

**Appendix E - Information Relevant to all Tributaries
(Fish Periodicity and HSI curves)**

A fish periodicity table is provided by nhc (2001) for Mission Creek. Fish periodicity for Mission Creek has also recently been updated by Ptolemy (2016a). Both are provided herein as Tables E-1 and E-2, respectively. These tables are generally applicable to Okanagan Lake tributaries where both Kokanee and Rainbow Trout are focal species. Adjustments will be required if either of those species is not present in a particular stream, and / or if there are additional species of interest. Timing adjustments can also be made in discussion with Regional Fisheries or ONA staff to fine tune the timing for each creek, particularly if the EFNs are set on a weekly, rather than on a monthly time step.

Fish periodicity information for Rainbow Trout, and Kokanee, Sockeye, Coho and Chinook Salmon for the Okanagan Region is also provided by ESSA and Solander (2009). The Okanagan Nation Alliance Fisheries Department (2003) provided similar information for other noted species at risk (e.g., Umatilla Dace and Chiselmouth). This information is summarized in Tables E-3 and E-4, respectively. Based on recent research by the Okanagan Nation Alliance, updated fish periodicity information may be available for all species within the Okanagan Basin (e.g., Salmon, Steelhead Trout).

Standard HSI curves for use in B.C., including the Okanagan area, were provided by Ptolemy (2016b), and are reproduced herein as Figures E-1 to E-9. The available HSI curves include:

- Juvenile Rainbow Trout rearing (fry and parr life stages);
- Juvenile Steelhead rearing;
- Juvenile Salmon rearing (Coho and Chinook);
- Generic insect production for use in rearing (riffle) transects;
- Kokanee spawning;
- Rainbow Trout spawning;
- Chinook Salmon spawning;
- Coho Salmon spawning; and
- Steelhead Trout spawning for use in spawning (glide) transects.

Sockeye Salmon spawning HSI curves are notably missing from the B.C. standard HSI set. The HSI values for Sockeye Salmon spawning will likely lie between those for Kokanee (similar but generally smaller species) and Coho Salmon. As such, Sockeye Salmon requirements will be covered if both Kokanee and Coho Salmon are considered in a stream.

Table E-1
Fish periodicity information for Mission Creek (as reported by nhc [2001])

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Flow Standard (%LT mad)
Ecological Needs/Issue													
Fish food production	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	20%LT mad; Riffle maintenance
Wetland/trib linkage				XXXX	XXXX	XXXX	XXXX						100; >400 for several days on alternative years
Flushing/Channel Maintenance					XXXX	XXXX							
Stream Temperatures > 7 °C					XXXX	XXXX	XXXX	XXXX	XXXX	XXX			May 1 – Oct 21
Icing (Code = B)	XXXX	XXXX										XXX	1997 reference year
Hydrology¹													
Nat monthly flow (%LT mad)	17	22	31	131	374	318	134	57	34	33	25	21	
Mean monthly flow (%LT mad)	13%	13%	18%	69%	283%	275%	75%	27%	33%	28%	23%	15%	
Conservation flow (%LT mad)	20%	20%	20%	35%	71%	71%	55%	20%	20%	20%	20%	20%	Highest per event in month
Observed mean flows (L/s)	1,050	1,010	1,480	5,560	22,900	22,200	6,030	2,160	2,630	2,230	1,840	1,240	
Observed Min Monthly (L/s)	316	353	507	1,140	10,700	3,150	921	732	633	533	498	450	Note: 1987 a very dry year!!!
Observed Min Monthly (%LT mad)	4%	4%	6%	14%	134%	39%	12%	9%	8%	7%	6%	6%	%LT mad values
Rainbow Trout (stream and migratory lake populations)													
Smolt/migrant passage					XXXX	XXXX							50
Adult passage				XX	XXXX	XXXX							71 for days-weeks
Spawning					XX	XXXX							71 for days-weeks
Incubation					XX	XXXX	XX						20
Emergence							XX	X					
Rearing (Juveniles)					XXXX	XXXX	XXXX	XXXX	XXXX	XXX			20; 174 days where temperatures > 7 °C
Rearing (Adults)					XXXX	XXXX	XXXX	XXXX	XXXX	XXX			55; 174 days where temperatures > 7 °C
Over-wintering	XXXX	XXXX	XXXX	XXXX						XXXX	XXXX	XXXX	20
Kokanee Salmon													
Smolt/migrant passage				XXXX	XXXX								50
Adult passage									XXXX				
Spawning									XXX	XXXX			20% LT mad or 1,600 L/s; riffle coverage: min passage flow of 11-14%LT mad or 850 to 1,130 L/s
Incubation	XXXX	XXXX	XX						XXX	XXXX	XXXX	XXXX	20
Emergence				XX	XXXX								
Rearing				XX	XXXX								

