Appendices

Appendix A

Study Planning Workshop Summary
August 26, 2010

Lower Tuolumne River Instream Flow Study
Study Coordination Meeting #1 — NOTES
Thursday, August 26, 2010, 10 AM – 5 PM
Turlock Irrigation District
333 East Canal Drive, Room 152, Turlock, CA

Attendees:

Scott Wilcox (Stillwater)
Russ Liebig (Stillwater)
Wayne Swaney (Stillwater)
Noah Hume (Stillwater)
Bill Johnston (MID)
Robert Nees (TID)
Ron Yoshiyama (CCSF-SF)
Allison Boucher (TRC) (phone)
Patrick Koepele (TRT)
Bob Hughes (CDFG) (Phone)
Jenny O'Brien (CDFG)
Ramon Martin (USFWS)
Jennifer Vick (SFPUC)
Jesse Raeder (TRT)
Jesse Roseman (TRT)
Jarvis Caldwell (HDR|DTA)
[italicized names attended for part of the meeting]

Scott Wilcox provided a general overview of Instream Flow studies and some additional background on prior instream flow studies on the Tuolumne River.

The purpose of this meeting was to determine: (1) the study reach, and (2) habitat types to include in refined mapping for transect selection. Other objectives of the meeting included introducing the HSC curve possibilities and soliciting additional curves, if suitable, and reviewing potential pulse-flow study sites.

Study Area Segmentation:
Previously, MID/TID had recommended RM 34 as the lower extent of the study reach. CDFG had recommended RM 24 (below the in-channel mining reach). TID/MID provided a revised proposal for RM 29 near Waterford, or near the RST location (RM 29.5), based on: slope; channel configuration; dominant substrates; hydrology; biology; and flow-responsive habitat types. The group reviewed the channel characteristics below RM 34 and discussed where the most appropriate segment boundary may be.

DECISION:
The group decided to make the study reach between LaGrange Dam and RM 29. The group agreed to have one week to come back with comments on this decision. The group discussed using an existing hydraulic model at SRP9 (near RM 25.9) below RM 29, re-run with the current HSC, but the group postponed that decision

that until after we get into the field since it is not time critical for new data collection.

Habitat Mapping:
As a component of the study, the river needs to be re-delineated and the habitat types quantified. The river has already been mapped using different habitat mapping criteria. However, USFWS preferred a different set of habitat types, which FERC concurred with. The group discussed updating the current maps using the USFWS proposed mesohabitat types. The group preferred that side channels, though limited in the Lower Tuolumne, should be included in the mapping; however, they could be mapped as a component of a flatwater or bar-complex unit rather than a separate unit, since they would presumably occur off to the side of the main channel habitat unit.

DECISION:
Mapping will be based on two channel forms (flatwater and bar-complex) and 4 habitat types, as proposed by USFWS, with side channels as a subset of flatwater or bar complex (rather than its own channel form – e.g., bar complex, with side channel, pool). Run/glide habitat types may be lumped (resulting in 3 categories) following the field mapping if the mapping results show that one habitat would drop out of consideration based on frequency; this decision can be made after the mapping is complete. The group also noted that if there is representation of side channels, we will want to consider that channel characteristic during transect selection.

Transect Selection:
Transect selection will take place after the habitat mapping. There will be an office meeting prior to selection in the field. Dates for the meeting and field selection were discussed (listed below).

Habitat Suitability Criteria:
The group discussed Habitat Suitability Criteria (HSC), the proposed process, and the HSC development schedule. Curves will be required for: *O. mykiss* (adult, spawning, fry, and juvenile), and Chinook (spawning, fry, and juvenile). TID/MID initially proposed using existing curves. FERC ordered the use of existing curves and collection of some site-specific data. The proposed process relies on existing curves with additional field observations for validation.

Ramon Martin (USFWS) noted that they have steelhead curves for the Merced (recommended) and Lower American rivers that USFWS (or HDR|DTA) will provide.

The group reviewed cover types; Ramon Martin (USFWS) would like cover data collected.

The group reviewed substrate coding. Scott Wilcox reviewed an issue with the USFWS proposed substrate table (regarding overlapping categories and model complications). The group discussed the need to have something with "exclusive" categories. Jen Vick offered a more "standard" substrate classification (Wentworth scale) that she said she would e-mail to Scott. Bob Hughes (CDFG) suggested also doing a subdominant category in addition to the dominant substrate, and recommended the Bovee Code (Wentworth Scale as used on the Klamath).

DECISION:
HSC development is expected to take a considerable amount of time and the group did not select curves to be used during this meeting. It was requested that any curves that participants would like to have included for consideration (that are not currently included) should be sent to Scott Wilcox for discussion during the HSC development meetings.

The study will collect cover information using codes listed in Table 7a (see *Cover Codes* handout). If the group has any alternative cover type recommendations than those presented, they need to get it to Scott Wilcox within a week.

