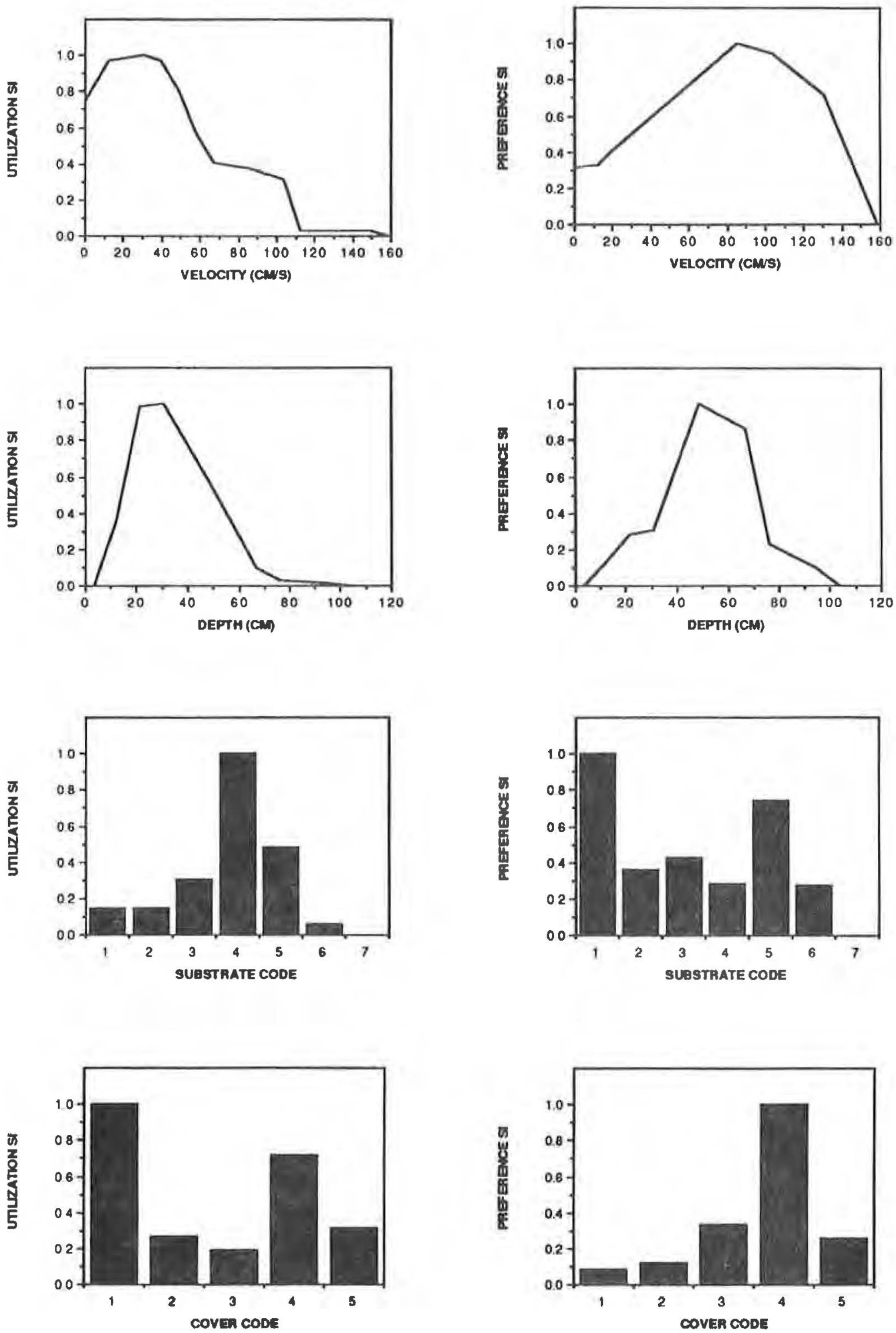


Figure 5.11. Utilization and preference suitability indices for sculpin adults. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

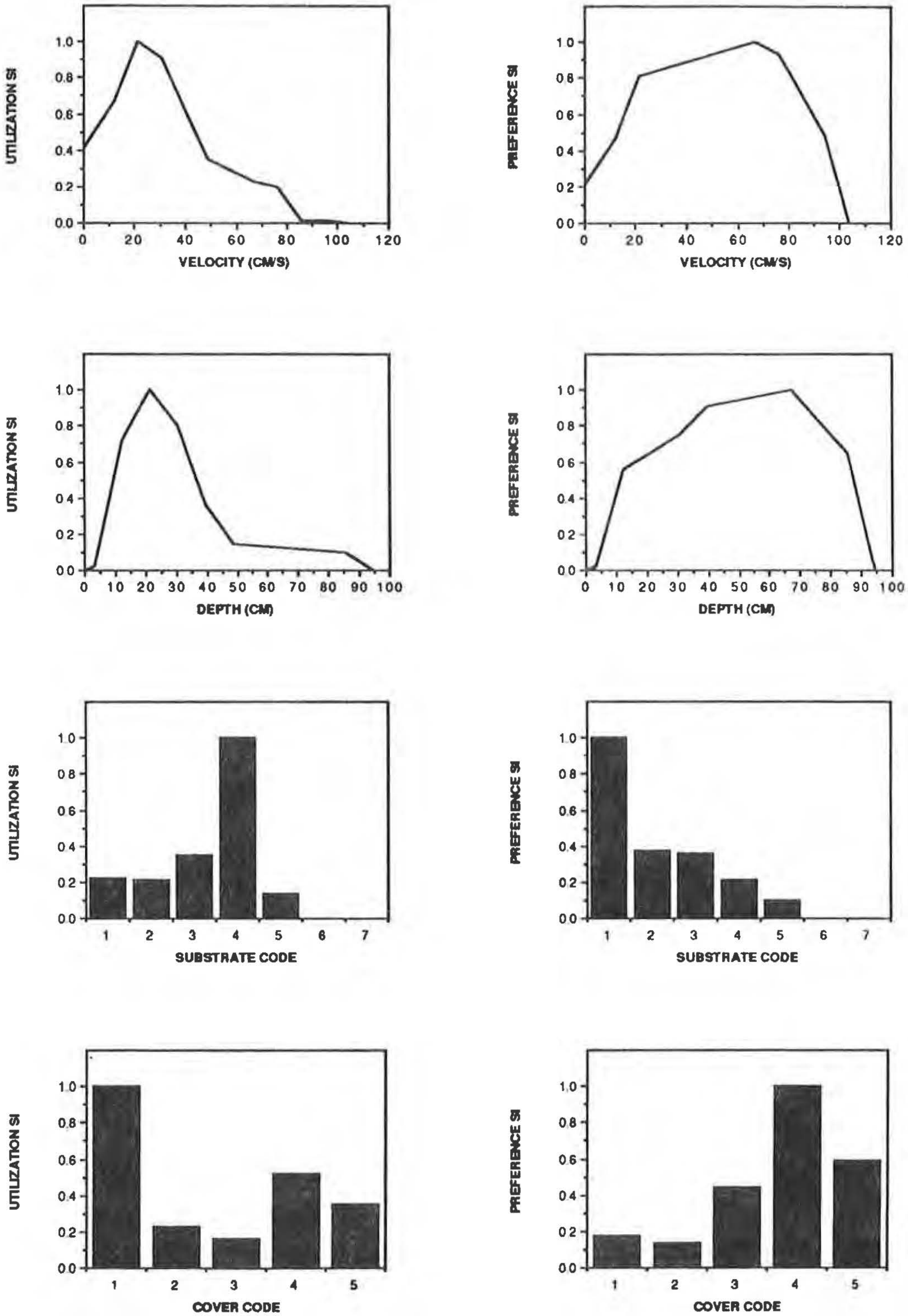


Figure 5.12. Utilization and preference suitability indices for sculpin sub-adults. Substrate codes 1 through 7 are silt, sand, gravel, small cobble, large cobble, boulder, and bedrock. Cover codes 1 through 5 are no cover, small object, large object, overhead, and combination.

5.7 COMPARISON OF CHAMOKANE CREEK BROWN TROUT AND RAINBOW TROUT UTILIZATION CRITERIA WITH THAT DEVELOPED BY OTHER RESEARCHERS

Comparison of preference criteria developed in this study with that of other studies was difficult since most of the criteria in the literature is utilization criteria. Some researchers refer to "preferred" habitat but do not define their usage (Raleigh *et al.* 1986), making it unclear if they are referring to preference criteria or simply the range of a habitat parameter utilized most frequently. Moyle and Baltz (1985) provided the only preference criteria, in the form of electivities. They calculated electivities for rainbow trout based upon the utilization and availability of habitat variables. These electivities indicate preference, no preference, or avoidance of each increment of each habitat variable.

The range and optimum of each habitat parameter measured for brown trout adults in Chamokane Creek generally agree with those of other studies (Table 5.1). Raleigh *et al.* (1986) and Bovee (1978) put the range of velocities utilized by brown trout at 0.0 to 182.9 cm/s. This range is considerably higher than found in this study. However, this difference is not as great as it may appear, since Raleigh *et al.* (1986) assigned a weighting factor of just 0.03 to velocities over 91.4 cm/s. These velocities are only used when object cover is available to act as a velocity break, as is shown in their curve for fish nose velocity, which goes to zero at 73.2 cm/s. In Chamokane Creek, when an object is large enough to provide a velocity break for an adult brown trout, it reduces the mean column velocity, since the stream is small and areas of high velocity are relatively shallow. In larger rivers, where much of the data was collected for the curves of Raleigh *et al.* (1986), an object may provide velocity cover, but not reduce mean column velocity significantly. Additionally, the highest velocity available in Chamokane Creek during the collection of adult brown trout habitat data was 128 cm/s.

Cover criteria were not readily available in the literature even though cover is regarded as an important feature of trout habitat. Cover is sought by adult brown trout more than by any other trout species (Raleigh *et al.* 1986). Devore and White (1978) found 81-83 percent of the brown trout in their experiment were under cover. Lewis (1969) found cover to be the most important factor for brown trout utilization of pools, and Butler and Hawthorne (1968) found that brown trout utilization of shade was higher than that of rainbow trout and brook trout. Wesche (1980) recognized the importance of cover to brown trout and Wesche *et al.* (1987) found that their cover variable, which combined overhead and deep water cover, was a significant predictor of brown trout standing stock. Raleigh *et al.* (1986) assigned a weighting factor of one to areas containing 35 percent or more cover. In this study, cover was categorized by type, and adult brown trout stongly preferred a combination of object and overhead cover, and 90 percent utilized some type of cover. Brown trout juveniles, YOY, and fry were associated with cover 94, 88, and 40 percent of the time, respectively.

The ranges and optima of habitat utilization criteria for juvenile brown trout were similar to those from other studies (Table 5.2). The size ranges utilized to construct brown trout fry criteria by Bovee (1978), Sando (1981), and Raleigh *et al.* (1986) and the juvenile curves of Moyle *et al.* (1983) were more comparable to the size ranges utilized to construct YOY criteria in the present study, and were utilized for comparison as such. Table 5.3 shows the ranges and optima are comparable between studies.

Brown trout fry criteria of the size range used in this study were not available in the literature. However, Sando (1981) did develop criteria for fry 25 to 47 mm in length, which he could not positively identify, but believed to be mostly brown trout. Ninety percent were found at velocities of 0.0 to 9.0 cm/s, depths of 6.0-27.0 cm, and substrates consisting of sand and smaller particle sizes, with optimum values of 0.0 to 2.0 cm/s, 10.0 cm, and silt-

Table 5.1. Velocities, depths, and substrates utilized by brown trout adults.

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	0.0-182.9	0.0-24.4	Bovee (1978)
	0.0-89.9[1]	0.0-9.9[1]	Moyle *et al.* (1983)
	0.0-65.0	26.7[2]	Shirvell & Dungey(1983)
	0.0-182.9[3]	15.2	Raleigh *et al.* (1986)
	0.0-70.1	0.0-21.3	Present study
Depth (cm)	>21.3	>73.0	Bovee (1978)
	10.0-79.9[1]	30.0-39.9[1]	Moyle *et al.* (1983)
	14.0-122.0	65.0[2]	Shirvell & Dungey(1983)
	>0.0	79.2	Raleigh *et al.* (1986)
	18.3-137.2	67.1	Present study
Substrate		sand-cobble	Bovee (1978)
		gravel[1]	Moyle *et al.* (1983)
		detritus-sand	Raleigh *et al.* (1986)
		small cobble	Present study

[1]Includes all fish > 120 mm SL.

[2]Mean (while feeding).

[3]Velocities over 91.4 cm/s assigned a weighting factor of 0.03.

Table 5.2. Velocities, depths, and substrates utitized by juvenile brown trout.

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	0.0-100.0	0.0-12.2	Bovee (1978)
	0.0-131.0	15.2	Raleigh *et al.* (1986)
	0.0-109.7	12.2	Present study
Depth (cm)	0.0-182.9	21.0-85.3	Bovee (1978)
	>0.0	91.4	Raleigh *et al.* (1986)
	9.1-115.8	48.8	Present study
Substrate		cobble	Bovee (1978)
		gravel-cobble	Raleigh *et al.* (1986)
		small cobble	Present study

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	0.0-91.4	0.0-36.3	Bovee (1978)
	3.0-19.0[1]	8.0-11.0	Sando (1981)
	0.0-129.0	20.0-29.9	Moyle *et al.* (1983)
	0.0-88.4	18.3	Raleigh *et al.* (1986)
	0.0-103.6	0.0	Present study
Depth (cm)	0.0-152.4	24.4-54.9	Bovee (1978)
	7.0-31.0[1]	14.5-17.5	Sando (1981)
	10.0-69.0	30.0-39.9	Moyle *et al.* (1983)
	0.0-140.2	39.9-49.1	Raleigh *et al.* (1986)
	9.1-88.4	39.6	Present study
Substrate		sand-gravel	Bovee (1978)
		silt-sand	Sando (1981)
		gravel	Moyle *et al.* (1983)
		gravel	Raleigh *et al.* (1986)
		silt-sand	Present study

[1]Middle 90 percent

Table 5.3. Velocities, depths, and substrates utilized by young-of-the-year brown trout.

sand for velocity, depth, and substrate respectively (Sando 1981). These values were all lower than those found in Chamokane Creek for brown trout fry.

Brown trout spawning and egg incubation criteria developed in this study were similar to those developed in other studies (Table 5.4). Brown trout usually spawned at the tails of pools and 90 percent (126 out of 140) were not associated with cover. Raleigh *et al.* (1986) found no evidence in the literature of cover being a requirement for spawning; however, Witzel and MacCrimmon (1983) found 84 percent of brown trout redds within 1.5 m of cover. Distance to cover was not measured in this study, although escape cover was usually available in the pools adjacent to spawning sites.

Table 5.5 shows that rainbow trout adults in Chamokane Creek utilize slower water than was found in other streams. Depths utilized were not comparable due to large differences in depth availability. Substrates utilized were generally found to be in the cobble size range.

Moyle and Baltz (1985) calculated electivities for rainbow trout adults ($\geq$ 120 mm SL) which approximated the size ranges used for juveniles and adults in this study. They found no preference or a moderate preference for velocities in the range of 10 to 90 cm/s, with a strong avoidance for all other velocities. In this study, it was found that adults showed the greatest preference for velocities of 21.3 cm/s, while juveniles preferred a velocity of 57.9 cm/s. Moyle and Baltz (1985) found that depths greater than 70 cm were generally preferred, as were substrates made up primarily of cobble. In this study, depths of 67.1 to 121.9 cm were preferred by rainbow trout adults and a depth of 57.7 cm was preferred by juveniles. Substrates preferred in this study were silt by both adults and juveniles. The differences in substrate perferences can be explained by the differences in the availability of substrates in the two streams. Rainbow trout were primarily found in the high gradient (2.0 to 2.7 percent) sections of Deer Creek, CA where silt substrates

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	15.2-97.5	42.6-57.9	Bovee (1978)
	35.0-95.0[1]	70.0-73.0	Sando (1981)
	28.0-63.0[1]	46.0-51.0	Sando (1981)
	15.0-75.0	39.4[2]	Shirvell & Dungey(1983)
	10.8-80.2	46.5[2]	Witzel & MacCrimmon (1983)
	9.1-118.9	21.3-51.8	Raleigh *et al.* (1986)
	18.3-97.5	45.7	Present study
Depth (cm)	9.1-94.5	21.3-27.4	Bovee (1978)
	17.0-46.0[1]	27.0-29.0	Sando (1981)
	17.0-34.0[1]	23.0-24.0	Sando (1981)
	6.0-82.0	31.0[2]	Shirvell & Dungey(1983)
	7.0-58.0	25.5[2]	Witzel & MacCrimmon (1983)
	>6.0	>24.4	Raleigh *et al.* (1986)
	9.1-42.7	18.3	Present study
Substrate		gravel	Bovee (1978)
		gravel-pebble	Sando (1981)
		gravel	Raleigh *et al.* (1986)
		gravel-small cobble	Present study

[1]Middle 90 percent

[2]Mean

Table 5.4. Velocities, depths, and substrates associated with brown trout redds.

were not available and the pools primarily contained bedrock substrate (Moyle and Baltz 1985). In Chamokane Creek, the gradient was lower (<1 percent) and pools generally contained silt and sand substrates.

Cover criteria were not found in the literature for rainbow trout. Raleigh *et al.* (1984) assumed that substrate met the cover requirement for all life stages of rainbow trout. Butler and Hawthorne (1968) found mature rainbow trout utilized overhead cover 36.2 percent of the time. Lewis (1969) found cover did not significantly contribute to the variance of rainbow trout numbers in pools. Campbell and Neuner (1985) found 94, 78, and 44 percent of rainbow trout >101 mm utilized velocity, visual, and shade cover respectively, while 100, 94, and 81 percent of fry utilized velocity, visual, and shade cover respectively. Stewart (1970) found that object and overhead cover was important in determining rainbow trout (>18 cm) density in a Colorado stream. Boussu (1954) was able to increase the number and weight of trout (primarily rainbow and brook trout) by adding brush cover, and reduce numbers and weight by removing cover. MacCrimmon and Kwain (1966) found rainbow trout yearlings showed a significant preference for overhead cover at low, intermediate, and high light intensities. In the present study, rainbow trout adults most frequently utilized and preferred combination cover, and 89 percent utilized some type of cover. Rainbow trout juveniles, YOY, and fry were associated with cover 89, 86, and 63 percent of the time, respectively.

The rainbow trout adult curves provided by Raleigh *et al.* (1984) applied to fish 127 to 229 mm. This range is close to the juveniles in the present study and was used as such to compare criteria. Chamokane Creek juveniles, like the adults, utilized slower water than in other streams, but depth and substrate utilization was comparable (Table 5.6). Rainbow trout juveniles most frequently utilized combination cover and preferred overhead cover. Eighty-nine percent utilized either object and/or overhead cover.

Table 5.5. Velocities, depths, and substrates utilized by rainbow trout adults.

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	3.0-115.8	18.3-42.7	Bovee (1978)
	0.0-106.7	15.2-61.0	Raleigh *et al.* (1984)
	0.0-97.5	0.0	Present study
Depth (cm)	>12.2	27.4-30.5	Bovee (1978)
	>0.0	>45.7	Raleigh *et al.* (1984)
	21.3-121.9	33.5-61.0	Present study
Substrate		gravel	Bovee (1978)
		cobble-boulder	Raleigh *et al.* (1986)
		small cobble	Present study

Table 5.6. Velocities, depths, and substrates utilized by rainbow trout juveniles.

PARAMENTER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	0.0-88.4	36.6-42.7	Bovee (1978)
		17.0-62.0[1]	Gosse (1982)
	0.0->105.0[2]	0.0-15.0[2]	Moyle *et al.* (1983)
	0.0-64.0	12.2	Present study
Depth (cm)	>0.0	>48.8	Bovee (1978)
		>354.0[1]	Gosse (1982)
	0.0->275.0[2]	75.0[2]	Moyle *et al.* (1983)
	15.2-140.2	67.1	Present study
Substrate		cobble	Bovee (1978)
		silt-rock(>30 cm)	Gosse (1982)
		boulder[2]	Moyle *et al.* (1983)
		small cobble	Present study

[1]Range of means for different seasons, flows, and activities of fish.

[2]Includes all fish >120 mm standard length.

Raleigh *et al.* (1984), constructed habitat suitability criteria for rainbow trout juveniles from data collected on individuals 51-120 mm. This size range was more accurately applied to the YOY life stage in Chamokane Creek. Additionally, information provided in Moyle and Baltz (1985) and Campbell and Neuner (1985) for juveniles also applied to the YOY life stage. Rainbow trout YOY in Chamokane Creek utilize a narrower range of velocities and shallower depths than those found in other studies (Table 5.7). Moyle and Baltz (1985) found that rainbow trout, 51 to 119 mm SL, showed a moderate preference for a velocity of 10 cm/s, showed no preference or avoidance for depths under 50 cm, and preferred silt/sand and boulder/bedrock substrates. In Chamokane Creek, rainbow trout YOY preferred a velocity of 0.0 cm/s, depth of 21.3 cm, and a substrate composed primarily of silt.

Table 5.8 shows that there was a wide range of velocities, depths, and substrates utilized by rainbow trout fry in different streams. The optima, however, were comparable. The electivities of Moyle and Baltz (1985) showed that rainbow trout fry (≤ 50 mm SL) strongly preferred velocities of 0.0 cm/s, moderately preferred depths of 20.0-40.0 cm, and strongly preferred substrates of sand, sand/gravel, and boulder/bedrock. These compared favorably with the preferences found in this study.

The range and optimum of each habitat parameter utilized by rainbow trout spawners were comparable to those found in other studies (Table 5.9). Tautz and Groot (1975) reported that rainbow trout selected areas of accelerating velocity and upwelling. In this study, rainbow trout redds were frequently located at the tail of pools/head of riffles where accelerating velocities occur. However, percolation occurs in these areas. The areas selected for spawning in Chamokane Creek generally agree with the observations of McAffee (1966).

No habitat suitability indices were found for Piute sculpins. Piute sculpins generally inhabit the rocky riffle sections of

Table 5.7. Velocities, depths, and substrates utilized by rainbow trout young-of-the-year.

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	0.0->105.0	15.0	Moyle et al. (1983)
	0.0-106.7	0.0	Raleigh et al. (1984)
	0.0-165.5	12.2	Campbell and Neuner (1985)
		10.0	Moyle & Baltz (1985)
	0.0-73.2	0.0	Present study
Depth (cm)	0.0-250.0	50.0	Moyle et al. (1983)
	>0.0	>61.0	Raleigh et al. (1984)
	18.3-170.7	61.0	Campbell & Neuner (1985)
		50.0	Moyle & Baltz (1985)
	15.2-106.7	21.3	Present study
Substrate		boulder	Moyle et al. (1983)
		boulder	Raleigh et al. (1984)
		sand	Campbell and Neuner (1985)
		cobble-boulder	Moyle & Baltz (1985)
		small cobble	Present study

Table 5.8. Velocities depths, and substrates utilized by rainbow trout fry.

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	0.0-79.2	12.2-18.3	Bovee (1978)
	1.0-17.0[1]	9.0-14.0	Sando (1981)
	0.0-90.0	0.0	Moyle *et al.* (1983)
	0.0-89.9	0.0	Raleigh *et al.* (1984)
	0.0-70.1	6.1	Campbell & Neuner (1985)
		0.0	Moyle & Baltz (1985)
	0.0-33.5	0.0	Present study
Depth (cm)	≥6.1	30.5	Bovee (1978)
	9.0-37.0[1]	12.0-20.0	Sando (1981)
	0.0-225.0	25.0	Moyle *et al.* (1983)
	0.0-249.9	25.0-50.0	Raleigh *et al.* (1984)
	6.1-134.1	27.4	Campbell & Neuner (1985)
		30.0	Moyle & Baltz (1985)
	9.1-36.6	27.4	Present study
Substrate		gravel	Bovee (1978)
		fines	Sando (1981)
		cobble	Moyle *et al.* (1983)
		cobble-boulder	Raleigh *et al.* (1984)
		boulder-sand	Campbell & Neuner (1985)
		cobble-boulder	Moyle & Baltz (1985)
		small cobble-silt	Present study

[1]Middle 90 percent

Table 5.9. Velocities, depths, and substrates utilized by rainbow trout for spawning

PARAMETER	RANGE	OPTIMUM	SOURCE
Velocity (cm/s)	48.8-90.9	69.8[1]	Smith (1973)
	15.2-97.5	42.7-57.9	Bovee (1978)
	40.0-8330[2]	73.0-74.0	Sando (1981)
	42.0-65.0[2]	48.0-51.0	Sando (1981)
	27.4-94.5	48.8-91.4	Raleigh *et al.* (1984)
	15.2-82.3	33.5-70.1	Present study
Depth (cm)	>18.3	34.2[1]	Smith (1973)
	9.1-97.5	21.3-27.4	Bovee (1978)
	23.0-43.0[2]	20.0-21.0	Sando (1981)
	24.0-34.0[2]	22.0-26.0	Sando (1981)
	18.3-253.0	21.3-249.9	Raleigh *et al.* (1984)
	12.2-30-5	15.2-27.4	Present study
Substrate		gravel	Bovee (1978)
		gravel-pebble	Sando (1981)
		gravel-small cobble	Present study

[1]Mean

[2]Middle 90 percent

streams, although they are sometimes found in lakes (Moyle 1976, Wydoski and Whitney 1979). In Chamokane Creek most were found in the cobble in riffles. However, it was not uncommon to capture them in pools.

6.0 HABITAT SIMULATION USING THE PHABSIM SYSTEM

6.1 BACKGROUND

The Physical Habitat Simulation System (PHABSIM) (Milhous *et al.* 1984) utilized the microhabitat data (see Section 4) and the preference suitability indices (see Section 5) to calculate the Weighted Usable Area (WUA) for each life stage of each evaluation organism at incremental streamflows.

The WUA for a cell was determined by calculating the composite suitability of three habitat variables (i.e. velocity, depth and substrate or cover) and multiplying by the area of the cell. The total WUA was calculated by summing the WUA for each cell within a stream reach as follows:

$$WUA = \sum_{i=1}^{n} A_i C_i,$$

Where:

- n = the number of habitat combinations in the reach simulation;
- A_i = the surface area of cell *i*; and
- C_i = composite suitability value for cell i as calculated by:

$$C_i = f_V(V_i) \times f_D(D_i) \times f_S(S_i),$$

Where:

- $f_V(V_i)$ = suitability weighting factor for the velocity in cell *i*;
- $f_D(D_i)$ = suitability weighting factor for the depth in cell *i*; and
- $f_S(S_i)$ = suitability weighting factor for the substrate type in cell *i*.

Since only three habitat variables can be used in the calculation of WUA, cover may be substituted for substrate in the calculations.

The use of WUA for determining instream flow regimes and impact analysis relies upon the validity of the assumption that there is a positive relationship between WUA and the standing stock of the evaluation organisms. The relationship between trout standing stock and physical habitat has been demonstrated in numerous studies (Gunderson 1966, Lewis 1969, Stewart 1970, Burns 1971, Wesche 1974 and 1980, Nickelson 1976, White *et al.* 1976, Nickelson and Hafile 1978, Binns and Eiserman 1979, Lanka *et al.* 1987, Wesche *et al.* 1987). A significant positive relationship between WUA and brown trout standing stock was demonstrated by Stalnaker (1979) in Wyoming streams, by Nehring (1979) in Colorado streams, and by Loar *et al.* (1985) in Tennessee and North Carolina streams. Conder and Annear (1987) found no significant relationship in WUA and trout standing crop in 16 Wyoming streams. Their results, and the results of Bowlby and Roff (1986) point out the importance of looking at factors other than physical habitat that may limit trout standing stocks. Several companion studies were conducted along with this IFIM study to determine if trout stocks are limited by water quality or food availability. (see section 6.3 for further details).

Once the WUA's were calculated for each life stage, it was useful in the final analysis to know at which life stage habitat was limiting. For example, there may be 1000 m^2 of adult habitat and 1000 m^2 of juvenile habitat available at a given flow, but if adults require twice as much habitat as juveniles, then adult habitat is limiting. Bovee (1982) recommended using habitat ratios to determine the limited life stage. For this study, the mean biomass was estimated for each life stage to determine these ratios. This method assumes that a fish requires more habitat as it grows. Allen (1969) found that for brown trout, rainbow trout, and other species of salmonids, the mean area of stream bed per fish is proportional to the weight of the fish.

6.2. MODEL CALIBRATION AND FLOW SIMULATIONS

The microhabitat data and preference suitability curves were placed in data files for use by PHABSIM in the computation of microhabitat availability. The hydraulic models (IFG4) for each segment were calibrated by simulating the discharges at which the microhabitat availability measurements were made (Milhous *et al.* 1984). The quality of the calibrations was determined by the Velocity Adjustment Factory (VAF) (Appendix L) and the Velocity Prediction Error (VPE) (Appendix M). The VAF was the adjustment made to each cell velocity on a transect to make the calculated discharge equal the measured discharge. The VPE is the difference between the measured velocity at a cell and the predicted velocity. Milhous *et al.* (1984) recommended that the VAF should be between 0.9 and 1.1, while 90 percent of the values have a VPE of less than 0.15 for a good calibration. Only one transect did not meet the above criteria for the low flow. However, it did meet the criteria at the high flow measurement.

Microhabitat availability was computed for each life stage of each evaluation species from 15 to 150 CFS. This range encompassed a flow below the minimum flow ever recorded at the USGS gaging station to the 50 percent exceedence flow for the highest flow month. Bovee (1982) recommended computing microhabitat availability over a range including, at least, the 90 percent exceedence flow for the lowest flow month, to the 50 percent exceedence flow for the highest flow month. This range of flows also fell within the recommended range of flows to be simulated (0.4 of the minimum calibration flow and 2.5 times the maximum calibration flow). Milhous *et al.* (1984) recommended that the VAF's for simulated flows should be in the 0.85 to 1.15 range, 75% of the transects met this criteria over the 15 to 150 CFS range, while 93% met this criteria for the 20 to 100 CFS range. The VAF's for simulated flows can be founded in Appendix N.

The output from the HABTAT program gave the weighted usable area (WUA) per 1000 ft of stream per study reach. This output was converted to WUA per segment and the segments summed to get WUA for the stream at each flow for each evaluation species. WUA was converted to meters squared, but the discharge was left in the English units of CFS since this is a universally understood and recognized unit and is generally used in hydrology.

Simulations were also run for the 50 percent exceedence flows for each month at the present flow regime. Simulations were then run for the flow regime which would result if the DOE calculated impact was correct. The DOE calculated the impact of the withdrawals at 3.83 CFS. This impact was assumed to affect the springs and seeps in proportion to their relative flow, so the impact at segments 3, 4, and 5 were calculated by multiplying 3.83 times the conversion factor (see section 4) calculated for the spring flow in each segment. The weighted usable areas for each life stage were then compared for each month to determine the impact that the reduced flow would have.

Simulations were run for each life stage of each evaluation species using the habitat parameters of velocity, depth, and substrate. A second set of simulations were run substituting cover for substrate for all life stages except the spawning/egg incubation life stage. Simulations with cover were not made for the spawning/egg incubation life stage since neither brown trout or rainbow trout spawners utilized cover very frequently, and substrate was obviously critical at this life stage.

In order to determine the life stage of brown trout and rainbow trout for which habitat was limiting, the mean biomass of each life stage was calculated. Population information was obtained from Scholz *et al.* (1988) for the YOY through adult life stages. The fry populations and number of eggs required to produce that number of fry were estimated based upon the emergent fry to YOY and egg to emergent fry survival rates from other studies. Mortensen (1977a, 1977b) reported survival rates ranging form 0.23 to 0.33 for brown trout fry for the first 90 days after emergence and a survival rate of 0.09 for the first year. Le Cren (1961) reported a survival rate of 0.027 for brown trout during their first year. Since the survival rates during the fry life stage are generally low and variable from population to population due to the density dependent nature of the mortality, a value of 0.15 was used as the survival rate for brown trout emergent fry to YOY life stage. This value should provide a margin of error on the side of overestimating the number of brown trout fry required to maintain the present population level since in this study they are only considered fry for the first two months after emergence.

Survival rates for rainbow trout fry were not found; however, information was available for steelhead trout. Fraser (1969) calculated annual survival rates for steelhead fry ranging from 0.014 to 0.95 depending upon the density of the fry. Tom Johnson (WDW, Anadromous Game Fish Investigations, Port Townsend, WA., personal communication) has calculated the mean survival of steelhead from emergent fry to smolt (usually 2+) at 0.083, and the mean survival from 1+ to smolt was 0.254. From these figures it can be calculated the annual survival rate of emergent fry to 1+ is 0.33. Based upon these annual survival rates, a survival rate for rainbow trout fry of 0.30 should underestimate survival for the short time they were considered fry in this study.

Survival rates for the egg to emergent fry were then used to determine how many eggs would be required to produce the number of fry estimated above. Mortensen (1977a) had a mean survival rate of brown trout eggs to emergence of 0.79 in Vilbert Boxes and Le Cren (1961) reported an embryo survival rate of 0.94 for brown trout. Berg (1986) had an embryo survival rate of 0.88 from eyed eggs to sac fry in his control site on the Clark Fork River, Montana. An embryo survival rate of 0.75 was used in the calculations. This should provide a margin of error on the side of overestimating the number of eggs needed.

Johnson (personal communication) found the mean embryo survival rate for steelhead trout in Snow Creek, WA was 0.20 with a range of 0.16 to 0.30 over ten years. Coble (1961) measured steelhead survival rates ranging from 0.16 to 0.62 in Oregon streams. Sowden and Power (1985) sampled 19 rainbow trout redds in an Ontario stream and found a mean embryo survival rate of 0.076 with a range of 0.0 to 0.43. MacCrimmon and Gordon (1981) estimated that the rainbow trout embryo survival rate in Normandale Creek, Ontario was 0.23. A value of 0.15 was used in this study to calculate habitat ratios.

The mean biomass for each life stage was then calculated by multiplying the estimated population for each age class times the mean weights obtained from Uehara *et al.* (1988). The spawning area required to produce the required number of eggs was then estimated by assuming that the average female brown trout contains 1500 eggs and the average female rainbow trout contains 1000 eggs. These were extremely conservative estimates based on the information in Carlander (1969). One female brown trout from Chamokane Creek was found to contain 4031 eggs. However, this was a larger-than-average female at 615 mm. The average fecundity values were then divided into the number of eggs needed, to yield a value representing the number of female spawners required. This number was then multiplied times the area utilized by brown trout and rainbow trout spawners, to obtain the spawning area required to maintain the population at its present level. The area required by spawners was obtained from Reiser and Wesche (1977) for brown trout and Hunter (1973) for rainbow trout. Reiser and Wesche (1977) found the average area of a brown trout redd to be 0.5 m^2. Hunter (1973) found the mean area of rainbow trout redds to be 0.23 m^2 for 300-350 mm fish. Since Chamokane Creek rainbows tend to be larger than this range, 0.3 m^2 was used. Assuming each female constructs four redds (2-4 is typical), brown trout require 2.0 m^2 and rainbows 1.2 m^2 of suitable spawning habitat.

Habitat ratios were computed by dividing the adult biomass into the biomass for each life stage. Before this step was accomplished, a 25 percent safety factor was applied to each life stage (Bovee 1982). This safety factor was intended to ensure that enough subadult habitat was available. This yielded a conversion factor that was used to compute the amount of habitat required for each of the life stages based upon the amount of adult habitat. Since the ratio of spawning habitat to adult habitat could not be determined using biomass, it was calculated by dividing the minimum amount of adult habitat that occurs during the year under the present flow regime into the spawning area required to maintain the present population, plus a 25 percent safety factor. The adult WUA's calculated using the habitat variable substrate were used for both brown trout and rainbow trout since these values were lower than the WUA's calculated using cover. This was done to ensure that the required spawning habitat was not underestimated in relation to adult habitat. The adult WUA's were minimized at 20 CFS, which is the minimum flow that could be expected to occur during a year.

6.3. OPTIMUM FLOWS FOR FISH HABITAT

The optimum flow represents the flow in Chamokane Creek when the greatest area of the stream has the hydraulic and structural characteristics preferred by a particular life stage of an evaluation species. These flows are not the recommended minimum flows, however, since they may be flows that have never occurred in Chamokane Creek during some months and are, therefore, not attainable. Additionally, a flow may maximize habitat availability for one life stage but reduce habitat availability for another. For example, one flow may optimize juvenile habitat, but reduce fry habitat to a level where there are not enough fry to produce enough juveniles to fill the habitat. The life stage at which habitat is limited must be taken into consideration when determining the flow to be recommended as the minimum flow.

Figs. 6.1 and 6.2 and Table 6.1 show the relationship of stream discharge and WUA and also clearly demonstrate two of the problems associated with determining the optimum flow for habitat: 1) which life stage is limiting at each flow, and 2) which simulation, using substrate or cover, more precisely demonstrates the relationship between discharge and habitat? The calculation of habitat ratios for brown trout and rainbow trout (Tables 6.2 and 6.3) eliminated the first problem. Based upon these calculations, the ratio of brown trout fry to adult habitat was 0.05:1.0; for YOY to adult, 0.11:1.0; for juvenile to adult, 1.16:1.0; and spawning to adult, 0.3:1.0. The habitat ratio for rainbow trout fry to adult was 0.07:1.0; YOY to adult, 0.18:1.0; juvenile to adult, 0.88:1.0; and spawning to adult, 0.3:1.0.

Applying the habitat ratios, it can be seen that brown trout adult habitat was limiting over the entire range of flows as calculated with either substrate or cover as the third habitat variable. For brown trout, habitat was optimized at flows of 150 CFS or above when computed with substrate, and at flows of 80 CFS when computed with cover. Rainbow trout adult habitat was limiting at all flows simulated. Therefore, rainbow trout habitat was optimized at discharges of 150 CFS or greater if substrates were used in the calculations, or at 70 CFS if cover was used.

Information on the space requirements of sculpins was not available in the literature. It is reasonable to assume that the same type of size-space relationship exists in sculpins as it does in trout. If this is the case, then sculpin adult habitat is limiting at least to 100 CFS as computed with substrate, and at all flows simulated with cover.