Notes:

- Mission Creek Naturalized Mean Annual Discharge (LT mad in L/s) = 8,080 L/s at WSC Station 08NM116

Appendix E - Information Relevant to all Tributaries (Fish Periodicity and HSI curves)

Table E-3
Salmonid Species-specific life stage periodicities observed in Okanagan Basin Streams (as reported by ESSA and Solander [2009])

Species	Life stage	# of weeks	Start date	End date
Rainbow Trout	Adult migration	19	17-Mar	16-Jul
	Spawning	10	17-May	16-Jul
	Incubation	15	17-May	24-Aug
	Rearing	52	1-Jan	31-Dec
	Juvenile migration	9	1-May	30-Jun
Steelhead	Adult migration	16	17-Mar	26-Jun
	Spawning	13	4-Apr	26-Jun
	Incubation	15	17-May	26-Aug
	Rearing	52	1-Jan	31-Dec
	Juvenile migration	9	1-May	30-Jun
Chinook	Adult migration	17	17-Jul	8-Nov
	Spawning	5	17-Oct	15-Nov
	Incubation	21	17-Oct	8-Mar
	Rearing	5	1-Aug	31-Aug
	Juvenile migration	19	1-Mar	8-Jul
Kokanee	Adult migration	8	25-Aug	8-Oct
	Spawning	7	1-Sep	8-Oct
	Incubation	31	1-Sep	31-Mar
	Juvenile migration	10	1-Apr	31-May
Sockeye	Adult migration	7	1-Aug	15-Sep
	Spawning	8	16-Sep	31-Oct
	Incubation	23	16-Sep	14-Feb
	Juvenile migration	13	8-Feb	30-Apr
Coho ¹	Adult migration	12	16-Sep	30-Nov
	Spawning	9	9-Oct	8-Dec
	Incubation	31	9-Oct	8-May
	Rearing	52	1-Jan	31-Dec
	Juvenile migration	9	24-Apr	23-Jun

Notes:

1. Coho periodicities are based on information for Coho Salmon in the Nicola River watershed (see ESSA and Solander [2009])

OBWB, ONA, FLNRO

Table E-4
Periodicity chart for Okanagan Region Species at risk (as reported by Okanagan Nation Alliance Fisheries Department [2003])

Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Spawning Comments
Chiselmouth						spn ¹	spn	*2	*				Time to hatch unknown; assume two months incubation. Eggs are laid along the bottom and buried among boulders.
(Northern) mountain sucker						spn	spn	spn	inc ³				Mountain suckers spawn in riffles adjacent to pools. Eggs are demersal and probably adhesive.
(Columbia) mottled sculpin			spn	spn	spn	inc							All eggs (over 100) are laid in a single nest on or under rocks where there is a steady flow of water.
Shorthead sculpin				spn	spn	inc	inc						Eggs are laid under rocks. Very little information on incubation available.
Westslope cutthroat trout					spn	spn	spn	inc	inc	inc			Eggs are incubated within the substrate until late summer, early fall.
Interior Fraser Coho salmon	inc	inc	inc	inc	inc	rear ⁴	rear	rear	rear	spn	spn	spn	Remain in the stream for one year after emerging from gravel. Interior coho are at significant risk from water abstraction for the late summer and early fall.
Bull trout	inc	inc	inc	inc	inc			spn	spn	spn	inc	inc	Clean gravel and cobble substrate are required for spawning.
Speckled dace							spn	inc					Assumed, in streams or riffles of lake inlets streams. Time to hatch 6 days at 18°C.
Umatilla dace						spn	spn	spn	spn	*	*		Time to hatch unknown.
White sturgeon					spn	spn	spn	*	*				Okanagan lake populations would need river access for spawning takes place over rocky bottom in swift currents, near rapids or waterfalls. Nothing is known of time to hatch.