The group proposed to use the Wentworth Scale (for substrates) and split the Wentworth small cobble scale into two groups (3-4.5" and 4.5-6", per request of Allison Boucher). Any objections should be presented within the next week. Subject to confirmation, this scale is presented below.

Modified Wentworth Scale (adapted for the Tuolumne River)	
Description	**Size (inches)**
Organic	N/A
Silt	<0.1
Sand	0.1 – 0.2
Small Gravel	0.2 - 1.0
Medium Gravel	1 - 2
Large Gravel	2 - 3
Very Small Cobble	3 – 4.5
Small Cobble	4.5 – 6
Medium Cobble	6 – 9
Large Cobble	9 – 12
Boulder	>12
Bedrock	N/A

Pulse Flow Assessment Study Sites:

Noah Hume discussed the proposed Pulse Flow Study site locations (see *Pulse Flow Assessments* handout). The group identified 9 possibilities (5 were viewed as preferred [bolded]):

RM 49
RM 48.5
RM 44.5 broad floodplain with a side channel
RM 45.5 broad floodplain with a side channel
RM 43.5 (Bobcat restoration site) currently floods at 3,800, but will flood at 3,000 after summer 2011.
RM 37.8-38.3 (not a great option)
RM 34 closer to what a majority of the river looks like (riffle 46)
RM 26 restoration site
RM 5 (Big bend), no LIDAR

These sites will be visited and site-specific ground truthing information provided to the group.

There was also interest in the temperature study and combining the two studies (i.e., temperature monitors at the 2D sites).

Upcoming meeting dates:

Habitat Mapping Refinement Float Trip week of September 13 (3 days)
Site Selection Meeting, October 5, 2010
Site Selection in Field, October 6-7, and 8th if needed.
HSC development 1st meeting, September 20 in Davis.

Appendix B

IFIM Study Site Selection and Transect Placement Workshop Summaries
October 5 and November 18–19, 2010

Lower Tuolumne River Instream Flow Study
Site Selection Meeting Summary
Tuesday, October 5, 2010, 10 AM – 3 PM
Turlock Irrigation District
333 East Canal Drive, Room 152, Turlock, CA

Attendees:

Scott Wilcox (Stillwater)	Allison Boucher (TRC)
Russ Liebig (Stillwater)	Alison Willy (USFWS)
Wayne Swaney (Stillwater)	Bob Hughes (CDFG)
Noah Hume (Stillwater)	Jenny O'Brien (CDFG)
Robert Nees (TID)	Mark Gard (USFWS) phone

[italicized names attended for part of the meeting]

Scott Wilcox suggested an agenda and provided a general overview of the recent mesohabitat mapping results.

Target Habitat Types

The river was recently re-mapped using the new mesohabitat types recommended by USFWS. The habitat mapping results include percent occurrence (by length) of the various habitat types (see Attachment 1).

During the discussion of which habitat types to include in the model, the group discussed the minimum percent occurrence needed. Generally, the goal was to include habitat types with >10% occurrence, per the FERC-approved study plan. Mark Gard suggested a >5% occurrence with a lower number of transects in rare habitats (i.e., include habitat types down to 5% occurrence, but do not allocate as many transects to them).

Decision:

The group decided to sample habitat types with a minimum of 5% percent occurrence, but with a reduced number of replicates/transects for those less than 10%. This resulted in an initial selection of 13-15 replicate units (based on groupings listed below). The group also decided that it is desirable, where reasonably efficient, to divide transects allocated to a "single replicate" habitat type between two different units in order to encourage more heterogeneity in sampling (e.g., if only one Glide unit was to be sampled, try to divide the transects between two different Glide units if practical).

Glide (lumped between Bar Complex and Flatwater): 1 Replicate unit

Bar Complex Pool: 1 Replicate unit (e.g., 2 transects, one in middle, one in tail)

Bar Complex Riffle:	3 Replicate units (prioritize spawning riffles)
Bar Complex Run:	3 Replicate units
Flatwater Pool:	2 Replicate units
Flatwater Riffle:	1 Replicate unit (prioritize spawning riffles)
Flatwater Run:	3 Replicate units

Side Channel habitat (lumped between Bar Complex and Flatwater) included 2.9% occurrence and was therefore not included as a separate habitat type.

Proposed Habitat Units

The group discussed distributing the selected habitat units selected into four river sections based on the spawning survey data delineations, in order to spread the sites along the length of the study reach and encourage better representation of the entire reach:

Section 1: units 1-39
Section 2: units 40-106
Section 3: units 107-193
Section 4: units >193

Based on the 14 replicate units being targeted, and grouping of 3-5 units per "site", approximately 4-5 sites were anticipated.

Initial habitat units for each site were randomly selected by targeting either (1) key spawning riffles, or (2) other limited habitat unit types (e.g., bar complex spawning riffle) and then selecting contiguous habitat units upstream or downstream from that habitat unit until the desired number (~3 or more) and type of units for that river section were obtained. Units were typically contiguous unless an intervening unit was (1) not required for sampling and therefore skipped, or (2) exceptionally long and therefore effectively acted as a "boundary" to the local collection of transects.