The second problem - which simulation was the most accurate at calculating WUA - must now be discussed. As pointed out in section 4, cover is recognized as an important component of salmonid habitat. In this study, all life stages of salmonids except brown trout fry and spawners showed a strong preference for cover

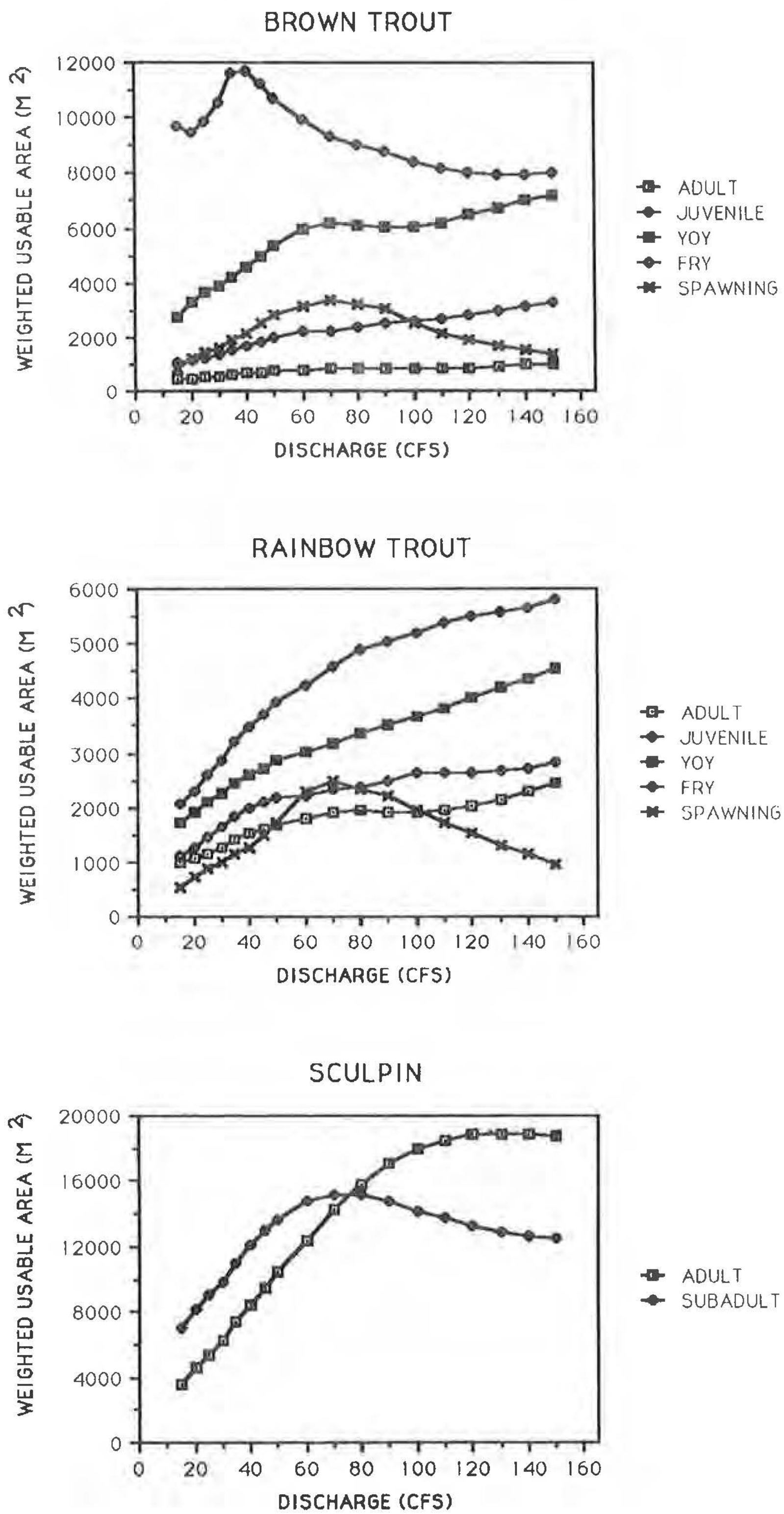


Figure 6.1. Relationship of discharge and WUA for each life stage of each evaluation organism when velocity, depth, and substrate were utilized in the simulations.

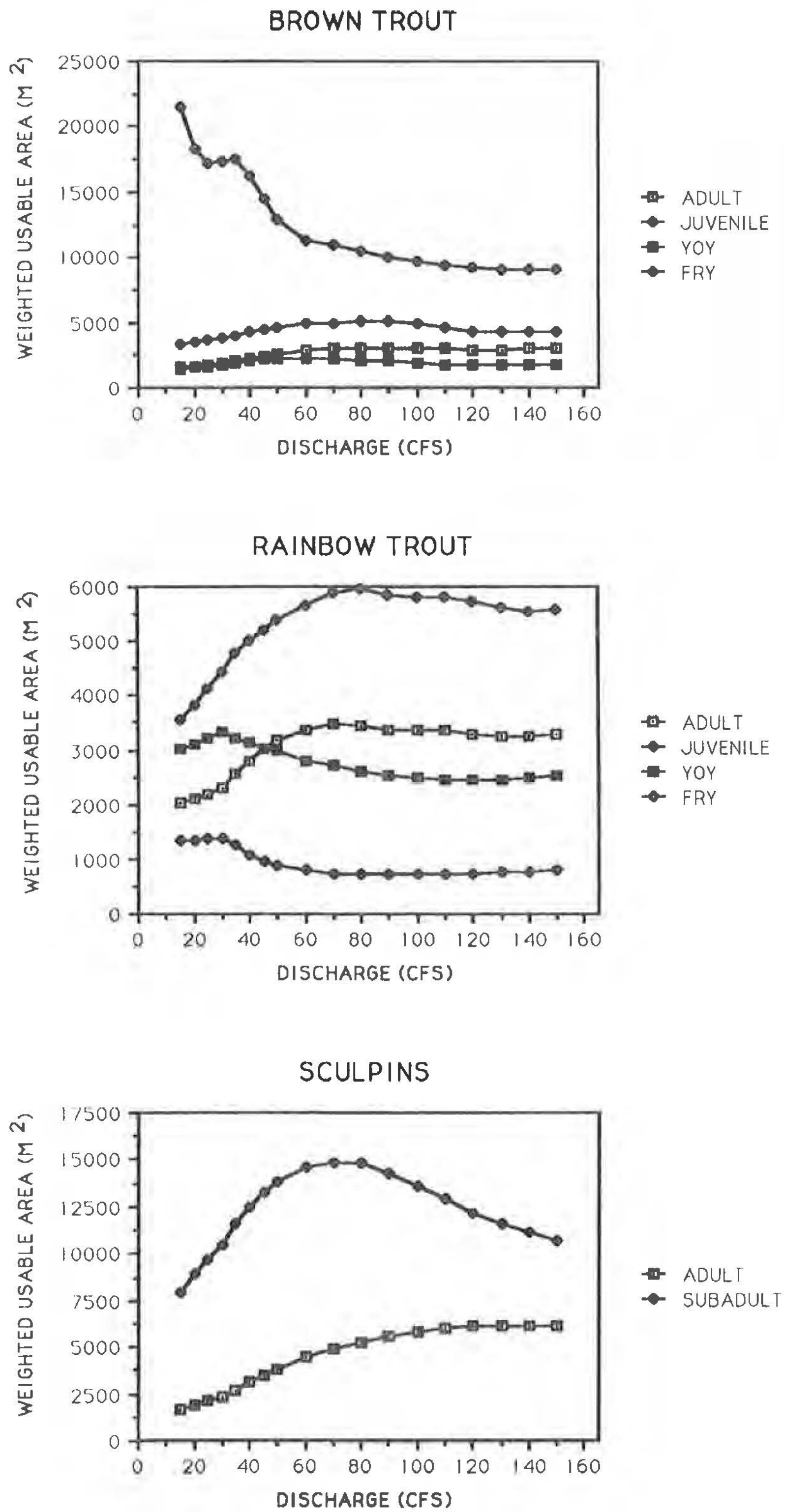


Figure 6.2. Relationship of discharge and WUA for each life stage of each evaluation organism when velocity, depth, and cover were utilized in the simulations.

BROWN TROUT

	Spawning/egg Incubation		Adult		Juvenile		Y-O-Y		Fry	
	Flow	WUA	Flow	WUA	Flow	WUA	Flow	WUA	Flow	WUA
Substrate	70	(3349)	≥150	(1007)	≥150	(3278)	≥150	(7211)	40	(11730)
Cover	- - - -		80	(3040)	80	(5061)	50-60	(2244)	15	(21473)

RAINBOW TROUT

	Spawning/egg incubation		Adult		Juvenile		Y-O-Y		Fry	
	Flow	WUA	Flow	WUA	Flow	WUA	Flow	WUA	Flow	WUA
Substrate	70	(2500)	≥150	(2452)	≥150	(5805)	≥150	(4535)	≥150	(2835)
Cover	- - - -		70	(3468)	80	(5948)	30	(3308)	25	(1361)

SCULPIN

	Adult		Sub-adult	
	Flow	WUA	Flow	WUA
Substrate	130	(18894)	70	(15208)
Cover	130	(6164)	70	(14824)

Table 6.1. Flow (in CFS) that optimizes WUA (m^2)for each life stage of each evaluation species. Substrate refers to values obtained when simulations were run utilizing velocity, depth, and substrate as the habitat variables and cover refers to simulations run with cover substituted for substrate.

types 4 and/or 5. Brown trout fry preferred cover type 2 (small object), but showed a fairly high preference for no cover. Brown trout fry frequently utilized the substrate for cover which was reflected by their high preference for no cover. On the other hand, they utilized cover type 4 (overhead) frequently enough to show a high preference for that also. Using cover in the simulation would seem to overestimate brown trout fry habitat since all areas with no cover would get a high weighting factor, regardless of whether or not the substrate was of the type to be utilized for cover. Using substrate in the simulations may be most accurate but certainly doesn't adequately resolve the problem of overestimation. However, brown trout fry habitat was far from limiting and can, in this respect, be ignored. The spawning life stage must be simulated using substrate.

Other models developed to predict trout standing crops have shown the importance of cover. Wesche *et al.* (1987) found that the best multiple regression model for predicting brown trout standing stock was one which included a variable that quantified overhead bank cover and deep water cover and a variable which represented the average annual base flow as a percentage of average annual daily flow. Substrate variables which were tested in the model included average diameter of substrate components in spawning areas, percent of substrate components 10-40 cm in diameter, dominant substrate type, percent fines, and rubble substrate. Of these, only rubble substrate was significantly correlated to trout standing stock and none of the others added to the equation's predictive ability (Wesche *et_al.* 1987). Binns and Eiserman (1979) did include a substrate variable in their model; however, it represented a measure of submerged aquatic vegetation, not a measure of the stream bed components. They did find cover to be an important variable in predicting trout standing stock. Wesche (1980) also recognized the importance of cover in habitat evaluation models. The importance of cover to trout has been recognized in several other papers (Greeley 1935; Tarzwell 1936; Boussu 1954; Hartman 1963; MacCrimmon and Kwain 1966; Butler and Hawthorne 1968;

Elser 1968; Hunt 1969, 1971 and 1976; Lewis 1969; Stewart 1970; Everest and Chapman 1972; Devore and White 1978; Campbell and Neuner 1985; Raleigh *et al.* 1986).

Based upon the information available, cover cannot be ignored as a habitat variable for most trout non-spawning/egg incubation life stages, and it appears to become more important as the fish grows. Thus, salmonid habitat in Chamokane Creek was optimized at a discharge of 80 CFS. This flow was optimal for brown trout while 70 CFS was optimal for rainbow trout. The increase of WUA for adult brown trout was 80 m^2 (2960 m^2 to 3040 m^2) from 70 to 80 CFS while the WUA loss for rainbow trout was 42 m^2 (3468 m^2 to 3426 m^2). Since the mean biomass of brown trout (Table 6.2) was higher than for rainbow trout (Table 6.3), this was a good trade off.

Companion studies on water quality (O'Laughlin *et al.* 1988a), benthic macroinvertebrates (O'Laughlin *et al.* 1988b), trout age and growth (Uehara *et al.* 1988), and trout feeding habits (Geist *et al.* 1988) indicate that water quality and food availability were not limiting trout biomass in Chamokane Creek. These studies indicate that the limiting factor is physical habitat.

6.4 IMPACT OF WATER WITHDRAWALS ON HABITAT AVAILABILITY IN CHAMOKANE CREEK

Tables 6.4 and 6.5 show the amount of habitat available at the 50 percent exceedence flows for brown trout and rainbow trout respectively. The bottom row of each table shows the amount of habitat that was required at each life stage to fill the minimum adult habitat based upon the habitat ratios in Tables 6.2 and 6.3. By comparing the value in the bottom row with the values in the column above, it can be seen that the required habitat was available at all life stages. Thus, adult habitat was limiting at all times during the year.

Table 6.2. Information on the brown trout population in Chamokane that was used to calculate habitat ratios.

BROWN TROUT			
Life Stage	Est. Populaltion	Mean Weight (g)	Mean Biomass (kg)
Egg	84960[1]	---	---
Fry	63720[2]	0.7[5]	45
YOY	9558	10.6	101
Juvenile I	4724	31.8	150
Juvenile II	2980	117.4	350
Juvenile III	1973	262.6	518
Total Juvenile	9677	---	1018
Adult IV	1022	683.2	698
Adult V	374	1076.3	403
Total Adult	1396	---	1101
Total Brown Trout	---	---	2265
Spawning Females	57[3]	---	---
Spawning Area	114 m^2[4]	---	---

HABITAT RATIOS

$$\frac{\text{Fry}}{\text{Adult}} = \frac{45 \times 1.25}{1101} = \frac{56\ \text{kg}}{1101\ \text{kg}} = \frac{0.05}{1.0}$$

$$\frac{\text{YOY}}{\text{Adult}} = \frac{101 \times 1.25}{1101} = \frac{126\ \text{kg}}{1101\ \text{kg}} = \frac{0.11}{1.0}$$

$$\frac{\text{Juvenile}}{\text{Adult}} = \frac{1018 \times 1.25}{1101} = \frac{1273\ \text{kg}}{1101\ \text{kg}} = \frac{1.16}{1.0}$$

$$\frac{\text{Spawning}}{\text{Adult}} = \frac{114 \times 1.25}{477} = \frac{143\ \text{m}^2}{477\ \text{m}^2} = \frac{0.3}{1.0}$$

[1] Based upon 0.75 embryo survival
[2] Based upon 0.15 fry survival
[3] Based upon 1500 eggs/female
[4] Based upon 2 m^2/female
[5] Median value estimated from length-weight relationship of Uehara *et al.*

Table 6.3. Information on rainbow trout population in Chamokane Cr that was used to calculate habitat ratios.

RAINBOW TROUT			
Life Stage	Est. Population	Mean Weight (g)	Mean Biomass (kg)
Egg	215200[1]	---	---
Fry	32280[2]	0.7[5]	23
YOY	9684	6.0	58
Juvenile I	3209	46.1	148
Juvenile II	1403	101.9	143
Total Juvenile	4612	---	291
Adult III	745	303.8	246
Adult IV	247	551.8	136
Adult V	34	900.0	31
Total Adult	1026	---	413
Total Rainbow Trout	---	---	785
Spawning Females	215[3]	---	---
Spawning Area	258 m² [4]	---	---

HABITAT RATIOS

$$\frac{\text{Fry}}{\text{Adult}} = \frac{23 \times 1.25}{413} = \frac{29 \text{ kg}}{413 \text{ kg}} = \frac{0.07}{1.0}$$

$$\frac{\text{YOY}}{\text{Adult}} = \frac{58 \times 1.25}{413} = \frac{73 \text{ kg}}{413 \text{ kg}} = \frac{0.18}{1.0}$$

$$\frac{\text{Juvenile}}{\text{Adult}} = \frac{291 \times 1.25}{413} = \frac{364 \text{ kg}}{413 \text{ kg}} = \frac{0.88}{1.0}$$

$$\frac{\text{Spawning}}{\text{Adult}} = \frac{258 \times 1.25}{1076} = \frac{323 \text{ m}^2}{1076 \text{ m}^2} = \frac{0.3}{1.0}$$

[1] Based upon 0.15 embryo survival
[2] Based upon 0.30 fry survival
[3] Based upon 1000 eggs/female
[4] Based upon 1.2 m²/female
[5] Median value estimated from length-weight relationship of Uehara *et al.*

BROWN TROUT

Month	Discharge (CFS)	HABITAT UNITS [1] Spawning/egg incubation	Fry	YOY	Juv.	Adult
October	30.3	16		17	38	19
November	30.2	16		17	38	19
December	37.1	20		20	42	22
January	30.4	17		17	38	19
February	47.0	27		22	46	25
March	140.5	15		17	43	30
April	150.9	14		17	42	30
May	53.1	29	106		48	27
June	33.7		114		40	20
July	28.5			17	37	18
August	27.7			17	37	18
September	29.5			17	37	18
Required to fill minimum adult habitat of 18 units		5.4	1	2	21	

[1]One habitat unit = 100 m^2

Table 6.4. Monthly discharges and habitat areas for five life stages of brown trout for a median water year. The bottom row indicates the number of habitat units required at each life stage to fill the minimum adult habitat available during the year.

RAINBOW TROUT

Month	Discharge (CFS)	HABITAT UNITS [1] Spawning/egg incubation	Fry	YOY	Juv.	Adult
October	30.3			33	44	23
November	30.2			33	44	23
December	37.1			32	49	27
January	30.4			33	45	23
February	47.0			30	53	31
March	140.5	11		25	56	33
April	150.9	10		25	56	33
May	53.1	19		29	55	32
June	33.7	11	13	32	47	25
July	28.5		14		43	23
August	27.7		14	33	43	22
September	29.5			33	44	23
Required to fill minimum adult habitat of 22 units		6.6	1.5	4.0	19.0	

[1] One habitat unit = 100 m^2

Table 6.5. Monthly discharges and habitat areas for five life stages of rainbow trout for a median water year. The bottom row indicates the number of habitat units required at each life stage to fill the minimum adult habitat available during the year.

Tables 6.6-6.9 show the impact the DOE calculated streamflow reductions would have on Chamokane Creek brown trout and rainbow trout. The impacts of greatest concern are on the adult life stages in Tables 6.6 and 6.7. Brown trout adult habitat losses would range from 3.6 to 4.2 percent from June through November at the 50 percent exceedence (median) flow. Rainbow trout adult habitat losses would range from 3.2 to 3.5 percent over the June through November period.

Assuming that there is a direct positive relationship between WUA and standing stock (Nehring 1979, Stalnaker 1979, Loar *et al.* 1985), and that the present standing stock is limited by the month with the lowest WUA (August), then the loss in biomass, or number, can be calculated. The potential biomass loss in brown trout adults would be 40.7 kg (90 lbs) or about 52 adults, based upon the total adult biomass and adult populations from Table 6.2 and a 3.7 percent loss in habitat in August. Using the adult biomass and adult population for rainbow trout (Table 6.3) and a 3.2 percent reduction in habitat in August, then the potential loss in biomass is 13.2 kg (29 lbs) or about 33 adults.

BROWN TROUT (COVER)

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Discharge (CFS)	30.4	47.0	140.5	150.9	53.1	33.7	28.5	27.7	29.5	30.3	30.2	37.1	
ADULT													
Present WUA (m^2)	1871	2498	2965	3009	2662	2028	1818	1803	1840	1868	1864	2156	26,382
WUA after red. (m^2)	1793	2412	2925	2973	2608	1956	1749	1737	1765	1790	1786	2090	25,584
WUA loss (m^2)	78	86	40	36	54	72	69	66	75	78	78	66	798
Percent loss	4.2	3.4	1.3	1.2	2.0	3.6	3.8	3.7	4.1	4.2	4.2	3.1	3.0
JUVENILE													
Present WUA (m^2)	3760	4558	4254	4231	4772	3989	3688	3670	3718	3757	3753	4164	48,314
WUA after red. (m^2)	3644	4443	4228	4218	4681	3866	3590	3576	3615	3643	3637	4049	47,190
WUA loss (m^2)	116	115	26	13	91	123	98	94	103	114	116	115	1,124
Percent loss	3.1	2.5	0.6	0.3	1.9	3.1	2.7	2.6	2.8	3.0	3.1	2.8	2.3
Y-O-Y													
Present WUS (m^2)	1744	2242	1748	1663	---	---	1690	1679	1720	1745	1744	1968	17,943
WUA after red. (m^2)	1649	2226	1761	1693	---	---	1639	1634	1645	1649	1645	1905	17,446
WUA loss (m^2)	95	16	+13	+30	---	---	51	45	75	96	99	63	497
Percent loss	5.4	0.7	+0.7	+1.8	---	---	3.0	2.7	4.4	5.5	5.7	3.2	2.8
FRY													
Present WUA (m^2)	---	---	---	---	12265	17705	---	---	---	---	---	---	29,970
WUA after red. (m^2)	---	---	---	---	12796	17133	---	---	---	---	---	---	29,929
WUA loss (m^2)	---	---	---	---	+531	572	---	---	---	---	---	---	41
Percent loss	---	---	---	---	+4.3	3.2	---	---	---	---	---	---	0.1

Table 6.6. Impact the DOE calculated streamflow reduction would have on the monthly habitat availability for each life stage of brown trout as computed utilizing the habitat variables velocity, depth, and cover.

RAINBOW TROUT (COVER)

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Discharge (CFS)	30.4	47.0	140.5	150.9	53.1	33.7	28.5	27.7	29.5	30.3	30.2	37.1	
ADULT													
Present WUA (m^2)	2315	3070	3255	3292	3238	2480	2265	2249	2287	2313	2311	2656	31,731
WUA after red. (m^2)	2234	3013	3222	3264	3188	2399	2188	2177	2208	2232	2229	2576	30,930
WUA loss (m^2)	81	57	33	28	50	81	77	72	79	81	82	80	801
Percent loss	3.5	1.9	1.0	0.9	1.5	3.3	3.4	3.2	3.5	3.5	3.5	3.0	2.5
JUVENILE													
Present WUA (m^2)	4453	5262	5559	5605	5490	4701	4341	4301	4390	4445	4440	4888	57,875
WUA after red. (m^2)	4239	5171	5546	5552	5380	4513	4122	4073	4185	4235	4226	4721	55,963
WUA loss (m^2)	214	91	13	53	110	188	219	228	205	210	214	167	1,912
Percent loss	4.8	1.7	0.2	0.9	2.0	4.0	5.0	5.3	4.7	4.7	4.8	3.4	3.3
Y-O-Y													
Present WUA (m^2)	3300	2999	2468	2502	2921	3245	---	3280	3300	3300	3304	3186	33,805
WUA after red. (m^2)	3240	2988	2451	2487	2922	3211	---	3178	3235	3241	3236	3161	33,350
WUA loss (m^2)	60	11	17	15	+1	34	---	102	65	59	68	25	455
Percent loss	1.8	0.3	0.7	0.6	+0.03	1.0	---	3.1	2.0	1.8	2.1	0.8	1.3
FRY													
Present WUA (m^2)	---	---	---	---	---	1307	1358	1364	---	---	---	---	4,029
WUA after red. (m^2)	---	---	---	---	---	1338	1360	1359	---	---	---	---	4,057
WUA loss (m^2)	---	---	---	---	---	+31	+2	5	---	---	---	---	+28
Percent loss	---	---	---	---	---	+2.4	+0.1	0.3	---	---	---	---	+0.7

Table 6.7. Impact the DOE calculated streamflow reduciton would have on the monthly habitat availability for each life stage of rainbow trout as computed utilizing the habitat variables velocity, depth, and cover.

BROWN TROUT (SUBSTRATE)

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Discharge (CFS)	30.4	47.0	140.5	150.9	53.1	33.7	28.5	27.7	29.5	30.3	30.2	37.1	
SPAWNING/EGG INCUBATION													
Present WUA (m^2)	1676	2664	1537	1388	2945	- - -	- - -	- - -	- - -	1649	1642	1989	15,490
WUA after red. (m^2)	1528	2413	1575	1441	2856	- - -	- - -	- - -	- - -	1522	1528	1819	14,682
WUA loss (m^2)	148	251	+38	+53	89	- - -	- - -	- - -	- - -	127	114	170	808
Percent loss	8.8	9.4	+2.5	+3.8	3.0	- - -	- - -	- - -	- - -	7.7	6.9	8.5	5.2
ADULT													
Present WUA (m^2)	558	740	973	1007	769	607	541	536	547	557	556	645	8,036
WUA after red. (m^2)	531	722	952	991	766	583	513	506	521	529	528	624	7,766
WUA loss (m^2)	27	18	21	16	3	24	28	30	26	28	28	21	270
Precent loss	4.8	2.4	2.2	1.6	0.4	4.0	5.2	5.6	4.8	5.0	5.0	3.3	3.4
JUVENILE													
Present WUA (m^2)	1366	1894	3116	3291	2056	1498	1319	1307	1334	1361	1359	1612	21,513
WUA after red. (m^2)	1284	1814	3055	3225	1978	1422	1245	1227	1265	1283	1278	1534	20,610
WUA loss (m^2)	82	80	61	66	78	76	74	80	69	78	81	78	903
Percent loss	6.0	4.2	2.0	2.0	3.8	5.1	5.6	6.1	5.2	5.7	6.0	4.8	4.2
Y-O-Y													
Present WUA (m^2)	3900	5128	7034	7225	- - -	- - -	3815	3800	3845	3896	3895	4341	46,879
WUA after red. (m^2)	3724	4959	6923	7146	- - -	- - -	3623	3560	3689	3729	3714	4215	45,282
WUA loss (m^2)	176	169	111	79	- - -	- - -	192	240	156	167	181	126	1,597
Precent loss	4.5	3.3	1.6	1.1	- - -	- - -	5.0	6.3	4.1	4.3	4.6	2.9	3.4
FRY													
Present WUA (m^2)	- - -	- - -	- - -	- - -	10556	11380	- - -	- - -	- - -	- - -	- - -	- - -	21,936
WUA after red. (m^2)	- - -	- - -	- - -	- - -	10722	10844	- - -	- - -	- - -	- - -	- - -	- - -	21,566
WUA loss (m^2)	- - -	- - -	- - -	- - -	+166	536	- - -	- - -	- - -	- - -	- - -	- - -	370
Precent loss	- - -	- - -	- - -	- - -	+1.6	4.7	- - -	- - -	- - -	- - -	- - -	- - -	1.7

Table 6.8. Impact the DOE calculated streamflow reduction would have on the monthly habitat availability for each life stage of brown trout as computed utilizing the habitat variables velocity, depth, and substrate.

RAINBOW TROUT (SUBSTRATE)

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Discharge (CFS)	30.4	47.0	140.5	150.9	53.1	33.7	28.5	27.7	29.5	30.3	30.2	37.1	
SPAWNING/EGG INCUBATION													
Present WUA (m^2)	---	---	1136	952	1938	1098	---	---	---	---	---	---	5,124
WUA after red (m^2)	---	---	1200	1023	1744	1024	---	---	---	---	---	---	4,991
WUA loss (m^2)	---	---	+64	+71	194	74	---	---	---	---	---	---	133
Percent loss	---	---	+5.6	+7.5	10.0	6.7	---	---	---	---	---	---	2.6
ADULT													
Present WUA (m^2)	1252	1655	2300	2463	1728	1361	1218	1207	1231	1252	1249	1453	18,369
WUA after red (m^2)	1196	1635	2244	2401	1717	1309	1154	1140	1173	1193	1190	1409	17,761
WUA loss (m^2)	56	20	56	62	11	52	64	67	58	59	59	44	608
Percent loss	4.5	1.2	2.4	2.5	0.6	3.8	5.3	5.6	4.7	4.7	4.7	3.0	3.3
JUVENILE													
Present WUA (m^2)	2866	3808	5657	5813	4023	3125	2761	2726	2805	2862	2856	3341	42,643
WUA after red (m^2)	2671	3690	5614	5745	3938	2945	2561	2516	2619	2668	2658	3166	40,791
WUA loss (m^2)	195	118	43	68	85	180	200	210	186	194	198	175	1,852
Percent loss	6.8	3.1	0.8	1.2	2.1	5.8	7.2	7.7	6.6	6.8	6.9	5.2	4.3
Y-O-Y													
Present WUA (m^2)	2272	2784	4360	4542	2902	2408	---	2192	2232	2271	2268	2517	30,748
WUA after red (m^2)	2154	2684	4300	4490	2843	2308	---	2050	2119	2153	2143	2415	29,659
WUA loss (m^2)	118	100	60	52	59	100	---	142	113	118	125	102	1,089
Percent loss	5.2	3.6	1.4	1.1	2.0	4.2	---	6.5	5.1	5.2	5.5	4.1	3.5
FRY													
Present WUA (m^2)	---	---	---	---	---	1793	1576	1556	---	---	---	---	4,925
WUA after red (m^2)	---	---	---	---	---	1691	1433	1408	---	---	---	---	4,532
WUA loss (m^2)	---	---	---	---	---	102	143	148	---	---	---	---	393
Percent loss	---	---	---	---	---	5.7	9.1	9.5	---	---	---	---	8.0

Table 6.9. Impact the DOE calculated streamflow reduction would have on the monthly habitat availability for each life stage of rainbow trout as computed utilizing the habitat variables velocity, depth, and substrate.

7.0 RECOMMENDATIONS

7.1. RECOMMENDED MINIMUM INSTREAM FLOW REGIME FOR CHAMOKANE CREEK

Monthly instream flow recommendations were made using effective habitat time series (Bovee 1982). Using this technique, the minimum amount of adult habitat that was available during a month of the year was determined. The amount of habitat required at all other life stages to support this minimum adult habitat was computed using habitat ratios. This information is contained in Tables 6.4 and 6.5. By comparing the required amount of habitat for each life stage with the monthly availability of habitat for each life stage, it can be seen that the required amount of habitat was available for each month. Thus, habitat for life stages other than adult do not appear to be a problem for brown trout or rainbow trout under the 50 percent exceedence (median) flow regime. Since adult habitat is limited for both species during the month of August, a minimum flow of 27.7 CFS for each month of the year would provide enough habitat to maintain present population levels.

This process ignores the necessity of high flows that are needed for the removal of sediment from the stream channel. Dennis Olson (BIA, Spokane Agency, personal communication) determined that the sediment begins to move from the channel at discharges of 77 CFS. The median monthly flows for March and April would provide for these maintenance flows and should be protected to ensure adequate channel cleaning. These flows will not reduce adult habitat below that available during other times of the year. Table 7.1 contains the recommended flow regime for Chamokane Creek.

This flow regime should require no regulatory action during most years; however, during low flow years the Water Master may be required to curtail, or at least reduce, pumping to protect the fishery. With the present snowpack, precipitation, and aquifer monitoring system in place, low flow periods should be apparent

Table 7.1. Monthly flow recommendations for Chamokane Creek based upon the limited life stage with no reduction over present limit.

Month	Flow (CFS)	Reason for Recommendation
October	27.7	Adult Habitat
November	27.7	Adult Habitat
December	27.7	Adult Habitat
January	27.7	Adult Habitat
February	27.7	Adult Habitat
March	140	Channel Maintenance
April	151	Channel Maintenance
May	27.7	Adult Habitat
June	27.7	Adult Habitat
July	27.7	Adult Habitat
August	27.7	Adult Habitat
September	27.7	Adult Habitat

several months in advance. This would allow for regulatory measures to be taken to ensure that the habitat availability in Chamokane Creek would not be reduced due to water withdrawals during dry years.

7.2 DIFFERENCE IN HABITAT AVAILABILITY BETWEEN THE RECOMMENDED FLOW OF 27.7 CFS AND THE COURT-ORDERED MINIMUM FLOW OF 20.0 CFS

Table 7.2 shows the Weighted Usable Area for each life stage of brown trout and rainbow trout at the recommended minimum flow of 27.7 CFS and the court-ordered minimum flow of 20 CFS. Also shown is the amount and the percent of the available habitat that would be lost if the flow was allowed to drop to 20 CFS. Adult habitat was limiting at 20 CFS for both species, so habitat loss at that life stage would result in a reduction in the number of adult fish that the stream could hold. An eight percent reduction in brown trout adult habitat could reduce the number of adults by 112 fish or 88 kg (194 lbs). Similarly, a six percent reduction in adult rainbow trout habitat could result in the loss of 62 adults with a total biomass of 25 kg (55 lbs.).

From Table 7.2 it can be seen that 23 percent of the spawning habitat would be lost if the flow was reduced to 20 CFS. This would reduces rainbow trout spawning area to about the minimum required to maintain the present population. A 23 percent reduction in spawning area is a concern, since it would reduce the number of spawners that could spawn in areas which have the best combination of conditions. It would force some spawners to spawn in areas that are less than ideal for spawning, resulting in lower than normal survival to emergence. Reduced spawning area could also concentrate spawners in a smaller area, resulting in late spawners disturbing the redds of early spawners.

A 23 percent loss in spawning habitat may result in a 23 percent loss in the genetic variability in the brown trout and

Table 7.2. **Weighted Usable Area (WUA) available for different life history stages of brown trout and rainbow trout at the recommended minimum flow of 27.7 CFS and the court-ordered minimum flow of 20 CFS. Amount Loss=the amount of habitat loss calculated by subtracting the WUA at the court-ordered flow from the WUA at the recommended flow. The percent loss was calculated by dividing the amount loss by the WUA at the recommended flow.**

SPECIES/LIFE HISTORY STAGE	RECOMMENDED MINIMUM FLOW	PRESENT COURT-ORDERED MINIMUM FLOW (20 CFS)		
Brown trout				
	WUA (m^2)	WUA (m^2)	Amt. loss	Percent loss
Fry	17,175	18,386	+1221	+7%
YOY	1,679	1,609	70	4%
Juveniles	3,670	3,472	198	5%
Adults	1,803	1,667	136	8%
Spawning	1,558	1,200	358	23%
Rainbow Trout				
Fry	1,364	1,351	13	1%
YOY	3,280	3,080	200	6%
Juveniles	4,301	3,829	472	11%
Adults	2,249	2,106	143	6%
Spawning	943	723	220	23%

rainbow trout populations. The 10.1 km (6.3 mi) section of Chamokane Creek between the falls and the point near Ford where the stream becomes intermittent, is isolated. Genetic variability can not be introduced into the population by immigrations. Genetic variability must, therefore, be maintained in the existing population to ensure the continued vigor that these populations exhibit.

7.3 RECOMMENDED RESEARCH

A study should be conducted to determine the fecundity and egg-to-fry survival rates for brown trout and rainbow trout in Chamokane Creek. A companion study should also be conducted to determine the influence that substrate particle sizes have on the survival rates. Fecundity rates can be determined by stripping females in spawning condition and enumerating the eggs in each female. These eggs can then be fertilized and used in the study to determine the egg-to-fry survival rates.

Egg-to-fry survival rates should be determined by placing a known number of eyed eggs in an emergence trap. Fraley *et al.* (1986) developed an inexpensive, simple, and effective emergence trap which should be used. The trap should be checked at least twice weekly during the emergence period to remove trapped fry. Once emergence is completed the contents of the trap should be removed and sieved to check for dead eggs and alevins. This would give an indication of the effectiveness of the trap. The substrate should be dried and sieved according to the sieve series recommended by Platts *et al.* (1983).

Brown trout redds should be marked in the fall and rainbow trout redds marked in the spring so that sediment samples can be taken after fry emergence. A McNeil sampler (McNeil 1964) should be used to collect substrate samples from redd sites. The sediments collected should be placed in a container for later drying. A sample of the water in the sampling tube should be taken so that the volume of the suspended sediments can be determined using an Imhoff settling cone. All samples should be over dried at 105°C for 24 hours and sieved using the sieve series of Platts *et al.* (1983).

Weights of each sieve fraction can then be used to calculate the fredle index (Lotspeich and Everest 1981) for the sediment. The fredle index provides an indicator of sediment permeability and pore size, the most important factors in the egg to emergent fry survival (Platts *et al.* 1983). By regressing the fredle indices and the respective egg-to-emergent fry survival rates for all the fry traps, the survival in other redds can be estimated based upon their fredle indices. With the information on fecundity, it would then be possible to estimate total fry production. This monitoring should continue on an annual basis to monitor sedimentation resulting from upstream land use practices.

Population estimates should be made each fall to monitor survival rates for each age class and to determine the effectiveness of the habitat improvements recommended in the following sections. In addition, a full-time creel clerk should be hired to monitor angler catch rates and to determine angler impact on the fish population.

A fish trap should be constructed near the mouth of Chamokane Creek to determine the contribution of salmonids to the Spokane River. The Wolf Trap (Wolf 1951) is an effective and popular trap for capturing downstream moving fish. It requires a weir to channel water over a spillway. The water falls through an inclined fine mesh screen which captures aquatic organisms and enough water to wash the organisms into a collecting box. An alternative to constructing a permanent trap would be a portable, floating, inclined plane trap. This would be less expensive and could be used at different locations.

The number of adults exceeds the number needed to maintain the brown trout and rainbow trout populations at their present level according to the calculations in section 6. There are several possible explanations that could account for the "lost" production in Chamokane Creek. First, all adults, as determined by the age-length relationship, may not be sexually mature. This is a reasonable assumption, as all brown trout do not mature at age 4, and all rainbows do not mature at age 3; however, some mature at younger ages which would somewhat compensate for the ones that mature later in life. Second, there may be a shortage of female spawners. This is unlikely since it was found that the sex ratio of brown trout females to males was 1.9:1.0, and the ratio of rainbow trout females to males was 1.7:1.0. The sample sizes used in these ratios was small (40 brown trout and 27 rainbow trout), but it is probably safe to assume that there are more females than males. Since one male may mate with more than one female, this is not an undesirable situation.

A third possible problem is that fecundity rates may be lower than normal for each species. This is unlikely, based upon the good growth and condition of brown trout and rainbow trout in Chamokane Creek (Uehara *et al.* 1988). Fourth, embryo survival may be lower than found in the literature. This may be the case, since Chamokane does contain relatively large amounts of sediment. Fifth, fry survival rates may be lower than the rates used in the calculations. One last possible explanation is that there is movement out of Chamokane Creek into the Spokane River by the fry and YOY life stages. The proposed studies would provide the information needed to assess each of these possibilities.

7.4 HABITAT IMPROVEMENT

7.4.1 BACKGROUND

The purpose of this section is to make general recommendations for habitat improvements based on the available information on what types of improvements would likely be successful and cost effective. Specific recommendations will require an extensive study to identify the number and exact location of structures to maximize the effect and minimize the costs.

Habitat improvements to Chamokane Creek were first recommended by Pillow (1970). He recognized the need for increased pool habitat and the problem of wide, shallow riffles. He recommended devices such as deflectors, check dams, jetties, and other devices to concentrate the current and create more pools.

Most of the early stream habitat improvement work occurred in the Midwest during the 1930's (Hall and Baker 1982). Early work in the West generally met with failure, due to structures not being able to withstand high runoff in higher gradient streams (Calhoun 1966). Early failures did not result in an abandonment of improving stream habitat in the West, but led to the evaluation of failures and with better planning some of the methods developed in the Midwest have been adapted to the West. Several publications provide useful information on methodologies for stream habitat improvements. White and Brynildson (1967), Everhart and Youngs (1981), and Bovee (1982) contain information on stream improvement methodologies that can be applied to western streams with some modifications, while Reeves and Roelofs (1982) review techniques that have been successfuly applied in the West. A training manual put together by the Oregon Chapter of the American Fisheries Society (1988) contains information on planning, designing, constructing, and evaluating habitat improvements.