Notes:

1. "spn" represents the month during which spawning occurs
2. "*" represent assumed time needed to emerge from substrate, however, in each case this is unknown
3. "inc" represents time early life stages remain within the gravel
4. "rear" refers to species at risk while they rear in streams

E-6

Appendix E - Information Relevant to all Tributaries (Fish Periodicity and HSI curves)

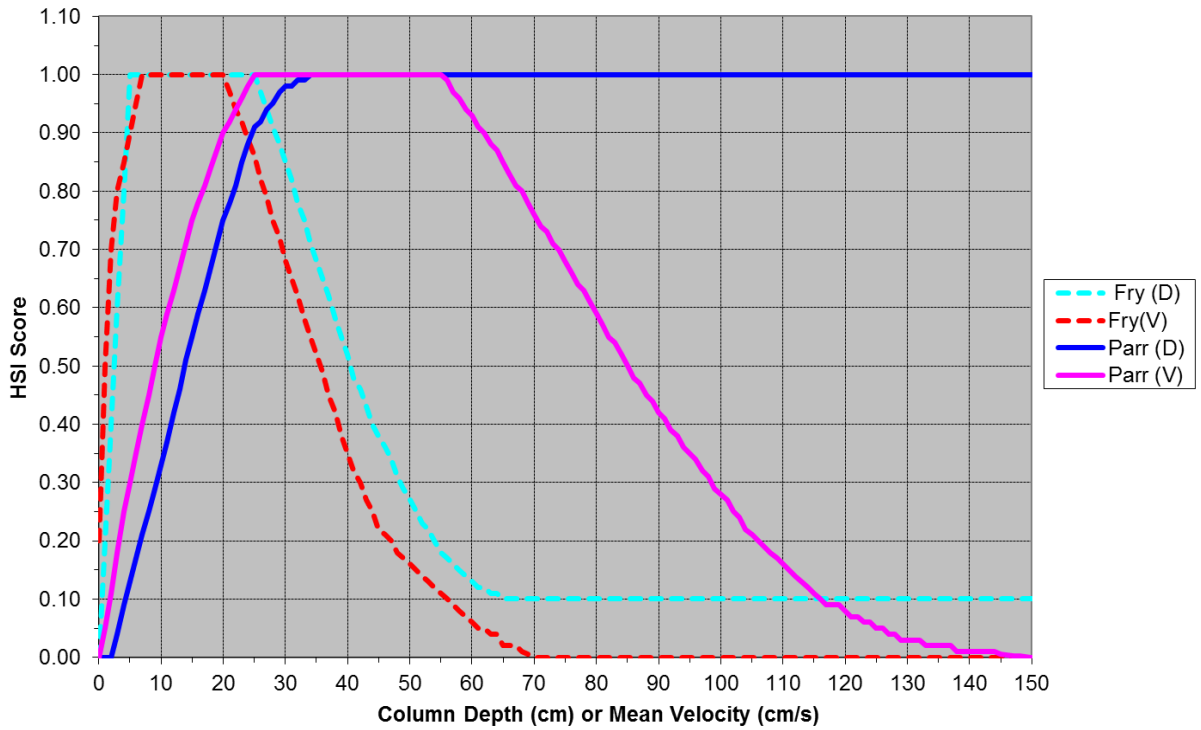


Figure E-1
Univariate HSI Curves for Juvenile Rainbow Trout Rearing (WUP Delphi Derived)