"Backup" units were selected near the randomly selected sites (and were not required to be contiguous) in order to provide more options during field transect selection, in the event that an originally selected random unit was less acceptable for some reason (access, hydraulics, logistics, habitat characteristics, etc.). However, it was understood that during field transect selection the backup units and initially selected units would be equally acceptable, and the group would place transects (as appropriate) in whichever unit was reviewed first (to avoid backtracking).

"Extra" units were selected as candidates for transects for those habitat unit types that are only targeted for one replicate. Transects would be divided between the originally selected unit and the "extra" unit.

Decision:

Selected habitat unit replicates for the Lower Tuolumne River IFIM Study

Habitat Type*	**No. of replicates**	**Units[1]**	**Backup**	**Transects/notes**
Glide	1	**29**, 202[e]	24, 205	Possibly split transects between two units
BC Pool	1	**155[e], 163**	92, 145	Possibly split transects between two units
BC Riffle	3	**25, 81, 160**	91, **162**	
BC Run	3	**26, 85, 161**	**83**	
FW Pool	2	**86, 196**	22, 225	Unit 22 was moved to a backup when the number of replicates was reduced from 3 to 2.
FW Riffle	1	**30**, 227[e]	197	Possibly split transects between two units
FW Run	3	**28, 82, 84**	198	Unit 82-potential overbank issues

* BC = Bar Complex, FW = Flatwater

[1] **Bold** signifies the randomly selected unit and adjacent contiguous units.

[e] Extra unit, which may be used to split transects between two replicates.

Habitat unit groupings for IFIM sites on the Lower Tuolumne River.

Site	Units		Backup	Section.
1	25-30	25-BC riffle; 26-BC run; 28-FW run; 29-glide; 30-FW riffle	22-FW pool; 24-glide	1
2	81-86	81-BC riffle; 82-FW run; 83-BC run; 84-FW run; 85-BC run; 86-FW pool	91-BC riffle; 92- BC pool	2
3	155[e], 160-163	155[e]-BC pool; 160-BC riffle; 161-BC run; 163-BC pool	145-BC pool; 162-BC riffle	3
4	196, 202[e]	196-FW pool; 202[e]-BC glide	197 FW riffle; 198-FW run; 205-BC glide	4
5	227[e]	227[e]-FW riffle	225-FW pool	4

[e] Extra unit, which may be used to split transects between two replicates.

Transect Selection
Site selection in field: Nov 17-18, 2010

Action Items
Wayne to make mapbook files available on the TRTAC website.
Russ to make meeting materials available as an attachment to this meeting summary.

Appendix B-1

Attachment 1

IFIM Study Site Selection Workshop Summary – October 5, 2010

Mesohabitat Mapping Data and Summary

Tuolumne River 2010 mesohabitat mapping summary

Chanel Form	Habitat	Count	Length (ft)	Percent
Bar Complex	Glide	8	2,085	1.73
Bar Complex	Pool	18	9,607	7.96
Bar Complex	Riffle	60	21480	17.80
Bar Complex	Run	40	24045	19.93
Flatwater	Glide	14	3,390	2.81
Flatwater	Pool	19	20,190	16.73
Flatwater	Riffle	17	6,660	5.52
Flatwater	Run	35	33,205	27.52
		211	120,662	100.00