Habitat improvements have resulted in increases in; habitat quality and quantity, salmonid populations, survival, catch rates, total catch, and angler hours. Shetter *et al.* (1949) found deflectors increased the number, size, and depth of pools in a small stream in Michigan. This resulted in increased survival and standing stock of brook trout. Angling effort increased 64 percent, catch increased 141 percent by weight, and catch increased 46 percent in weight per hour. Boussu (1954) more than tripled trout abundance in a Montana stream by adding brush cover to about 5 percent of the stream area.

The most extensive evaluation of a habitat improvement project was conducted by Hunt (1969, 1971, and 1976). He evaluated the addition, in 1964, of 86 paired bank covers and current deflectors to the upper 1.7 km of Lawrence Creek, a Wisconsin brook trout stream. This resulted in the following physical changes: a 51 percent decrease in surface area; a 70 percent decrease in silt bottom; a 40 percent decrease in sand bottom; a 289 percent increase in pool area; a 416 percent increase in permanent bank cover; and a 40 percent increase in mean depth. In the three years (1965-1967) following habitat development there was a 41 percent increase in mean biomass, a 101 percent increase in trout over 15 cm, a 156 percent increase in trout over 20 cm, a 191 percent increase in trout creeled, a 196 percent increase in the weight of trout creeled, and a 196 percent increase in angling trips per season. The greatest changes in the trout population were found in the second three year period (1968-1970) after habitat improvement. During this period, trout biomass exceeded the preimprovement period by 180 percent and trout over 15 cm increased 191 percent.

A more recent study conducted by House and Boehne (1985) evaluated the effectiveness of gabions, logs, and boulders in improving habitat in the East Fork Lobster Creek, Oregon. They found the structures increased the diversity of the stream bed, increased gravel deposition, increased the size and quality of pools, and resulted in increased salmonid spawning and rearing. Another study by House and Boehne (1986) compared a section of Oregon stream that had been logged and cleaned of large debris with a section that was unlogged and contained large amounts of woody debris. They found the unlogged section had twice as many pools, ten times the amount of spawning gravel, and significantly higher salmonid biomass than the cleaned section. Gabions were installed in the "cleaned" section to simulate debris. This resulted in increased pool and spawning habitat in the cleaned section, and salmonid biomass increased to such an extent that there was no significant difference between sections.

A study by Thorn (1988) evaluated habitat improvements on two streams in Minnesota. Habitat improvements on Hay Creek included the addition of 60 m of permanent overhead bank cover, 635 m of streambank riprap, and the exclusion of cattle during the summer. Five years after improvements, the spring adult brown trout biomass was 368 percent higher than the preimprovement level. Habitat improvements on West Indian Creek included the addition of 60 m of overhead bank cover, 590 m of riprap, and the stream banks were sloped and seeded. Within five years of improvement, the spring biomass of adult brown trout increased 899 percent in the improved section while control sections showed no improvement over the same period.

The technology is available to improve degraded habitat in streams. The success of a steam habitat improvement project may be limited if the problems causing stream degradation are not addressed before an attempt is made to physically alter the habitat. Platts and Rinne (1985) recommend that stream habitat improvements not be substituted for the responsible management of the watershed, while Elmore and Beschta (1987) believe that building habitat improvement structures without dealing with the problems of riparian habitat management allows managers to avoid difficult decisions.

Land use practices can have a significant impact on the stream channel. Cattle grazing has been called the greatest threat to trout habitat in the western United States (Behnke and Zarn 1976). Saltzman (1976) listed overgrazing and irrigation as the most serious ecological problems in the western United States. Meehan and Platts (1978) reviewed the literature and found that streams impacted by cattle grazing are wider and more shallow, their channels contain more fine sediment, their streambanks are more unstable, undercut banks are reduced, and summer water temperatures are higher than in undisturbed streams.

Livestock grazing can have an impact on the four components of an aquatic system: streamside vegetation; channel morphology; quality and quantity of the water column; and structure of the soil portion of the streambank (Platts 1981). Streamside vegetation is important as trout cover, the importance of which has been discussed in previous sections. Streamside vegetation is also important habitat for terrestrial insects, some of which fall prey to fish. Cummins (1974) found that about 50 percent of a stream's nutrient energy is provided by streamside vegetation and that a reduction in this organic matter can result in a loss of aquatic organisms that feed upon this matter. These aquatic organisms are important food items for fish. Streamside vegetation is also important in providing shade for the stream and which helps keep water temperatures low during the summer (Barton *et al.* 1985, Martin *et al.* 1986). Another important function of streamside vegetation is reducing water velocities during high flows and allowing sediment to be trapped for streambank building. The root systems provide structure that holds banks together, reducing channel migration and allowing the formation of undercut banks. Additionally, streamside vegetation provides improtant rearing habitat.

Streamside grazing results in the removal of streamside vegetation, the sloughing and collapse of the banks, and leads to a wide, shallow stream channel with a great deal of sediment (Platts 1981). Sediment fills the interstitial spaces in the substrate, reducing cover for salmonid fry. Sediments deposited in the spawning beds reduce the interstitial flow required for the delivery of oxygen to, and removal of wastes from, the developing embryos. Sediment deposits have also been shown to trap hatched fry in the gravel because of their inability to emerge through the sediment layer (Hausle and Coble 1976).

Several studies cited by Platts (1981) have shown that trout populations are adversely impacted by cattle grazing. Armour (1977) reported that three years after the exclusion of livestock, Otto Creek, Nebraska improved from a non-producer to a major producer of trout. The increase in trout abundance was accompanied by a decrease in channel width, stabilization of stream banks, and a 2 to 5 ^{o}F drop in summer water temperatures. Brown trout biomass was 340 percent higher in an ungrazed section of Rock Creek, Montana than in an adjacent grazed section (Marcuson 1977). Kennedy (1977) found 240 percent more trout in nongrazed -v.- grazed sections of an Oregon stream. Lorz (1974) found trout populations were 350 percent higher in ungrazed than in grazed sections of the Little Deschutes River, Oregon. Thorn (1988) found that adult brown trout spring biomass increased 171 percent five years after cattle were removed from sections of West Indian Creek, Minnesota.

7.4.2. RECOMMENDED HABITAT IMPROVEMENTS

It is recommended that cattle grazing be eliminated in the riparian areas of Chamokane Creek. This is the necessary first step in habitat improvement. Other alternatives, such as rest-rotation grazing, have failed to protect riparian habitat. Platts and Nelson (1985) found that when a pasture was grazed at a moderate intensity, the stream bank sustained heavy grazing pressure and that streambank degradation was observed soon after the introduction of cattle into a rested pasture. Duff (1977) found that riparian conditions in an area that had not been grazed in four years deteriorated to pre-rest conditions within six weeks of cattle introduction. Platts and Martin (1980) compared grazing strategies with the resulting condition of riparian-aquatic habitat, and found that the only grazing strategy that resulted in good to excellent conditions was no grazing. Once the riparian habitat has been fenced, streambank revegetation and stabilization should be undertaken to expedite habitat recovery.

We recommend that habitat improvements be designed to increase the pool-to-riffle ratio to 1:1. A 1:1 ratio is generally considered to provide the necessary food-producing riffle habitat and the required pool habitat for resting and feeding (Needam 1940, Platts *et al.* 1983). The present pool:riffle ratios are found in Table 7.3. Based upon these estimates, about 23,334 m^2 (31%) of riffle habitat can be converted to pool habitat. Geist *et al.* (1988) calculated, based upon trout consumption rates and invertebrate abundance, that a 31 percent reduction in riffle area would not reduce invertebrate production to levels where food would be limiting, even if the trout population increased by the same percentage as the increase in pool area (82 percent). Since the adult populations for brown trout and rainbow trout are limiting, only an 82 percent increase in adult populations would be expected. However, the combination of habitat improvement and riparian management may result in even greater increases in trout populations based upon the results of other studies. The findings of Geist *et al.* (1988) indicated food will not become limiting even if the increase in trout population is larger than 82 percent.

Chamokane Creek itself may be the best indicator as to what degree the pool-to-riffle ratio can be altered and not upset the balance between predators and prey. Using the information of Scholz *et al.* (1988) on the trout populaton, fish densities were compared between segments. Table 7.4 shows the total number of all age classes of brown and rainbow trout in each segment of Chamokane Creek. The greatest density of fish was found in segment 4 which also has a pool-to-riffle ratio of 1:0.8. When densities of fish two years or older are compared, the differences between segments are even greater (Table 7.5). This indicates that a pool-to-riffle ratio near 1:1 will not only result in more fish, but will result in increased numbers of catchable size fish. Most importantly, it shows that a pool-to-riffle ratio of 1:0.8 provides enough food producing area to sustain trout densities that are considerably higher than other segments of the stream.

The planning study should identify the areas of Chamokane Creek that would benefit the most from habitat improvement. From Table 7.3 it can be seen that segment 4 is the only segment which

Table 7.3. Pool to riffle ratios for Chamokane creek as measured at about base flow.

Segment	Pool Area m^2	Riffle Area m^2	Ratio
1	7861	19888	1:2.5
2	8303	31304	1:3.8
3	4092	11868	1:2.9
4	6659	5327	1:0.8
5	1654	6850	1:4.1
Total	28569	75237	1:2.6

Table 7.4 Total number of brown trout and rainbow trout by segment (Scholz *et al.,* 1988), the number of fish per kilometer, and the number of fish per square meter.

Segment	Brown trout	Rainbow trout	Total	Fish/ km	Fish/ m^2
1	557	386	943	349	0.034
2	7849	6128	13977	2911	0.353
3	4284	2587	6871	3272	0.431
4	6054	2604	8658	5411	0.722
5	697	4860	5557	3473	0.653

Table 7.5 Total number of brown trout and rainbow trout, 2+ or older by segment (Scholz *et al.,* 1988), the number of fish per kilometer, and the number of fish per square meter.

Segment	Brown trout	Rainbow trout	Total	Fish/ km	Fish/ m^2
1	364	19	383	142	0.014
2	2443	968	3411	711	0.086
3	1411	294	1705	812	0.107
4	1859	573	2432	1520	0.203
5	155	572	727	454	0.085

has a good pool-to-riffle ratio. Segment 5 has a very poor ratio and is very poor in spawning-size gravel. Structures should be considered in this segment that will create pools and trap spawning gravel. Segment 2 also has a very poor pool-to-riffle ratio at 1:3.8. The habitat in this segment is especially poor in the lower 1.1 km (0.7 mi) where the pool-to-riffle ratio is 1:6.4. Habitat improvement in segment 2 should be focused in this area since access is not a problem whereas the upper 3.7 km (2.3 mi) is more isolated with no access to get equipment into the area. Segment 3 has a fairly regular pool-riffle sequence with only one area, just above Galbraith Springs, where there is a long riffle with a great deal of braiding due to the lack of stable banks. For the most part, segment 3 will need spot improvements instead of intensive treatment. Segment 1 needs intensive improvement efforts over much of the lower 1.3 km (0.8 mi). This section contains very limited pool habitat. The upper 1.4 km (0.9 mi) contains some good pool habitat and the only overwintering habitat in the segment.

During the planning study the entire reach, from the mouth to Ford, should be mapped, detailing the channel profile, substrate, bank materials, water velocity, large organic debris, and riparian vegetation. This task should be a cooperative effort of a biologist and a hydrolologist. From this map, the locations and types of structures needed can be determined based upon the hydraulic and structural characteristics of the channel and the hydraulic, structural, and biological results desired. This process will help ensure successful results and enable evaluation by repeating the mapping process after habitat improvements are made. The involvement of a hydrolologist with experience in fluvial geomorphology is essential in determining the placement of structures to ensure that scouring and deposition occurs where needed and the involvement of a fisheries biologist with experience in fish habitat is necessary to ensure that the structures provide the needed components for fish habitat.

A trail system along the creek should be constructed with designated access points that will also serve as creel check stations. The potential exists for guided fishing trips. Anglers will pay for the opportunity to catch wild brown trout in the size range found in Chamokane Creek. During the planning study, the market for such a service should be analyzed. It should be emphasized that this will not occur overnight. It may require 4 to 6 years for the fishery to reach its carrying capacity (Hunt 1976). It may, however, be able to sustain a catch and release fishery immediately, based upon present populations (Scholz *et al.* 1988).

Sediment entering the lower 13 km (8 mi) of Chamokane Creek from Walker's Prairie is presently a major source of fine sediment. The agricultural use of this area will increase if the proposed irrigation permits under consideration by the WDOE are approved, increasing sediment yield even further. Buchanan *et al.* (1988) recommend opening up the side channels in Walker's Prairie, that have been closed in an attempt to channelize the stream to increase the aquifer recharge. This may also aid in reducing sediment transport by spreading out the water, reducing the velocity and limiting its ability to carry sediment. If sediment is found to be a problem in the future, restrictions should be placed on the amount of sediment that a particular unit of land may yield.

The final recommendation deals with augmentation of flows during low flow years. As pointed out earlier, the minimum flow recommendation is based upon a median flow year. During dry years the water may not be available to naturally sustain this level. The Tribe has Winter Rights to about 25,000 acre feet of water for irrigation and the Court has given them the right to transfer water not used for irrigation to maintain the fishery. The Tribe should, therefore, consider drilling a well with a capacity of about 2000 gallons per minute. This would provide about 4.5 CFS that could be pumped directly into the creek at Ford. The well would only need to operate when the flows drop below 27.7 CFS and would be of sufficient capacity to keep flows near this minimum level during most years. The well should penetrate the lower aquifer to ensure that pumping will not interfere with the present springs which are fed by the upper aquifer. (Buchanan *et al.* 1988).

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APPENDIX A

SUMMARY OF LEGAL PROCEEDINGS CONCERNING CHAMOKANE CREEK

U.S. -v.-. Barbara J. Anderson et al., No. 3643. Memorandum opinion and order, filed in the U.S. District Court, Eastern District of Washington. July 23, 1979.

The United States and the Spokane Tribe of Indians brought suit against the State of Washington, acting in its governmental and proprietary capacities, and all other persons or corporations who might have an interest in the waters of the Chamokane Basin. The plaintiffs sought an adjudication of water rights in the Chamokane Basin, which includes Chamokane Creek, its tributaries, and its ground water basin.

Judge Marshall A. Neill found that:

1. The Tribe has reserved water rights for the irrigation of 8489 acres at three acre feet/year/acre with a priority date of August 18, 1877;

2. the Tribe has water rights for reacquired acres with a priority date of the date of reacquisition;

3. the minimum flow from the falls into Lower Chamokane Creek be at least 20 CFS or whatever flow is necessary to maintain water temperatures at or below 20°C (68°F), to protect the fishery;

4. the Bureau of Reclamation has a valid right to 10 CFS of the flow of Spring Creek, for the propagation of fish;

5. "defendants who have perfected their water claims under state law have valid water rights regardless of whether their lands are located within or outside the exterior boundaries of the reservation". The defendants recognized water rights, along with the effective reduction in the flow of Chamokane Creek, are found in pages 13 and 14 of the opinion;

6. the court will retain jurisdiction to permit the Tribe to apply for a modification of the judgment on showing a change in circumstances resulting in a greater need for water;

7. the State may continue to issue additional permits but such permits are subject to existing rights; and

8. the appointment of a Water Master is necessary and authorized this person to: (a) "cut off the water of owners or water users" not conforming to the ruling; (b) "requiring the owners of the water rights to install and maintain a measuring device to measure the amount of water being diverted or pumped; (c) install "devices to measure and record water temperature below the fall in order to regulate water diversions"; and (d) "regulate the necessary headgates, ditches, and other works (including pumps), whenever any person or party is not receiving the amount of water he is entitled".

U.S. -v.- Barbara J. Anderson et al., No. 3643. Memorandum and order granting, in part, motions to amend memorandum opinion and order, filed in the U.S. District Court, Eastern District of Washington. August 23, 1982.

Judge Justin L. Quackenbush, on August 23, 1982, ruled:

1. that he would not increase the minimum flow in Chamokane Creek above 20 CFS. He did acknowledge that 20 CFS is not adequate to maintain water temperatures at 20°C (68°F), and that the Water Master has the authority to adjust the flow, and that if over time it becomes apparent that 20 CFS is not adequate the "judgment is subject to modification";

2. that the recharge capacity of the aquifer is about 19,000 acre feet with the flow of the springs approximately 21,000 acre feet;

3. that the State may not select the Water Master, and appointed Ira D. Woodward, the nominee of the Tribe and United States;

4. that the Tribe may transfer water reserved for irrigation to enhance the fishery;

5. that the Tribe has reserved water rights for the fishery;

6. that "the Tribe has a prior reserved right to all or practically all of the waters of Chamokane Creek and that any use of the waters by defendant is in strict subordination to those prior rights"; and

7. that the State may regulate "excess waters" on non-Indian land on the reservation.

U.S. -v.- Barbara J. Anderson et al., No. 82-3597 and 82-3625, D.C. No. CV-72-3643-JLQ. Opinion, filed in the United States Court of Appeals for the Ninth Circuit. July 10, 1984.

The Ninth Circuit Court of Appeals decided on July 10, 1984 that:

1. there were three categories of reservation land involved in the litigation; "lands now owned in fee by non-Indians; lands which never left trust status; and lands removed from trust status which were subsequently reacquired by the Tribe";

2. the lands that never left trust status and unclaimed homesteading land had a priority date of 1877;

3. the state has the authority to regulate the use of excess Chamokane Basin waters by non-Indians on non-Tribal, i.e., fee, land"; and

4. the Water Master had the responsibility "to administer the available waters in accordance with the priorities of all water rights adjudicated". The court also stated that the Water Master has the authority to modify or deny permits granted by the State to use non-existent water or whenever these permits infringe upon Tribal rights.

APPENDIX B

SUMMARY OF THE APPLICATIONS FOR THE WATER OF THE CHAMOKANE BASIN

Seven new applications (Table A.1) to appropriate the waters of the Chamokane Basin have been processed by the Washington Department of Ecology (DOE). These applications have been processed in spite of the fact that the temperature of lower Chamokane Creek is frequently above the court ordered maximum of 20°C (68°F) (See appendix A for summary of court proceeding concerning the Chamokane Basin.) during the summer. The stream has also been below the court ordered minimum flow of 20 CFS on several occasions over the period of record, and at or just above 20 CFS on many occasions. By the DOE's own calculations in their reports of examinations, these seven diversions or withdrawals will result in a total reduction of 3.83 CFS in lower Chamokane Creek. However, the impact recognized by the court (U.S.-v.- Barbara J. Anderson, *et al.*,1979) is 5.26 CFS. An aquifer study by Buchanan *et al.* (1988) indicates that both of these values are high; that the withdrawals will have little impact during "normal" flow years.

The reports of examination state that some of the diversions will have "no effect" on Chamokane Creek while others will have no effect other than a small reduction in flow. From Table A.1 it can be seen that the primary uses of water are for irrigation and livestock. The DOE does not consider the secondary effects that groundwater diversions, irrigation, grazing, agriculture, and urbanization can have on Chamokane Creek. These land and water uses can have a devastating impact on the fishery in Chamokane Creek by altering sediment yield, water yield, channel morphology, substrate character, cover, timing of flow, magnitude of peak flow, magnitude of base flow, thermal regime, water quality, and drainage density (Bovee 1982). All of the reports should contain a detailed analysis of the impacts to the Chamokane system.

In addition to the seven applications mentioned above, at least eleven additional applications have been submitted to the DOE for action. As with the previous applications, it is impossible to determine the impact the diversions, withdrawals or changes in land use will have on Chamokane Creek without a more detailed impact analysis.

LITERATURE CITED

Bovee, K.D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper 12. USDI Fish and Wildl. Serv., FWS/OBS-82/26. 248 pp.

Buchanan, J.P., J.V. Wozniewicz, and R.H. Lambeth. 1988. Hydrogeology of the Chamokane Valley Aquifer System. Upper Columbia United Tribes Fisheries Center, Technical Report No. 20. 69 pp.

U.S. -v.- Barbara J. Anderson *et al.,* No. 3643. Memorandum opinion, and order, filed in the U.S. District Court, Eastern District of Washington. July 23, 1979.

APPENDIX C
CHECKLIST OF SCOPING ACTIVITIES

__X___ Study objectives have been identified and stated.

__X___ Project area has been reconnoitered.

__X___ Length of mainstream to be included in study has been determined.

__X___ Environmental conditions affected by proposed action have been identified (check those which apply):

- _____ Watershed
- _____ channel structure
- _____ Water quality
- _____ Temperature
- ___X__ Flow regime

___X__ Initial contracts with professional personnel have been made.

_N/A__ Tributaries to be included in study have been identified, if applicable.

___X__ Topographic maps of area have been obtained.

___X__ Geologic maps of area have been obtained, if available.

___X__ Streamflow records for area have been obtained.

___X__ Arrangements have been made to develop synthetic hydrographs for ungaged streams.

___X__ Equilibrium conditions of watershed and channel have been evaluated.

_N/A__ Arrangements have been made to model future channel structure, if necessary.

___X_ Existing water quality characteristics have been evaluated and screening equations applied to determine future water quality status.

_N/A__ Arrangements have been made to model future water quality, if necessary.

___X__ Longitudinal distribution of species has been determined.

___X__ Evaluation species have been selected.

___X__ Pertinent details of target species have been compiled (life history, food habits, water quality tolerances, and microhabitat usage).

___X__ Periodicity charts for target species have been prepared and referenced to stream segments

___X__ Display and interpretation requirements have been determined and acquisition of biological data, if required, has been included in study design.

APPENDIX D

CHECKLIST FOR ESTABLISHING STUDY AREAS

___X__ Topographic maps or suitable substitutes (e.g., aerial photos or other maps) of the study area have been assembled so that entire area is shown on one map.

___X__ Tributaries accreting more than 10% to the average base flow below the confluences have been identified and marked on the map.

_N/A__ Diversions removing more than 10% of the total flow of the river above the diversion have been identified and marked on the map.

___X__ Ground water sources or diffuse small tributaries, which in aggregate add 10% to the average base flow or add 10% to the drainage area-precipitation product, have been isolated and marked on the map.

___X__ Longitudinal profile of stream(s) has (have) been constructed.

___X__ Segment boundaries, based on relief, have been determined and marked on the map.

__X__ Significant sediment sources, such as moraines, landslides, and areas of sediment-generating land use, have been identified and marked on the map (if applicable).

___X__ Locations where channel sinuosity or width to depth ratio changes appreciably (more than 25%) have been identified and marked on the map (if applicable).

__N/A__ Locations where channel shape, channel pattern, bed particle size, or bank vegetation change appreciably have been identified and marked on the map (if applicable).

___X__ Stream reaches containing populations of coldwater species and warmwater species, as well as transitional reaches, have been identified and marked on the map (if applicable).

___X__ Point sources of pollution or thermal effluent have been located and marked on the map (if applicable).

___X__ Areas of land use affecting nonpoint pollution have been identified and marked on the map (if applicable).

___X__ If water quality is suspected to be a problem, or may be a problem under a proposed action, an expert has been consulted and water quality monitoring or modeling stations have been identified and marked on the map.

_N/A__ If watershed or channel change problems are anticipated, an expert in sediment transport and channel change has been consulted and appropriate actions recommended.

___X__ Segment boundaries isolating lengths of stream of less than 10% of the total stream length have been consolidated (remember well defined segment boundaries take precedence over poorly defined boundaries).

___X__ Average width of stream within each segment has been determined.

___X__ Length of candidate representative reaches has been calculated.

___X__ Candidate representative reaches have been marked on the map at appropriate spacing and numbered sequentially from the bottom of the segment to the top.

___X__ Candidate reaches having bridge crossings have been eliminated.

___X__ Three to five representative reaches have been chosen at random for each segment.

_N/A__ If not random, how were the representative reaches selected? Why?

_N/A__ Critical reaches, if present, have been identified and marked on the map (may include reaches less than 10% of total stream length in segment). What is the nature of the critical reach? (e.g., culvert, shallow bar inhibiting passage, or spawning areas).

___X__ Selected reaches have been inspected, redundant reaches eliminated and new reaches added where unrepresented portions of the river are detected.

___X__ Landowner permission to work at selected reaches has been obtained (if applicable).

__N/A_ If landowner permission to work at selected reaches is denied or the selected reaches are inaccessible, alternate reaches have been selected (if applicable). If so, how were the alternate sites selected?

___X__ Lengths of stream represented by representative reaches have been determined.

__N/A_ Lengths of stream represented by critical reaches have been determined.

APPENDIX E

CROSS-SECTIONAL PROFILE OF TRANSECTS

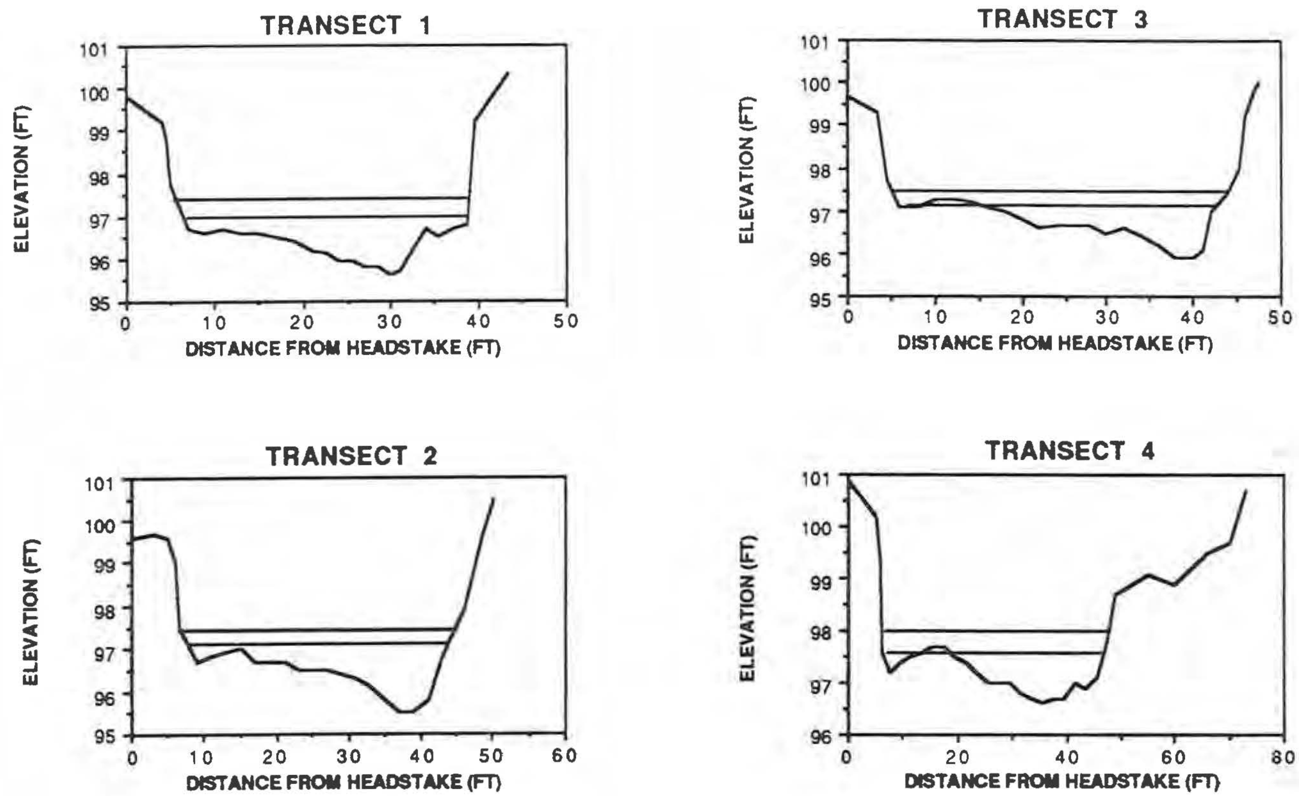


Figure E.1. Cross sectional profile of each transect, along which measurements were made, in the study reach representing the habitat in segment 1. the upper horizontal line represents the water surface elevation at the time high flow measurements were made and the lower line represents the water surface elevation at low flow measurements.

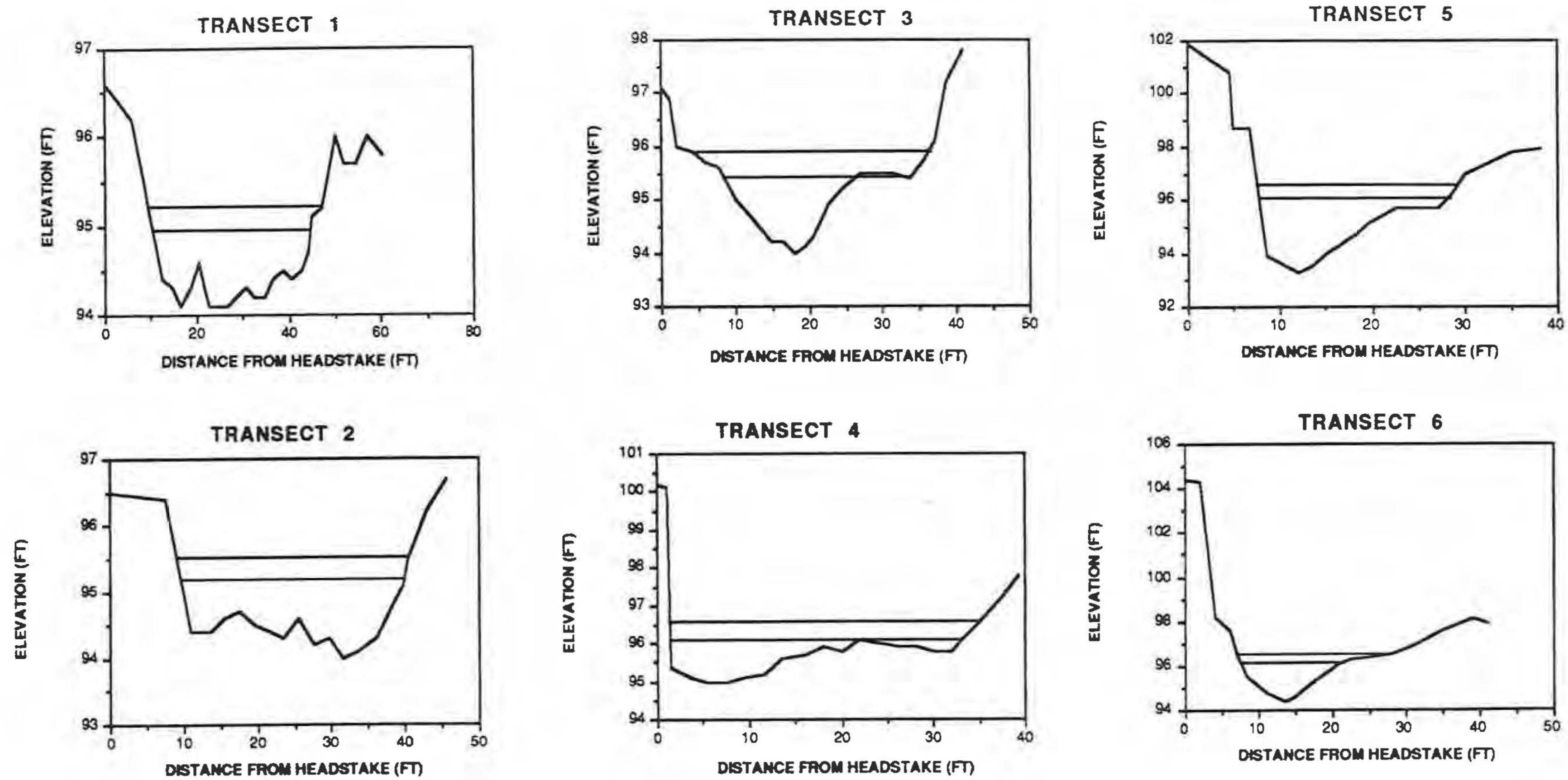


Figure E.2. Cross sectional profile of each transect, along which measurements were made, in the study reach representing the habitat in segment 2. the upper horizontal line represents the water surface elevation at the time high flow measurements were made and the lower line represents the water surface elevation at low flow measurements.

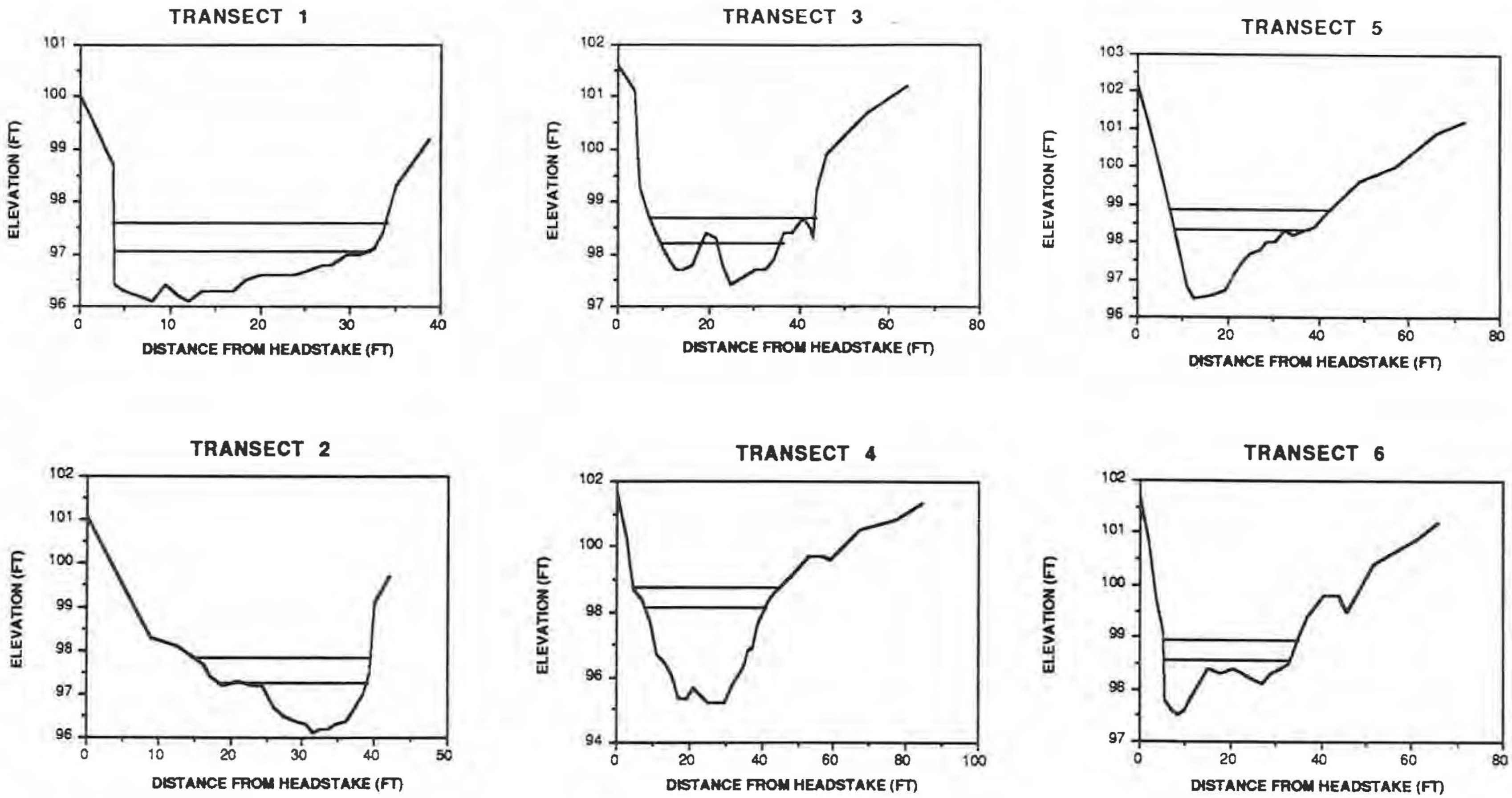


Figure E.3. Cross sectional profile of each transect, along which measurements were made, in the study reach representing the habitat in segment 3. the upper horizontal line represents the water surface elevation at the time high flow measurements were made and the lower line represents the water surface elevation at low flow measurements.

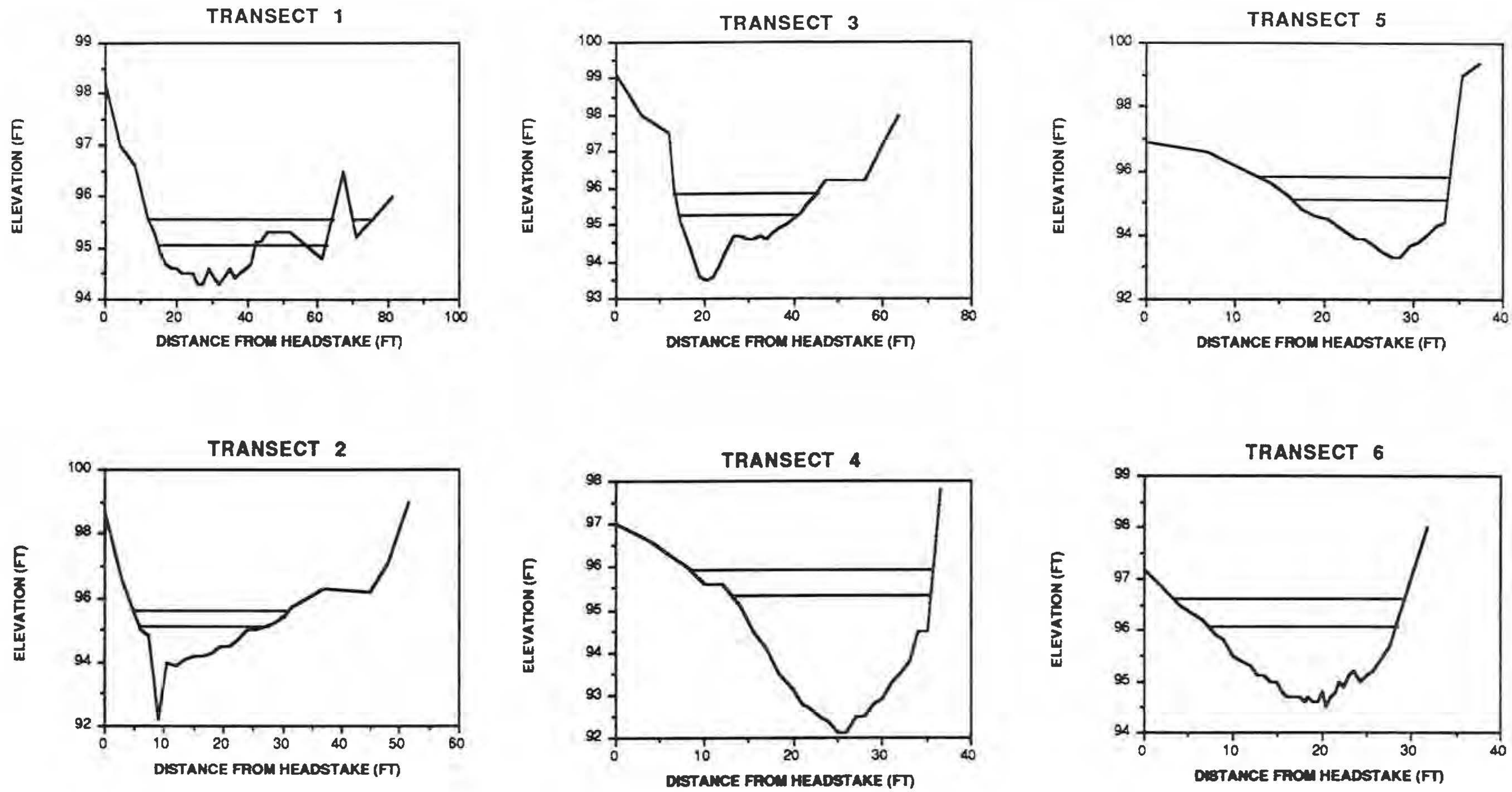


Figure E.4. Cross sectional profile of each transect, along which measurements were made, in the study reach representing the habitat in segment 4. the upper horizontal line represents the water surface elevation at the time high flow measurements were made and the lower line represents the water surface elevation at low flow measurements.