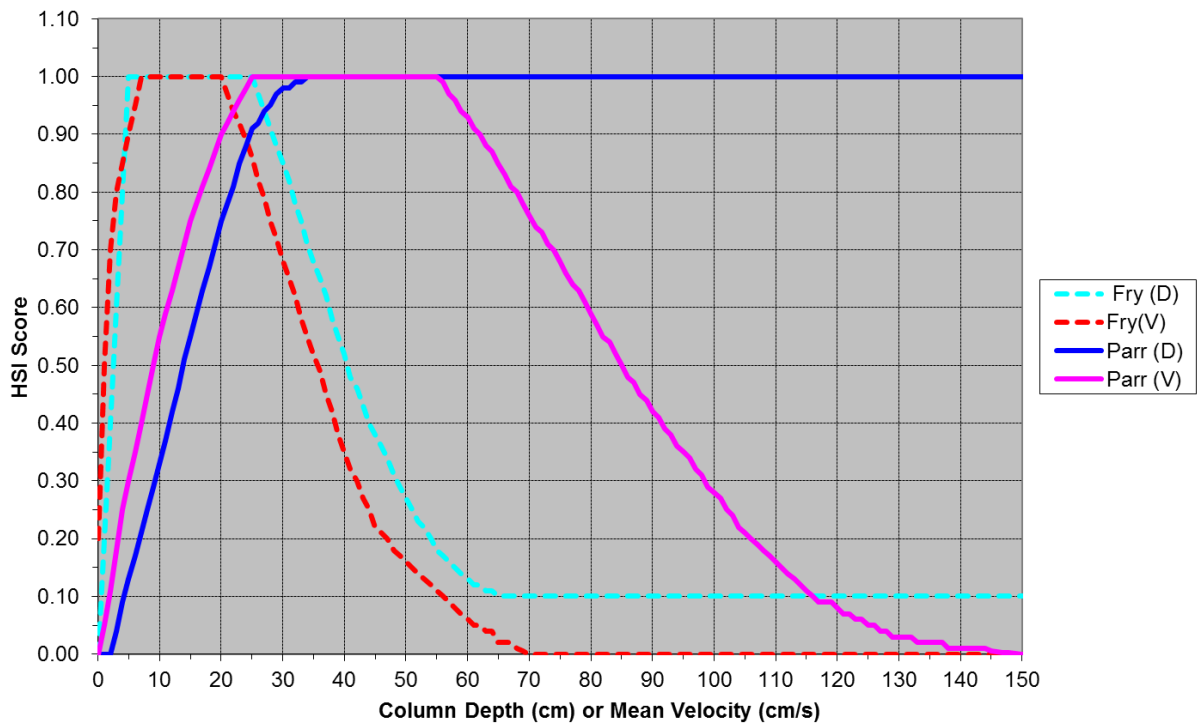


Figure E-2
Univariate HSI Curves for Juvenile Steelhead Rearing (WUP Delphi Derived)

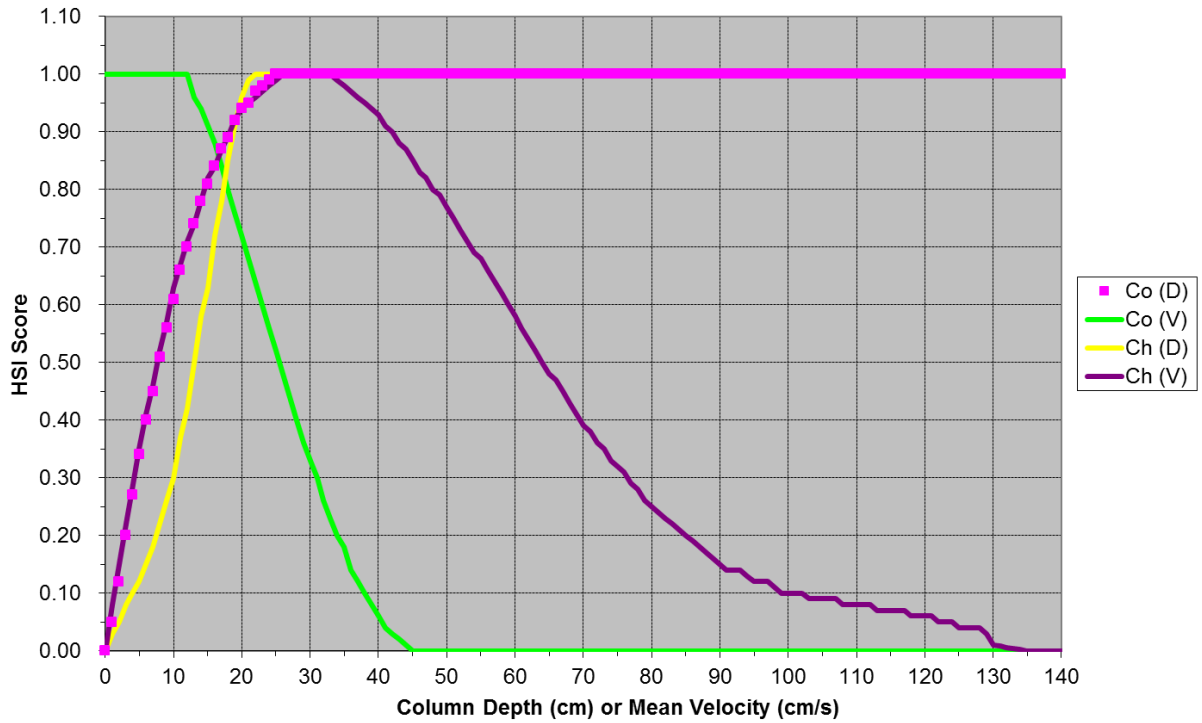


Figure E-3
Univariate HSI Curves for Juvenile Salmon Rearing (WUP Delphi Derived)