MESOHABITAT	**%**
Pool	24.69
Riffle	23.32
Run/Glide	51.98
	100.00

Side channels with 20% of flow at 300 cfs

Chanel Form	Habitat	Count	Length (ft)	% SC
Side Channel	n/a	10	3490	2.9%

Mesohabitats mapped for IFIM									
RM	**ID**	**CHFORM**	**HABITAT**	**Length**	**Access**	**Group**	**Suggested**	**Notes**	**Reference**
51.68	1	Flatwater	Pool	610	poor	n/a		steep descent from powerhouse	
51.59	2	Flatwater	Pool	475	TID	A		split channel tail	
51.47	4	Flatwater	Riffle	660	TID	A			
51.05	5	Flatwater	Run	2225	TID	A			
50.96	6	Flatwater	Pool	450	TID	B	yes		
50.80	7	Flatwater	Run	850	TID	B	yes		
50.78	8	Flatwater	Glide	105	TID	B	"		
50.65	11	Flatwater	Riffle	710	TID	B	yes		snorkel RA7
50.49	12	Flatwater	Pool	855	TID	B			
50.44	13	Bar Complex	Glide	220	TID	B			
50.28	14	Bar Complex	Riffle	840	TID	B			
50.24	16	Bar Complex	Pool	230	TID	C	yes		
50.11	17	Bar Complex	Run	700	TID	C	yes		
50.07	18	Bar Complex	Riffle	230	TID	C	yes		
49.87	19	Bar Complex	Run	1005	TID	D			
49.82	20	Flatwater	Glide	285	TID	D			
49.71	21	Flatwater	Riffle	560	TID	D	yes		snorkel R2
49.64	22	Flatwater	Pool	410	TID	D	yes	Backup unit	
49.37	23	Flatwater	Run	1410	TID	D			
49.34	24	Flatwater	Glide	165	TID	D		Backup unit	
49.22	25	Bar Complex	Riffle	645	TID	E	yes	Selected	
49.16	26	Bar Complex	Run	320	TID	E	yes	Selected	snorkel R3B
49.12	27	Flatwater	Riffle	165	TID	F	yes		
49.10	28	Flatwater	Run	145	TID	F	yes	Selected	
49.07	29	Flatwater	Glide	120	TID	F	"	Selected	
48.87	**30**	**Flatwater**	**Riffle**	**1085**	**TID**	**G**		**Randomly Selected**	**R4A**
48.75	31	Flatwater	Run	625	TID	G	yes		
48.71	32	Flatwater	Glide	215	TID	G	"		
48.45	33	Flatwater	Riffle	1360	TID	H			R4B
48.33	34	Flatwater	Run	670	TID	H			
48.25	35	Flatwater	Glide	405	TID	H			
48.18	36	Bar Complex	Riffle	340	TID	H	yes		snorkel R5A
48.08	37	Bar Complex	Pool	530	TID	H	yes		
48.04	38	Bar Complex	Riffle	215	TID	H			R5B
47.31	39	Flatwater	Pool	3895	TID	H		long pool above/below Basso	
47.22	40	Flatwater	Glide	445	poor	n/a			
46.94	41	Bar Complex	Riffle	1490	poor	n/a			snorkel R7
46.88	43	Flatwater	Riffle	320	poor	n/a			
46.83	44	Flatwater	Run	260	poor	n/a			
46.81	45	Flatwater	Glide	120	poor	n/a			
46.76	46	Flatwater	Riffle	260	poor	n/a			
46.00	48	Flatwater	Run	4025	poor	n/a			
45.98	52	Bar Complex	Riffle	95	Zanker	n/a		complex channel, poor transects	
45.95	53	Bar Complex	Riffle	165	Zanker	n/a		complex channel, poor transects	
45.88	54	Bar Complex	Riffle	360	Zanker	n/a		complex channel, poor transects	
45.83	55	Bar Complex	Run	240	Zanker	n/a		complex channel, poor transects	
45.82	56	Flatwater	Riffle	40	Zanker	n/a		complex channel, poor transects	
45.76	57	Bar Complex	Riffle	330	Zanker	n/a		complex channel, poor transects	
45.71	58	Bar Complex	Run	285	Zanker	n/a		complex channel, poor transects	
45.68	59	Bar Complex	Riffle	135	Zanker	n/a		complex channel, poor transects	snorkel Zanker
45.65	60	Bar Complex	Run	160	Zanker	I			
45.59	61	Bar Complex	Riffle	310	Zanker	I	yes		
45.38	62	Flatwater	Run	1115	Zanker	I			
45.32	66	Flatwater	Pool	310	Zanker	I	yes	pool at Peaslee Creek confluence	
45.14	67	Flatwater	Run	970	poor	n/a			
45.06	69	Flatwater	Pool	420	poor	n/a			
44.99	70	Bar Complex	Riffle	385	poor	n/a			
44.94	71	Bar Complex	Pool	235	poor	n/a			