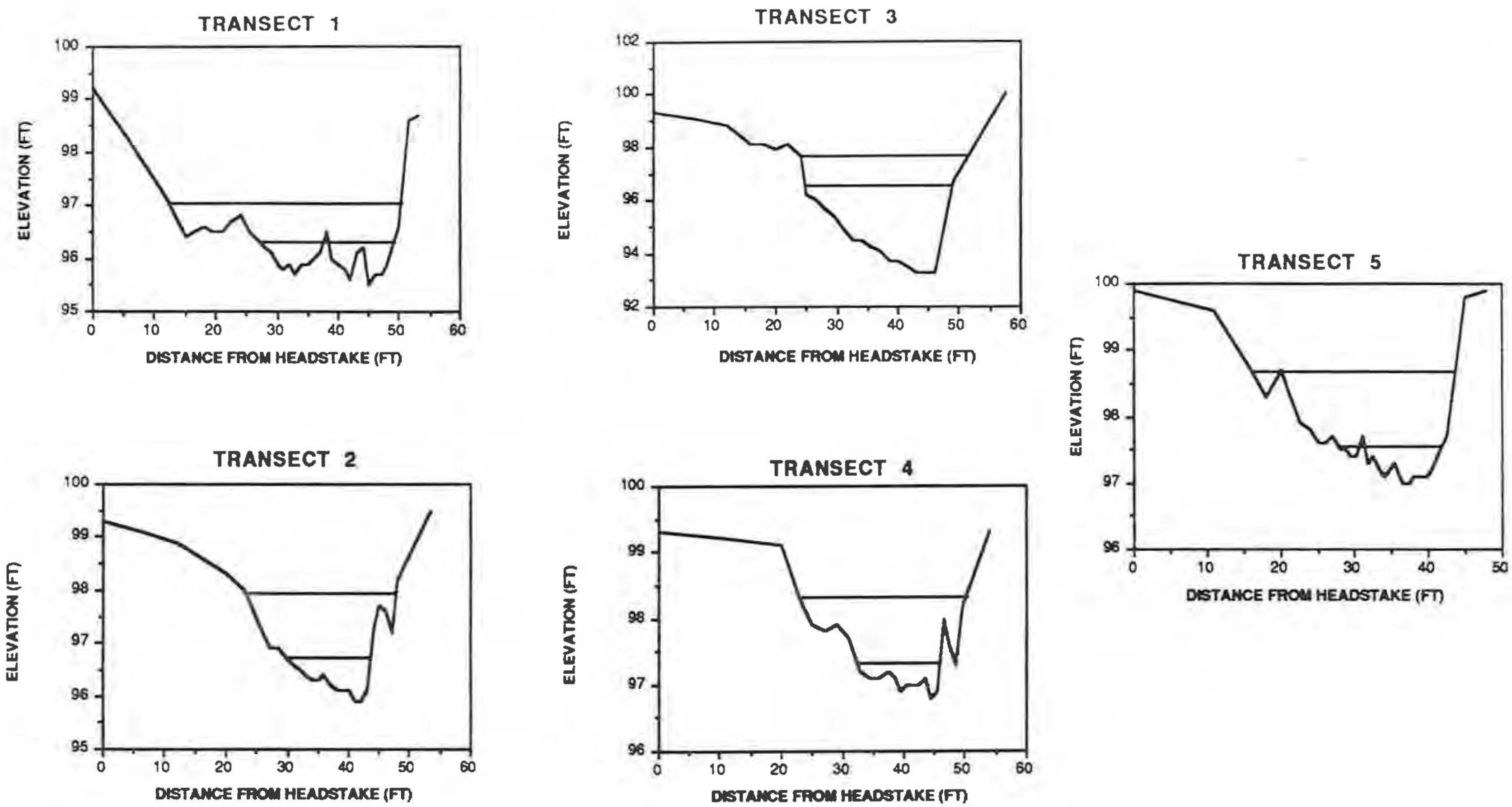


Figure E.5. Cross sectional profile of each transect, along which measurements were made, in the study reach representing the habitat in segment 5. the upper horizontal line represents the water surface elevation at the time high flow measurements were made and the lower line represents the water surface elevation at low flow measurements.

APPENDIX F

MICROHABITAT DATA COLLECTED FOR EACH TRANSECT

Table F.1. Microhabitat data for transect 1 of segment 1.

CHAMOKANE CREEK, REACH LOCATION - NW 1/4, Sec. 11, T. 27N, R. 39E
SEGMENT 1 REACH 1 TRANSECT # 1 OF 4
SITE ID - 0 STAGE ZERO FLOW - 95.6 SLOPE - 0.000208
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank- 0 R. Bank- 0
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-16-86	9-11-86
WATER SURFACE ELEVATION (Mean)	97.40	97.05
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.8	-	-	1.0	1
4.0	99.2	-	-	1.0	2
4.6	98.8	-	-	1.0	2
5.0	97.7	-	-	1.0	5
7.0	96.7	0	0	1.5	1
9.0	96.6	0	0	1.5	1
11.0	96.7	0.13	0	1.5	1
13.0	96.6	0.14	0	1.5	1
15.0	96.6	0.76	0.39	1.5	1
17.0	96.5	1.16	0.79	2.3	1
19.0	96.4	1.76	1.19	2.8	1
21.0	96.2	2.11	0.96	3.9	1
22.5	96.1	2.20	1.02	4.2	1
24.0	95.9	2.15	1.22	4.1	1
25.5	95.9	2.25	1.46	4.1	1
27.0	95.8	2.60	1.69	3.9	1
28.5	95.8	2.64	1.56	3.9	1
30.0	95.6	2.55	1.76	4.5	2
31.0	95.7	2.90	1.98	4.7	2
32.5	96.2	2.41	1.85	4.5	2
34.0	96.7	2.74	1.93	4.4	1
35.5	96.5	1.73	0.98	4.4	1
37.0	96.7	1.31	0.27	4.4	5
38.5	96.8	0.14	0	4.5	5
39.6	99.2	-	-	1.0	5
43.3	100.3	-	-	1.0	1

Table F.2. Microhabitat data for transect 2 of segment 1.

CHAMOKANE CREEK, REACH LOCATION - NW 1/4, Sec. 11, T. 27N, R. 39E
SEGMENT 1 REACH 1 TRANSECT # 2 OF 4
SITE ID - 48.1 STAGE ZERO FLOW - 95.6 SLOPE - 0.000789
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-15.2 R. Bank-81.0
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-16-86	9-11-86
WATER SURFACE ELEVATION (Mean)	97.41	97.06
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.6	-	-	1.0	1
3.0	99.7	-	-	1.0	2
5.0	99.6	-	-	1.0	1
6.0	99.0	-	-	1.0	2
6.5	97.5	-	-	3.2	5
9.0	96.7	0	0	1.5	1
11.0	96.8	0	0.43	2.3	1
13.0	96.9	0.33	0	2.1	1
15.0	97.0	0.39	0	2.4	1
17.0	96.7	0.74	0.25	2.2	1
19.0	96.7	1.53	1.16	3.7	1
21.0	96.7	2.11	1.36	3.8	1
23.0	96.5	2.25	1.39	3.9	1
25.0	96.5	2.60	1.11	4.1	1
27.0	96.5	2.30	0.94	4.3	1
29.0	96.4	2.30	0.83	4.5	1
31.0	96.3	2.64	1.11	4.5	1
33.0	96.1	2.25	1.36	4.6	1
35.0	95.8	1.85	1.28	4.2	1
37.0	95.5	2.35	1.14	3.5	1
39.0	95.5	2.11	1.89	4.3	1
41.0	95.8	0.69	0.96	4.7	5
43.0	96.8	0	-0.19	1.0	5
46.0	97.9	-	-	2.1	5
48.5	99.6	-	-	1.6	3
50.2	100.5	-	-	2.0	2

Table F.3. Microhabitat data for transect 3 of segment 1.

CHAMOKANE CREEK, REACH LOCATION - NW 1/4, Sec. 11, T. 27N, R. 39E
SEGMENT 1 REACH 1 TRANSECT # 3 OF 4
SITE ID - 63.4 STAGE ZERO FLOW - 95.9 SLOPE - 0.007648
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-19.1 R. Bank-11.5
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-16-86	9-11-86
WATER SURFACE ELEVATION (Mean)	97.45	97.19
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.7	-	-	1.0	1
3.5	99.3	-	-	1.0	2
4.6	97.7	-	-	1.0	5
6.0	97.1	1.39	0.19	3.3	5
8.0	97.1	1.93	0.69	4.9	2
10.0	97.3	0.88	-	4.5	1
12.0	97.3	0.76	-	2.6	1
14.0	97.2	0.49	-	3.5	1
16.0	97.1	0.33	0	3.5	1
18.0	97.0	0.98	0	3.5	1
20.0	96.8	0.98	0.52	3.8	1
22.0	96.6	2.25	1.59	3.8	1
24.0	96.7	2.79	2.20	4.1	1
26.0	96.7	2.64	1.11	3.9	1
28.0	96.7	2.79	1.93	3.9	1
30.0	96.5	3.21	3.44	4.1	1
32.0	96.6	2.85	2.79	3.8	1
34.0	96.4	2.15	1.98	3.6	1
36.0	96.2	2.55	0.46	3.8	1
38.0	95.9	2.30	2.35	3.6	1
40.0	95.9	3.02	2.90	3.2	1
41.0	96.1	1.76	2.64	1.8	1
42.0	97.0	0.51	-0.27	2.1	1
43.8	97.4	0	-	1.0	4
45.2	98.0	-	-	1.5	1
46.0	99.2	-	-	1.0	1
47.0	99.9	-	-	1.0	1
47.5	100.0	-	-	1.0	1

Table F.4. Microhabitat data for transect 4 of segment 1.

CHAMOKANE CREEK, REACH LOCATION - NW 1/4, Sec. 11, T. 27N, R. 39E
SEGMENT 1 REACH 1 TRANSECT # 4 OF 4
SITE ID - 100.4 STAGE ZERO FLOW - 96.6 SLOPE - 0.009730
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-40.6 R. Bank-33.4
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-16-86	9-11-86
WATER SURFACE ELEVATION (Mean)	97.81	97.59
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	100.9	-	-	1.0	2
5.0	100.2	-	-	1.0	2
5.8	99.4	-	-	1.0	5
6.2	97.6	0	-	1.8	5
7.5	97.2	1.80	0.81	3.5	5
9.5	97.4	2.20	0.76	3.8	1
11.5	97.5	1.69	0.44	3.8	2
13.5	97.6	1.28	-	3.8	1
15.5	97.7	1.30	-	3.7	1
17.5	97.7	1.42	-	4.1	1
19.5	97.5	2.41	0	4.4	1
21.5	97.4	1.62	0.49	3.5	2
23.5	97.2	1.22	1.22	3.6	1
25.5	97.0	1.98	1.42	3.9	1
27.5	97.0	2.35	1.93	3.5	1
29.5	97.0	2.60	1.98	3.7	1
31.5	96.8	2.47	2.30	3.8	1
33.5	96.7	2.90	2.15	3.8	1
35.5	96.6	3.44	2.51	4.1	2
37.5	96.7	3.21	3.08	4.2	1
39.5	96.7	3.36	2.35	4.3	1
41.5	97.0	3.15	3.36	4.3	1
43.5	96.9	1.98	0.64	4.1	1
45.5	97.1	0.67	0	3.9	1
47.5	97.8	0	-	3.5	1
49.5	98.7	-	-	1.0	1
55.0	99.1	-	-	2.0	1
60.0	98.9	-	-	2.0	1
66.0	99.5	-	-	1.0	1
70.0	99.7	-	-	1.5	1
73.1	100.7	-	-	1.0	1

Table F.5. Microhabitat data for transect 1 of segment 2.

CHAMOKANE CREEK, REACH LOCATION - NE 1/4, Sec. 2, T. 27N, R. 39E
SEGMENT 2 REACH 1 TRANSECT # 1 OF 6
SITE ID - 0 STAGE ZERO FLOW - 94.1 SLOPE - 0.004306
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-0 R. Bank-0
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-11-86	9-8-86
WATER SURFACE ELEVATION (Mean)	95.24	94.99
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	96.6	-	-	2.0	1
3.0	96.4	-	-	2.0	1
6.0	96.2	-	-	2.0	1
8.0	95.6	-	-	2.0	1
9.0	95.3	-	-	2.0	2
10.4	95.0	0.69	-	3.8	2
10.9	94.8	1.25	0	6.0	3
12.6	94.4	0.74	0.40	4.5	2
14.6	94.3	2.02	1.87	4.2	1
16.6	94.2	2.41	1.73	4.2	1
18.6	94.3	1.89	1.16	3.8	1
20.6	94.6	2.41	0.84	3.9	2
21.6	94.3	2.30	1.30	3.8	2
22.6	94.1	2.74	1.39	3.8	1
24.6	94.1	2.69	1.98	3.7	1
26.6	94.1	2.74	1.76	3.9	1
28.6	94.2	2.74	0.73	4.2	1
30.6	94.3	2.25	1.11	4.2	1
32.6	94.1	1.09	0.86	4.4	3
34.7	94.2	1.80	0.84	4.4	3
36.6	94.4	2.64	1.42	4.1	1
38.6	94.5	2.30	1.11	3.9	1
40.6	94.4	1.46	0.77	3.8	1
42.6	94.5	1.80	0.88	3.8	1
44.2	94.7	0.73	0	2.1	1
45.0	95.1	0.27	-	2.0	1
47.1	95.2	0	-	2.0	3
50.0	96.0	-	-	2.0	1
52.0	95.7	-	-	2.0	1
54.6	95.7	-	-	2.0	1
57.0	96.0	-	-	2.0	1
60.2	95.8	-	-	2.0	1

Table F.6. Microhabitat data for transect 2 of segment 2.

CHAMOKANE CREEK, REACH LOCATION - NE 1/4. Sec. 2. T. 27N. R. 39E
SEGMENT 2 REACH 1 TRANSECT # 2 OF 6
SITE ID - 62.7 STAGE ZERO FLOW - 94.1 SLOPE - 0.004420
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-62.0 R. Bank-63.5
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-11-86	9-8-86
WATER SURFACE ELEVATION (Mean)	95.51	95.23
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	96.5	-	-	2.0	1
7.5	96.4	-	-	2.0	1
11.0	94.4	1.19	0.39	2.3	4
13.6	94.4	1.42	0.35	3.8	1
15.6	94.6	1.42	1.02	3.9	1
17.6	94.7	1.42	0.90	4.0	1
19.6	94.5	1.66	1.20	3.8	1
21.6	94.4	1.98	1.23	3.8	1
23.6	94.3	3.79	1.33	3.8	1
25.6	94.6	2.96	1.38	6.0	2
27.6	94.2	2.47	1.57	3.6	1
29.6	94.3	2.64	1.54	4.2	2
31.6	94.0	2.74	1.54	3.8	1
33.6	94.1	2.35	1.38	4.2	1
36.0	94.3	1.42	0.59	3.8	2
38.0	94.7	1.36	0.37	4.6	2
39.7	95.1	0.69	0	5.0	1
40.5	95.5	0	-	2.0	1
43.0	96.2	-	-	2.0	1
45.6	96.7	-	-	2.0	1

Table F.7. Microhabitat data for transect 3 of segment 2.

CHAMOKANE CREEK, REACH LOCATION - NE 1/4, Sec 2, T. 27N, R. 39E
SEGMENT 2 REACH 1 TRANSECT # 3 OF 6
SITE ID - 156.1 STAGE ZERO FLOW - 94.1 SLOPE - 0.007555
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-91.8 R. Bank-95.0
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-11-86	9-8-86
WATER SURFACE ELEVATION (Mean)	95.93	95.49
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	97.1	-	-	2.0	3
1.2	96.9	-	-	2.0	1
2.0	96.0	-	-	4.0	2
4.4	95.9	0.39	-	4.9	1
6.0	95.7	0.57	-	3.9	1
7.8	95.6	0.57	-	4.1	1
10.0	95.0	0.27	0	3.2	5
12.0	94.7	1.00	0.58	3.8	5
14.9	94.2	3.06	1.89	5.8	5
16.5	94.2	4.52	4.10	4.3	1
18.0	94.0	3.69	3.02	4.3	1
19.5	94.1	3.21	2.47	4.3	1
20.5	94.3	2.15	1.73	4.0	1
22.5	94.9	1.66	0.69	3.9	1
24.5	95.2	1.25	0.40	3.5	1
27.0	95.5	0.98	0	3.9	1
29.5	95.5	0.94	0	3.4	1
31.5	95.5	1.73	0.84	4.0	1
33.5	95.4	0.96	0.43	4.0	1
35.5	95.7	0.76	-	2.9	1
36.9	96.1	-	-	3.9	1
38.5	97.2	-	-	3.5	1
40.8	97.8	-	-	2.2	1

Table F.8. Microhabitat data for transect 4 of segment 2.

CHAMOKANE CREEK, REACH LOCATION - NE 1/4, Sec. 2, T. 27N, R. 39E
SEGMENT 2 REACH 1 TRANSECT # 4 OF 6
SITE ID - 197.7 STAGE ZERO FLOW - 95.0 SLOPE - 0.010682
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-43.0 R. Bank-40.2
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-11-86	9-8-86
WATER SURFACE ELEVATION (Mean)	96.53	96.13
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	100.2	-	-	1.0	1
1.1	100.1	-	-	1.0	1
1.5	95.4	0.45	0.47	3.8	3
2.9	95.2	0.91	0.95	4.0	3
3.6	95.1	1.36	1.42	4.1	3
5.5	95.0	2.64	3.08	4.2	1
7.5	95.0	0.76	2.51	4.0	1
9.5	95.1	3.36	2.96	4.0	1
11.6	95.2	3.69	1.42	4.1	1
13.6	95.6	3.69	2.96	4.1	1
16.0	95.7	2.85	0.83	3.8	1
18.0	95.9	1.66	0	3.9	1
20.0	95.8	2.06	0.36	3.9	2
22.0	96.1	1.94	0.52	3.9	1
24.0	96.0	2.35	0.52	3.7	1
26.1	95.9	2.25	0.52	3.7	1
28.1	95.9	2.25	0.44	4.1	1
30.0	95.8	2.25	0.35	2.9	1
32.0	95.8	1.49	0.37	2.9	1
33.0	96.1	1.00	0	2.7	1
35.0	96.6	-	-	2.8	1
37.5	97.2	-	-	3.4	1
39.3	97.8	-	-	2.0	1

Table F.9. Microhabitat data for transect 5 of segment 2.

CHAMOKANE CREEK, REACH LOCATION - NE 1/4, Sec. 2, T. 27N, R. 39E
SEGMENT 2 REACH 1 TRANSECT # 5 OF 6
SITE ID - 223.5 STAGE ZERO FLOW - 95.0 SLOPE - 0.002622
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-28.8 R. Bank-22.8
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-11-86	9-8-86
WATER SURFACE ELEVATION (Mean)	96.65	96.23
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	101.9	-	-	1.0	1
4.5	100.8	-	-	1.0	1
4.9	98.7	-	-	1.5	1
6.8	98.7	-	-	1.5	1
8.5	93.9	0.27	0.14	4.0	3
9.6	93.7	0.69	0.27	4.5	3
12.0	93.3	2.72	1.36	4.5	4
13.5	93.5	2.97	1.35	4.0	1
15.0	94.0	2.31	1.11	3.8	4
16.5	94.3	1.98	0.84	3.8	1
18.0	94.7	1.66	0.86	3.5	4
19.5	95.1	1.48	0.55	3.5	1
22.5	95.7	0.81	0.51	1.7	1
25.0	95.7	0.68	0.32	2.0	1
27.0	95.7	0.32	0.18	3.2	1
28.5	96.2	0.34	0	4.0	1
30.0	97.0	-	-	3.2	1
35.0	97.8	-	-	2.0	1
38.2	97.9	-	-	2.0	1

Table F.10. Microhabitat data for transect 6 of segment 2.

CHAMOKANE CREEK, REACH LOCATION - NE 1/4, Sec. 2, T. 27N, R. 39E
SEGMENT 2 REACH 1 TRANSECT # 6 OF 6
SITE ID - 251.1 STAGE ZERO FLOW - 95.0 SLOPE - 0.000725
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-35.0 R. Bank-20.2
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-11-86	9-8-86
WATER SURFACE ELEVATION (Mean)	96.67	96.26
DISCHARGE (CFS)	66.9	27.0

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	104.4	-	-	1.0	1
2.1	104.3	-	-	1.0	1
4.0	98.2	-	-	1.0	1
6.2	97.6	-	-	1.0	1
7.0	96.5	0	0	2.0	1
8.4	95.5	0.84	-0.27	2.0	1
11.1	94.8	4.68	3.52	1.0	1
13.6	94.4	4.10	2.85	4.9	1
15.0	94.6	3.36	1.73	4.6	1
16.5	95.0	3.08	0.84	4.7	1
17.5	95.3	1.89	0.42	4.7	1
19.0	95.6	1.00	0	3.9	1
20.7	96.1	1.00	0	3.9	1
22.5	96.3	0.31	-	3.2	1
25.0	96.4	0.24	-	2.3	1
28.0	96.5	0	-	2.1	1
31.0	96.9	-	-	2.2	4
35.0	97.6	-	-	2.0	1
39.0	98.1	-	-	2.0	1
41.0	97.9	-	-	2.0	1

Table F.11. Microhabitat data for transect 1 of segment 3.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 23, T. 28N, R. 39E
SEGMENT 3 REACH 1 TRANSECT # 1 OF 6
SITE ID - 0 STAGE ZERO FLOW - 96.1 SLOPE - 0.002742
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-0 R. Bank-0
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-9-86	9-9-86
WATER SURFACE ELEVATION (Mean)	97.55	97.05
DISCHARGE (CFS)	50.3	14.3

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	100.0	-	-	1.0	3
3.6	98.7	-	-	1.0	2
3.8	96.4	1.50	0	1.5	3
5.0	96.3	0.28	0.47	1.5	3
6.5	96.2	0.43	1.16	2.0	3
8.0	96.1	2.02	0.90	2.0	3
9.5	96.4	0.58	0.73	2.0	2
10.9	96.2	0.32	0.32	2.2	1
12.0	96.1	1.25	1.85	4.0	1
13.5	96.3	3.08	2.51	4.0	1
15.0	96.3	3.02	2.02	3.8	1
17.0	96.3	2.47	1.73	3.8	1
18.5	96.5	2.30	1.25	4.0	1
20.0	96.6	2.60	1.66	4.0	1
21.5	96.6	1.13	1.22	4.0	1
22.5	96.6	1.80	0.98	4.0	1
24.0	96.6	1.42	0.94	4.0	1
25.5	96.7	0.73	0.35	3.9	1
27.0	96.8	1.76	0.31	3.9	1
28.0	96.8	0.94	0	5.1	3
29.5	97.0	1.69	0	3.8	1
31.0	97.0	0.96	0	4.0	1
32.7	97.1	0.69	-	2.0	2
33.6	97.4	0	-	2.0	2
35.0	99.3	-	-	2.0	1
38.7	99.2	-	-	2.0	1

Table F.12. Microhabitat data for transect 2 of segment 3.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 23, T. 28N, R. 39E
SEGMENT 3 REACH 1 TRANSECT # 2 OF 6
SITE ID - 76.6 STAGE ZERO FLOW - 96.1 SLOPE - 0.008885
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-83.0 R. Bank-70.2
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-9-86	9-9-86
WATER SURFACE ELEVATION (Mean)	97.76	97.33
DISCHARGE (CFS)	50.3	14.3

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	101.1	-	-	1.0	2
4.0	99.8	-	-	1.0	2
9.0	98.3	-	-	1.0	2
12.5	98.1	-	-	2.5	1
16.3	97.7	0	-	1.8	1
17.1	97.4	0	-	1.8	1
19.0	97.2	0	0	2.3	1
21.0	97.3	0	0	2.5	1
23.	97.2	0.25	0	3.8	1
24.5	97.2	0.15	0	4.0	1
26.0	96.7	0.88	0	3.3	1
27.5	96.5	1.62	0.35	4.0	1
29.0	96.4	2.51	1.15	4.0	1
30.5	96.3	3.21	1.53	3.9	1
31.5	96.1	3.52	1.46	3.9	1
32.5	96.2	3.02	2.20	3.7	1
33.5	96.2	3.08	2.35	4.5	1
34.5	96.3	4.79	3.02	4.5	1
36.0	96.4	4.47	0.62	4.0	4
37.0	96.6	3.21	0.29	3.2	4
38.3	97.0	0.59	0	3.8	5
39.3	97.5	0	-	2.8	5
40.0	99.1	-	-	1.0	2
42.1	99.7	-	-	1.0	1

Table F.13. Microhabitat data for transect 3 of segment 3.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 23, T. 28N, R. 39E
SEGMENT 3 REACH 1 TRANSECT # 3 OF 6
SITE ID - 128.3 STAGE ZERO FLOW - 97.4 SLOPE - 0.014443
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-47.0 R. Bank-56.4
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-9-86	9-9-86
WATER SURFACE ELEVATION (Mean)	98.69	98.33
DISCHARGE (CFS)	50.3	14.3

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	101.6	-	-	1.0	2
3.6	101.1	-	-	1.0	1
4.7	99.3	-	-	1.8	1
7.0	98.7	-	-	1.0	1
8.5	98.4	0.74	-	2.7	1
10.0	98.1	0.85	0	3.8	3
11.5	97.9	1.16	0.39	4.1	3
12.7	97.7	2.35	1.00	4.1	2
14.4	97.7	2.51	1.56	4.1	2
16.5	97.8	3.02	1.22	4.0	1
18.0	98.1	1.98	0.57	4.1	1
19.5	98.4	1.89	-	4.3	1
21.5	98.3	1.98	0.69	5.0	1
22.9	97.8	2.30	1.25	5.0	1
25.0	97.4	3.02	2.15	4.2	1
26.5	97.5	2.85	1.59	4.0	1
28.5	97.6	3.15	1.19	4.0	1
30.5	97.7	2.74	2.35	4.0	1
32.5	97.7	2.74	2.11	3.8	1
34.5	97.9	1.98	0.76	3.5	1
36.5	98.4	2.47	-	3.1	1
38.5	98.4	0.88	-	3.0	1
40.9	98.7	-	-	2.9	1
42.5	98.5	0	-	2.0	1
43.5	98.3	0	0	2.0	3
43.8	99.2	-	-	1.0	1
46.0	99.9	-	-	2.0	1
55.0	100.69	-	-	2.0	1
64.0	101.21	-	-	2.0	1

Table F.14. Microhabitat data for transect 4 of segment 3.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 23, T. 28N, R. 39E
SEGMENT 3 REACH 1 TRANSECT # 4 OF 6
SITE ID - 149.3 STAGE ZERO FLOW - 97.4 SLOPE - 0.005476
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-25.5 R. Bank-16.5
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-9-86	9-9-86
WATER SURFACE ELEVATION (Mean)	98.81	98.32
DISCHARGE (CFS)	50.3	14.3

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	101.7	-	-	1.0	1
2.7	100.2	-	-	1.0	1
3.6	99.4	-	-	1.0	1
4.6	98.7	0	-	2.6	1
7.0	98.4	-0.18	-	2.6	1
9.0	97.7	-0.29	0	3.2	1
11.0	96.7	0.14	0	4.5	4
13.0	96.5	0.83	0.25	3.5	4
15.0	96.1	0.81	0.40	3.2	5
17.0	95.4	0.76	0.35	4.5	5
19.0	95.3	0.71	0.31	3.8	5
21.0	95.7	0.31	0.10	2.9	5
23.0	95.5	0.25	0.25	4.7	5
25.0	95.2	1.28	0.33	4.3	5
27.0	95.2	1.33	0.31	4.5	5
29.5	95.2	1.18	0.52	3.9	5
31.5	95.7	0.67	0.81	2.8	5
32.5	95.9	0.78	0.69	3.9	5
34.0	96.1	0.73	0.37	4.5	5
35.3	96.4	0.53	0.25	4.5	5
36.3	96.8	0.49	-0.23	3.8	3
37.5	96.9	0.18	-0.35	2.5	1
39.0	97.6	0.47	-0.28	2.0	1
42.0	98.4	0.48	-	2.2	1
44.4	98.7	0	-	2.8	1
49.0	99.2	-	-	2.0	1
53.0	99.7	-	-	2.0	1
56.5	99.7	-	-	2.0	1
59.0	99.6	-	-	2.0	1
67.0	100.5	-	-	2.0	1
77.0	100.8	-	-	2.0	1
84.4	101.3	-	-	2.0	1

Table F.15. Microhabitat data for transect 5 of segment 3.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 23, T. 28N, R. 39E
SEGMENT 3 REACH 1 TRANSECT # 5 OF 6
SITE ID - 163.0 STAGE ZERO FLOW - 97.4 SLOPE - 0.004698
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-26.0 R. Bank-1.3
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-9-86	9-9-86
WATER SURFACE ELEVATION (Mean)	98.88	98.41
DISCHARGE (CFS)	50.3	14.3

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	102.2	-	-	2.0	1
4.0	100.4	-	-	1.0	2
7.5	98.6	0	-	1.0	5
10.9	96.8	0.38	0.39	4.0	5
12.5	96.5	0.76	0.35	3.5	4
16.3	96.6	0.96	0.09	4.0	4
19.4	96.7	1.00	0.23	4.3	5
21.5	97.2	0.84	0.86	4.0	5
23.5	97.5	1.25	1.93	4.0	1
25.0	97.7	1.98	0.27	4.0	1
27.0	97.8	2.47	2.15	4.0	1
28.5	98.0	2.35	2.15	4.0	1
30.5	98.0	3.44	2.15	4.0	1
32.5	98.3	3.52	3.36	4.0	1
34.4	98.2	3.08	1.85	4.0	1
37.0	98.3	1.89	1.16	3.8	1
39.0	98.4	0.55	0	3.3	1
42.0	98.8	0	-	3.2	1
49.0	99.6	-	-	2.0	1
57.0	100.0	-	-	2.0	1
66.0	100.9	-	-	2.0	1
72.3	101.2	-	-	2.0	1

Table F.16. Microhabitat data for transect 6 of segment 3.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 23, T. 28N, R. 39E
SEGMENT 3 REACH 1 TRANSECT # 6 OF 6
SITE ID - 179.1 STAGE ZERO FLOW - 97.5 SLOPE - 0.004348
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-20.5 R. Bank-11.6
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-9-86	9-9-86
WATER SURFACE ELEVATION (Mean)	98.95	98.57
DISCHARGE (CFS)	50.3	14.3

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	101.7	-	-	1.0	4
2.0	100.9	-	-	1.0	1
3.5	99.7	-	-	1.0	1
5.2	99.1	-	-	1.0	1
5.5	97.8	0.98	0.25	2.0	3
7.0	97.6	0.69	0.40	2.0	4
8.5	97.5	0.57	0.19	2.2	4
10.0	97.6	2.35	1.36	3.3	4
11.0	97.8	2.35	0.78	4.0	2
13.0	98.1	1.59	1.66	4.0	1
15.0	98.4	1.89	1.39	4.0	1
18.0	98.3	3.69	2.35	4.0	1
20.5	98.4	3.60	2.47	4.3	1
22.5	98.3	3.28	2.47	4.1	1
24.5	98.2	3.69	2.25	4.1	1
27.0	98.1	3.52	2.20	4.1	1
29.0	98.3	3.28	1.80	4.0	1
31.0	98.4	3.52	1.59	3.9	1
33.0	98.5	1.80	0.16	3.7	1
35.0	99.0	-	-	2.4	1
37.0	99.4	-	-	2.2	1
40.5	99.8	-	-	2.5	2
44.0	99.8	-	-	2.0	1
45.5	99.5	-	-	2.0	1
51.5	100.4	-	-	2.0	2
61.0	100.9	-	-	2.0	1
65.7	101.2	-	-	2.0	1

Table F.17. Microhabitat data for transect 1 of segment 4.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 24, T. 28N, R. 39E
SEGMENT 4 REACH 1 TRANSECT # 1 OF 6
SITE ID - 0 STAGE ZERO FLOW - 94.3 SLOPE - 0.002826
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-0 R. Bank-0
UPSTREAM WEIGHING FACTOR - 0.5

DATE SET NUMBER	1	2
DATE	4-5-86	9-10-86
WATER SURFACE ELEVATION (Mean)	95.59	95.15
DISCHARGE (CFS)	72.2	13.45

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	98.2	-	-	2.5	1
4.0	97.0	-	-	2.0	1
8.0	96.6	-	-	2.2	2
12.0	95.6	-	-	3.3	2
14.0	95.2	0.91	-	4.5	1
15.5	94.9	2.00	0	4.6	2
17.0	94.7	2.39	1.14	5.3	2
18.5	94.6	2.92	1.19	5.3	2
20.0	94.6	2.86	0.78	5.2	1
21.5	94.5	2.55	0.83	5.4	2
23.0	94.5	2.44	0.90	5.2	1
24.5	94.5	2.99	1.09	5.4	2
26.0	94.3	2.55	0.71	5.0	2
27.5	94.3	2.99	0.98	5.4	2
29.0	94.6	2.80	1.25	5.8	2
30.5	94.4	3.06	1.14	5.4	2
32.0	94.3	2.92	1.39	5.6	2
33.5	94.4	2.39	0.60	5.7	2
35.0	94.6	2.74	1.00	5.3	2
36.5	94.4	2.74	0.68	5.1	2
38.0	94.5	2.34	0.88	5.0	2
39.5	94.6	1.73	0.73	5.0	1
41.0	94.7	2.05	0.35	5.0	2
42.5	95.1	1.03	0	4.8	2
44.0	95.1	0.68	0	4.6	2
45.5	95.3	0.23	-	4.8	1
52.0	95.3	0	-	5.4	2
61.0	94.8	0	-	1.0	2
67.0	96.5	-	-	1.0	2
71.0	95.2	-	-	1.0	2
81.4	96.0	-	-	1.0	2

Table F.18. Microhabitat data for transect 2 of segment 4.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 24, T. 28N, R. 39E
SEGMENT 4 REACH 1 TRANSECT # 2 OF 6
SITE ID - 92.0 STAGE ZERO FLOW - 94.3 SLOPE - 0.003128
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-96.0 R. Bank-88.0
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-5-86	9-10-86
WATER SURFACE ELEVATION (Mean)	95.85	95.23
DISCHARGE (CFS)	72.2	13.4

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	98.7	-	-	3.5	1
3.0	96.5	-	-	3.6	4
4.5	95.8	0	-	4.4	1
6.0	95.0	0.80	0	5.5	2
7.5	94.8	2.10	0.15	5.2	1
9.0	92.2	2.55	0.73	5.3	1
10.5	94.0	2.44	0.96	5.4	2
12.0	93.9	2.39	0.86	5.3	2
13.5	94.1	2.24	0.76	4.8	2
15.0	94.2	2.0	1.22	4.5	1
16.5	94.2	2.29	0.96	4.5	1
18.0	94.3	2.29	1.16	4.5	2
19.5	94.5	2.10	0.64	4.5	2
21.0	94.5	2.15	0.68	4.7	2
22.5	94.7	2.55	0.27	5.2	2
24.0	95.0	2.44	0.29	5.2	2
25.5	95.0	2.34	0.10	5.1	2
27.0	95.1	1.88	0.10	5.1	2
28.5	95.2	1.96	0	5.3	2
30.0	95.4	1.65	-	4.9	2
31.5	95.7	0.83	-	4.5	2
37.0	96.3	-	-	4.2	1
45.0	96.2	-	-	2.5	2
48.0	97.1	-	-	2.5	1
51.6	99.0	-	-	1.0	1

Table F.19. Microhabitat data for transect 3 of segment 4.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 24, T. 28N, R. 39E
SEGMENT 4 REACH 1 TRANSECT # 3 OF 6
SITE ID - 102.3 STAGE ZERO FLOW - 94.3 SLOPE - 0.002809
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-14.5 R. Bank-6.0
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-5-86	9-10-86
WATER SURFACE ELEVATION (Mean)	95.91	95.26
DISCHARGE (CFS)	72.2	13.4

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.1	-	-	2.5	1
6.0	98.0	-	-	2.0	1
12.0	97.5	-	-	1.0	2
13.0	96.0	-	-	3.2	4
14.5	95.1	0.53	0	4.1	4
16.0	94.6	0.98	0.31	4.5	1
17.5	94.1	1.73	0.47	4.7	1
19.0	93.6	1.76	0.46	4.7	1
20.5	93.5	1.54	0.43	4.8	1
22.0	93.6	1.62	0.43	3.5	1
23.5	93.9	1.38	0.38	3.7	1
25.0	94.3	1.38	0.38	3.6	1
26.5	94.7	1.65	1.49	3.5	1
28.0	94.7	2.44	1.76	3.8	1
29.5	94.6	2.74	1.73	3.8	1
31.0	94.6	2.68	1.16	4.3	2
32.5	94.7	2.92	1.11	4.5	2
34.0	94.6	2.50	0.55	4.6	2
35.5	94.8	2.68	0.96	4.6	2
37.0	94.9	2.50	1.22	3.8	2
38.5	95.0	2.15	0.51	4.6	2
40.0	95.2	1.88	0.29	4.5	2
41.5	95.3	1.54	-	4.4	2
43.0	95.6	1.02	-	4.6	2
45.0	95.8	0.51	-	3.8	1
47.0	96.2	-	-	2.7	1
56.0	96.2	-	-	1.0	1
60.0	97.2	-	-	2.8	1
63.5	98.0	-	-	1.0	2

Table F.20. Microhabitat data for transect 4 of segment 4.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 24, T. 28N, R. 39E
SEGMENT 4 REACH 1 TRANSECT # 4 OF 6
SITE ID - 127.6 STAGE ZERO FLOW - 94.3 SLOPE - 0.001038
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-28.5 R. Bank-22.0
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-5-86	9-10-86
WATER SURFACE ELEVATION (Mean)	95.95	95.29
DISCHARGE (CFS)	72.2	13.4