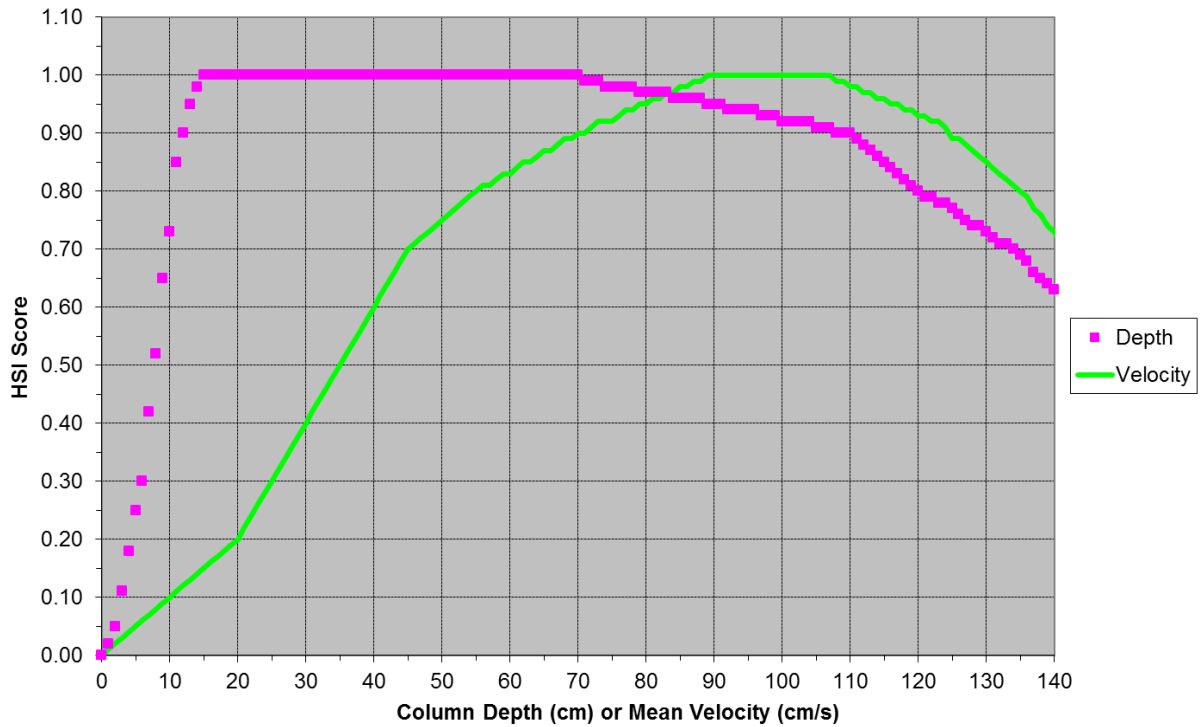


Figure E-4
Univariate HSI Curves for Generic Insect Production (from Stalnaker and Arnette 1976)

Appendix E - Information Relevant to all Tributaries (Fish Periodicity and HSI curves)