RM	ID	CHFORM	HABITAT	Length	Access	Group	Suggested	Notes	Reference
44.81	72	Bar Complex	Riffle	710	poor	n/a			
44.74	74	Bar Complex	Run	350	poor	n/a			
44.71	75	Bar Complex	Riffle	150	poor	n/a			
44.69	76	Bar Complex	Run	150	poor	n/a			
44.66	77	Bar Complex	Pool	130	poor	n/a			
44.62	78	Bar Complex	Run	225	poor	n/a			
44.58	79	Bar Complex	Riffle	190	poor	n/a			
44.54	80	Bar Complex	Run	240	poor	n/a			
44.45	81	Bar Complex	Riffle	470	poor	n/a		Selected	
44.36	82	Flatwater	Run	450	poor	n/a		Selected	
44.27	83	Bar Complex	Run	500	poor	n/a		Selected	
44.02	84	Flatwater	Run	1320	poor	n/a		Selected	
43.91	85	Bar Complex	Run	545	poor	n/a		Selected	
43.71	**86**	**Flatwater**	**Pool**	**1055**	**poor**	**n/a**		**Randomly Selected**	
43.51	87	Flatwater	Pool	1075	poor	n/a			
43.30	88	Bar Complex	Run	1140	poor	n/a			
43.23	89	Bar Complex	Riffle	335	poor	n/a			
43.05	90	Bar Complex	Run	965	Bobcat	G	yes		
43.00	91	Bar Complex	Riffle	240	Bobcat	G	yes	Backup unit	snorkel R21
42.96	92	Bar Complex	Pool	245	Bobcat	G	yes	Backup unit	
42.89	93	Bar Complex	Run	360	Bobcat	G	yes		
42.87	94	Bar Complex	Riffle	120	Bobcat	G			
42.68	95	Flatwater	Run	975	Bobcat	G	yes		
42.66	96	Bar Complex	Riffle	120	Bobcat	G			
42.40	97	Flatwater	Run	1360	TRR	H		currently no access, but potential	
42.35	98	Flatwater	Glide	275	TRR	H		currently no access, but potential	
42.31	99	Bar Complex	Riffle	215	TRR	n/a		side channel area, poor transects	snorkel TRR
42.29	101	Bar Complex	Run	100	TRR	n/a		side channel area, poor transects	
42.24	102	Bar Complex	Riffle	265	TRR	n/a		side channel area, poor transects	
42.19	103	Flatwater	Run	285	TRR	n/a		side channel area, poor transects	
42.15	104	Flatwater	Riffle	205	TRR	I		currently no access, but potential	
42.06	105	Flatwater	Run	455	TRR	I		currently no access, but potential	
42.02	106	Flatwater	Glide	205	TRR	I		currently no access, but potential	
41.92	107	Bar Complex	Riffle	560	TLSRA	J	yes		
41.74	108	Bar Complex	Run	935	TLSRA	J	yes		
41.67	109	Bar Complex	Riffle	360	TLSRA	J	yes		
41.43	110	Flatwater	Run	1255	poor	n/a			
41.17	111	Bar Complex	Pool	1410	poor	n/a			
41.10	113	Bar Complex	Glide	340	poor	n/a			
40.99	114	Bar Complex	Run	565	poor	n/a			
40.95	115	Bar Complex	Glide	250	poor	n/a			
40.90	116	Bar Complex	Riffle	260	poor	n/a			
40.40	118	Bar Complex	Run	2625	poor	n/a			
40.16	120	Bar Complex	Riffle	1265	poor	n/a			
39.86	121	Flatwater	Run	1605	poor	n/a			
39.77	122	Flatwater	Glide	475	poor	n/a			
39.67	123	Flatwater	Run	505	poor	n/a			
39.61	124	Bar Complex	Riffle	305	poor	n/a			
39.43	125	Bar Complex	Run	945	7/11	K	yes		
39.42	285	Bar Complex	Riffle	85	7/11	K			
39.26	286	Bar Complex	Run	825	7/11	L	yes		
39.20	126	Bar Complex	Riffle	350	7/11	L	yes		
38.89	127	Bar Complex	Pool	1607	7/11	L			
38.86	128	Flatwater	Riffle	170	7/11	L	yes		
38.77	129	Flatwater	Run	485	7/11	L	yes		
38.73	130	Flatwater	Pool	215	7/11	L	yes		
38.65	131	Flatwater	Run	415	7/11	M	yes		
38.63	132	Flatwater	Riffle	75	7/11	M			
38.58	133	Flatwater	Pool	265	7/11	M	yes		