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	97.0	-	-	2.7	1
4.0	96.6	-	-	2.8	1
8.0	96.0	-	-	2.5	1
10.0	95.6	0.54	-	2.5	1
12.0	95.6	0.86	-	2.5	1
14.0	95.1	0.99	0	3.2	1
15.5	94.5	1.38	0.18	3.8	1
17.0	94.1	1.88	0.27	3.8	1
18.5	93.5	2.39	0.54	3.8	1
20.0	93.1	2.26	0.67	3.3	1
21.0	92.8	2.37	0.64	3.5	1
22.0	92.7	2.33	0.61	3.3	1
23.0	92.5	2.18	0.89	3.3	1
24.0	92.4	2.29	0.77	3.4	1
25.0	92.1	2.89	0.61	3.5	1
26.0	92.1	3.12	0.31	4.5	1
27.0	92.5	1.40	0.15	4.5	5
28.0	92.5	0.64	-0.16	3.7	5
29.0	92.8	0.32	-0.08	3.4	5
30.0	92.9	0.16	-0.08	3.5	5
31.0	93.3	-0.85	-0.05	2.2	5
32.0	93.5	-0.85	-0.05	2.3	5
33.0	93.8	-0.85	-0.05	2.5	5
34.0	94.5	0	-0.02	2.6	5
35.0	94.5	0	0	1.5	5
36.6	97.8	-	-	1.0	4

Table F.21. Microhabitat data for transect 5 of segment 4.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 24, T. 28N, R. 39E
SEGMENT 4 REACH 1 TRANSECT # 5 OF 6
SITE ID - 160.1 STAGE ZERO FLOW - 94.3 SLOPE - 0.002778
DISTANCE TO ADJACENT DOWN STREAM TRANSECT: L. Bank-33.0 R. Bank-32.0
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-5-86	9-10-86
WATER SURFACE ELEVATION (Mean)	95.97	95.26
DISCHARGE (CFS)	72.2	13.4

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	96.9	-	-	2.5	2
7.0	96.6	0	-	2.2	1
14.0	95.6	0	-	2.5	1
16.0	95.2	0	0	2.6	1
17.5	94.8	0.11	0	2.5	1
19.0	94.6	0.91	-0.09	2.5	1
20.5	94.5	1.23	0	2.8	1
22.5	94.1	2.05	0.48	2.8	1
23.5	93.9	2.34	0.67	3.2	1
24.5	93.9	2.10	0.75	4.2	1
25.5	93.7	2.00	0.82	4.0	1
26.5	93.5	2.86	1.11	4.2	1
27.5	93.3	3.22	1.33	4.2	1
28.5	93.3	3.44	1.58	4.3	1
29.5	93.7	3.80	0.90	4.4	1
30.5	93.8	3.50	0.40	4.5	1
31.5	94.0	2.44	-0.41	4.5	2
32.5	94.3	1.26	-0.31	4.5	5
33.5	94.4	0.63	0	4.2	5
34.5	97.0	-	-	1.0	5
35.5	99.0	-	-	1.0	1
37.5	99.4	-	-	1.0	2

Table F.22. Microhabitat data for transect 6 of segment 4.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 24, T. 28N, R. 39E
SEGMENT 4 REACH 1 TRANSECT # 6 OF 6
SITE ID - 217.6 STAGE ZERO FLOW - 94.5 SLOPE - 0.004000
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-45.0 R. Bank-70.0
UPSTREAM WEIGHING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-5-86	9-10-86
WATER SURFACE ELEVATION (Mean)	96.20	95.64
DISCHARGE (CFS)	72.2	13.4

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	97.2	-	-	2.5	1
4.0	96.5	-	-	2.7	1
6.5	96.2	0	-	2.7	1
8.0	95.9	0.93	-	2.8	1
9.0	95.8	1.41	-	2.8	1
10.0	95.5	1.84	0	3.2	1
11.0	95.4	2.50	0.09	3.3	1
12.0	95.3	2.20	0.26	3.5	1
12.75	95.1	2.61	0.27	3.6	1
13.5	95.1	2.55	0.52	3.6	1
14.25	95.0	3.13	0.76	3.6	1
15.0	95.0	3.21	0.83	4.0	1
15.5	94.8	3.50	0.76	3.5	1
16.0	94.7	3.50	1.00	3.8	1
16.5	94.7	3.21	1.19	3.8	1
17.0	94.7	2.74	1.11	3.8	1
17.5	94.7	3.06	1.36	4.2	1
18.0	94.6	3.06	1.46	4.2	1
18.5	94.7	3.21	1.36	4.5	1
19.0	94.6	3.43	1.85	4.3	1
19.5	94.6	3.72	1.80	4.5	1
20.0	94.8	3.89	1.76	4.5	1
20.5	94.5	4.07	1.98	4.5	1
21.0	94.7	4.26	1.30	4.7	1
21.5	94.8	3.98	1.73	4.7	1
22.0	95.0	3.89	1.66	4.8	1
22.5	94.9	3.72	1.28	4.3	1
23.0	95.1	2.74	1.39	4.5	1
23.5	95.2	3.28	0.64	4.5	1
24.25	95.0	2.99	1.16	4.3	1
25.0	95.1	3.28	1.30	4.5	1
25.75	95.2	2.99	0.81	4.5	2
26.5	95.4	2.68	0.20	4.4	2
27.5	95.7	1.18	-	4.3	2
28.5	96.2	0.78	-	4.0	1
31.8	98.0	-	-	2.5	1

Table F.23. Microhabitat data for transect 1 of segment 5.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 19, T. 28N, R. 40E
SEGMENT 5 REACH 1 TRANSECT # 1 OF 5
SITE ID - 0 STAGE ZERO FLOW - 95.6 SLOPE - 0.008224
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-0 R. Bank-0
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-3-86	9-12-86
WATER SURFACE ELEVATION (Mean)	97.07	96.33
DISCHARGE (CFS)	66.7	0.93

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.2	-	-	1.0	1
6.0	98.2	-	-	1.0	1
12.0	97.1	-	-	1.0	1
15.0	96.4	1.26	-	3.8	1
16.5	96.5	1.13	-	3.5	1
18.0	96.6	1.88	-	3.8	1
19.5	96.5	2.24	-	4.0	1
21.0	96.5	2.41	-	4.3	1
22.5	96.7	2.06	-	4.4	1
24.0	96.8	2.44	-	2.5	1
25.5	96.5	2.10	-	3.5	1
27.0	96.3	1.88	0.10	4.2	1
28.0	96.2	2.74	0.10	4.5	1
29.0	96.1	3.24	0.15	4.5	1
30.0	95.9	2.74	0.26	4.3	1
31.0	95.8	3.21	0.25	4.2	1
32.0	95.9	2.80	0.22	4.5	1
33.0	95.7	2.39	0.15	4.7	1
34.0	95.9	3.13	0.18	4.5	1
35.0	95.9	3.28	0.39	4.6	1
36.0	96.0	2.74	0.70	4.5	1
37.0	96.1	2.15	1.05	3.8	1
38.0	96.5	0.70	-	3.8	2
39.0	96.0	0.70	0.16	3.2	2
40.0	95.9	0.70	0.17	3.2	2
41.0	95.8	0.82	0.18	4.0	2
42.0	95.6	0.91	0.10	3.8	1
43.0	96.1	1.38	0.10	1.0	1
44.0	96.2	2.20	0.15	3.5	1
45.0	95.5	2.55	0.10	3.8	1
46.0	95.7	0.78	0.10	3.8	1
47.0	95.7	0.44	0.10	3.8	1
48.0	95.9	0.41	0.05	2.5	1
49.0	96.3	0.28	0	2.5	1
50.0	96.6	0.15	-	2.0	3
51.5	98.6	-	-	1.0	1
53.1	98.7	-	-	1.0	1

Table F.24. Microhabitat data for transect 2 of segment 5.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 19 T. 28N. R. 40E
SEGMENT 5 REACH 1 TRANSECT # 2 OF 5
SITE ID - 107.0 STAGE ZERO FLOW - 95.9 SLOPE - 0.007378
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-102.5 R. Bank-111.5
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-3-86	9-12-86
WATER SURFACE ELEVATION (Mean)	97.95	96.69
DISCHARGE (CFS)	66.7	0.93

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.3	-	-	1.0	3
6.0	99.1	-	-	1.0	3
12.0	98.9	-	-	1.0	2
20.0	98.3	-	-	1.0	1
23.0	98.0	-	-	1.0	2
25.0	97.5	0	-	2.5	1
27.0	96.9	0.43	-	4.0	1
28.5	96.9	2.24	-	3.5	1
30.0	96.7	2.74	-	3.8	1
31.0	96.6	3.13	0	4.3	1
32.0	96.5	3.21	0.10	4.7	2
33.0	96.4	3.28	0.27	4.2	1
34.0	96.3	3.21	0.48	4.5	1
35.0	96.3	3.37	0.34	4.7	2
36.0	96.4	3.13	0.58	4.5	1
37.0	96.2	3.50	0.34	4.6	1
38.0	96.1	3.43	0.55	4.8	2
39.0	96.1	3.21	0.39	4.7	2
40.0	96.1	3.06	0.27	4.4	1
41.0	95.9	3.37	0.10	4.2	1
42.0	95.9	3.13	0.10	4.0	1
43.0	96.1	3.13	0.10	2.0	4
44.0	97.3	0.20	-	1.0	1
45.0	97.7	0.20	-	1.0	1
46.0	97.6	0	-	3.5	1
47.0	97.2	0	-	4.2	2
48.0	98.2	-	-	5.0	1
53.4	99.5	-	-	2.5	1

Table F.25. Microhabitat data for transect 3 of segment 5.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4, Sec. 19 T. 28N. R. 40E
SEGMENT 5 REACH 1 TRANSECT # 3 OF 5
SITE ID - 124.7 STAGE ZERO FLOW - 95.9 SLOPE - 0.007422
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-10.0 R. Bank-25.5
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-3-86	9-12-86
WATER SURFACE ELEVATION (Mean)	97.99	96.68
DISCHARGE (CFS)	66.7	0.93

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.3	-	-	1.0	3
7.0	99.1	-	-	1.0	3
12.0	98.8	-	-	1.0	3
16.0	98.1	-	-	1.0	2
18.0	98.1	-	-	1.0	3
20.0	97.9	0	-	1.0	2
22.0	98.1	-	-	1.0	4
24.0	97.7	0	-	1.0	4
25.0	96.2	-0.38	-0.01	2.0	4
26.5	96.0	-0.33	-0.01	2.5	4
28.0	95.7	-0.47	-0.02	3.5	4
29.5	95.4	-0.40	-0.02	3.5	4
31.0	94.9	0.61	0.03	2.2	4
32.5	94.5	0.79	0.04	2.4	4
34.0	94.5	1.25	0.06	3.6	4
35.5	94.2	1.51	0.06	3.8	4
37.0	94.1	1.59	0.01	3.5	4
38.5	93.7	1.90	0.01	4.5	4
40.0	93.7	2.05	0.01	4.0	4
41.5	93.5	2.13	0.01	4.0	4
43.0	93.3	1.47	0.06	4.0	4
44.5	93.3	0.82	0.06	4.0	4
46.0	93.3	0.50	0.03	4.0	5
49.0	96.7	0.10	-	3.5	5
57.5	100.0	-	-	3.5	1

Table F.26. Microhabitat data for transect 4 of segment 5.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4 Sec. 19 T. 28N. R.40E
SEGMENT 5 REACH 1 TRANSECT # 4 OF 5
SITE ID - 158.2 STAGE ZERO FLOW - 96.8 SLOPE - 0.010127
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-21.5 R. Bank-45.5
UPSTREAM WEIGHTING FACTOR - 0.5

DATA SET NUMBER	1	2
DATE	4-3-86	9-12-86
WATER SURFACE ELEVATION (Mean)	98.33	97.33
DISCHARGE (CFS)	66.7	0.93

Distance from Head Pin(ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate Cover Code	
		1	2	SUB	COV
0	99.3	-	-	1.0	3
11.0	99.2	-	-	1.0	3
20.0	99.1	-	-	1.5	1
23.0	98.3	0	-	1.0	1
25.0	97.9	1.47	-	3.8	1
27.0	97.8	2.12	-	4.0	1
29.0	97.9	2.97	-	4.0	1
31.0	97.7	0.20	-	2.5	1
33.0	97.2	3.37	0	3.9	1
34.5	97.1	3.31	0.33	4.2	1
36.0	97.1	2.97	0	3.8	1
37.5	97.2	4.26	0.43	4.3	1
38.5	97.1	4.07	0.18	4.3	1
39.5	96.9	4.82	0.20	4.4	1
40.5	97.0	3.72	0.20	4.5	1
41.5	97.0	4.75	0.57	4.5	1
42.5	97.0	4.96	2.15	4.3	1
43.5	97.1	4.16	0.20	4.2	1
44.5	96.8	4.46	0.10	4.2	3
45.5	96.9	3.13	0	1.5	3
46.5	98.0	0	-	1.0	3
47.5	97.6	2.55	-	4.2	5
48.5	97.3	2.00	-	2.2	5
49.5	98.2	0	-	1.0	1
54.1	99.3	-	-	1.0	1

Table F.27. Microhabitat data for transect 5 of segment 5.

CHAMOKANE CREEK, REACH LOCATION - SE 1/4 Sec 19 T. 28N. R. 40E
SEGMENT 5 REACH 1 TRANSECT # 5 OF 5
SITE ID - 187.9 STAGE ZERO FLOW - 97.0 SLOPE - 0.010101
DISTANCE TO ADJACENT DOWNSTREAM TRANSECT: L. Bank-28.0 R. Bank-31.5
UPSTREAM WEIGHTING FACTOR - 0.5

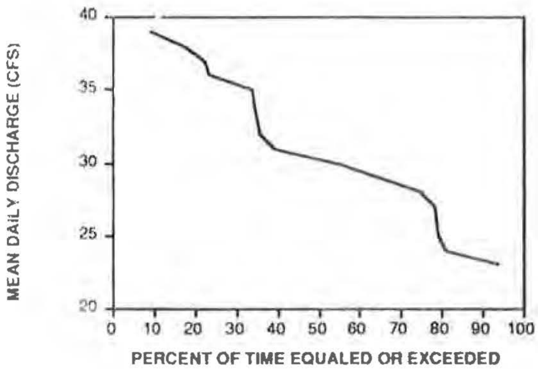
DATA SET NUMBER	1	2
DATE	4-3-86	9-12-86
WATER SURFACE ELEVATION (Mean)	98.63	97.58
DISCHARGE (CFS)	66.7	0.93

Distance from Head Pin (ft.)	Ground Elevation (feet)	Mean Cell Velocity (FPS)		Substrate/ Cover Code	
		1	2	SUB	COV
0	99.9	-	-	1.0	1
11.0	99.6	-	-	1.0	4
16.0	98.7	-	-	1.0	1
18.0	98.3	-	-	1.0	1
20.0	98.7	-	-	1.0	1
21.0	98.4	0	-	1.0	1
22.5	97.9	2.00	-	3.4	1
24.0	97.8	1.26	-	3.8	1
25.0	97.6	1.65	-	4.1	1
26.0	97.6	2.44	-	4.2	1
27.0	97.7	2.20	-	4.4	1
28.0	97.5	2.80	0	4.5	1
28.75	97.5	2.68	0	4.7	1
29.5	97.4	2.74	0.14	4.5	1
30.25	97.4	1.88	0	4.3	1
31.0	97.7	3.28	-	4.4	1
31.75	97.3	3.13	0.29	4.0	1
32.5	97.4	3.06	0.29	3.8	1
33.25	97.2	2.68	0.25	3.8	1
34.0	97.1	2.68	0.25	4.3	2
34.75	97.2	3.13	0.25	4.5	1
35.5	97.3	3.31	0.25	4.0	1
36.0	97.1	3.28	0.62	4.0	1
36.5	97.0	3.06	0.98	4.2	1
37.0	97.0	3.65	1.04	4.5	2
37.5	97.0	3.65	0.57	4.5	2
38.0	97.1	3.80	0.25	4.2	1
38.5	97.1	3.06	0.10	3.8	1
39.0	97.1	3.28	0.14	3.8	1
39.75	97.1	2.39	0.14	3.8	1
40.5	97.2	2.50	0.10	3.5	1
41.5	97.5	2.00	0	3.2	2
42.5	97.7	0.20	-	2.5	2
45.0	99.8	-	-	1.0	1
47.9	99.9	-	-	2.5	1

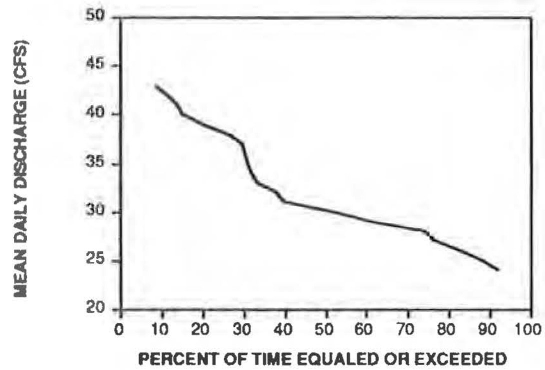
APPENDIX G.

FLOW DURATION CURVES FOR CHAMOKANE CREEK

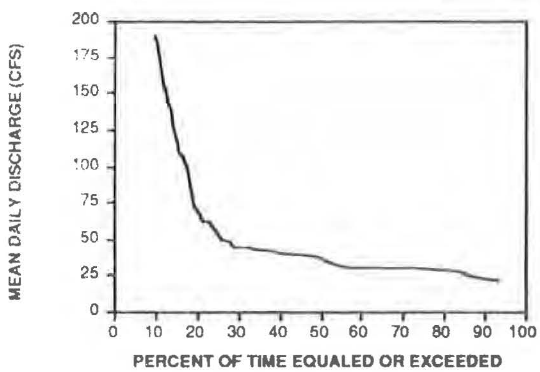
OCTOBER



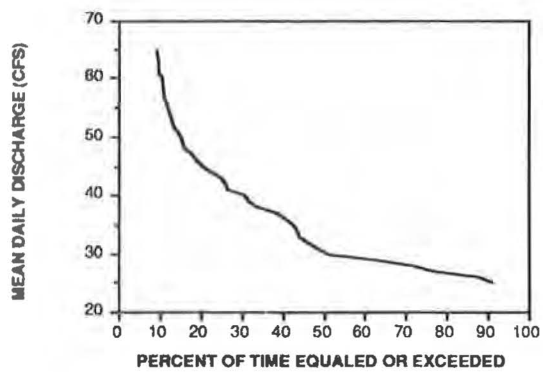
NOVEMBER



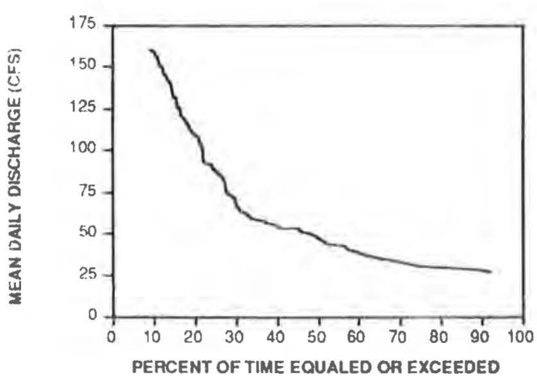
DECEMBER



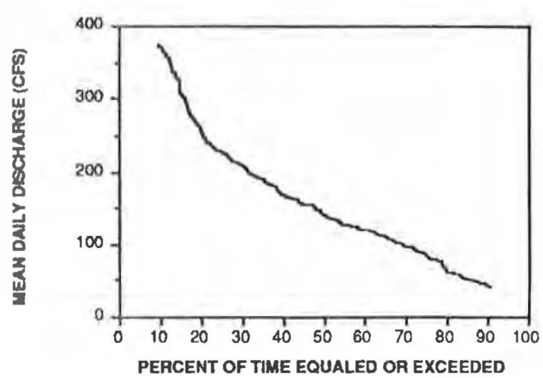
JANUARY



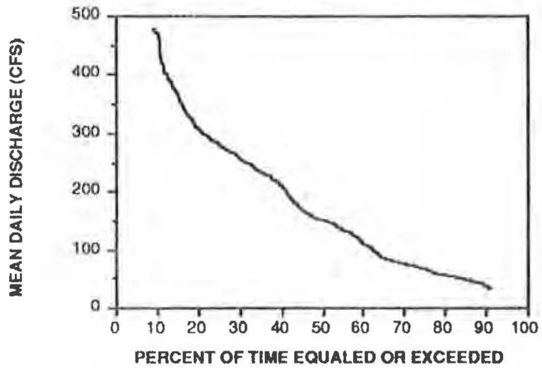
FEBRUARY



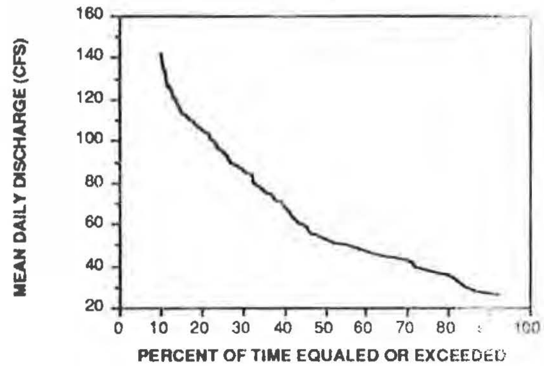
MARCH



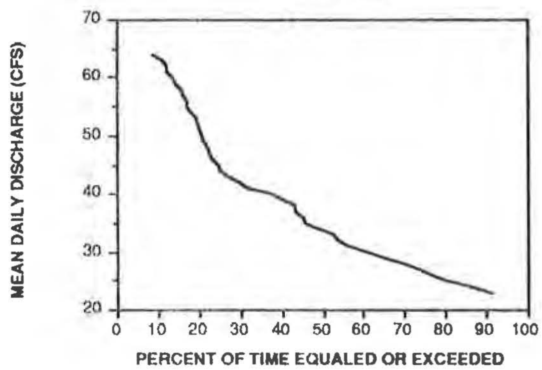
APRIL



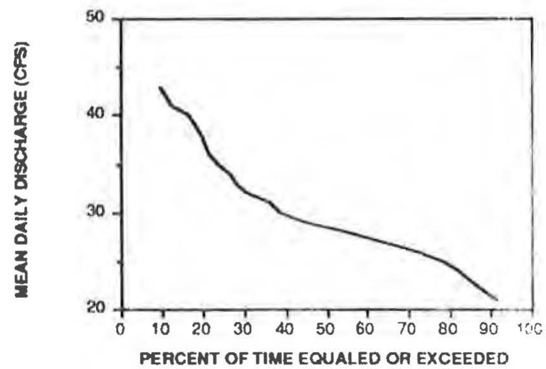
MAY



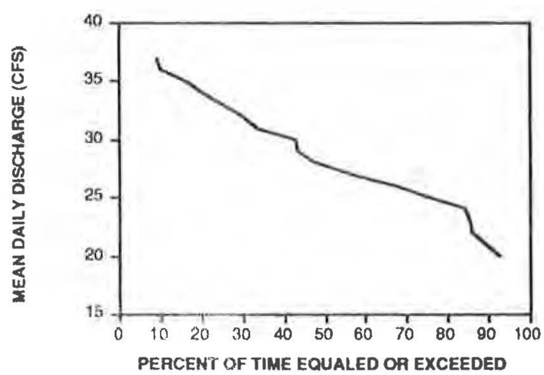
JUNE



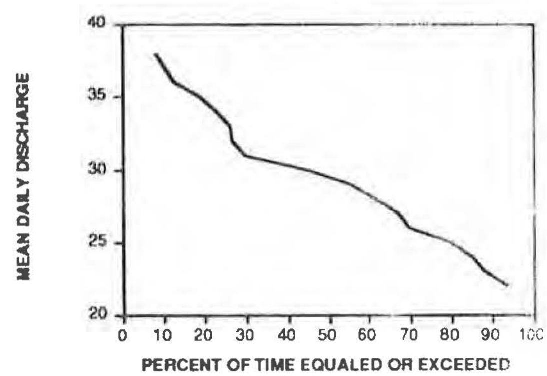
JULY



AUGUST



SEPTEMBER



APPENDIX H

FORTRAN PROGRAM, WRITTEN BY JAMES K. UEHARA, TO READ HABITAT OUTPUT FILE TO GET HABITAT AVAILABILITY INFORMATION

```
PROGRAM AVAIL
REAL  VEL(400),DEPTH(400),SUB(400),AREA(400),D,V
REAL  TOTAL(400),TOTAL2,VAREA(400),VEL2(400),TOTAL1
REAL  SUB2(400),DEPTH2(400),ATOTAL,ATOTAL2,FACT
CHARACTER STREAM*20,SEG*8
C
C      THIS PROGRAM IS USED TO READ THE HABTAT OUTPUT FILE
C      FILE2.HAB CONTAINING DATA ON SUBSTRATES,VELOCITIES,
C      DEPTHS,AND AREAS.  THE PURPOSE IS TO OBTAIN TOTAL
C      AREAS AT CERTAIN VELOCITIES,SUBSTRATES AND
C      AREAS AT 0.1 INCREMENTS.
C
       OPEN(UNIT=20,FILE='FILE20.HAB',STATUS='OLD')
       OPEN(UNIT=25,FILE='STORE.DAT',STATUS='OLD')
C
       PRINT *,'ENTER THE NAME OF THE STREAM'
       READ(5,20)STREAM
       PRINT *,'ENTER THE SEGMENT NUMBER'
       READ(5,21)SEG
       WRITE(25,22)STREAM,SEG
       PRINT *,'ENTER THE MULTIPLICATION FACTOR TO BE APP
       #LIED  TO THE REACH AREAS TO'
       PRINT *, 'CALCULATE AREAS FOR THE SEGMENT.'
       READ(5,19)FACT1
       FACT=ANINT(10000.*FACT1)/10000.
       19 FORMAT(F7.4)
C
C      THIS SECTION READS THE FILE THAT CONTAINS COMPUTATION
C      DETAILS FROM HABITAT
C
       N=500
       DO 7 I=1,N
          READ(20,10)SUB(I)
          READ(20,15,END=8)V,D,AREA(I)
          VEL(I)=ANINT(10.*V)/10.
          DEPTH(I)=ANINT(10.*D)/10.
       7  continue
       8  CONTINUE
          VEL(I)=ANINT(10.*V)/10.
          DEPTH(I)=ANINT(10.*D)/10.
       10    FORMAT(73X,F3.2)
       15 .  FORMAT(29X,F4.2,7X,F4.2,5X,F6.2/)
```

```
20    FORMAT(A20)
21    FORMAT(A8)
22    FORMAT(1X,A20,2X,'SEGMENT No.',A8//)
24    FORMAT(A10)
C     THIS SECTION DETERMINS THE AREA BASED ON VELOCITY
      TOTAL2=0.0
      ATOTAL2=0.00
      I4=I
      R=0.0
      R1=ANINT(10.*R)/10.
      DO 35 I2=1,61
         ATOTAL=0.00
         TOTAL1=0
         I3=1
         N1=1
        DO 30 I1=1,I4
         IF(VEL(I1).EQ.R1)THEN
         VAREA(N1)=AREA(I1)
         VEL2(N1)=VEL(I1)
         TOTAL1=TOTAL1+AREA(I1)
         I3=I3+1
         N1=N1+1
         END IF
30       CONTINUE
         TOTAL(I2)=TOTAL1
         ATOTAL=TOTAL1*FACT
         TOTAL2=TOTAL2+TOTAL1
         ATOTAL2=ATOTAL2+ATOTAL
         WRITE(25,36)
         WRITE(25,38)(VAREA(N1),VEL2(N1),N1=1,I3-1)
         WRITE(25,39)R1,TOTAL(I2)
         WRITE(25,34)ATOTAL
         R=R+0.10
         R1=ANINT(10.*R)/10.
36       FORMAT(1X,'    AREA  VELOCITY')
35       CONTINUE
         WRITE(25,37)TOTAL2
         WRITE(25,33)ATOTAL2
37       FORMAT(1X,'THE TOTAL AREA OF ALL VELOCITY IS ',F10.2)
33       FORMAT(1X,'THE GRAND TOTAL AREA FOR THE
         SEGMENT IS ',F11.2)
34       FORMAT(1X,'THE TOTAL FOR THE SEGMENT IS ',F10.2/)
38       FORMAT(1X,F8.2,3X,F4.1)
```

```
39    FORMAT(1X,'THE TOTAL AREA FOR',F5.1,1X,'IS',F10.2)
        WRITE(25,60)
C
C     THIS SECTION SORTS THE SUBSTRATES AND DETERMINES
C     THE TOTAL AREA.
C
      ATOTAL2=0.00
      TOTAL2=0.0
      I4=I
      R=1.0
      R1=ANINT(10.*R)/10.
      DO 45 I2=1,81
      TOTAL1=0
      ATOTAL=0.00
      I3=1
      N1=1
        DO 40 I1=1,I4
          IF(SUB(I1).EQ.R1)THEN
          VAREA(N1)=AREA(I1)
          SUB2(N1)=SUB(I1)
          TOTAL1=TOTAL1+AREA(I1)
          I3=I3+1
          N1=N1+1
          END IF
40    CONTINUE
      TOTAL(I2)=TOTAL1
      TOTAL2=TOTAL2+TOTAL(I2)
      ATOTAL=TOTAL1*FACT
      ATOTAL2=ATOTAL2+ATOTAL
      WRITE(25,46)
      WRITE(25,48)(VAREA(N1),SUB2(N1),N1=1,I3-1)
      WRITE(25,49)R1,TOTAL(I2)
      WRITE(25,44)ATOTAL
      R=R+0.10
      R1=ANINT(10.*R)/10.
45    CONTINUE
      WRITE(25,47)TOTAL2
      WRITE(25,43)ATOTAL2
44    FORMAT(1X,'THE TOTAL FOR THE SEGMENT IS ',F10.2/)
43    FORMAT(1X,'THE GRAND TOTAL FOR THE
      SEGMENT IS ',F11.2)
46    FORMAT(1X,'    AREA     SUBSTRATE')
47    FORMAT(1X,'THE TOTAL AREA FOR SUBSTRATE IS ',F10.2)
```

```
      48    FORMAT(1X,F8.2,6X,F4.1)
      49    FORMAT(1X,'THE TOTAL AREA OF SUBSTRATE',F5.1,1X,'IS',F9.2)
      WRITE(25,60)
C
C     THIS SECTION DETERMINES THE AREA FOR DEPTH
C
      ATOTAL2=0.00
      TOTAL2=0.0
      I4=I
      R=0.0
      R1=ANINT(10.*R)/10.
      DO 55 I2=1,61
      TOTAL1=0
      ATOTAL=0.00
      I3=1
      N1=1
      DO 50 I1=1,I4
      IF(DEPTH(I1).EQ.R1)THEN
      VAREA(N1)=AREA(I1)
      DEPTH2(N1)=DEPTH(I1)
      TOTAL1=TOTAL1+AREA(I1)
      I3=I3+1
      N1=N1+1
      END IF
      50    CONTINUE
      TOTAL(I2)=TOTAL1
      TOTAL2=TOTAL2+TOTAL(I2)
      ATOTAL=TOTAL1*FACT
      ATOTAL2=ATOTAL2+ATOTAL
      WRITE(25,56)
      WRITE(25,58)(VAREA(N1),DEPTH2(N1),N1=1,I3-1)
      WRITE(25,59)R1,TOTAL(I2)
      WRITE(25,54)ATOTAL
      R=R+0.10
      R1=ANINT(10.*R)/10.
      55    CONTINUE
      WRITE(25,57)TOTAL2
      WRITE(25,53)ATOTAL2
      53    FORMAT(1X,'THE GRAND TOTAL FOR THE
            SEGMENT IS ',F11.2)
      54    FORMAT(1X,'THE TOTAL FOR THE SEGMENT IS ',F10.2)
      56    FORMAT(1X,'    AREA    DEPTH')
      57    FORMAT(1X,'THE TOTAL AREA FOR DEPTH IS ',F10.2)
```

```
58    FORMAT(1X,F8.2,6X,F4.1)
59    FORMAT(1X,'THE TOTAL AREA OF DEPTH',F5.1,1X,'IS',F9.2/)
60    FORMAT(1X,'--------------------------------------
      ---'/)
END
```

APPENDIX I

HABITAT UTILIZATION INFORMATION FOR BROWN TROUT

Table I.1. Habitat Utilization Information for brown trout adults.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	2	410	1.5	2.2	11.0	5.0	4
042686	2	418	0.3	2.3	11.2	4.5	5
042686	2	346	0.8	1.4	11.0	3.8	1
042686	2	422	0.8	1.4	11.0	3.8	1
042686	2	425	0.6	2.1	11.3	4.8	1
042786	5	494	0.6	4.5	8.0	5.1	5
042786	5	455	1.4	.9	10.0	4.7	1
042786	5	565	1.3	3.1	9.5	4.1	1
052186	4	493	0.5	3.2	11.5	4.5	5
052186	4	485	1.0	1.4	11.5	2.7	5
052186	4	452	0.9	1.7	10.8	4.2	5
052186	4	444	1.4	2.2	10.5	4.5	5
052186	4	495	0.4	1.5	10.8	3.8	5
052186	4	480	1.3	2.4	10.5	3.8	5
052186	4	457	1.0	3.0	10.5	3.1	5
063086	1	372	1.9	1.8	22.0	4.0	3
070186	3	461	1.9	1.6	19.0	4.0	5
070186	2	389	0.7	2.5	1.7	4.3	5
070186	3	439	0.1	1.5	19.5	1.5	5
070186	2	356	0.7	2.5	1.7	4.3	5
070186	3	430	1.1	1.4	19.5	3.7	5
070186	3	440	0.2	3.1	19.5	1.0	5
072986	1	375	1.0	3	14	4.5	3
080786	3	432	0.3	1.3	19	3.9	5
080786	3	410	0.5	2.3	19.5	3.2	5
080886	4	470	0.4	3.6	14	4.5	5
080886	4	530	0.4	2.1	18	4.0	5
080886	4	495	0.4	3.6	14	4.5	5
080886	4	455	.2	1.4	13	4.5	1
080886	4	468	0.4	2.1	18	4.0	5
082686	3	365	0.1	.6	17	4.5	2
082686	3	400	1.9	2.1	15	4.2	5
082686	3	405	1.7	.9	15	3.9	4
082686	3	455	1.4	2.1	15	4.2	5
082686	3	515	1.2	1.7	16	3.9	4

Table I.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
102186	2	360	0.6	2.1	10.0	4.8	5
102186	2	367	0.8	0.7	10.0	3.1	4
102186	2	416	0.0	0.8	10.0	4.9	3
121886	2	364	0.9	2.3	3.2	3.4	2
121886	2	420	0.6	2.4	3.2	1.5	5
121886	2	465	1.5	2.5	3.2	3.5	5
121886	2	369	2.2	1.3	2.8	3.8	5
121886	2	440	0.3	2.5	3.0	1.5	5
121886	2	361	1.4	1.8	2.5	3.8	5
121886	2	365	2.2	1.3	2.8	3.8	5
121886	2	370	0.5	2.6	3.2	1.5	3
121886	2	395	1.2	1.0	2.5	3.9	4
121886	2	445	0.9	1.3	3.0	2.9	2
121886	3	470	0.7	3.0	3.0	1.5	5
121886	3	430	0.2	2.9	4.0	3.8	5
121886	3	400	0.7	3.0	3.0	1.5	5
121886	3	460	0.0	2.2	4.0	1.0	5
121886	3	415	1.6	1.3	3.0	3.3	5
121886	3	350	1.6	1.3	3.0	3.3	5
121886	3	390	0.2	0.8	3.0	2.2	5
121886	3	408	0.0	2.5	3.0	1.0	5
121886	3	350	1.9	1.4	3.9	4.2	5
121886	3	380	1.2	1.7	3.9	3.9	5
121886	3	375	0.0	2.1	4.0	1.0	5
121886	3	470	1.0	3.2	4.0	3.9	5
121886	3	365	0.0	2.2	4.0	1.0	5
121886	3	372	0.9	2.3	4.0	3.4	5

Table I.2. Habitat Utilization Information for brown trout juveniles

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	1	125	1.4	1.5	6.5	4.5	2
042686	2	155	0.7	2.3	11.3	2.2	5
042686	1	133	0.5	0.6	7.0	1.0	5
042686	1	152	1.4	1.5	6.5	4.5	2
042686	2	157	0.1	1.2	11.0	0.0	3
042686	2	169	0.6	2.5	11.3	3.2	5
042686	2	142	0.2	1.7	11.3	1.5	4
042686	2	143	0.6	2.3	11.3	2.0	2
042686	1	121	0.3	1.5	7.0	4.5	5
042686	1	130	1.1	0.3	10.0	5.8	1
042686	1	145	0.3	2.0	10.0	2.0	1
042686	2	130	0.0	0.6	11.3	1.0	5
042686	2	130	0.8	0.6	11.3	3.5	3
042686	2	335	1.6	1.8	11.3	4.9	5
042686	1	135	0.3	1.5	7.0	4.5	5
042686	1	153	1.9	1.4	7.0	3.6	5
042686	1	304	0.9	1.6	6.5	3.2	5
042686	1	170	0.9	1.3	10.0	7.0	3
042686	1	185	0.7	1.8	8.5	1.5	5
042686	2	255	1.0	1.6	11.3	3.3	3
042686	2	162	0.6	2.3	11.3	2.0	2
042786	5	151	1.3	1.4	8.5	4.1	1
052186	4	177	0.1	1.4	12.0	2.0	3
052186	4	186	0.8	1.6	12.0	2.0	5
052186	4	173	0.8	2.0	10.8	3.2	5
052186	4	124	.2	0.8	11.5	2.0	2
052186	4	160	0.0	1.1	12.0	4.6	5
052186	4	135	0.0	1.7	10.5	1.3	5
052186	4	141	0.3	1.7	10.5	2.0	5
052186	4	119	0.8	1.7	10.8	3.5	5
052186	4	147	0.6	1.7	10.8	4.1	3
063086	1	181	2.5	1.5	22.0	4.5	2
063086	1	188	1.2	1.2	22.0	4.0	5
063086	1	187	2.4	3.5	22.0	4.5	3
063086	1	229	0.1	2.4	22.0	2.0	3