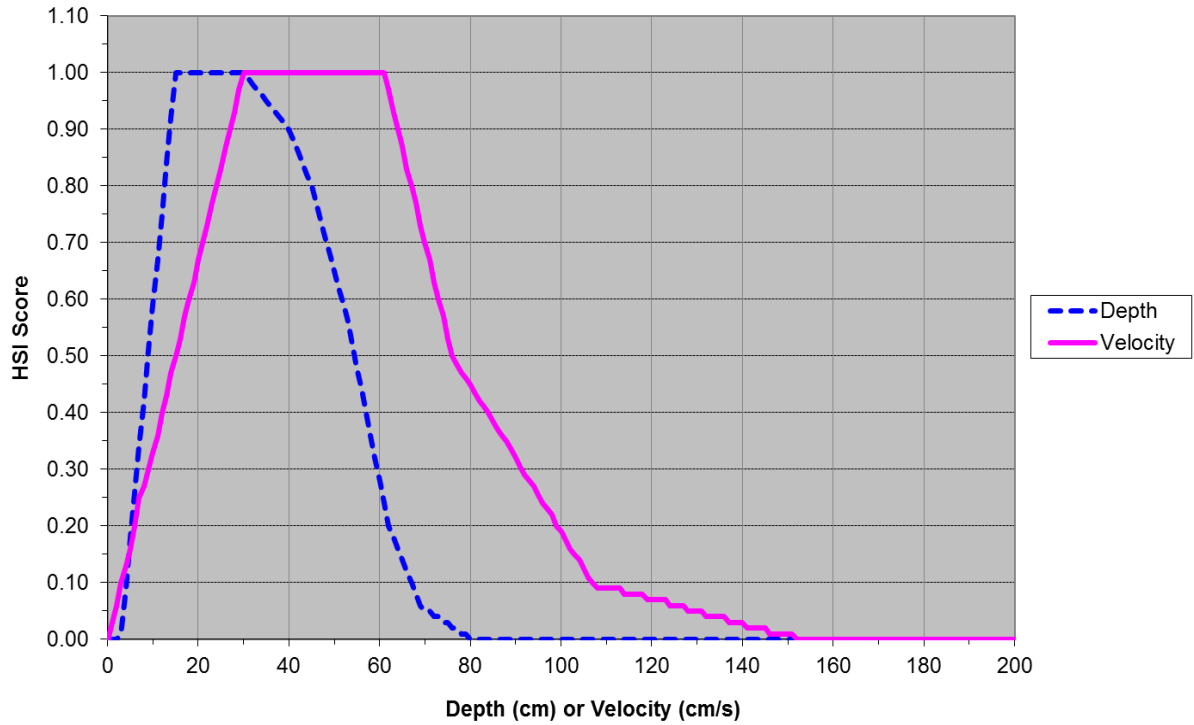


Figure E-5
HSI Curves for Kokanee Salmon Spawning

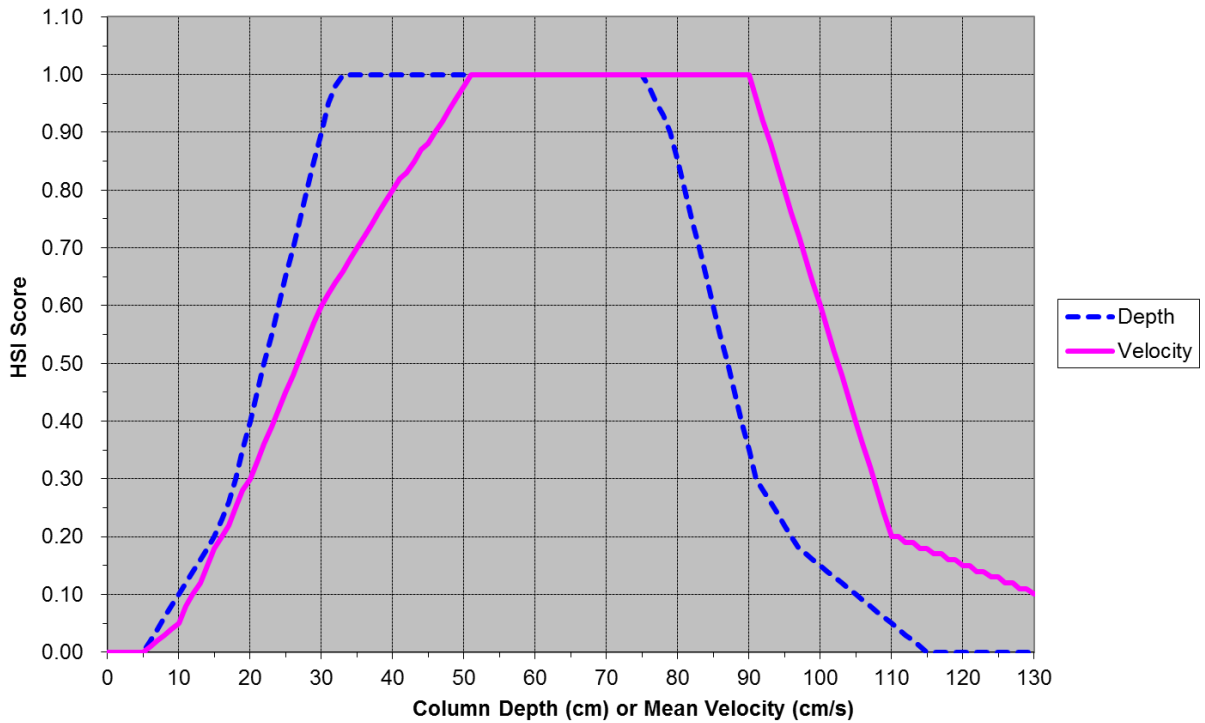


Figure E-6
Univariate HSI Curves for Adult Rainbow Trout Spawning (WUP Delphi Derived)