RM	ID	CHFORM	HABITAT	Length	Access	Group	Suggested	Notes	Reference
38.55	134	Bar Complex	Glide	200	7/11	M	"		
38.47	135	Bar Complex	Riffle	400	7/11	M	yes		
38.33	137	Bar Complex	Run	740	7/11	M	yes		
38.26	138	Bar Complex	Pool	380	7/11	M	yes		
38.18	139	Bar Complex	Run	395	7/11	M			
38.12	140	Bar Complex	Riffle	310	7/11	N			snorkel 7/11
38.05	141	Bar Complex	Pool	415	7/11	N	yes		
37.93	142	Bar Complex	Pool	610	7/11	N	yes		
37.87	143	Bar Complex	Run	320	7/11	N	yes		
37.81	144	Bar Complex	Riffle	305	7/11	N	yes		
37.58	145	Bar Complex	Pool	1240	Sante Fe	O		Backup unit	
37.55	146	Bar Complex	Riffle	140	Sante Fe	O			
37.39	147	Flatwater	Run	850	Sante Fe	O	yes		
37.31	148	Bar Complex	Riffle	420	Sante Fe	P			
37.17	149	Bar Complex	Run	730	Sante Fe	P			
37.01	151	Bar Complex	Run	850	Sante Fe	P			
36.97	152	Bar Complex	Riffle	235	Sante Fe	P		Pit/Pool	snorkel Ruddy
36.91	154	Bar Complex	Pool	295	Sante Fe	n/a		Pit/Pool	
36.86	**155**	**Bar Complex**	**Pool**	**280**	**Sante Fe**	**Q**		**Randomly Selected Extra Unit**	
36.79	156	Bar Complex	Riffle	340	Sante Fe	Q			
36.62	157	Flatwater	Run	895	Sante Fe	Q	yes		
36.59	158	Bar Complex	Riffle	185	Sante Fe	R			
36.33	159	Flatwater	Run	1345	Sante Fe	R			
36.29	**160**	**Bar Complex**	**Riffle**	**225**	**Sante Fe**	**R**		**Randomly Selected**	
36.23	161	Bar Complex	Run	335	Sante Fe	R	yes	Selected	
36.18	162	Bar Complex	Riffle	235	Sante Fe	R	yes	Backup unit	
36.13	163	Bar Complex	Pool	280	Sante Fe	R	yes	Selected	
35.58	164	Flatwater	Pool	2885	Sante Fe	S	yes		
35.52	165	Flatwater	Riffle	350	Sante Fe	S	yes		
35.17	166	Flatwater	Run	1810	Sante Fe	S			
35.16	167	Bar Complex	Riffle	80	Deardorff	n/a		complex channel, poor transects	snorkel Deardorff
35.12	169	Bar Complex	Pool	195	Deardorff	n/a		complex channel, poor transects	
35.03	170	Bar Complex	Riffle	495	Deardorff	T			
34.96	171	Bar Complex	Run	365	Deardorff	T		good Q	
34.93	172	Bar Complex	Riffle	180	Deardorff	T			
34.66	173	Bar Complex	Run	1400	poor	n/a			
34.57	174	Flatwater	Pool	475	poor	n/a			
34.52	175	Bar Complex	Riffle	290	poor	n/a			
34.48	176	Bar Complex	Pool	190	poor	n/a			
34.42	177	Bar Complex	Run	320	poor	n/a			
34.37	178	Bar Complex	Glide	235	poor	n/a			
34.30	179	Bar Complex	Run	410	poor	n/a			
34.19	180	Bar Complex	Glide	575	poor	n/a			
34.07	181	Bar Complex	Run	640	poor	n/a			
34.00	182	Bar Complex	Riffle	345	poor	n/a			
33.91	183	Flatwater	Run	480	poor	n/a			
33.82	185	Bar Complex	Riffle	500	poor	n/a			
33.75	186	Bar Complex	Run	340	poor	n/a			
33.65	187	Bar Complex	Riffle	550	poor	n/a			
33.47	188	Flatwater	Run	945	poor	n/a			
33.43	189	Flatwater	Glide	225	poor	n/a			
33.39	190	Bar Complex	Riffle	165	poor	n/a			
33.20	191	Bar Complex	Pool	1045	poor	n/a			
33.16	192	Bar Complex	Riffle	180	poor	n/a			
33.05	193	Bar Complex	Run	590	poor	n/a			
32.96	194	Bar Complex	Riffle	460	poor	n/a			
32.46	195	Flatwater	Pool	2635	poor	n/a			
32.09	196	Flatwater	Pool	1990	poor	n/a		**Randomly Selected**	Hickman spill
32.03	197	Flatwater	Riffle	295	poor	n/a		Backup unit	

RM	ID	CHFORM	HABITAT	Length	Access	Group	Suggested	Notes	Reference
31.93	198	Flatwater	Run	550	poor	n/a		Backup unit	
31.88	200	Bar Complex	Riffle	225	poor	n/a			
31.69	201	Bar Complex	Run	1045	poor	n/a			
31.67	202	Bar Complex	Glide	110	poor	n/a		**Randomly Selected Extra Unit**	
31.63	203	Bar Complex	Riffle	180	poor	n/a			
31.51	204	Bar Complex	Run	620	poor	n/a			
31.49	205	Bar Complex	Glide	155	poor	n/a		Backup unit	
31.40	206	Bar Complex	Riffle	440	poor	n/a			
31.27	208	Flatwater	Run	720	poor	n/a			
31.15	209	Bar Complex	Riffle	605	Waterford	U			
31.10	210	Bar Complex	Pool	290	Waterford	U			Hickman Bridge
31.06	211	Bar Complex	Riffle	205	Waterford	U			snorkel Hickman
30.68	212	Flatwater	Run	1985	Waterford	U		partial access to u/s portion	
30.64	213	Flatwater	Glide	200	poor	n/a			
30.60	214	Flatwater	Riffle	230	poor	n/a			
30.47	215	Flatwater	Run	675	poor	n/a			
30.41	216	Bar Complex	Riffle	320	poor	n/a			
30.36	217	Bar Complex	Run	265	poor	n/a			
30.18	219	Bar Complex	Riffle	935	poor	n/a		extreme turbulence	
30.10	220	Bar Complex	Run	435	poor	n/a			
30.05	221	Bar Complex	Riffle	270	poor	n/a			
29.92	223	Flatwater	Pool	665	poor	n/a			
29.83	224	Flatwater	Run	485	poor	n/a			
29.72	225	Flatwater	Pool	610	poor	n/a		Backup unit	
29.55	226	Flatwater	Pool	895	poor	n/a			
29.53	227	Flatwater	Riffle	105	poor	n/a		Extra Unit	
29.46	228	Flatwater	Run	345	poor	n/a			
29.45	229	Flatwater	Riffle	70	poor	n/a			
29.37	230	Flatwater	Run	395	poor	n/a			
29.35	231	Flatwater	Glide	150	poor	n/a			
29.29	233	Flatwater	Run	320	poor	n/a			
29.20	234	Bar Complex	Run	460	Short	V	yes		
29.15	235	Bar Complex	Riffle	240	Short	V	yes		
29.04	236	Bar Complex	Run	605	Short	V	yes		RST
28.95	237	Bar Complex	Riffle	480	Short	V	yes		
28.95	238	ds_Flatwater	ds_Run		poor	n/a			downstream SRP