Table I.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
070186	3	194	0.2	3.8	19.0	3.5	5
070186	3	279	0.0	1.9	19.5	1.5	5
070186	2	216	2.1	0.9	17.5	4.8	1
070186	2	175	3.6	0.9	16.0	4.1	5
070186	2	344	0.2	3.8	17.0	4.3	5
070186	3	143	0.6	1.6	19.0	2.5	5
070186	3	204	0.3	2.3	19.0	4.5	5
070186	3	187	0.0	1.9	19.5	1.5	5
070186	3	127	0.5	1.5	19.0	1.3	5
072986	1	220	0.4	2.1	15.0	4.0	3
080786	3	155	0.1	2.1	18.0	1.5	5
080786	3	157	1.1	2.8	18.5	3.2	5
080786	3	235	0.2	0.9	18.5	3.8	5
080786	3	300	1.0	2.4	18.5	3.2	5
080786	3	164	0.2	0.9	18.5	3.8	5
080786	3	214	0.2	0.9	18.5	3.8	5
080786	3	315	0.6	1.6	18.5	1.0	4
080786	3	325	0.7	1.1	19.5	3.2	5
080786	3	305	0.7	3.3	16.5	1.0	5
080786	3	297	0.2	2.1	18.0	1.0	5
080786	3	192	0.2	2.1	18.0	1.0	5
080786	3	250	0.8	1.7	16.5	4.2	5
080786	3	144	0.3	1.6	19.0	2.3	4
080786	3	198	0.9	3.3	16.5	1.0	5
080786	3	229	0.1	2.1	18.0	1.5	5
080786	3	214	0.1	2.1	18.0	1.5	5
080786	3	213	0.0	2.4	18.0	1.0	5
080786	3	219	0.1	2.6	18.0	1.0	5
080786	3	183	0.4	1.2	18.5	1.5	5
080786	3	189	1.8	2.7	18.5	3.2	5
080786	3	223	1.2	0.6	18.0	3.8	5
080786	3	223	0.1	1.0	19.5	4.2	4
080786	3	183	0.8	1.5	19.5	3.6	3
080786	3	187	0.9	1.9	19.5	4.0	4
080786	3	190	0.9	1.9	19.5	4.0	4
080786	3	193	1.3	2.1	19.5	3.9	5

Table I.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080786	3	227	1.2	2.7	18.5	3.4	5
080786	3	184	0.7	0.6	19.5	4.0	3
080786	3	189	0.3	2.4	19.5	4.5	1
080786	3	167	1.2	1.0	19.0	2.7	5
080786	3	220	0.7	1.2	19.0	2.5	4
080786	3	200	1.7	1.3	19.0	1.0	4
080786	3	222	1.2	2.7	18.5	3.4	5
080786	3	232	1.2	2.7	18.5	3.4	5
080786	3	182	1.1	2.5	19.0	2.2	4
080786	3	207	2.0	1.1	19.0	3.9	3
080786	3	234	0.3	1.6	19.0	2.3	4
080786	3	206	0.7	1.2	19.0	2.5	4
080786	3	187	0.7	1.2	19.0	2.5	4
080886	4	184	0.7	1.2	13.0	1.0	1
080886	4	218	1.9	1.7	13.0	2.0	3
080886	4	179	1.1	1.4	13.0	4.5	5
080886	4	196	1.0	0.5	18.0	3.3	4
080886	4	225	0.5	2.1	18.0	4.0	5
080886	4	185	0.0	2.1	18.0	2.8	4
080886	4	180	0.0	2.1	18.0	2.8	4
080886	4	152	0.1	1.2	18.0	4.2	4
080886	4	181	0.8	1.6	12.5	2.2	4
080886	4	138	1.3	1.5	12.5	2.8	4
080886	4	305	0.5	2.1	18.0	4.0	5
080886	4	191	1.1	1.4	13.0	4.5	5
080886	4	162	1.1	1.4	13.0	4.5	5
080886	4	283	0.1	3.6	14.0	4.5	5
080886	4	191	0.3	1.8	16.5	3.3	2
080886	4	200	0.3	1.8	16.5	3.3	2
080886	4	232	0.3	1.8	16.5	3.3	2
080886	4	201	0.4	1.8	17.0	4.3	4
080886	4	226	1.6	1.1	17.0	3.8	4
080886	4	182	0.8	0.9	12.5	4.1	4
080886	4	220	1.3	1.5	12.5	2.8	4
080886	4	225	0.4	3.6	14.0	4.5	5

Table I.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	244	0.3	1.8	16.5	3.3	2
080886	4	227	1.4	0.7	16.0	3.1	4
080886	4	204	0.4	1.8	17.0	4.3	4
080886	4	170	1.0	0.8	17.5	4.0	1
080886	4	185	1.4	0.4	17.5	3.6	1
080886	4	198	1.4	0.4	17.5	3.6	1
080886	4	165	1.7	1.7	18.0	3.5	3
080886	4	141	0.7	1.2	13.0	1.0	1
080886	4	172	0.4	0.9	12.5	2.2	4
080886	4	172	1.7	1.7	18.0	3.5	3
080886	4	173	1.4	0.4	17.5	3.6	1
082686	3	169	0.3	2.9	16.0	3.8	5
082686	3	205	1.9	2.1	15.0	4.2	5
082686	3	214	0.3	2.9	16.0	3.8	5
082686	3	225	0.3	2.9	16.0	3.8	5
082686	3	152	0.3	1.5	16.0	1.4	3
082686	3	221	0.4	1.2	15.0	3.2	5
082686	3	190	0.6	2.2	14.5	3.5	4
082686	3	201	0.4	0.9	15.0	3.8	4
082686	3	197	0.4	1.2	15.0	3.2	5
082686	3	134	0.4	19.0	15.0	3.5	4
082686	3	125	1.0	2.1	16.0	2.5	5
082686	3	215	0.7	1.6	16.0	4.5	5
082686	3	180	0.4	1.5	14.0	1.5	5
082686	3	120	0.1	1.9	16.0	1.5	5
082686	3	228	0.4	1.4	16.0	4.3	1
082686	3	199	1.1	2.3	16.0	4.2	5
082686	3	339	0.3	2.9	16.0	3.0	5
082686	3	166	0.6	1.9	16.0	2.8	5
082686	3	175	0.6	1.9	16.0	2.8	5
082686	3	225	0.6	1.8	17.0	3.7	4
082686	3	247	0.6	1.8	17.0	3.7	4
082686	3	195	0.3	1.2	17.0	3.7	4
082686	3	220	0.3	1.2	17.0	3.7	4
082686	3	190	0.3	1.2	17.0	3.7	4

Table I.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
082686	3	230	0.3	2.0	17.0	2.0	5
082686	3	242	0.3	2.0	17.0	2.0	5
082686	3	200	0.3	2.0	17.0	2.0	5
082686	3	205	0.6	1.8	17.0	3.7	4
082686	3	206	0.6	1.8	17.0	3.7	4
082686	3	134	0.4	2.3	17.0	2.8	5
082686	3	231	0.4	2.3	17.0	2.8	5
082686	3	210	0.4	2.3	17.0	2.8	5
082686	3	119	0.8	1.2	17.0	3.8	2
082686	3	180	0.4	2.3	17.0	2.8	5
082686	3	231	2.5	1.9	17.0	4.3	3
082686	3	200	0.7	1.5	17.0	3.8	4
082686	3	185	2.5	1.9	17.0	4.3	3
082686	3	252	0.4	2.3	17.0	2.8	5
082686	3	126	2.5	1.9	17.0	4.3	3
082686	3	298	0.3	2.0	17.0	2.0	5
082686	3	200	0.3	2.0	17.0	2.0	5
102186	2	245	2.0	0.9	10.0	4.2	5
102186	2	265	2.0	0.9	10.0	4.2	5
102186	2	120	1.4	1.7	10.0	2.5	4
102186	2	120	2.4	1.4	10.0	3.5	5
102186	2	131	1.3	1.3	10.0	3.0	5
102186	2	126	0.5	1.4	10.0	4.2	5
102186	2	262	0.2	2.2	13.0	2.2	4
102186	2	282	1.3	1.3	10.0	3.0	5
102186	2	130	0.5	1.4	10.0	4.2	5
102186	2	123	0.3	1.6	10.0	1.2	5
102186	2	191	0.0	1.7	10.0	4.1	5
102186	2	229	1.2	1.9	10.0	3.9	5
102186	2	298	0.0	1.7	10.0	4.1	5
102186	2	228	0.0	1.7	10.0	4.1	5
102186	2	255	1.2	1.9	10.0	3.9	5
102186	2	220	0.3	1.6	10.0	1.2	5
102186	2	214	0.3	1.6	10.0	1.2	5
102186	2	135	0.3	1.6	10.0	1.2	5

Table I.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
102186	2	220	0.3	1.6	10.0	1.2	5
102186	2	192	0.2	2.2	13.0	2.2	4
102186	2	143	0.6	0.8	10.0	5.2	3
102186	2	262	0.0	1.4	10.0	3.1	4
102186	2	121	2.0	0.5	10.0	5.2	3
102186	2	142	1.0	0.4	10.0	5.2	3
102186	2	127	0.0	1.4	10.0	3.1	4
102186	2	276	0.5	1.7	10.0	4.3	5
102186	2	234	0.5	1.7	10.0	4.3	5
102186	2	263	2.3	0.9	10.0	4.3	4
102186	2	270	2.3	0.9	10.0	4.3	4
102186	2	157	0.7	1.1	10.0	4.1	4
102186	2	150	1.2	1.0	10.0	3.5	5
102186	2	132	1.2	1.4	10.0	5.2	3
102186	2	251	1.3	1.0	10.0	4.2	5
102186	2	126	0.1	1.4	10.0	2.0	4
102186	2	250	0.6	2.1	10.0	4.8	5
102186	2	254	0.4	0.7	10.0	4.2	5
102186	2	125	0.4	0.7	10.0	4.2	5
102186	2	124	1.6	0.7	10.0	3.6	4
102186	2	130	0.2	1.1	10.0	1.8	4

Table I.3. Habitat Utilization Information for brown trout young-of-the-year.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	2	100	1.2	1.2	11.2	4.1	1
042686	1	116	0.9	0.6	7.0	3.2	1
042686	1	116	0.5	0.6	7.0	1.0	5
042786	5	97	1.3	1.4	8.5	4.1	1
042786	5	87	0.2	1.7	9.5	4.1	4
070186	3	79	0.4	1.4	19.5	1.9	5
070186	3	63	0.7	0.4	19.0	3.9	1
070186	3	65	0.4	0.8	19.0	3.9	1
070186	3	61	0.7	0.4	19.0	3.9	1
070186	3	67	0.5	1.5	19.0	1.3	5
070186	3	76	0.3	0.7	19.0	3.9	4
070186	2	80	0.3	0.4	17.0	4.5	5
070186	2	66	0.2	0.6	17.0	4.0	2
070186	2	77	0.3	0.4	17.0	4.5	5
070186	2	78	0.3	0.4	17.0	4.5	5
072986	1	79	.3	0.9	15.0	4.5	3
080786	3	92	0.9	1.9	19.5	4.9	4
080786	3	109	1.2	0.6	19.0	4.0	4
080786	3	88	1.2	0.6	19.0	4.0	4
080786	3	105	0.5	1.5	19.5	1.5	5
080786	3	112	1.2	1.0	19.0	2.7	5
080786	3	86	1.7	1.3	19.0	4.2	5
080786	3	103	0.2	0.9	18.5	3.8	5
080786	3	103	0.2	0.9	18.5	3.8	5
080786	3	80	0.9	1.4	19.5	2.5	4
080786	3	104	0.6	0.5	18.5	2.5	5
080786	3	90	1.7	1.3	19.0	4.2	5
080786	3	80	0.6	0.5	18.5	2.5	5
080786	3	85	0.6	0.5	18.5	2.5	5
080786	3	90	1.7	1.3	19.0	4.2	5
080786	3	110	0.8	1.7	16.5	4.2	5
080786	3	102	0.4	1.2	18.5	1.5	5
080786	3	76	1.3	1.3	19.0	3.7	1
080786	3	86	0.9	0.9	18.0	3.3	4
080786	3	109	0.5	2.9	16.0	2.5	5

Table I.3. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080786	3	86	0.8	1.3	18.5	4.0	4
080886	4	110	0.7	0.7	18.0	2.5	3
080886	4	55	1.7	1.7	18.0	3.2	5
080886	4	70	1.7	1.7	18.0	3.2	5
080886	4	94	0.1	1.2	18.0	4.2	4
080886	4	105	0.7	0.7	18.0	2.5	3
080886	4	95	0.7	0.7	18.0	2.5	3
080886	4	90	1.7	1.7	18.0	3.2	5
080886	4	62	0.0	0.6	18.0	3.9	4
080886	4	90	0.4	0.7	18.0	3.3	5
080886	4	90	0.4	0.7	18.0	3.3	5
080886	4	71	1.7	1.7	18.0	3.2	5
080886	4	76	1.7	1.7	18.0	3.2	5
080886	4	62	0.0	0.6	18.0	3.9	4
080886	4	80	0.1	1.2	18.0	4.2	4
080886	4	97	0.6	0.6	18.0	4.7	2
080886	4	90	0.1	1.2	18.0	4.2	4
080886	4	85	0.1	1.2	18.0	4.2	4
080886	4	70	1.0	0.5	18.0	3.3	4
080886	4	101	1.0	0.5	18.0	3.3	4
080886	4	96	1.0	0.5	18.0	3.3	4
080886	4	63	0.1	1.2	18.0	4.2	4
080886	4	90	0.1	1.2	18.0	4.2	4
080886	4	84	0.1	1.2	18.0	4.2	4
080886	4	66	0.1	1.2	18.0	4.2	4
080886	4	84	0.1	1.2	18.0	4.2	4
080886	4	62	0.1	1.2	18.0	4.2	4
080886	4	74	0.1	1.2	18.0	4.2	4
080886	4	90	0.8	1.6	12.5	2.2	4
080886	4	86	0.8	1.6	12.5	2.2	4
080886	4	74	1.5	0.3	13.0	1.8	1
080886	4	76	1.5	0.8	13.0	1.8	4
080886	4	76	1.5	0.8	13.0	1.8	4
080886	4	77	0.4	1.4	13.0	3.9	5
080886	4	100	1.1	1.6	13.0	4.2	4

Table I.3. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	95	1.1	1.4	13.0	4.5	5
080886	4	86	0.8	1.6	12.5	2.2	4
080886	4	99	1.1	1.4	13.0	4.5	5
080886	4	95	1.5	0.8	13.0	1.8	4
080886	4	79	0.0	0.9	14.0	1.9	4
080886	4	80	0.0	0.9	14.0	1.9	4
080886	4	83	0.0	0.9	14.0	1.9	4
080886	4	110	0.0	0.9	14.0	1.9	4
080886	4	83	0.0	0.9	14.0	1.9	4
080886	4	85	1.2	0.9	13.0	4.1	4
080886	4	85	1.3	1.5	12.5	2.2	4
080886	4	50	0.6	0.6	13.0	3.5	4
080886	4	76	0.0	0.9	14.0	1.9	4
080886	4	78	0.0	0.9	14.0	1.9	4
080886	4	76	1.1	1.6	13.0	4.2	4
080886	4	71	1.6	1.1	17.0	3.8	4
080886	4	50	1.4	0.8	17.5	3.9	4
080886	4	96	1.4	0.4	17.5	3.6	1
080886	4	100	0.4	0.8	16.5	3.5	5
080886	4	54	0.4	0.8	16.5	3.5	5
080886	4	76	1.6	1.1	17.0	3.8	4
080886	4	96	1.0	0.8	17.5	4.0	1
080886	4	48	1.0	0.8	17.5	4.0	1
080886	4	105	1.0	0.8	17.5	4.0	1
080886	4	98	1.4	0.4	17.5	3.6	1
080886	4	86	1.4	0.4	17.5	3.6	1
080886	4	86	0.6	1.3	17.5	2.0	2
080886	4	100	0.4	0.8	16.5	3.5	5
080886	4	86	0.0	0.9	14.0	1.9	4
080886	4	90	0.0	0.9	14.0	1.9	4
080886	4	95	2.2	0.3	14.0	4.4	3
080886	4	82	2.2	0.3	14.0	4.4	3
082686	3	87	0.4	1.5	14.0	1.5	5
082686	3	112	1.3	1.3	16.0	3.8	3
082686	3	74	0.4	1.5	14.0	1.5	5

Table I.3. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
082686	3	92	1.3	1.3	16.0	3.8	3
082686	3	101	1.3	1.3	16.0	3.8	3
082686	3	100	1.1	2.3	16.0	4.2	5
082686	3	105	0.4	1.4	16.0	4.3	1
082686	3	79	1.2	1.5	15.0	1.3	4
082686	3	109	0.3	1.1	17.0	3.5	4
082686	3	80	1.7	0.9	15.0	3.9	4
082686	3	74	0.4	1.3	16.0	1.5	5
082686	3	100	0.8	1.2	17.0	3.8	2
082686	3	80	0.3	2.1	16.0	2.5	4
082686	3	110	0.4	1.4	16.0	4.3	1
082686	3	100	0.3	0.6	17.0	3.8	2
082686	3	90	0.7	0.8	17.0	3.6	2
082686	3	110	1.2	0.9	17.0	4.1	2
082686	3	95	0.3	0.6	17.0	3.8	2
082686	3	115	0.4	1.4	16.0	4.3	1
082686	3	102	0.4	1.4	16.0	4.3	1
082686	3	87	0.4	1.3	16.0	1.5	5
082686	3	70	0.3	2.1	16.0	2.5	4
082686	3	100	0.1	1.9	16.0	1.5	5
082686	3	92	.8	1.2	17.0	3.8	2
082686	3	115	1.3	1.3	16.0	3.8	3
082686	3	100	1.3	1.3	16.0	3.8	3
082686	3	80	0.1	1.9	16.0	1.5	5
082686	3	109	0.8	1.2	17.0	3.8	2
082686	3	81	1.2	1.5	15.0	1.3	4
082686	3	105	0.3	1.5	16.0	1.4	3
082686	3	99	0.7	0.8	17.0	3.6	2
082686	3	105	1.2	0.9	17.0	4.1	2
082686	3	105	0.8	1.2	17.0	3.8	2
082686	3	95	1.2	0.9	17.0	4.1	2
082686	3	110	0.1	1.9	16.0	1.5	5
082686	3	80	0.1	1.9	16.0	1.5	5
082686	3	91	1.0	1.5	14.5	3.8	5
082686	3	92	1.3	1.3	16.0	3.8	3

Table I.3. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
082686	3	90	1.3	1.3	16.0	3.8	3
082686	3	107	0.1	1.1	15.0	2.1	4
082686	3	105	0.1	1.1	15.0	2.1	4
082686	3	110	0.4	0.9	15.0	3.5	4
082686	3	92	0.4	0.9	15.0	3.8	4
102186	3	113	0.5	1.4	10.0	4.2	5
102186	3	107	0.0	0.8	10.0	5.3	4
102186	3	105	1.4	1.7	10.0	2.5	4
102186	3	118	3.4	1.4	10.0	3.5	5
102186	3	106	0.0	0.7	10.0	2.5	3
102186	3	116	0.4	0.7	10.0	4.2	5

Table I.4. Habitat Utilization Information for brown trout fry.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVER
050186	3	•	0.6	0.8	•	3.7	1
050186	3	•	0.6	0.7	•	3.7	1
050186	3	•	0.6	0.7	•	3.7	1
050186	3	•	1.1	1.2	•	3.8	1
050186	3	•	0.2	0.4	•	3.7	1
050186	3	•	0.2	0.4	•	3.7	1
050186	3	•	0.8	0.8	•	3.8	1
050186	3	•	0.5	1.1	•	3.2	4
050186	3	•	1.1	1.2	•	3.8	1
050186	3	•	0.6	0.4	•	3.5	1
050186	3	•	0.4	0.9	•	2.2	4
050186	3	•	0.4	0.4	•	3.7	1
050186	3	•	0.8	1.2	•	2.8	2
050186	3	•	0.2	1.0	•	2.2	4
050886	3	•	0.6	1.2	16.1	3.2	1
050886	3	•	0.8	1.0	16.1	3.2	1
050886	3	•	0.7	1.3	16.1	3.1	1
050886	3	•	0.4	1.0	16.1	3.2	1
050886	3	•	0.3	0.8	16.1	2.1	2
050886	3	•	0.9	0.6	16.1	2.9	1
050886	3	•	0.3	0.8	16.7	2.3	2
050886	3	•	0.7	1.1	16.1	3.1	1
050886	3	•	0.3	0.4	16.1	2.9	1
050886	2	•	0.2	0.7	13.3	4.4	2
050886	2	•	0.0	0.4	13.3	4.4	2
050886	2	•	0.5	0.6	13.3	4.6	2
050886	2	•	0.3	0.5	12.2	1.2	3
050886	3	•	0.1	0.5	16.7	3.7	2
050886	3	•	0.7	0.5	15.6	4.4	1
050886	2	•	0.4	0.5	12.2	2.7	1
050886	2	•	0.1	0.2	13.3	1.0	1
050886	3	•	1.1	0.4	16.1	3.5	1
050886	3	•	0.6	0.8	16.1	3.2	1
050886	3	•	0.7	1.0	16.1	3.2	1
050886	3	•	0.7	0.6	16.1	3.7	1

Table I.4. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVER
050886	2	•	0.1	0.3	13.3	1.0	1
050886	3	•	0.9	0.8	16.1	3.1	1
050886	3	•	0.7	0.8	16.1	3.2	2
052186	4	42	0.5	0.8	11.5	4.1	2
052186	4	38	0.5	0.8	11.5	4.1	2
052186	4	•	0.8	0.5	11.5	4.5	2
052186	4	36	0.8	0.5	11.5	4.5	2
052186	4	•	0.5	0.2	11.5	3.5	1
052186	4	44	0.5	0.2	11.5	3.5	1
052186	4	43	0.0	0.2	11.5	2.3	2
052186	4	38	0.3	0.2	11.5	2.3	2
052186	4	•	0.3	0.4	11.5	4.2	1
052186	4	•	0.3	0.3	10.8	3.9	1
052186	4	•	0.3	0.2	11.5	4.0	1
052186	4	•	0.6	0.3	11.5	3.7	1
052186	4	•	0.6	0.3	11.5	3.7	1
052186	4	32	0.6	0.3	11.5	3.7	1
052186	4	38	0.6	0.6	11.5	4.2	2
052186	4	38	0.1	0.3	11.5	3.8	1
052186	4	37	0.5	0.3	11.5	4.3	1
052186	4	37	0.5	0.3	10.8	4.4	1
052186	4	40	0.5	0.5	10.8	4.4	1
052186	4	•	0.6	0.8	10.8	4.3	1
052186	4	36	0.0	0.3	10.8	2.0	2
052186	4	42	0.0	0.2	10.8	2.0	2
052186	4	39	0.0	0.3	10.8	2.0	2
052186	4	32	0.0	0.3	10.8	2.0	2
052186	4	43	0.6	0.9	10.5	4.3	1
052186	4	38	0.9	0.5	10.5	3.8	1
052186	4	41	0.4	0.5	10.5	3.7	2
052186	4	41	0.8	0.6	10.5	3.7	1
052186	4	45	0.3	0.5	10.5	3.9	1
052186	4	41	0.5	0.9	10.5	4.3	1
052186	4	44	0.8	0.5	10.5	4.2	2
052186	4	44	0.2	0.3	10.5	3.1	1

Table I.4. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVER
052186	4	32	0.0	0.2	10.8	2.0	2
052186	4	42	0.3	0.4	11.5	3.5	1
052186	4	40	0.0	0.5	11.5	4.0	2
052186	4	•	0.3	0.9	11.5	4.0	4
052186	4	40	0.5	0.3	11.5	3.9	1
052186	4	44	0.5	0.2	11.5	3.5	1
052186	4	39	0.2	0.3	11.5	4.5	2
052186	4	42	0.5	0.3	11.5	4.0	1
052186	4	42	0.3	0.3	10.8	3.9	1
052186	4	42	0.1	1.8	10.8	2.0	2
052186	4	41	0.0	0.4	10.8	2.0	2
052186	4	36	0.0	0.4	10.8	2.0	2
052186	4	•	0.6	0.7	10.8	3.9	2
052186	4	42	0.3	0.3	10.8	3.9	1
052186	4	39	0.3	0.3	10.8	3.9	1
052186	4	42	0.5	0.5	10.8	3.9	2

Table I.5. Habitat Uitlization Information for spawning brown trout.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
103186	3	6	2.0	0.7	10.0	3.6	1
103186	3	6	1.2	0.7	10.0	3.6	1
103186	3	6	1.2	0.8	10.0	3.6	1
103186	3	6	2.6	0.5	10.0	3.2	1
103186	3	6	1.0	0.8	10.0	3.6	1
103186	3	4	1.6	0.7	10.0	3.4	1
103186	3	13	1.1	0.6	10.0	3.3	1
103186	4	8	1.0	0.8	10.0	3.6	1
103186	4	8	1.2	0.8	10.0	3.6	1
103186	4	5	2.0	0.6	10.0	3.7	1
103186	4	6	1.0	0.6	10.0	3.5	1
103186	4	11	1.6	0.7	10.0	3.8	2
103186	4	3	1.1	0.5	10.0	3.4	1
103186	4	4	1.4	0.7	10.0	3.3	1
103186	3	8	1.4	0.9	10.0	3.2	1
103186	2	16	2.0	0.5	10.0	3.4	1
103186	2	8	1.2	0.8	10.5	3.7	1
103186	2	9	1.3	0.7	10.0	3.6	1
103186	2	6	2.2	0.6	10.0	3.7	1
103186	2	8	1.9	0.5	10.0	2.8	1
103186	2	15	1.5	1.3	10.0	2.4	4
103186	2	4	1.8	0.7	10.0	3.5	1
103186	3	6	1.9	0.8	10.0	3.7	1
103186	3	7	0.9	0.6	10.0	3.7	2
103186	3	9	1.1	0.9	10.0	3.6	1
103186	3	15	1.8	0.6	10.0	3.8	1
103186	2	4	1.7	1.0	10.0	3.8	1
103186	3	6	1.9	0.8	10.0	3.2	1
103186	3	7	1.5	0.8	10.0	3.4	1
110886	2	6	1.7	0.5	7.5	3.6	1
110886	2	4	2.0	0.6	7.5	3.6	1
110886	2	7	2.7	0.6	7.0	3.1	1
110886	2	4	1.7	0.9	7.5	3.7	1
110886	2	6	2.0	1.0	7.5	3.7	1
110886	2	5	1.2	1.1	7.5	3.4	1

Table I.5. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
110886	2	6	1.5	1.0	7.5	3.5	1
110886	2	4	2.5	0.8	7.0	3.5	1
110886	2	15	2.5	1.1	7.0	3.3	1
110886	2	6	1.8	0.7	7.0	3.3	1
110886	2	9	2.5	0.8	7.0	3.5	1
110886	2	6	0.8	1.0	7.0	3.2	1
110886	2	9	2.2	0.9	7.0	3.2	1
110886	2	9	1.8	0.6	7.0	3.2	1
110886	2	3	1.1	0.7	7.5	3.2	1
110886	3	6	1.6	0.8	6.0	3.1	1
110886	3	3	0.9	0.6	7.0	3.7	1
110886	3	6	1.3	0.7	7.5	3.6	1
110886	3	7	1.6	0.8	6.0	3.8	1
110886	2	7	1.8	0.9	7.5	3.6	1
110886	3	6	1.6	1.0	6.0	3.4	1
110886	3	4	1.8	1.0	6.0	3.8	1
110886	2	8	1.2	0.5	7.5	3.3	1
110886	2	5	2.0	0.6	7.5	3.4	1
110886	2	3	2.1	0.5	7.5	3.2	1
110886	2	6	2.1	1.1	7.5	3.6	1
110886	3	3	1.5	0.6	7.5	3.4	1
110886	3	3	2.5	0.9	7.5	3.7	1
110886	2	12	1.7	1.1	7.5	3.4	1
110886	2	5	1.5	0.7	7.5	3.5	1
110886	2	4	1.7	0.4	7.0	3.5	1
110886	2	6	1.8	0.5	7.0	3.5	1
110886	2	6	1.2	1.0	6.0	4.1	2
110886	2	8	1.8	0.5	7.0	3.3	1
110886	2	5	1.8	0.7	7.5	3.6	1
110886	2	6	2.1	0.8	7.5	3.7	1
110886	2	12	2.4	1.4	7.0	3.3	1
110886	1	5	1.7	1.2	5.0	4	1
110886	1	5	1.9	0.8	5.0	3.5	1
110886	1	11	1.9	1.1	5.0	3.7	1
110886	1	12	1.1	0.5	5.0	3.1	4

Table I.5. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
110886	2	4	3.0	0.9	5.5	3.1	3
110886	1	14	1.2	1.0	5.0	3.6	1
110886	1	14	0.9	1.0	5.0	3.6	1
110886	2	6	2.1	0.8	7.5	3.6	1
110886	2	3	1.9	1.2	7.5	3.5	1
110886	2	5	1.4	0.6	7.5	3.7	1
110886	2	8	1.4	0.5	7.5	3.6	1
110886	2	8	1.2	1.4	7.5	3.5	1
110886	2	7	2.9	0.9	7.5	3.3	1
110886	2	4	1.5	0.6	7.5	3.2	4
110886	2	4	1.6	0.8	7.5	3.6	1
110886	2	6	1.7	1.1	7.5	3.3	1
110886	2	5	2.1	0.8	7.5	3.4	1
110886	2	8	2.0	0.8	7.5	3.6	1
110886	2	9	2.5	0.9	7.5	3.9	1
110886	2	5	2.4	0.6	7.5	3.6	4
110886	2	6	1.3	0.5	7.5	3.2	1
110886	2	8	1.7	0.8	7.5	3.2	1
110986	4	5	1.7	0.6	5.5	3.3	1
110986	4	7	1.3	0.8	5.5	3.7	1
110986	4	8	1.5	0.8	5.5	3.4	1
110986	4	3	1.5	0.8	5.5	3.4	1
110986	4	5	1.2	0.6	5.5	3.3	1
110986	4	6	1.2	0.7	5.5	3.3	1
110986	4	6	1.6	0.6	5.5	3.4	1
110986	4	12	2.2	0.8	5.0	3.6	1
110986	4	14	1.7	0.7	5.0	3.6	1
110986	4	6	0.9	0.8	5.5	3.4	1
110986	4	6	0.9	0.7	5.5	3.5	1
110986	4	6	1.5	0.5	5.5	3.3	1
110986	4	7	1.6	0.5	5.5	3.2	4
110986	4	6	1.3	0.6	5.0	3.5	1
110986	4	6	1.2	0.6	5.0	3.5	1
110986	4	6	1.2	0.3	5.0	3.6	1
110986	5	4	0.7	0.5	4.0	3.9	1

Table I.5. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
110986	5	8	0.8	0.5	4.0	3.5	1
110986	4	7	0.7	0.8	5.5	3.8	1
110986	4	12	0.9	0.7	5.5	2.8	4
110986	4	6	1.0	0.6	5.5	3.2	4
110986	4	6	2.0	1.1	5.0	3.0	4
110986	4	4	0.7	1.3	5.0	2.9	5
110986	4	4	1.2	0.7	5.0	3.9	1
110986	4	5	1.2	0.7	5.0	3.9	1
110986	3	9	1.5	0.5	4.0	3.5	4
110986	3	6	1.8	0.8	4.0	3.8	1
110986	3	7	1.4	0.8	4.0	3.8	1
110986	4	6	1.2	0.9	4.5	3.9	1
110986	3	5	2.1	0.8	4.0	3.4	1
110986	3	12	1.2	0.6	4.0	3.8	1
110986	3	9	0.8	0.8	3.5	3.9	1
110986	3	12	3.1	0.7	3.5	3.7	1
110986	3	4	1.2	0.7	3.5	3.5	1
110986	3	8	1.1	0.6	3.5	3.6	1
110986	3	5	1.5	0.6	3.5	3.8	1
110986	3	10	1.3	0.7	3.5	3.8	1
110986	3	10	1.5	0.9	3.5	3.5	1
110986	4	3	1.5	0.7	4.5	3.2	1
110986	4	3	1.3	0.8	4.5	3.1	1
110986	4	4	1.4	0.6	4.5	3.4	1
110986	4	6	1.1	0.9	5.0	3.5	1
110986	4	5	1.7	0.5	5.0	3.9	1
110986	4	5	1.4	0.6	4.5	3.7	1
110986	4	6	1.9	0.7	4.5	2.9	1
110986	4	6	0.9	0.7	4.5	4.2	1
110986	4	6	1.0	0.4	4.5	3.9	1
110986	4	7	1.4	0.4	4.5	3.6	1
110986	4	6	1.2	0.8	4.5	3.4	1
110986	4	6	1.5	0.7	4.5	3.6	1
110986	4	15	1.4	0.7	4.5	3.7	1

APPENDIX J

HABITAT UTILIZATION INFORMATION FOR RAINBOW TROUT

Table J.1. Habitat Utilization Information for rainbow trout adults.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	1	275	.3	2.6	6.5	2	5
042686	1	356	1.9	1.3	7	4.9	1
042686	1	290	.4	2	6.5	2	3
042686	2	305	1.5	1.7	11.3	3.1	4
042686	1	270	1.9	1.3	7	4.9	1
042786	5	309	1	1.1	9	7	4
042786	5	321	1.1	1.5	8.5	4.7	4
042786	5	329	1.1	1.3	9.5	5	4
042786	5	400	.7	4	8	6	2
052186	4	310	.7	2.5	10.5	2.3	5
052186	4	340	.7	2.5	10.5	2.3	5
052186	4	293	2.1	1.8	10.5	4.3	1
052186	4	280	.7	1.1	12	3.2	5
052186	4	293	1.4	2.4	11.5	4.2	2
080786	3	303	.9	1.7	19	2.1	2
080786	3	266	.4	3	19.5	4.5	5
080786	3	395	.3	2.4	19.5	4.5	1
080786	3	390	1	2.1	19	3.5	5
080886	4	279	.2	3.6	14	4.5	5
080886	4	295	.4	.8	16.5	3.5	5
080886	4	285	.1	3.2	17	4.3	4
080886	4	305	.2	1.4	13	4.5	1
080886	4	292	.2	3.6	14	4.5	5
082686	3	312	.4	2.3	17	2.8	5
082686	3	328	.4	2.3	17	2.8	5
082686	3	348	.1	.6	17	4.5	2
082686	3	378	.4	2.3	17	2.8	5
082686	3	352	.4	2.3	17	2.8	5
082686	3	340	.7	1.6	16	4.5	5
102186	2	320	0	1.4	10	3.1	4
102186	2	354	.1	1.4	10	3.1	4
102186	2	355	1.2	1.2	10	3	4
102186	2	274	.5	4.6	11	3.8	4
102186	2	359	.5	1.4	10	4.2	5
121886	2	395	.2	2.5	3	2.2	5

Table J.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
121886	3	350	.8	3.7	4	3.9	5
121886	3	360	.8	3.7	4	3.9	5
121886	2	400	.6	1.4	3	1.5	5
121886	2	368	.4	2.8	2.5	4.5	5
121886	2	399	.4	2.8	2.5	4.5	5
121886	2	405	.3	1.3	2.8	1	5
121886	2	299	.6	2.8	2.8	1.5	5
121886	2	291	.7	2.6	2.5	2.9	5
121886	2	300	1.8	2.1	3	3.9	5
121886	2	280	.2	2.7	3	1.5	1
121886	2	295	.5	1.6	2.5	1.1	5
121886	2	295	1.6	1.6	2.5	3.9	5
121886	2	345	1	2.3	2.5	3	5
121886	2	309	1	1.9	2.5	2.7	5
121886	3	305	1	3.2	4	3.9	5
121886	3	295	1	3.2	4	3.9	5
121886	3	395	1.1	2.4	3	4.5	5
121886	3	335	0	2.3	3	1	5
121886	2	289	.9	3.1	3.2	3.5	3
121886	2	280	1.8	2.1	3	3.9	5
121886	3	330	1.2	1.8	4	4.1	5
121886	2	330	.6	1.7	3.2	1.9	5

Table J.2. Habitat Utilization Information for rainbow trout juveniles.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	2	242	3.2	2.8	11.3	5	2
042686	2	261	.6	2.5	11.3	3.2	5
042686	2	120	.6	.8	11.3	4.5	1
042686	2	255	1.9	1.1	11	4.5	4
042786	5	160	.2	.9	10	4.8	4
042786	5	169	1.2	1.3	10	4.8	1
042786	5	166	2	1.4	8.5	3.9	1
042786	5	170	.5	4	10	4.9	4
042786	5	238	1.3	2.3	9	4.8	4
042786	5	244	.3	2	10	5.2	3
042786	5	167	.8	2	10	3.8	1
042886	1	119	.2	.8	8.5	1	2
052186	4	181	.8	3.2	10.5	4.5	3
052186	4	158	.8	1.6	12	4.2	5
052186	4	240	1.9	2.1	10.5	4.2	5
052186	4	127	.6	1.7	10.8	4.1	3
052186	4	125	.7	1.7	10.8	3.5	5
052186	4	164	2.1	2	10.5	4.6	4
052186	4	138	.8	2	10.8	3.2	5
052186	4	149	0	1.1	12	4.6	5
052186	4	135	2.2	.9	11.5	2.6	4
052186	4	120	.8	2	10.8	3.2	5
052186	4	124	1.6	1.5	11.5	4.2	1
052186	4	134	.2	.8	11.5	2	2
052186	4	263	1.5	3.2	10.5	4.4	2
052186	4	196	1.2	1.9	12	4.3	4
052186	4	225	1.8	3.2	10.5	4.4	2
052186	4	168	0	1.9	11.5	4.4	5
070186	2	159	1.1	1.1	16	3.9	5
070186	2	161	.7	.7	16	4.9	5
080886	4	151	.1	1.2	18	4.2	4
080886	4	162	.6	.7	18	3.2	1
080886	4	150	1.6	1.7	18	3.5	3
080886	4	162	1.7	1.7	18	3.5	3
080886	4	150	.5	2.1	18	2.8	4

Table J.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	177	.1	1.2	18	4.3	4
080886	4	156	.1	1.2	18	4.2	4
080886	4	180	.5	2.1	18	2.8	4
080886	4	142	.1	1.2	18	4.2	4
080886	4	250	1	1.7	18	3.8	4
080886	4	189	.6	1.3	17.5	2	2
080886	4	225	0	1.9	17.5	1	4
080886	4	190	.1	1.2	18	4.2	4
080886	4	202	.6	1	18	3.5	5
080886	4	201	1	1.7	18	3.8	4
080886	4	186	1.4	.8	17.5	3.9	4
080886	4	188	.7	1.2	13	1	1
080886	4	245	.5	1.5	19.5	1.5	5
080886	4	190	1.3	1.3	19	3.7	1
080886	4	240	.2	3.2	17	4.3	4
080886	4	220	.2	1.2	17	4.2	3
080886	4	195	2.5	.7	13	3.8	1
080886	4	175	1.4	.8	17.5	3.9	4
080886	4	166	1.3	1.5	12.5	2.8	4
080886	4	177	.9	1.1	13	2.7	4
080886	4	180	1.7	1.7	18	3.5	3
080886	4	170	1.7	1.7	18	3.5	3
080886	4	140	.4	.8	17.5	2.5	5
082686	3	155	.2	1.9	15	3.8	5
082686	3	195	.3	2	17	2	5
082686	3	199	.3	2	17	2	5
102186	2	234	1.3	1	10	4.2	5
102186	2	246	1.8	1.1	10	2.2	4
102186	2	174	.5	1.7	10	4.3	5
102186	2	190	1.4	1.9	10	3.9	5
102186	2	255	.1	1.8	10	2.2	5
102186	2	232	2	.9	10	4.2	5
121886	2	130	.5	2.8	3	3.8	5
121886	2	194	1	1.9	3.2	3.4	5
121886	2	205	.2	2.7	3	1.5	1