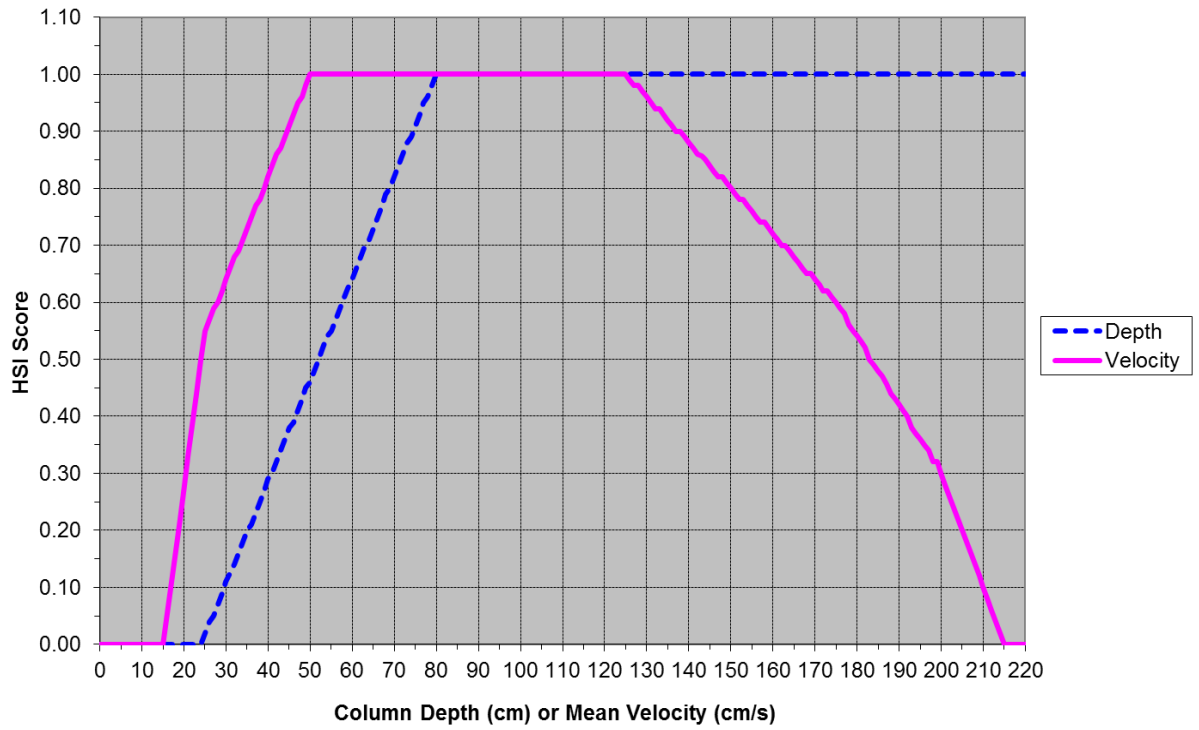


Figure E-7
Univariate HSI Curves for Adult Chinook Spawning (WUP Delphi derived)