Lower Tuolumne River Instream Flow Study
Transect Placement Field Summary
Thursday–Friday, November 18–19, 2010

<u>Participants</u>:

Scott Wilcox (Stillwater)	Allison Boucher (TRC)
Russ Liebig (Stillwater)	Zac Jackson (USFWS)
Ken Jarrett (Stillwater)	Bob Hughes (CDFG)

The group met in Waterford on Thursday, November 18, for a tailgate session prior to heading out to the river. Scott Wilcox reviewed the site selection process and results of the October 5, 2010 office-based site selection workshop in Turlock, which included: 14 selected mesohabitat units; 3 extra units (intended for splitting of transects into multiple units where only one replicate was required); and 11 backup units. Russ Liebig reviewed the results of a reconnaissance survey of each habitat unit including: (1) general representativeness of habitat within the Lower Tuolumne River, (2) complexities that may limit modeling accuracy, and (3) physical accessibility. The reconnaissance survey of each habitat unit found that 13 of the 14 selected habitats were suitable for the study (i.e., representative, accessible, and modelable). The one selected unit that did not meet these criteria was restricted by limited access; however one backup unit had already been identified during the October 5 meeting as an appropriate alternative for that unit. In addition, two of the extra units and six of the backup units were found to be suitable in the event they were needed.

The Districts were able to secure vehicle access to each of the habitat units for transect placement, though complete access (e.g., both sides of the river) required to conduct the field study has not yet been obtained. The group visited each selected habitat unit for transect placement as well as suitable extra and backup units. During the process, the group eliminated one additional selected unit (Riffle #81) and included seven extra or backup units (including one added in the field [Run #83] not previously identified during the October 5 workshop).

At each habitat unit, agency representatives designated transect locations (or concurred with proposed transect locations suggested by Stillwater staff) sufficient to represent the hydraulic and habitat variability in the unit. A total of 40 transects were placed in 19 habitat units between River Mile 29.7 and 49.3. Participating agency representatives confirmed the locations as described in a draft version of this summary (Attachment 1).

Transect locations are described in Table 1 and shown in Attachment 2.

Table 1. Tuolumne River Instream Flow Study Transect Location Documentation

Channel Form	Unit Type	Unit & Transect Letter[1]	Tile Number[2]	Transect Characteristics	Location/Notes
Flatwater	Glide	24A	6	Deeper, slower	Approx. 110 ft upstream of riffle break at Unit 25
Flatwater	Glide	24B	6	Faster, shallower	Approx. 45 ft upstream of riffle break at Unit 25
Bar Complex	Riffle	25A	6	Faster, steeper	Approx. 100 ft from the top of bar complex
Bar Complex	Riffle	25B	6	Slower, flatter	Top of point bar on RR[3]; Approx. 100 ft downstream of mid-channel island on RL
Bar Complex	Run	26A	6	Head of run, more turbulent	Point bar on RR, approx. 50-75 ft downstream of Riffle 25
Bar Complex	Run	26B	6	Mid-run, less turbulent	Point bar on RR, large oak on RL, approx. 150 ft upstream of Riffle 27
Flatwater	Run	28A	7	More turbulent, faster, deeper	Approx. 100 ft downstream of Riffle 27; opening in the brush on RR
Flatwater	Run	28B	7	Flatter, less turbulent	Approx. 100 ft downstream of transect 28A
Flatwater	Glide	29A	7	Mid-glide, uniform	Supplements transects in selected glide 24
Flatwater	Riffle	30A	7	More varied hydraulic conditions	Approx. 50 ft from the top of unit; point bar on RR, over large woody debris on RL
Flatwater	Riffle	30B	7	More uniform conditions, faster	Approx. 40 ft downstream of RR bar
Flatwater	Run	82A	16		Off RR point just downstream of turn out of Riffle; complex flow and cover on RL
Flatwater	Run	82B	16		Downstream side of island with backwater on RR, between trees on RL
Flatwater	Run	82C	16	Faster, more cobble, than transects A & B	Off top of point bar on RR
Bar Complex	Run	83A	16	Narrow, fast	Backup provisional unit in case downstream selected Runs are less suitable. Subsequently decided to sample all of them because of different conditions in Run 83
Bar	Run	83B	16	Flatter, more	Downstream of 83A approx.