Table J.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
121886	2	248	.4	2.8	2.5	4.5	5
121886	2	232	.4	2.8	2.5	4.5	5
121886	2	226	1	1.9	3.2	3.4	5
121886	2	203	.5	1.3	3	2.5	4
121886	2	220	1.6	1.6	2.5	3.9	5
121886	2	205	.5	.9	3	1.5	5
121886	2	206	1.1	2.2	2.5	2.7	5
121886	2	130	.9	1.9	3	2.9	2
121886	2	265	.6	1.4	3	1.5	5
121886	2	196	.8	1.6	2.8	3.1	5
121886	2	250	.1	1.1	3	1.5	5
121886	2	220	1.6	1	2.8	4.6	2
121886	2	178	1	1	2.8	4.8	2
121886	2	178	.4	1.5	2.8	2.1	2
121886	2	200	.5	1.6	2.5	1.1	5
121886	3	200	1.2	1.6	3.9	3.7	5
121886	2	174	1	1.9	2.5	2.7	5
121886	3	208	1	3.2	4	3.9	5
121886	2	188	.2	2.4	2.5	2.9	5

Table J.3. Habitat Utilization Information for rainbow trout young-of-the-year.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042786	5	92	0	1.9	9.5	3.1	1
042786	5	80	1.4	1.1	9.5	4.1	4
042786	5	118	.8	2	10	3.8	1
042786	5	86	1	1.1	8.5	3.7	4
042786	5	86	.8	2	10	3.8	1
042786	5	84	1.1	1.3	9.5	4.8	1
042786	5	90	.1	1.6	8.5	4.7	4
042786	5	91	.1	1.6	8.5	4.7	4
042786	5	102	2	.7	8.5	4.4	1
042786	5	86	.2	.9	9	7	5
042786	5	95	.2	.9	9	7	5
052186	4	110	0	3.5	10.5	2.3	5
052186	4	100	.8	2	10.8	3.2	5
080886	4	86	.1	1.2	18	4.2	4
080886	4	63	.1	1.2	18	4.2	4
080886	4	80	.1	1.2	18	4.2	4
080886	4	98	.1	1.2	18	4.2	4
080886	4	76	.6	.6	18	4.7	2
080886	4	77	1	.5	18	3.3	4
080886	4	80	1.4	.8	17.5	3.9	4
080886	4	70	.6	.6	18	4.7	2
080886	4	73	1	.5	18	3.3	4
080886	4	76	.4	.8	16.5	3.5	5
080886	4	75	.4	.8	16.5	3.5	5
080886	4	92	0	1	17	1	4
080886	4	60	.4	.8	16.5	3.5	5
080886	4	61	.4	.8	16.5	3.5	5
080886	4	101	.4	.8	16.5	3.5	5
080886	4	83	.1	1.2	18	4.2	4
080886	4	88	.1	1.2	18	4.2	4
080886	4	85	.1	1.2	18	4.2	4
080886	4	92	1.7	1.7	18	3.5	3
080886	4	80	1.1	.8	18	2	1
080886	4	69	0	.5	18	2.1	1
082686	3	75	.3	1.4	16	4.3	1

Table J.3. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
082686	3	69	.3	1.8	14	1.5	5
082686	3	65	.4	1.3	16	1.5	5
082686	3	70	.1	1.9	16	1.5	5
102186	2	95	2.5	.6	10	3.8	4
102186	2	110	1.5	.6	10	3.8	4
102186	2	85	.4	.5	10	4.9	1
102186	2	100	1.3	1.3	10	3	5
102186	2	110	0	.7	10	2.5	3
102186	2	91	.2	1.4	10	4.8	4
102186	2	113	.2	1.4	10	4.8	4
102186	2	103	.5	1.7	10	4.3	5
102186	2	85	.2	.8	10	2	3
102186	2	97	0	1.7	10	4.1	5
102186	2	97	.7	.7	10	3.1	4
121886	3	74	.2	.8	3	2.1	5
121886	3	95	1.6	.6	3	3.2	5
121886	3	83	0	1.8	3	1	5
121886	2	116	.5	1.6	2.5	1.1	5
121886	2	90	1.8	.8	2.5	2.8	5
121886	2	102	.5	1.2	3	2.2	5
121886	3	100	2.2	1.3	2.8	3.8	5
121886	2	91	1.2	1.1	2.5	3.2	5
121886	2	105	.5	1.6	2.5	1.1	5
121886	2	100	.9	1.9	3	2.9	2
121886	3	78	0	1	3.9	1	2
121886	3	80	.2	.8	3	2.1	5
121886	3	88	.2	.8	3	2.1	5
121886	2	100	.9	1.9	3	2.9	2
121886	2	100	.3	2	4	1	2
121886	3	105	.2	2.5	4	1	5

Table J.4. Habitat Utilization Information for rainbow trout fry.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.8	.	1.8	1
062687	4	.	0	.8	.	1.8	1
062687	4	.	.2	.3	.	2	4
062687	4	.	0	.8	.	1.8	1
062687	4	.	0	.8	.	1.8	1
062687	4	.	0	.8	.	1.8	1
062687	4	.	1.2	.3	.	3	1
062687	4	.	.9	.7	.	2.5	1
062687	4	.	.7	.6	.	2.5	1

Table J.4. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
062687	4	.	.2	.3	.	2	4
062687	4	.	.2	.3	.	2	4
062687	4	.	.7	.3	.	2.3	4
062687	4	.	0	.8	.	1.8	1
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.8	.	1.8	1
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.6	.	1.5	4
062687	4	.	0	.8	.	1.5	4
062687	4	.	.5	.4	.	3	1
062687	4	.	.8	.4	.	3.2	2
062687	4	.	.5	.4	.	3.5	1
062687	4	.	.3	.9	.	2.5	4
062687	4	.	.3	.9	.	2.5	4
062687	4	.	.5	.4	.	3	1
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.3	.9	.	2.5	4
062687	4	.	.3	1.1	.	3	4
062687	4	.	.3	1.1	.	3	4
062687	4	.	.3	1.1	.	2.5	4
062687	4	.	.4	1.1	.	2.9	4
062687	4	.	.4	1.1	.	2.9	4

Table J.4. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
062687	4	.	.3	1.1	.	3	4
062687	4	.	.3	1.1	.	2.5	4
062687	4	.	.3	.9	.	2.5	4
062687	4	.	.3	.9	.	2.5	4
062687	4	.	.3	1.1	.	2.5	4
062687	4	.	.3	1.1	.	2.5	4
062687	4	.	.3	1.1	.	2.5	4
062687	4	.	.1	.9	.	1	5
062687	4	.	0	1	.	2	1
062687	4	.	0	1	.	2	1
062687	4	.	0	1	.	2	1
062687	4	.	0	.3	.	1	1
062687	4	.	0	1	.	2	1
062687	4	.	0	1	.	2	1
062687	4	.	0	1	.	2	1
062687	4	.	0	1	.	2	1
062687	4	.	0	.8	.	1.5	4
062687	4	.	0	1	.	2	1
062687	4	.	0	1	.	2	1
062687	4	.	0	1	.	2	1
062687	4	.	0	.3	.	1	1
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.3	.	1	4
062687	4	.	.1	.5	.	1	4
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.1	.9	.	1	5
062687	4	.	.7	.5	.	3.9	4
062687	3	.	.1	1	.	1	2

Table J.4. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
062687	3	•	.1	1	•	1	2
062687	3	•	.1	1	•	1	2
062687	3	•	.6	1.2	•	3.5	1
062687	3	•	.1	1	•	1	2
062687	3	•	.1	1	•	1	2
062687	3	•	.1	1	•	1	2
062687	3	•	.1	1	•	1	2
062687	3	•	.4	1.1	•	1	5
062687	3	•	.1	1	•	1	2
062687	3	•	.1	1	•	1	2
062687	3	•	.1	1	•	1	2
062687	3	•	.6	1.2	•	3.5	1
062687	3	•	1.1	1.2	•	4.1	2
062687	3	•	.7	.8	•	1	5
062687	3	•	.7	.8	•	1	5
062687	4	•	.8	.8	•	4	1
062687	4	•	.8	.8	•	4	1
062687	3	•	1.1	1.2	•	4.1	2
062687	3	•	.2	.4	•	1	4
062687	3	•	.6	1.2	•	3.5	1
062687	3	•	.6	1.2	•	3.5	1
062687	3	•	.7	.8	•	1	5
062687	3	•	.2	.4	•	1	4
062687	3	•	.2	.4	•	1	4
062687	3	•	.4	1.1	•	1	5
062687	3	•	.2	.4	•	1	1
062687	3	•	.2	.4	•	1	1
062687	3	•	.3	.5	•	1	1
062687	3	•	.6	.9	•	1	4
062687	3	•	.2	.4	•	1	1
062687	3	•	.2	.4	•	1	1
062687	3	•	.5	1.1	•	3.9	4
062687	3	•	.3	.3	•	2.5	5
062687	3	•	.3	.3	•	2.5	5
062687	3	•	.3	.5	•	1	1

Table J.4. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
062687	3	.	.3	.5	.	1	1
062687	3	.	.3	.5	.	1	1
062687	3	.	.6	.9	.	1	4
062687	3	.	.4	1.1	.	1	5
062687	3	.	.6	.9	.	1	4
062687	3	.	.6	.9	.	1	4
062687	3	.	.4	1.1	.	1	5
062687	3	.	.4	1.1	.	1	5
062687	3	.	.4	1.1	.	1	5
062687	3	.	.6	.9	.	1	4
062687	3	.	.6	.9	.	1	4
062687	3	.	.6	.9	.	1	4
062687	3	.	.6	.9	.	1	4
062687	3	.	.6	.9	.	1	4
062687	3	.	.6	.9	.	1	4
062687	4	.	.8	.8	.	4	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.4	.8	.	4.2	1
062687	2	.	.4	.3	.	4.1	1
062687	4	.	0	.7	.	1	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.4	.8	.	4.2	1
062687	4	.	.4	.8	.	4.2	1
062687	4	.	.2	.8	.	4	1
062687	4	.	.7	.5	.	3.9	4
062687	4	.	.7	.5	.	3.9	4
062687	4	.	.7	.5	.	3.9	4
062687	4	.	.7	.5	.	3.9	4
062687	4	.	.7	.5	.	3.9	4
062687	4	.	.7	.5	.	3.9	4

Table J.4. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
062687	4	.	0	.4	.	4.2	2
062687	4	.	0	.4	.	4.2	2
062687	4	.	0	.4	.	4.2	2
062687	4	.	1.1	.5	.	4	1
062687	4	.	1.1	.5	.	4	1
062687	4	.	1.1	.5	.	4	1
062687	4	.	0	.7	.	1	1
062687	4	.	.2	.7	.	3.7	1
062687	4	.	.3	1	.	4.1	1
062687	4	.	.3	1	.	4.1	1
062687	4	.	.3	1	.	4.2	1
062687	4	.	.3	1.4	.	4.2	1
062687	4	.	.2	.7	.	3.7	1
062687	4	.	.8	.8	.	4	1
062687	4	.	.8	.8	.	4	1
062687	4	.	.8	.8	.	4	1
062687	4	.	.5	.6	.	3.8	1
062687	4	.	.5	.6	.	3.8	1
062687	4	.	.5	.6	.	3.8	1
062687	4	.	.3	1	.	4.2	1
062687	4	.	0	.9	.	1	1
062687	4	.	.2	.5	.	4.2	2
062687	4	.	.2	.5	.	4.2	2
062687	4	.	0	.7	.	1	1
062687	4	.	0	.7	.	1	1
062687	4	.	0	.9	.	1	1
062687	4	.	.2	.5	.	4.2	2
062687	4	.	.3	1	.	4.2	1
062687	4	.	.3	1	.	4.2	1
062687	4	.	.2	.5	.	4.2	2
062687	4	.	.2	.5	.	4.2	2
062687	4	.	.2	.5	.	4.2	2

Table J.5. Habitat Utilization Information for spawning rainbow trout.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042187	•	5	2.4	.8	10	3.3	1
042187	•	3	1.8	.7	12.5	3.5	1
042187	•	•	2.7	.7	10	3.6	1
042187	•	•	1.6	.6	10	3.3	1
042187	•	•	1.6	.5	10	3.2	1
042187	•	2	2.2	.8	12.5	3.6	1
042187	•	•	1.6	.7	12.5	3.3	1
042187	•	•	1.5	.7	12.5	3.2	1
042187	•	6	1.8	.6	12.5	3.1	1
042187	•	2	2.2	.6	12.5	3.5	1
042187	•	4	2.2	.6	12.5	3.2	1
042187	•	4	.8	.9	8	3.3	1
042187	•	4	1.1	.5	8	3.1	1
042187	•	6	1.5	1	8	3.7	1
042187	•	5	2.5	.5	8	3	1
042187	•	6	1.9	1	8	3.7	1
042187	•	4	1.7	1	8	2.9	5
042187	•	4	1	.7	10	3	4
042187	•	3	1.6	.8	10	3	4
042187	•	6	1.9	.5	9	3.1	1
042187	•	3	.5	.4	8	3.2	1
042187	•	5	1.1	.9	9	3.5	1

APPENDIX K

HABITAT UTILIZATION INFORMATION FOR SCULPINS

Table K.1. Habitat Utilization Information for sculpin adults.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	2	66	3.3	1.4	11.2	5	5
042686	2	77	1.7	.6	11.2	4.8	4
042686	2	51	1.4	1.6	11.2	4.8	1
042686	2	50	.7	.7	11.2	4.7	1
042686	2	50	1.4	1.6	11.2	4.8	1
042686	2	94	1.5	.9	11.2	3.9	5
042686	2	50	1.5	.9	11.2	3.9	5
042686	2	74	2.1	1	11.2	4.6	1
042686	2	67	.1	.8	11.2	4.5	1
042686	2	68	2.1	1	11.2	4.6	1
042686	2	75	.7	.7	11.2	4.7	1
042686	2	61	1.7	.8	11.2	5	1
042686	2	50	1.7	.8	11.2	5	1
042686	2	48	1.7	.8	11.2	5	1
042686	2	60	1.7	.8	11.2	5	1
042686	2	71	1.7	.8	11.2	5	1
042686	2	50	1	1	11.2	4.3	4
042686	2	80	.7	.7	11.2	4.7	1
042686	2	57	1	1	11.2	4.3	4
042686	2	50	1.7	.8	11.2	5	1
042686	2	61	1	1	11.2	4.3	4
042686	2	73	1.4	1.6	11.2	4.9	1
042686	2	65	2.1	1.5	11	4.7	1
042686	2	57	2.7	.9	11	1.9	1
042686	2	49	2	1	11	3.7	1
042686	2	56	1.9	.8	11.2	5.1	2
042686	2	68	1.9	.8	11.2	5.1	2
042686	2	61	.1	1.2	11	4.5	1
042686	2	65	2.1	1.5	11	4.7	1
042686	2	66	.1	1.2	11	4.5	1
042686	2	70	2.7	.9	11	1.9	1
042686	2	62	2.7	.9	11	1.9	1
042686	2	52	1.8	.7	11.2	4.5	1
042686	2	97	1.1	.9	11.2	3	4
042686	2	96	1.1	.9	11.2	3	4

Table K.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	2	78	1.1	.9	11.2	3	4
042686	2	65	1.4	1.6	11.2	4.9	1
042686	2	70	1.1	.9	11.2	3	4
042686	2	58	1.8	.7	11.2	4.5	1
042686	2	75	1.8	.7	11.2	4.5	1
042686	2	61	.7	1.9	11.2	2	4
042686	2	64	4.5	1.5	11.2	3.8	4
042686	2	85	1	2.3	11.2	4.5	3
042686	1	62	3.6	1.2	9	4.5	1
042686	1	52	3.3	1.5	9	5	1
042686	1	55	2.7	1.4	9	5	1
042686	1	63	2.7	1	8.5	3	1
042686	1	85	1.9	1.7	8.5	4.5	1
042686	1	66	0	.8	9	1.5	4
042686	1	76	2.1	1.8	9.5	6	2
042686	1	63	0	.8	9	1.5	4
042686	1	72	3.3	1.5	9	5	1
042686	1	65	3.3	1.5	9	5	1
042686	1	60	2.7	1.1	8	3.7	2
042686	1	64	1.7	1.1	7	4.9	3
042686	1	71	1.7	1.1	7	4.8	3
042686	1	66	1.7	1.1	7	4.8	3
042686	1	49	.5	.6	7	1	5
042686	1	50	2.1	.8	7	3.7	1
042686	1	80	2.4	1.5	8	5.3	2
042686	1	66	1.9	1.5	8	3.4	3
042686	1	56	1	1.3	8	4.8	2
042686	1	50	2	.9	8	4.6	1
042686	1	62	1	1.3	8	4.8	2
042686	1	85	4.3	1.8	9.5	6	3
042686	2	66	1.8	.8	11.2	5.8	2
042686	2	103	.6	.7	11.2	5	2
042686	2	56	1.8	.8	11.2	5.8	2
042686	2	74	1.2	.8	11.2	4	4
042686	2	52	1.8	.8	11.2	5.8	2

Table K.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	2	65	1.6	.6	11.2	3.7	1
042686	2	60	1.6	.6	11.2	3.7	1
042686	2	62	1.1	.9	11.2	4.9	4
042686	2	72	.6	.7	11.2	5	2
042686	2	32	.6	.7	11.2	5	2
042686	2	56	.6	.4	11.2	3.6	4
042686	2	80	2.8	.6	11.2	5	5
042686	2	76	1.3	.8	11.2	4.8	1
042686	1	90	.8	.4	10	5.8	1
042686	1	76	4.9	1.1	10	5.2	3
042686	1	70	.9	.9	10	4.8	1
042686	2	75	2	.8	11.2	4.5	4
042686	2	65	.6	.4	11.2	3.6	4
042686	2	72	2	.8	11.2	4.5	4
042686	2	57	.1	.7	11.2	4.8	1
042686	2	99	2	.8	11.2	4.5	4
042786	5	67	2.5	1.3	9.5	4.3	1
042786	5	73	2.5	1.3	9.5	4.3	1
042786	5	67	1.4	1.1	9.5	3.8	4
042786	5	50	2.5	1.3	9.5	4.3	1
042786	5	56	.9	1.3	9.5	4.4	1
042786	5	67	.9	1.3	9.5	4.4	1
042786	5	63	.1	2.2	9.5	4.5	4
042786	5	68	1.2	1.2	9.5	4.8	4
042786	5	66	2.4	.8	10	4.3	1
042786	5	49	2.4	.8	10	4.3	1
042786	5	75	.8	2	10	3.8	1
042786	5	53	2.4	.8	10	4.3	1
042786	5	72	2.8	1.1	10	4.2	2
042786	5	80	.5	1.4	10	5.9	4
042786	5	73	2.4	.8	10	4.3	1
042786	5	70	1.7	.6	8.5	4.1	1
042786	5	49	1.7	.6	8.5	4.1	1
042786	5	81	1.1	1.3	8.5	4.1	4
042786	5	64	1.7	.6	8.5	4.1	1

Table K.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042786	5	56	1.7	1.1	8	4.1	1
042786	5	74	1.9	1.5	8.5	3.9	1
042786	5	61	1.9	.6	8.5	4.2	1
042786	5	65	1.9	1.3	8.5	4.4	1
042786	5	73	1.4	.6	9.5	4.6	2
042786	5	63	1.4	.6	9.5	4.6	2
042786	5	55	.6	1.5	9.5	4.8	1
042786	5	63	1	.9	8.5	3.7	4
042786	5	71	2.2	.8	8.5	4.4	1
042786	5	71	.6	2.3	9	4.8	4
042786	5	67	3	1.3	9.5	4.9	3
063086	1	75	.9	1.6	22	4.5	2
063086	1	93	.4	1.9	22	4	2
063086	1	91	.3	.9	22	4	2
063086	1	67	.9	1.6	22	4.5	2
063086	1	101	.5	1.5	21	5.1	2
063086	1	94	.3	1.1	22	2	3
063086	1	76	1.1	1.3	22	2	3
070186	2	61	.1	.6	17	1.5	2
070186	2	71	.5	.5	17	3.9	1
070186	2	56	.5	.5	17	3.9	1
070186	2	60	.1	.6	17	1.5	2
070186	2	84	1.4	1.5	17.5	4.2	1
070186	2	79	1.4	1.5	17.5	4.2	1
070186	2	67	.1	.6	17	1.5	2
070186	2	64	1.1	1.1	16	3.9	5
070186	2	64	1.1	1.1	16	3.9	5
070186	2	70	1.1	1.1	16	3.9	5
070186	2	188	1.1	1.1	16	3.9	5
070186	2	68	2.9	.5	16	4	4
070186	2	73	2.9	.5	16	4	4
070186	2	51	2.9	.5	16	4	4
070186	3	58	.4	.8	19	3.9	1
070186	3	67	1.3	1.6	19	4.2	1
070186	2	67	2.9	1.1	17.5	4.3	2

Table K.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
070186	2	78	2.9	1.1	17.5	4.3	2
070186	3	57	1.3	1.6	19	4.2	1
070186	3	59	.3	1.5	19	4.2	1
070186	3	70	1.2	3.1	19.5	1	5
070186	3	82	1.3	1.6	19	4.2	1
070186	3	80	.3	1.5	19	4.2	1
070186	2	88	1.3	1.3	17.5	3.8	1
070186	2	96	1.7	1.4	17.5	5.2	2
070186	2	66	1.4	1.5	17.5	4.2	1
070186	2	70	1.3	1.3	17.5	3.8	1
070186	2	88	1.7	1.4	17.5	5.2	2
070186	2	63	.9	.9	17.5	4.9	1
070186	2	56	.9	.9	17.5	4.9	1
070186	2	87	.5	.8	17.5	4.9	1
070186	2	62	.5	.8	17.5	4.9	1
072986	1	78	.6	.7	15	3.9	1
072986	1	82	.5	1.5	15	4.2	3
072986	1	76	2.2	1.6	14	4.2	4
080786	3	64	.6	1.6	18.5	1	4
080786	3	56	.6	1.6	18.5	1	4
080786	3	53	1.2	1	19	2.7	5
080786	3	69	1.2	1	19	2.7	5
080786	3	70	1.2	1	19	2.7	5
080786	3	72	1	.8	118.5	4.6	1
080786	3	76	.8	1.3	18.5	4	4
080786	3	66	1	.8	18.5	4.6	1
080786	3	53	.6	1.6	18.5	1	4
080786	3	70	.9	.7	18.5	3.7	4
080786	3	77	.3	1.6	19	2.3	4
080786	3	75	.7	1.1	19.5	3.2	5
080786	3	59	1.2	.6	19	4	4
080786	3	70	.7	1.1	19.5	3.2	5
080786	3	67	.9	1.9	19.5	4	4
080786	3	72	.9	1.9	19.5	4	4
080786	3	71	1.7	1.2	19	4.5	1

Table K.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080786	3	75	1.3	1.3	19	3.7	1
080786	3	61	1.7	1.2	19	4.5	1
080786	3	56	1.6	.8	19	4.2	1
080786	3	67	1.6	.8	19	4.2	1
080786	3	70	3.4	.4	18	4.5	1
080786	3	75	3.4	.4	18	4.5	1
080786	3	68	3.4	.4	18	4.5	1
080786	3	30	3.4	.4	18	4.5	1
080786	3	59	3.4	.4	18	4.5	1
080786	3	75	.5	2.6	16	1	5
080786	3	82	.5	2.6	16	1	5
080786	3	73	.8	1.7	16.5	4.2	5
080786	3	74	3.4	.4	18	4.5	1
080786	3	67	.3	1	18	3.5	1
080786	3	63	3.4	.4	18	4.5	1
080786	3	86	.2	.9	18.5	2.9	4
080786	3	76	.2	.9	18.5	2.9	4
080786	3	88	.2	.9	18.5	2.9	4
080786	3	81	.2	.9	18.5	2.9	4
080786	3	91	.2	.9	18.5	2.9	4
080786	3	69	2.4	.5	18	4.5	1
080786	3	71	2.4	.5	18	4.5	1
080786	3	67	2.4	.5	18	4.5	1
080786	3	69	1.2	.9	18	4.7	1
080786	3	62	2.4	.5	18	4.5	1
080886	4	63	1.3	1.5	12.5	2.8	4
080886	4	52	.8	.9	12.5	4.1	4
080886	4	92	1.2	.9	13	4.1	4
080886	4	92	1.9	1.7	13	2	3
080886	4	67	.7	1.4	13	3.9	3
080886	4	82	1.3	1.5	12.5	2.8	4
080886	4	63	1.4	.7	16	3.1	4
080886	4	70	1.4	.7	16	3.1	4
080886	4	54	1.4	.7	16	3.1	4
080886	4	83	0	.9	14	1.9	4

Table K.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	70	0	.9	14	1.9	4
080886	4	85	2.2	.3	16	4.4	3
080886	4	73	.7	.7	18	2.5	3
080886	4	68	.5	2.1	18	2.8	4
080886	4	72	.5	2.1	18	2.8	4
080886	4	80	1	.5	18	3.3	4
080886	4	66	.6	.6	18	4.7	2
080886	4	75	.1	1.2	18	4.2	4
080886	4	76	.2	1.4	13	4.5	1
080886	4	172	.9	1.1	13	2.7	4
080886	4	50	.9	1.1	13	2.7	4
080886	4	50	1.5	.3	13	1.8	1
080886	4	55	1.1	1.6	13	4.2	4
080886	4	93	.2	1.4	13	4.5	1
080886	4	55	.4	.8	17.5	2.5	5
080886	4	83	2.3	.7	18	3.8	4
080886	4	77	1.1	.8	18	2	1
080886	4	62	.4	1.1	17	4.5	4
080886	4	55	1.4	.8	17.5	3.9	4
080886	4	55	.4	.8	17.5	2.5	5
080886	4	69	0	.5	18	2.1	1
080886	4	73	.6	1	18	3.5	5
080886	4	58	.6	1	18	3.5	5
080886	4	79	.5	2.1	18	2.8	4
080886	4	69	0	.5	18	2.1	1
080886	4	69	0	.5	18	2.1	1
080886	4	62	.4	.8	16.5	3.5	5
080886	4	84	.8	1	17	4.2	1
080886	4	70	0	1	17	1	4
080886	4	75	.4	.8	16.5	3.5	5
080886	4	75	.4	.8	16.5	3.5	5
080886	4	85	.4	.8	16.5	3.5	5
080886	4	84	.4	1.1	17	4.5	4
080886	4	71	.4	1.1	17	4.5	4
080886	4	71	.4	1.1	17	4.5	4

Table K.1. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	80	1.6	1.1	17	3.8	4
080886	4	82	1.6	1.1	17	3.8	4
080886	4	62	1.6	1.1	17	3.8	4
082686	3	72	1.8	.8	16.5	3.8	4
082686	3	65	.7	1.6	16	4.5	5
082686	3	80	.7	1.5	17	3.8	4
082686	3	82	.4	1.3	16	1.5	5
082686	3	65	1.4	.7	14	3.6	5
082686	3	74	2.5	1.2	15	3.3	3
082686	3	66	.4	1.5	14	1.5	5
082686	3	80	1.4	.7	14	3.6	5
082686	3	74	2.5	1.2	15	3.3	3
082686	3	72	.1	1.3	16	1	3
082686	3	70	.4	1.3	16	1.5	5
082686	3	55	2.5	1.2	15	3.3	3
082686	3	62	.1	1.3	16	1	3

Table K.2. Habitat Utilization Information for sculpin sub-adults.

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
042686	1	47	.9	.8	8	5	4
042686	1	46	2.7	1.1	8	3.7	2
042686	1	47	0	.8	9	1.5	4
042686	1	39	0	.8	9	1.5	4
042686	2	44	1.4	1.6	11.2	4.8	1
042686	2	47	1.1	.9	11.2	4.9	4
042686	2	42	2	.8	11	4.5	1
042686	2	35	1.1	.9	11.2	3	4
042686	2	32	.6	.7	11.2	5	2
042686	2	42	1.1	.9	11.2	3	4
042786	5	36	2.2	.8	8.5	4.4	1
042786	5	35	3	1.3	9.5	4.9	3
042786	5	41	1.7	1.4	8.5	4.1	4
042786	5	41	1	.9	8.5	3.7	4
042786	5	30	1.5	1.4	9.5	4.1	4
042786	2	46	1.7	.6	8.5	4.1	1
042786	5	45	2.4	.8	10	4.3	1
042786	5	38	0	1.9	9.5	3.1	1
070186	2	23	.1	.2	17	3.7	2
070186	2	22	1	.4	17	4.5	2
070186	2	22	.1	.6	17	1.5	2
070186	2	22	.1	.6	17	1.5	2
070186	2	21	.1	.6	17	1.5	2
070186	2	23	.1	.6	17	1.5	2
070186	2	22	.1	.6	17	1.5	2
070186	2	23	.1	.6	17	1.5	2
070186	2	22	.1	.6	17	1.5	2
070186	2	23	.1	.6	17	1.5	2
070186	2	23	.1	.6	17	1.5	2
070186	2	22	.1	.6	17	1.5	2
070186	2	21	.1	.6	17	1.5	2
070186	2	18	1.8	.7	19	3.1	1
070186	2	47	.9	.9	17.5	4.9	1
070186	2	18	.9	1	19	3.8	1
070186	2	18	.9	1	19	3.8	1

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
070186	2	18	.9	1	19	3.8	1
070186	2	18	.9	1	19	3.8	1
070186	2	20	.8	.3	19	1.2	1
070186	2	18	1.8	.7	19	3.1	1
070186	2	18	1.8	.7	19	3.1	1
070186	2	18	.9	1	19	3.8	1
070186	2	21	1.3	1.6	19	4.2	1
070186	2	18	.9	1	19	3	1
072986	1	28	1.8	.3	14	4.4	1
072986	1	34	1.4	1.5	14	4.7	1
072986	1	37	1.4	1.5	14	4.7	1
080786	3	30	.9	.7	18.5	3.7	4
080786	3	33	1.1	2.1	16	1	2
080786	3	33	1.1	2.1	16	1	2
080786	3	28	.9	.7	18.5	3.7	4
080786	3	27	.5	2.9	16	2.5	5
080786	3	29	.5	2.9	16	2.5	5
080786	3	22	.5	2.9	16	2.5	5
080786	3	30	.9	.7	18.5	3.7	4
080786	3	33	.9	.7	18.5	3.7	4
080786	3	25	1.7	1.3	19	4.2	5
080786	3	35	1.7	1.3	19	4.2	5
080786	3	26	.9	.7	18.5	3.7	4
080786	3	21	.9	.7	18.5	3.7	4
080786	3	26	.4	1.2	18.5	1.5	5
080786	3	35	.7	.5	19	3.9	1
080786	3	33	2.4	.5	18	4.5	1
080786	3	29	1.1	2.1	16	1	2
080786	3	31	1.1	2.1	16	1	2
080786	3	33	1.2	.9	18	4.7	1
080786	3	24	2.4	.5	18	4.5	1
080786	3	36	1.2	.9	18	4.7	1
080786	3	29	.3	1	18	3.5	1
080786	3	29	.8	1.7	16.5	1	1
080786	3	31	1.2	2.7	18.5	3.4	5

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080786	3	28	.3	1	18	3.5	1
080786	3	37	1.1	2.1	16	1	2
080786	3	23	.3	1	18	3.5	1
080786	3	33	1.2	2.7	18.5	3.4	5
080786	3	35	1.1	1.3	18.5	4	4
080786	3	29	1.1	1.3	18.5	4	4
080786	3	31	.6	1.6	18.5	1	4
080786	3	27	1.1	2.1	16	1	2
080786	3	27	1.1	1.3	18.5	4	4
080786	3	31	1.1	1.3	18.5	4	4
080786	3	34	1.1	1.3	18.5	4	4
080786	3	31	1.2	2.7	18.5	3.4	5
080786	3	30	1.1	1.3	18.5	4	4
080786	3	33	1.2	2.7	18.5	3.4	5
080786	3	32	1.2	2.7	18.5	3.4	5
080786	3	26	1.2	2.7	18.5	3.4	5
080786	3	35	1.7	1.3	19	4.2	5
080786	3	29	1.7	1.3	19	4.2	5
080786	3	36	1.1	1.3	18.5	4	4
080786	3	29	.9	.7	18.5	3.7	4
080786	3	29	1.2	.6	18	3.9	5
080786	3	27	.9	.7	18.5	3.7	4
080786	3	31	.2	1.5	16	1	5
080786	3	32	1.1	2.1	16	1	2
080786	3	31	2.4	.5	18	4.5	1
080786	3	33	1.2	.6	18	3.9	5
080786	3	31	1.2	.6	18	3.9	5
080786	3	34	1.1	1.3	18.5	4	4
080786	3	32	1.1	1.3	18.5	4	4
080786	3	29	.6	.5	18.5	2.5	5
080786	3	29	1.1	1.3	18.5	4	4
080786	3	32	1.2	.6	18	3.9	5
080786	3	28	1.2	.9	18	4.7	1
080786	3	22	2.3	.4	19	3.8	1
080786	3	31	.7	.5	19	3.9	1

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080786	3	37	1.6	.8	19	4.2	1
080786	3	39	.7	.5	19	3.9	1
080786	3	28	.7	.5	19	3.9	1
080786	3	27	1.3	1.3	19	3.7	1
080786	3	32	.7	.5	19	3.9	1
080786	3	37	1.6	.8	19	4.2	1
080786	3	37	.7	.5	19	3.9	1
080786	3	24	.9	1.9	19.5	4	4
080786	3	20	.9	1.9	19.5	4	4
080786	3	36	1.6	.8	19	4.2	1
080786	3	29	.7	.5	19	3.9	1
080786	3	28	1.6	.8	19	4.2	1
080786	3	35	.7	.5	19	3.9	1
080786	3	33	.7	.5	19	3.9	1
080786	3	35	1.3	1.3	19	3.7	1
080786	3	28	.7	.5	19	3.9	1
080786	3	30	1.3	1.3	19	3.7	1
080786	3	32	1.2	1	19	2.7	5
080786	3	34	.7	.5	19	3.9	1
080786	3	34	.7	.5	19	3.9	1
080786	3	37	.7	.5	19	3.9	1
080786	3	33	.7	.5	19	3.9	1
080786	3	30	.7	.5	19	3.9	1
080786	3	27	.7	.5	19	3.9	1
080786	3	38	.7	.5	19	3.9	1
080786	3	37	.7	.5	19	3.9	1
080786	3	35	2.4	.5	18	4.5	1
080786	3	24	2.4	.5	18	4.5	1
080786	3	21	2.4	.5	18	4.5	1
080786	3	34	1.2	.9	18	4.7	1
080786	5	27	.5	1.9	16	1	4
080786	3	32	2.4	.5	18	4.5	1
080786	3	35	2.4	.5	18	4.5	1
080786	3	33	1.2	.9	18	4.7	1
080786	3	31	1.2	.9	18	4.7	1

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080786	3	32	1.2	.9	18	4.7	1
080786	3	32	1.2	.6	18	3.9	5
080786	3	28	2.4	.5	18	4.5	1
080786	3	39	1.2	.9	18	4.7	1
080786	3	28	1.2	.9	18	4.7	1
080786	3	31	.7	.5	19	3.9	1
080786	3	35	2.3	.4	19	3.8	1
080786	3	31	2.3	.4	19	3.8	1
080786	3	36	2.3	.4	19	3.8	1
080786	3	33	1.6	.8	19	4.2	1
080786	3	34	1.6	.8	19	4.2	1
080786	3	27	.9	1.9	19.5	4	4
080786	3	35	2.3	.4	19	3.8	1
080786	3	37	1.2	1	19	2.7	5
080786	3	34	2.3	.4	19	3.8	1
080786	3	39	.7	.5	19	3.9	1
080786	3	36	.7	.5	19	3.9	1
080786	3	34	2.3	.4	19	3.8	1
080786	3	29	2.3	.4	19	3.8	1
080886	4	28	1.9	1.7	13	2	3
080886	4	24	1	.7	13	3.9	3
080886	4	29	1	.7	13	3.9	3
080886	4	29	1	.7	13	3.9	3
080886	4	31	1	.7	13	3.9	3
080886	4	24	.8	1.6	12.5	2.2	4
080886	4	26	1	.7	13	3.9	3
080886	4	30	1.6	1.1	17	3.8	4
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	1.6	1.1	17	3.8	4
080886	4	30	0	.9	14	1.9	4
080886	4	30	1.6	1.1	17	3.8	4
080886	4	30	1.6	1.1	17	3.5	4
080886	4	46	.2	1.4	13	4.5	1
080886	4	33	1.5	.8	13	1.8	4

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	40	.9	1.1	13	2.7	4
080886	4	34	.8	1.6	12.5	2.2	4
080886	4	30	1.1	.8	13	4.2	3
080886	4	28	.6	.6	14	3.5	4
080886	4	40	2.5	.7	13	3.8	1
080886	4	30	1.5	.3	13	1.8	1
080886	4	27	.9	1.1	13	2.7	4
080886	4	28	1	.7	13	3.9	3
080886	4	26	1.5	.8	13	1.8	4
080886	4	22	.2	1.4	13	4.5	1
080886	4	31	1.5	.3	13	1.8	1
080886	4	33	1.5	.3	13	1.8	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.4	.8	16.5	3.5	5
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	25	.4	.8	16.5	3.5	5
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	1	.8	17.5	4	1
080886	4	30	2.3	.7	18	2.9	2
080886	4	30	.8	1	17	4.2	1
080886	4	30	1.6	1.1	17	3.8	4
080886	4	30	2.3	.7	18	2.9	2
080886	4	30	2.2	.3	16	4.4	3

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	30	2.2	.3	16	4.4	3
080886	4	30	.8	1	17	4.2	1
080886	4	30	.8	1	17	4.2	1
080886	4	45	0	1.9	17.5	1	4
080886	4	30	2.3	.7	18	2.9	2
080886	4	30	1	.8	17.5	4	1
080886	4	30	2.5	.7	13	3.8	1
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.6	.2	16	3.9	1
080886	4	25	1.4	.7	16	3.1	4
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.4	.8	17.5	2.5	5
080886	4	25	1.4	.7	16	3.1	4
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.6	.2	16	3.9	1
080886	4	25	1.4	.7	16	3.1	4
080886	4	30	.5	.5	17.5	3.3	1
080886	4	25	1.4	.7	16	3.1	4
080886	4	25	1.4	.7	16	3.1	4
080886	4	38	.5	.8	9	4.8	4
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	1	.5	18	3.3	4
080886	4	30	.6	.6	18	4.7	2
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.6	.6	18	4.7	2
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	.1	1.2	18	4.2	4
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	1	.5	18	3.3	4
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	1	.5	18	3.3	4

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
080886	4	30	.4	.8	17.5	2.5	5
080886	4	30	.5	.5	17.5	3.3	1
080886	4	31	.8	1.6	12.5	2.2	4
080886	4	30	.8	1.6	12.5	2.2	4
080886	4	30	.5	.5	17.5	3.3	1
080886	4	28	1.1	.8	13	4.2	3
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	.5	.5	17.5	3.3	1
080886	4	25	.6	.6	14	3.5	4
080886	4	30	0	.9	14	1.9	4
080886	4	22	0	.9	14	1.9	4
080886	4	25	.6	.6	14	3.5	4
080886	4	22	.8	.9	12.5	4.1	4
080886	4	24	.8	.9	12.5	4.1	4
080886	4	30	1.1	.8	13	4.2	3
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	1.1	.8	13	4.2	3
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	.4	.8	17.5	2.5	5
080886	4	40	1.4	1.1	9.5	4.8	4
080886	4	25	1.4	.7	16	3.1	4
080886	4	26	.8	.9	12.5	4.1	4
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	1.1	.8	13	4.2	3
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	.5	.5	17.5	3.3	1
080886	4	30	.4	.8	17.5	2.5	5
082686	3	20	.1	1.3	16	1	3
082686	3	20	.1	1.3	16	1	3
082686	3	30	.4	1.5	14	1.5	5
082686	3	23	2.5	1.2	15	3.3	3
082686	3	35	.6	1.1	17.5	4	1
082686	3	30	.6	1.1	17.5	4	1

Table K.2. (cont.)