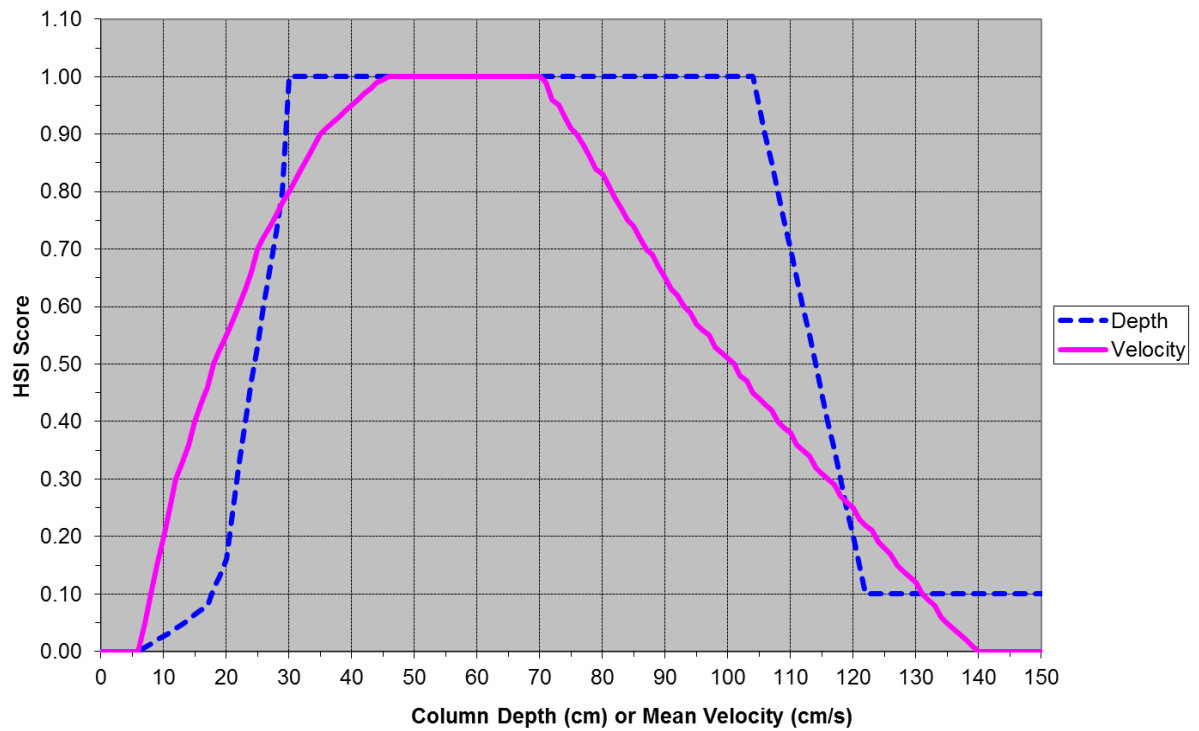


Figure E-8
Univariate HSI Curves for Adult Coho Spawning (WUP Delphi Derived)

Appendix E - Information Relevant to all Tributaries (Fish Periodicity and HSI curves)

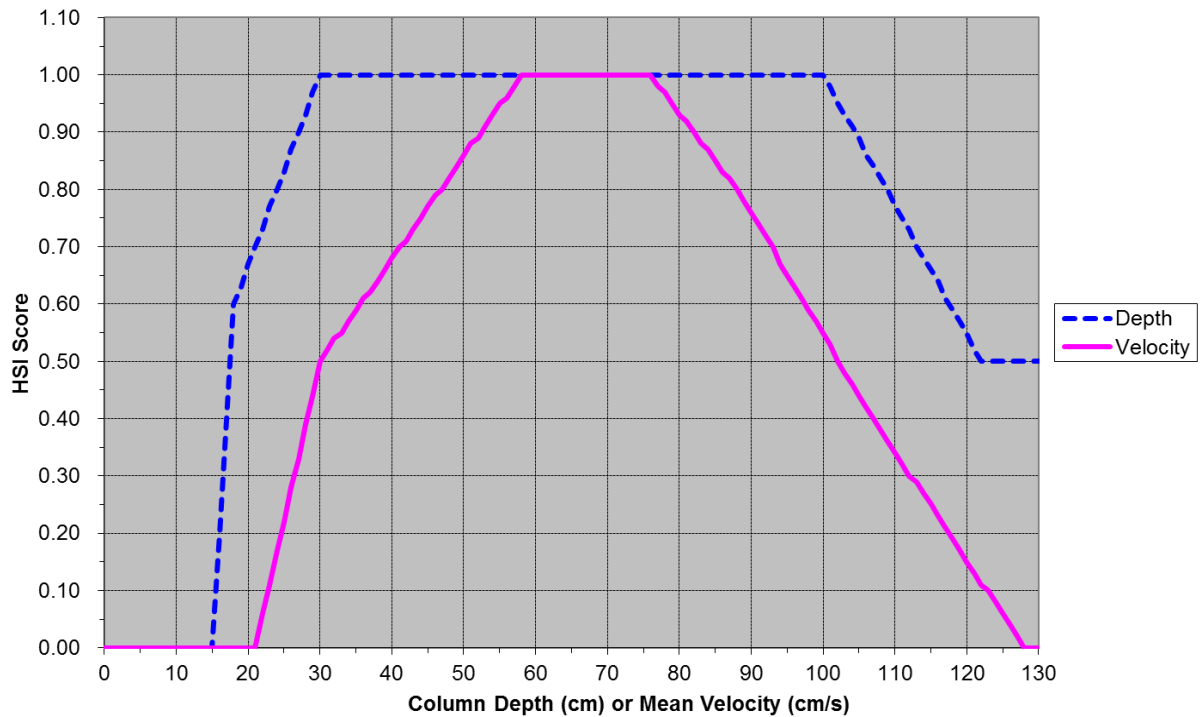


Figure E-9
Univariate HSI Curves for Adult Steelhead Spawning (WUP Delphi Derived)

References:

Stalnaker, C.B. and Arnette, J.L. (Editors). 1976. Methodologies for the Determination of Stream Resource Flow Requirements: An Assessment. U.S. Fish and Wildlife Service, Office of Biological Service. 199 Pages.