DATE	SEGMENT	LENGTH	VELOCITY	DEPTH	TEMP	SUBSTRATE	COVERS
082686	3	35	2.5	1.2	15	3.3	3
082686	3	35	.6	1.1	17.5	4	1
082686	3	29	1.4	.7	14	3.6	5
082686	3	20	.1	1.3	16	1	3
082686	3	10	.4	1.3	16	1.5	5
082686	3	10	.4	1.3	16	1.5	5
082686	3	25	.1	1.3	16	1	3
082686	3	32	1.8	.8	16.5	3.8	4
082686	3	30	1.4	.7	14	3.6	5
082686	3	30	1.2	.9	17	4.1	2
082686	3	42	1.2	.9	17	4.1	2
082686	3	30	.6	1.1	17.5	4	1
082686	3	35	.6	1.1	17.5	4	1
082686	3	35	.6	1.1	17.5	4	1
082686	3	35	.6	1.1	17.5	4	1
082686	3	30	1.2	.9	17	4.1	2

APPENDIX L

VELOCITY ADJUSTMENT FACTORS AT CALIBRATION FLOWS

SEGEMENT 1

TRANSECT	DISCHARGE	VAF
0.0	61.2	0.997
0.0	27.2	0.992
48.1	60.9	0.989
48.1	25.7	0.994
63.4	59.3	0.999
63.4	33.1	0.993
100.4	64.6	0.999
100.4	35.2	0.984

SEGEMENT 2

TRANSECT	DISCHARGE	VAF
0.0	65.2	1.006
0.0	27.0	0.989
62.7	67.3	1.001
62.7	26.1	0.997
156.1	60.6	1.000
156.1	29.1	0.996
197.7	67.1	1.000
197.7	29.9	0.983
223.5	65.4	1.000
223.5	25.1	0.999
251.1	63.5	1.000
251.1	27.4	0.969

SEGEMENT 3

0.0	47.3	1.053
0.0	18.5	0.984
76.6	51.6	0.993
76.6	15.6	0.958
128.3	58.0	0.997
149.3	64.4	0.999
149.3	21.9	0.997
163.0	55.5	0.995
163.0	17.8	0.998
179.1	54.3	1.000
179.1	15.4	0.999

SEGEMENT 4

0.0	76.8	0.998
0.0	15.3	0.980
92.0	77.3	1.020
92.0	14.5	0.993
102.3	14.5	0.996
127.6	83.1	1.001
127.6	14.0	0.991
160.1	72.8	0.999
160.1	12.5	0.899
217.6	68.0	1.000
217.6	12.9	0.993

SEGEMENT 5

0.0	58.9	1.000
0.0	1.6	0.975
107.0	80.5	1.000
107.0	1.7	0.973
124.7	86.7	1.000
124.7	1.5	0.996
158.2	78.3	1.011
158.2	1.3	0.623
187.9	66.5	0.997
187.9	1.5	0.912

APPENDIX M

VELOCITY PREDICTION ERRORS AT CALIBRATION FLOWS

Table M.1. Velocity Prediction Errors for segment 1.

TRANSECT	DISCHARGE	VPE
0.00	61.2	0.00
0.00	61.2	0.07
0.00	61.2	0.09
0.00	61.2	0.00
0.00	61.2	0.00
0.00	61.2	0.00
0.00	61.2	0.00
0.00	61.2	0.00
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.01
0.00	61.2	0.00
0.00	61.2	0.00
0.00	27.2	0.00
0.00	27.2	0.04
0.00	27.2	0.02
0.00	27.2	0.08
0.00	27.2	0.09
0.00	27.2	0.00
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.01
0.00	27.2	0.00
0.00	27.2	0.06
0.00	27.2	0.00
48.1	60.9	0.00
48.1	60.9	0.16
48.1	60.9	0.75
48.1	60.9	0.00
48.1	60.9	0.00
63.4	59.3	0.00
63.4	59.3	0.01
63.4	59.3	0.00
63.4	59.3	0.00
63.4	59.3	0.00
63.4	59.3	0.00
63.4	59.3	0.09
63.4	59.3	0.00
63.4	33.1	0.00
63.4	33.1	0.00
63.4	33.1	0.00
63.4	33.1	0.00
63.4	33.1	0.00
63.4	33.1	0.00
63.4	33.1	0.13
63.4	33.1	0.55
63.4	33.1	0.00
63.4	33.1	0.01
63.4	33.1	0.02
63.4	33.1	0.01
63.4	33.1	0.01
63.4	33.1	0.03
63.4	33.1	0.02
63.4	33.1	0.01
63.4	33.1	0.00
63.4	33.1	0.02
63.4	33.1	0.02
63.4	33.1	0.02
63.4	33.1	0.00
63.4	33.1	0.00
100.4	64.6	0.00
100.4	64.6	0.21
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.00
100.4	64.6	0.03
100.4	64.6	0.00
100.4	35.2	0.00
100.4	35.2	0.01

Table M.1. (cont.)

TRANSECT	DISCHARGE	VPE
100.4	35.2	0.01
100.4	35.2	0.01
100.4	35.2	0.00
100.4	35.2	0.00
100.4	35.2	0.00
100.4	35.2	10.4
100.4	35.2	0.01
100.4	35.2	0.02
100.4	35.2	0.03
100.4	35.2	0.03
100.4	35.2	0.04
100.4	35.2	0.03
100.4	35.2	0.04
100.4	35.2	0.05
100.4	35.2	0.04
100.4	35.2	0.05
100.4	35.2	0.01
100.4	35.2	0.00

Table M.2. Velocity Prediction Errors for segment 2.

TRANSECT	DISCHARGE	VPE
0.00	65.2	0.00
0.00	65.2	0.31
0.00	65.2	0.49
0.00	65.2	0.00
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.02
0.00	65.2	0.02
0.00	65.2	0.02
0.00	65.2	0.02
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.02
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.01
0.00	65.2	0.08
0.00	65.2	0.01
0.00	65.2	0.11
0.00	65.2	0.00
0.00	27.0	0.00
0.00	27.0	0.42
0.00	27.0	0.00
0.00	27.0	0.02
0.00	27.0	0.02
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.02
0.00	27.0	0.04
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.01
0.00	27.0	0.00
62.7	27.0	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.00
62.7	67.3	0.14
62.7	67.3	0.03
62.7	67.3	0.00
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.01
62.7	26.1	0.01
62.7	26.1	0.01
62.7	26.1	0.01
62.7	26.1	0.01
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.00
62.7	26.1	0.25
62.7	26.1	0.00
156.1	60.6	0.00
156.1	60.6	0.17
156.1	60.6	0.00
156.1	60.6	0.02
156.1	60.6	0.01
156.1	60.6	0.01
156.1	60.6	0.01
156.1	60.6	0.00
156.1	60.6	0.00
156.1	60.6	0.00
156.1	60.6	0.00
156.1	60.6	0.84
156.1	60.6	0.00
156.1	60.6	0.00
156.1	60.6	0.00
156.1	60.6	0.00
156.1	60.6	0.00
156.1	60.6	0.00
156.1	29.1	0.00
156.1	29.1	0.17
156.1	29.1	0.00
156.1	29.1	0.01
156.1	29.1	0.02
156.1	29.1	0.01
156.1	29.1	0.01
156.1	29.1	0.01

Table M.2. (cont.)

TRANSECT	DISCHARGE	VPE
156.1	29.1	0.00
156.1	29.1	0.00
156.1	29.1	0.00
156.1	29.1	0.00
156.1	29.1	0.84
156.1	29.1	0.00
156.1	29.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	67.1	0.00
197.7	29.9	0.00
197.7	29.9	0.01
197.7	29.9	0.02
197.7	29.9	0.02
197.7	29.9	0.05
197.7	29.9	0.04
197.7	29.9	0.05
197.7	29.9	0.02
197.7	29.9	0.05
197.7	29.9	0.01
197.7	29.9	0.83
197.7	29.9	0.01
197.7	29.9	0.01
197.7	29.9	0.01
197.7	29.9	0.01
197.7	29.9	0.01
197.7	29.9	0.01
197.7	29.9	0.01
197.7	29.9	0.17
197.7	29.9	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	65.4	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.00
223.5	25.1	0.06
223.5	25.1	0.00
251.1	63.5	0.00
251.1	63.5	0.08
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.00
251.1	63.5	0.12
251.1	63.5	0.00
251.1	27.4	0.00
251.1	27.4	0.11
251.1	27.4	0.09
251.1	27.4	0.06
251.1	27.4	0.03
251.1	27.4	0.01
251.1	27.4	0.70
251.1	27.4	0.41
251.1	27.4	0.00

Table M.3. Velocity Prediction Errors for segment 3.

TRANSECT	DISCHARGE	VPE
0.00	47.3	0.00
0.00	47.3	0.90
0.00	47.3	0.01
0.00	47.3	0.02
0.00	47.3	0.11
0.00	47.3	0.03
0.00	47.3	0.02
0.00	47.3	0.07
0.00	47.3	0.16
0.00	47.3	0.16
0.00	47.3	0.13
0.00	47.3	0.12
0.00	47.3	0.14
0.00	47.3	0.06
0.00	47.3	0.09
0.00	47.3	0.07
0.00	47.3	0.04
0.00	47.3	0.09
0.00	47.3	0.26
0.00	47.3	0.96
0.00	47.3	0.41
0.00	47.3	0.37
0.00	47.3	0.15
0.00	47.3	0.00
0.00	18.5	0.00
0.00	18.5	0.38
0.00	18.5	0.01
0.00	18.5	0.02
0.00	18.5	0.02
0.00	18.5	0.01
0.00	18.5	0.01
0.00	18.5	0.03
0.00	18.5	0.04
0.00	18.5	0.03
0.00	18.5	0.03
0.00	18.5	0.02
0.00	18.5	0.03
0.00	18.5	0.02
0.00	18.5	0.02
0.00	18.5	0.02
0.00	18.5	0.01
0.00	18.5	0.01
0.00	18.5	0.30
0.00	18.5	0.14
0.00	18.5	0.10
0.00	18.5	0.00
76.6	51.6	0.00
76.6	51.6	0.04
76.6	51.6	0.14
76.6	51.6	0.17
76.6	51.6	0.00
76.6	51.6	0.00
76.6	51.6	0.01

TRANSECT	DISCHARGE	VPE
76.6	51.6	0.01
76.6	51.6	0.02
76.6	51.6	0.02
76.6	51.6	0.02
76.6	51.6	0.02
76.6	51.6	0.02
76.6	51.6	0.03
76.6	51.6	0.03
76.6	51.6	0.02
76.6	51.6	0.13
76.6	51.6	0.23
76.6	51.6	0.00
76.6	15.6	0.00
76.6	15.6	0.07
76.6	15.6	0.03
76.6	15.6	0.09
76.6	15.6	0.05
76.6	15.6	0.59
76.6	15.6	0.02
76.6	15.6	0.04
76.6	15.6	0.07
76.6	15.6	0.06
76.6	15.6	0.09
76.6	15.6	0.10
76.6	15.6	0.13
76.6	15.6	0.03
76.6	15.6	0.01
76.6	15.6	0.26
76.6	15.6	0.00
128.3	58.0	0.00
128.3	58.0	0.00
128.3	58.0	0.00
128.3	58.0	0.00
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.01
128.3	58.0	0.00
128.3	58.0	0.00
128.3	58.0	0.39
128.3	58.0	0.63
128.3	58.0	0.00

Table M.3. (cont.)

TRANSECT	DISCHARGE	VPE
128.3	18.7	0.00
128.3	18.7	0.45
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.01
128.3	18.7	0.01
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.01
128.3	18.7	0.01
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.01
128.3	18.7	0.01
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.00
128.3	18.7	0.11
128.3	18.7	0.00
149.3	64.3	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.00
149.3	64.4	0.17
179.3	21.9	0.00
149.3	21.9	0.20
149.3	21.9	0.12
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00

TRANSECT	DISCHARGE	VPE
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
149.3	21.9	0.00
163.0	55.9	0.00
163.0	55.9	0.11
163.0	55.9	0.00
163.0	55.9	0.01
163.0	55.9	0.01
163.0	55.9	0.00
163.0	55.9	0.01
163.0	55.9	0.01
163.0	55.9	0.01
163.0	55.9	0.01
163.0	55.9	0.02
163.0	55.9	0.02
163.0	55.9	0.02
163.0	55.9	0.01
163.0	55.9	0.00
163.0	55.9	0.16
163.0	55.9	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.01
163.0	17.8	0.01
163.0	17.8	0.00
163.0	17.8	0.00
163.0	17.8	0.04
163.0	17.8	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00

Table M.3. (cont.)

TRANSECT	DISCHARGE	VPE
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	54.3	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00
179.1	15.4	0.00

Table M.4. Velocity Prediction Errors for segment 4.

TRANSECT	DISCHARGE	VPE
0.00	76.8	0.00
0.00	76.8	0.31
0.00	76.8	1.12
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.01
0.00	76.8	0.00
0.00	76.8	0.01
0.00	76.8	0.19
0.00	76.8	0.07
0.00	76.8	0.00
0.00	76.8	0.17
0.00	76.8	0.34
0.00	76.8	0.00
0.00	76.8	0.17
0.00	76.8	0.00
0.00	15.3	0.00
0.00	15.3	0.44
0.00	15.3	0.02
0.00	15.3	0.02
0.00	15.3	0.01
0.00	15.3	0.02
0.00	15.3	0.02
0.00	15.3	0.02
0.00	15.3	0.01
0.00	15.3	0.02
0.00	15.3	0.02
0.00	15.3	0.02
0.00	15.3	0.03
0.00	15.3	0.01
0.00	15.3	0.02
0.00	15.3	0.01
0.00	15.3	0.02
0.00	15.3	0.01
0.00	15.3	0.01
0.00	15.3	0.17
0.00	15.3	0.13
0.00	15.3	0.00
0.00	15.3	0.00
0.00	15.3	0.19

TRANSECT	DISCHARGE	VPE
0.00	15.3	0.00
92.0	77.3	0.00
92.0	77.3	0.08
92.0	77.3	0.02
92.0	77.3	0.04
92.0	77.3	0.05
92.0	77.3	0.05
92.0	77.3	0.05
92.0	77.3	0.05
92.0	77.3	0.04
92.0	77.3	0.05
92.0	77.3	0.05
92.0	77.3	0.04
92.0	77.3	0.04
92.0	77.3	0.05
92.0	77.3	0.05
92.0	77.3	0.05
92.0	77.3	0.04
92.0	77.3	0.90
92.0	77.3	0.82
92.0	77.3	0.59
92.0	77.3	0.00
92.0	14.5	0.00
92.0	14.5	0.33
92.0	14.5	0.00
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.01
92.0	14.5	0.00
92.0	14.5	0.00
92.0	14.5	0.00
92.0	14.5	0.00
92.0	14.5	0.13
92.0	14.5	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00

Table M.4. (cont.)

TRANSECT	DISCHARGE	VPE
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	75.0	0.00
102.3	14.5	0.00
102.3	14.5	0.18
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.01
102.3	14.5	0.01
102.3	14.5	0.01
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
102.3	14.5	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.1	0.00
127.6	83.4	0.00
127.6	83.4	0.00
127.6	83.4	0.00
127.6	83.4	0.00
127.9	14.0	0.00
127.6	14.0	0.36
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.01
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.01
127.6	14.0	0.01
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.00
127.6	14.0	0.02
127.6	14.0	0.00
160.1	72.8	0.00
160.1	72.8	0.05
160.1	72.8	0.08
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.01
160.1	72.8	0.01
160.1	72.8	0.01
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.00
160.1	72.8	0.10
160.1	72.8	0.00
160.1	12.5	0.00
160.1	12.5	0.01
160.1	12.5	0.05
160.1	12.5	0.01
160.1	12.5	0.71
160.1	12.5	0.05
160.1	12.5	0.07
160.1	12.5	0.08
160.1	12.5	0.08

Table M.4. (cont.)

TRANSECT	DISCHARGE	VPE
160.1	12.5	0.11
160.1	12.5	0.14
160.1	12.5	0.16
160.1	12.5	0.09
160.1	12.5	0.04
160.1	12.5	0.04
160.1	12.5	0.03
160.1	12.5	0.32
160.1	12.5	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	68.0	0.00
217.6	12.9	0.00
217.6	12.9	0.62
217.6	12.9	0.00
217.6	12.9	0.00
217.6	12.9	0.00
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01

TRANSECT	DISCHARGE	VPE
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.02
217.6	12.9	0.02
217.6	12.9	0.02
217.6	12.9	0.01
217.6	12.9	0.02
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.01
217.6	12.9	0.00
217.6	12.9	0.00

Table M.5. Velocity Prediction Errors for segment 5.

TRANSECT	DISCHARGE	VPE
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	58.9	0.00
0.00	1.6	0.00
0.00	1.6	0.01
0.00	1.6	0.01
0.00	1.6	0.01
0.00	1.6	0.02
0.00	1.6	0.02
0.00	1.6	0.01
0.00	1.6	0.01
0.00	1.6	0.01
0.00	1.6	0.02
0.00	1.6	0.03
0.00	1.6	0.04
0.00	1.6	0.00
0.00	1.6	0.01
0.00	1.6	0.03
0.00	1.6	0.01
0.00	1.6	0.01
0.00	1.6	0.01
0.00	1.6	0.01

TRANSECT	DISCHARGE	VPE
0.00	1.6	0.01
0.00	1.6	0.01
0.00	1.6	0.00
0.00	1.6	0.00
0.00	1.6	0.03
0.00	1.6	0.00
107.0	80.5	0.00
107.0	80.5	0.11
107.0	80.5	0.00
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.01
107.0	80.5	0.00
107.0	80.5	0.00
107.0	80.5	0.21
107.0	80.5	0.30
107.0	80.5	0.00
107.0	1.7	0.00
107.0	1.7	0.50
107.0	1.7	0.00
107.0	1.7	0.01
107.0	1.7	0.01
107.0	1.7	0.01
107.0	1.7	0.02
107.0	1.7	0.01
107.0	1.7	0.01
107.0	1.7	0.01
107.0	1.7	0.01
107.0	1.7	0.00
107.0	1.7	0.00
107.0	1.7	0.00
107.0	1.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.01
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00

Table M.5. (cont.)

TRANSECT	DISCHARGE	VPE
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	86.7	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
124.7	1.5	0.00
158.2	78.3	0.00
158.2	78.3	0.10
158.2	78.3	0.02
158.2	78.3	0.02
158.2	78.3	0.03
158.2	78.3	0.00
158.2	78.3	0.04
158.2	78.3	0.04
158.2	78.3	0.03
158.2	78.3	0.05
158.2	78.3	0.05
158.2	78.3	0.05
158.2	78.3	0.04
158.2	78.3	0.05
158.2	78.3	0.06
158.2	78.3	0.05
158.2	78.3	0.05
158.2	78.3	0.03
158.2	78.3	0.14
158.2	78.3	0.03
158.2	78.3	1.38

TRANSECT	DISCHARGE	VPE
158.2	78.3	0.15
158.2	78.6	0.00
158.2	1.3	0.00
158.2	1.3	0.49
158.2	1.3	0.12
158.2	1.3	0.60
158.2	1.3	0.16
158.2	1.3	0.07
158.2	1.3	0.08
158.2	1.3	0.08
158.2	1.3	0.21
158.2	1.3	0.81
158.2	1.3	0.08
158.2	1.3	0.04
158.2	1.3	0.87
158.2	1.3	0.00
158.2	1.3	0.00
158.2	1.3	0.04
158.2	1.3	0.00
187.9	66.5	0.00
187.9	66.5	0.28
187.9	66.5	0.00
187.9	66.5	0.28
187.9	66.5	0.01
187.9	66.5	0.00
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01

Table M.5. (cont.)

TRANSECT	DISCHARGE	VPE
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.01
187.9	66.5	0.00
187.9	66.5	0.00
187.9	1.5	0.00
187.9	1.5	0.43
187.9	1.5	0.41
187.9	1.5	0.01
187.9	1.5	0.47
187.9	1.5	0.00
187.9	1.5	0.03
187.9	1.5	0.03
187.9	1.5	0.02
187.9	1.5	0.02
187.9	1.5	0.02
187.9	1.5	0.02
187.9	1.5	0.05
187.9	1.5	0.09
187.9	1.5	0.09
187.9	1.5	0.05
187.9	1.5	0.02
187.9	1.5	0.01
187.9	1.5	0.01
187.9	1.5	0.01
187.9	1.5	0.01
187.9	1.5	0.31
187.9	1.5	0.00

APPENDIX N

VELOCITY ADJUSTMENT FACTORS FOR SIMULATED FLOWS IN THE 15 TO 150 CFS RANGE

Table N.1. Velocity Adjustment Factors for segment 1.

TRANSECT	DISCHARGE	VAF
0.00	15.0	0.989
0.00	20.0	0.986
0.00	25.0	0.989
0.00	30.0	0.991
0.00	35.0	0.995
0.00	40.0	0.992
0.00	45.0	0.994
0.00	50.0	0.993
0.00	60.0	0.997
0.00	70.0	0.992
0.00	80.0	0.996
0.00	90.0	0.994
0.00	100.0	0.988
0.00	110.0	0.985
0.00	120.0	0.980
0.00	130.0	0.972
0.00	140.0	0.969
0.00	150.0	0.964
48.10	15.0	0.933
48.10	20.0	0.977
48.10	25.0	0.993
48.10	30.0	0.998
48.10	35.0	1.000
48.10	40.0	1.004
48.10	45.0	1.000
48.10	50.0	1.002
48.10	60.0	0.993
48.10	70.0	0.984
48.10	80.0	0.968
48.10	90.0	0.956
48.10	100.0	0.948
48.10	110.0	0.937
48.10	120.0	0.931
48.10	130.0	0.918
48.10	140.0	0.909
48.10	150.0	0.899
63.40	15.0	0.751
63.40	20.0	0.849
63.40	25.0	0.924
63.40	30.0	0.972
63.40	35.0	1.008
63.40	40.0	1.022
63.40	45.0	1.032
63.40	50.0	1.025
63.40	60.0	0.992
63.40	70.0	0.951
63.40	80.0	0.890
63.40	90.0	0.819
63.40	100.0	0.750
63.40	110.0	0.688
63.40	120.0	0.619
63.40	130.0	0.560
63.40	140.0	0.509

TRANSECT	DISCHARGE	VAF
63.40	150.0	0.458
100.40	15.0	0.815
100.40	20.0	0.881
100.40	25.0	0.932
100.40	30.0	0.957
100.40	35.0	0.980
100.40	40.0	1.004
100.40	45.0	1.015
100.40	50.0	1.016
100.40	60.0	1.007
100.40	70.0	0.992
100.40	80.0	0.965
100.40	90.0	0.942
100.40	100.0	0.913
100.40	110.0	0.891
100.40	120.0	0.866
100.40	130.0	0.838
100.40	140.0	0.809
100.40	150.0	0.779

Table N.2. Velocity Adjustment Factors for segment 2.

TRANSECT	DISCHARGE	VAF
0.00	15.0	0.948
0.00	20.0	0.962
0.00	25.0	0.982
0.00	30.0	0.987
0.00	35.0	0.994
0.00	40.0	1.007
0.00	45.0	1.000
0.00	50.0	1.002
0.00	60.0	1.007
0.00	70.0	1.002
0.00	80.0	0.990
0.00	90.0	0.984
0.00	100.0	0.974
0.00	110.0	0.971
0.00	120.0	0.966
0.00	130.0	0.958
0.00	140.0	0.949
0.00	150.0	0.939
62.70	15.0	0.975
62.70	20.0	0.988
62.70	25.0	0.993
62.70	30.0	0.998
62.70	35.0	1.005
62.70	40.0	1.005
62.70	45.0	1.010
62.70	50.0	1.002
62.70	60.0	1.006
62.70	70.0	1.002
62.70	80.0	0.992
62.70	90.0	0.986
62.70	100.0	0.977
62.70	110.0	0.973
62.70	120.0	0.968
62.70	130.0	0.960
62.70	140.0	0.952
62.70	150.0	0.942
156.10	15.0	0.858
156.10	20.0	0.920
156.10	25.0	0.970
156.10	30.0	0.995
156.10	35.0	1.012
156.10	40.0	1.014
156.10	45.0	1.014
156.10	50.0	1.017
156.10	60.0	1.004
156.10	70.0	0.984
156.10	80.0	0.962
156.10	90.0	0.942
156.10	100.0	0.919
156.10	110.0	0.901
156.10	120.0	0.887
156.10	130.0	0.866
156.10	140.0	0.856
156.10	150.0	0.839
197.70	15.0	0.560
197.70	20.0	0.751

TRANSECT	DISCHARGE	VAF
197.70	25.0	0.887
197.70	30.0	0.986
197.70	35.0	1.042
197.70	40.0	1.075
197.70	45.0	1.081
197.70	50.0	1.080
197.70	60.0	1.038
197.70	70.0	0.987
197.70	80.0	0.919
197.70	90.0	0.845
197.70	100.0	0.780
197.70	110.0	0.724
197.70	120.0	0.670
197.70	130.0	0.619
197.70	140.0	0.572
197.70	150.0	0.533
223.50	15.0	0.987
223.50	20.0	0.994
223.50	25.0	0.999
223.50	30.0	1.001
223.50	35.0	1.004
223.50	40.0	1.003
223.50	45.0	1.004
223.50	50.0	1.002
223.50	60.0	1.000
223.50	70.0	0.997
223.50	80.0	0.995
223.50	90.0	0.994
223.50	100.0	0.992
223.50	110.0	0.987
223.50	120.0	0.986
223.50	130.0	0.983
223.50	140.0	0.982
223.50	150.0	0.978
251.10	15.0	0.912
251.10	20.0	0.944
251.10	25.0	0.962
251.10	30.0	0.975
251.10	35.0	0.985
251.10	40.0	0.994
251.10	45.0	0.996
251.10	50.0	1.001
251.10	60.0	1.000
251.10	70.0	0.994
251.10	80.0	0.987
251.10	90.0	0.980
251.10	100.0	0.969
251.10	110.0	0.959
251.10	120.0	0.947
251.10	130.0	0.937
251.10	140.0	0.921
251.10	150.0	0.908

Table N.3. Velocity Adjustment Factors for segment 3.

TRANSECT	DISCHARGE	VAF
0.00	7.8	0.748
0.00	10.4	0.842
0.00	13.1	0.909
0.00	15.7	0.952
0.00	20.5	1.003
0.00	25.2	1.017
0.00	30.0	1.024
0.00	34.8	1.027
0.00	44.4	1.016
0.00	54.0	1.004
0.00	63.6	0.988
0.00	73.2	0.979
0.00	82.8	0.955
0.00	92.4	0.942
0.00	102.0	0.925
0.00	111.6	0.911
0.00	121.2	0.889
0.00	130.8	0.877
76.60	7.8	0.843
76.60	10.4	0.893
76.60	13.1	0.928
76.60	15.7	0.960
76.60	20.5	0.988
76.60	25.2	1.006
76.60	30.0	1.016
76.60	34.8	1.021
76.60	44.4	1.007
76.60	54.0	0.986
76.60	63.6	0.960
76.60	73.2	0.932
76.60	82.8	0.899
76.60	92.4	0.869
76.60	102.0	0.837
76.60	111.6	0.804
76.60	121.2	0.777
76.60	130.8	0.749
128.30	7.8	0.901
128.30	10.4	0.922
128.30	413.1	0.958
128.30	15.7	0.988
128.30	20.5	0.995
128.30	25.2	1.022
128.30	30.0	1.006
128.30	34.8	1.016
128.30	44.4	1.012
128.30	54.0	1.005
128.30	63.6	1.001
128.30	73.2	0.989
128.30	82.8	0.984
128.30	92.4	0.976
128.30	102.0	0.975
128.30	111.6	0.972
128.30	121.2	0.967
128.30	130.8	0.970
149.30	7.8	0.835
149.30	10.4	0.893
149.30	131.1	0.932
149.30	15.7	0.958
149.30	20.5	0.989
149.30	25.2	1.009
149.30	30.0	1.017
149.30	34.8	1.021
149.30	44.4	1.017
149.30	54.0	1.009
149.30	63.6	1.002
149.30	73.2	0.990
149.30	82.8	0.975
149.30	92.4	0.963
149.30	102.0	0.952
149.30	111.6	0.940
149.30	121.2	0.927
149.30	130.8	0.913
163.00	7.8	0.832
163.00	10.4	0.945
163.00	13.1	0.960
163.00	15.7	0.980
163.00	20.5	1.001
163.00	25.2	1.037
163.00	30.0	1.042
163.00	34.8	1.043
163.00	044.4	10.27
163.00	54.0	0.996
163.00	63.6	0.968
163.00	73.2	0.939
163.00	82.8	0.903
163.00	92.4	0.864
163.00	102.0	0.830
163.00	111.6	0.800
163.00	121.2	0.769
163.00	130.8	0.734
179.10	7.8	1.207
179.10	10.4	1.100
179.10	13.1	1.022
179.10	15.7	1.011
179.10	20.5	0.968
179.10	25.2	0.981
179.10	30.0	0.967
179.10	34.8	0.982
179.10	44.4	0.991
179.10	54.0	0.997
179.10	63.6	1.005
179.10	73.2	1.014
179.10	82.8	1.016
179.10	92.4	1.023
179.10	102.0	1.024
179.10	111.6	1.022
179.10	121.2	1.026
179.10	130.8	1.026

Table N.4. Velocity Adjustment Factors for segment 4.

TRANSECT	DISCHARGE	VAF
0.00	6.9	0.975
0.00	9.2	0.965
0.00	11.5	0.976
0.00	13.8	0.975
0.00	18.5	0.986
0.00	23.2	0.979
0.00	27.9	0.991
0.00	32.6	0.992
0.00	42.0	0.993
0.00	51.4	0.994
0.00	60.8	0.999
0.00	70.2	0.996
0.00	79.6	1.001
0.00	89.0	1.001
0.00	98.4	0.998
0.00	107.8	1.006
0.00	117.2	1.005
0.00	126.6	1.006
92.00	6.9	0.880
92.00	9.2	0.925
92.00	11.5	0.957
92.00	13.8	0.982.
92.00	18.5	1.002
92.00	23.2	1.043
92.00	27.9	1.045
92.00	32.6	1.054
92.00	42.0	1.049
92.00	51.4	1.042
92.00	60.8	1.030
92.00	70.2	1.009
92.00	79.6	0.998
92.00	89.0	0.975
92.00	98.4	0.957
92.00	107.8	0.936
92.00	117.2	0.920
92.00	126.6	0.903
102.30	6.9	0.978
102.30	9.2	0.988
102.30	11.5	0.995
102.30	13.8	0.988
102.30	18.5	0.998
102.30	23.2	1.010
102.30	27.9	1.009
102.30	32.6	1.009
102.30	42.0	1.012
102.30	51.4	1.008
102.30	60.8	1.003
102.30	70.2	0.999
102.30	79.6	0.998
102.30	89.0	0.993
102.30	98.4	0.993
102.30	107.8	0.990
102.30	117.2	0.985
102.30	126.6	0.978
127.60	6.9	0.945
127.60	9.2	0.963
127.60	11.5	0.976
127.60	13.8	0.988
127.60	18.5	1.007
127.60	23.2	1.018
127.60	27.9	1.021
127.60	32.6	1.027
127.60	42.0	1.025
127.60	51.4	1.021
127.60	60.8	1.016
127.60	70.2	1.011
127.60	79.6	1.003
127.60	89.0	0.998
127.60	98.4	0.990
127.60	107.8	0.982
127.60	117.2	0.976
127.60	126.6	0.970
160.10	6.9	0.986
160.10	9.2	0.928
160.10	11.5	0.907
160.10	13.8	0.895
160.10	18.5	0.900
160.10	23.2	0.909
160.10	27.9	0.919
160.10	32.6	0.926
160.10	42.0	0.951
160.10	51.4	0.965
160.10	60.8	0.981
160.10	70.2	0.996
160.10	79.6	1.006
160.10	89.0	1.016
160.10	98.4	1.024
160.10	107.8	1.033
160.10	117.2	1.039
160.10	126.6	1.044
217.60	6.9	0.950
217.60	9.2	0.972
217.60	11.5	0.984
217.60	13.8	0.995
217.60	18.5	1.016
217.60	23.2	1.023
217.60	27.9	1.026
217.60	32.6	1.030
217.60	42.0	1.026
217.60	51.4	1.016
217.60	60.8	1.012
217.60	70.2	1.000
217.60	79.6	0.983
217.60	89.0	0.978
217.60	98.4	0.962
217.60	107.8	0.952
217.60	117.2	0.939
217.60	126.6	0.932

Table N.5. Velocity Adjustment Factors for segment 5.

TRANSECT	DISCHARGE	VAF
0.00	0.9	0.982
0.00	1.2	0.986
0.00	1.5	0.996
0.00	1.9	0.992
0.00	6.3	1.042
0.00	10.7	1.027
0.00	15.1	1.018
0.00	19.5	1.005
0.00	28.3	0.993
0.00	37.1	0.991
0.00	45.9	0.990
0.00	54.7	0.995
0.00	63.5	1.006
0.00	72.3	1.010
0.00	81.1	1.010
0.00	89.9	1.019
0.00	98.7	1.025
0.00	107.5	1.028
107.00	0.9	1.007
107.00	1.2	0.990
107.00	1.5	0.978
107.00	1.9	0.952
107.00	6.3	0.889
107.00	10.7	0.886
107.00	15.1	0.894
107.00	19.5	0.901
107.00	28.3	0.919
107.00	37.1	0.945
107.00	45.9	0.952
107.00	54.7	0.972
107.00	63.5	0.982
107.00	72.3	0.986
107.00	81.1	1.000
107.00	89.9	1.002
107.00	98.7	1.009
107.00	107.5	1.019
124.70	0.9	0.779
124.70	1.2	0.912
124.70	1.5	1.009
124.70	1.9	1.086
124.70	6.3	1.294
124.70	10.7	1.292
127.70	15.1	1.268
124.70	19.5	1.242
124.70	28.3	1.197
124.70	37.1	1.155
124.70	45.9	1.119
124.70	54.7	1.088
124.70	63.5	1.060
124.70	72.3	1.036
124.70	81.1	1.012
124.70	89.9	0.992
124.70	98.7	0.973
124.70	107.5	0.957
158.20	0.9	0.597
158.20	1.2	0.602
158.20	1.5	0.618
158.20	1.9	0.648
158.20	6.3	0.772
158.20	10.7	0.827
158.20	15.1	0.863
158.20	19.5	0.893
158.20	28.3	0.940
158.20	37.1	0.952
158.20	45.9	0.970
158.20	54.7	0.987
158.20	63.5	0.992
158.20	72.3	1.003
158.20	81.1	1.019
158.20	89.9	1.019
158.20	98.7	1.026
158.20	107.5	1.041
187.90	0.9	0.898
187.90	1.2	0.909
187.90	1.5	0.925
187.90	1.9	0.922
187.90	6.3	0.858
187.90	10.7	0.864
187.90	15.1	0.870
187.90	19.5	0.882
187.90	28.3	0.915
187.90	37.1	0.938
187.90	45.9	0.961
187.90	54.7	0.971
187.90	63.5	0.991
187.90	72.3	1.004
187.90	81.1	1.020
187.90	89.9	1.030
187.90	98.7	1.046
187.90	107.5	1.049

APPENDIX O

EFFORT CERTIFICATION

FIELD DATA COLLECTION

TASK	# PEOPLE	# HOURS	TOTAL HOURS
Site evaluation/scoping	3	30	90
Fish relative abundance collection	4	20	80
Field evaluation of candidate study reaches	3	20	60
Selecting and marking transects at study reaches	2	24	48
High flow microhabitat measurements	4	50	200
Low flow microhabitat measurements	4	40	160
Habitat utilization measurements			
4-26-86	9	10	90
4-27-86	9	10	90
5-1-86	6	10	60
5-8-86	7	9	63
5-21-86	6	11	66
6-30-86	5	8	40
7-1-86	5	7	45
7-29-86	6	8	48
8-7-86	7	10	70
8-8-86	7	10	70
8-26-86	5	9	45
10-21-86	7	9	63
10-31-86	3	9	27
11-8-86	3	11	33
11-9-86	3	12	36
12-18-86	8	11	88
4-21-87	3	10	30
6-26-87	5	9	45
Pool to riffle measurements	4	36	144
Measure discharge at each study reach	2	10	20
TOTAL FIELD EFFORT			**1811**

DATA ANALYSIS/REPORT WRITE-UP

ACTIVITY	TOTAL MAN HOURS
Literature review/background information	320
Construct longitudinal profile & calculate sinuosity	12
Reach selection	10
Summarizing microhabitat measurements and data entry into computer	80
Develop flow duration curves	40
Develop equations to convert discharge at gage to segments 3,4,5	12
Summarize habitat utilization data and data entry into computer	80
Write program to read utilization data	8
Run simulations to get habitat availability information	30
Construct habitat suitability curves	60
Enter curve data into computer	4
Model calibration	8
Run simulations	32
Convert PHABISM output to entire stream	16
Calculate habitat ratios	24
Impact analysis	16
Determine recommended instream flow	4
Determine habitat loss from recommended flow and court-ordered flow	8
Calculate pool to riffle ratios	8
First draft	240
Second draft	200
Final report	160
Graphics/illustrations/appendices	300
Typing	80
Editing report	80
TOTAL DATA ANALYSIS/REPORT WRITE-UP	**1832**
TOTAL EFFORT (MAN HOURS)	**3643**