[1] Unit numbers from Tuolumne River Mapbook – IFIM Mesohabitats, 2010. Transects lettered from upstream to downstream within a unit.
[2] Tuolumne River Mapbook – IFIM Mesohabitats, 2010
[3] RR (river right) and RL (river left), defined as looking downstream

Channel Form	Unit Type	Unit & Transect Letter[1]	Tile Number[2]	Transect Characteristics	Location/Notes
Complex				laminar	100 ft
Flatwater	Run	84A	16/17	Faster portion of the run	Near fence gate at “boat launch” location
Flatwater	Run	84B	16/17	Flatter, slower portion of run	At valley oak RR, bedrock edge face RL
Flatwater	Run	84C	16/17	Pool-like portion, low velocity	Approx. 200 ft downstream of 84B
Bar Complex	Run	85A	17	Fast, shallow	Sample as extra run cross section due to cobble substrate; off of bar on RR
Flatwater	Pool	86A	17	Some higher velocity	Head of very large pool near corral
Flatwater	Pool	86B	17	Slow velocity in middle of pool	At gate access approx. 500 ft downstream of 86A; all middle of pool is approx. the same
Flatwater	Pool	86C	17	Shallower tail at bottom of pool	Marshy bar on RL; 350-400 ft downstream of picnic bench area on RL
Bar Complex	Pool	155A	31	Swifter section	Extra pool; transect at head
Bar Complex	Pool	155B	31	Shallow, slow	Extra pool; at tail; will get the mid pool conditions at downstream pools
Bar Complex	Riffle	156A	32	Across island at the top of the riffle	Would be good to add if units 160 & 162 don’t work as bar complex riffles. The group subsequently decided to add unit 156 & only put 1 transect in unit 162.
Bar Complex	Riffle	156B	32	Between islands in middle of the riffle	
Bar Complex	Riffle	160A	33	At head with faster thalweg	Approx. 40 ft downstream of gravel conveyor
Bar Complex	Riffle	160B	33	Near tail in more uniform cross section	Approx. 100 ft downstream of 160A
Bar Complex	Run	161A	33	Head of run is faster	Open on RR bank
Bar Complex	Run	161B	33	Flatter, more uniform; slower at tail of run	
Bar Complex	Riffle	162A	33	Wide, shallow cross section	Above a transverse flow split & the backwater, at the downstream end of the left bank bar. Use Riffle 156 for two additional transects
Bar Complex	Pool	163A	33	Faster outflow from riffle	Head of Pool

Channel Form	Unit Type	Unit & Transect Letter[1]	Tile Number[2]	Transect Characteristics	Location/Notes
Bar Complex	Pool	163B	33	Mid Pool same as for 163A	Left bank end pin crosses 163C due to angle of the river at the bend
Bar Complex	Pool	163C	33	Shallower tail	Approx. 100 ft downstream of 163B tail; Right bank is directly below oak , then is first oak upstream of ravine on right bank. All pool cross sections are very wide (>300 ft)
Bar Complex	Glide	205A	42	Upstream end of glide	30 ft upstream of greenbelt bench at base of valley oak; work from left bank. Next to Waterford gated subdivision on RR.
Bar Complex	Glide	205B	42	Downstream end of glide, similar habitat	Above large woody debris on right bank; 1 tree downstream of 205A, at black walnut
Flatwater	Pool	225A	46	Upstream end	Cross section is at divider between upstream run; Right bank is open cobble bar
Flatwater	Pool	225B	46	Slow, deep, wide cross section	Approx. 200 ft downstream of 225A, in middle of unit; left bank campfire is near cross section, and open grassy area is on right bank
Flatwater	Pool	225C	46	Narrower tail	Approx. 200 ft from downstream end of unit. Thick brush on both sides.

Appendix B-2

Attachment 1

IFIM Transect Placement Field Summary
November 18-19

Resource Agency and Stakeholder
Concurrence on Transect Selection Summary

Lower Tuolumne River Instream Flow Study
Resource Agency and Stakeholder Concurrence of Transect Selection Summary

From: Bob Hughes (CDFG)
Sent via e-mail: Wednesday, January 05, 2011

The Department of Fish and Game concurs with the number and location of transects, as specified in the field trip summary and associated maps. Please let me know if there are any questions.

Robert W. Hughes, P.E.
Senior Hydraulic Engineer
California Department of Fish and Game
Office Phone: (916) 445-3362
Mobile Phone: (916) 591-2016

From: Zachary Jackson (USFWS)
Sent via e-mail: Thursday, January 06, 2011

I concur with the number of transects and locations.

Zac Jackson
Fish Biologist
Anadromous Fish Restoration Program
United States Fish and Wildlife Service
4001 N. Wilson Way
Stockton, CA 95205
Tel (209) 334-2968 x 408
Cell (209) 403-1457
Fax (209) 334-2171
Zachary_Jackson@fws.gov

From: Allison Boucher (Tuolumne River Conservancy)
Sent via e-mail: Thursday, January 06, 2011

We concur with the number and location of transects.

Allison Boucher
Tuolumne River Conservancy, Inc.

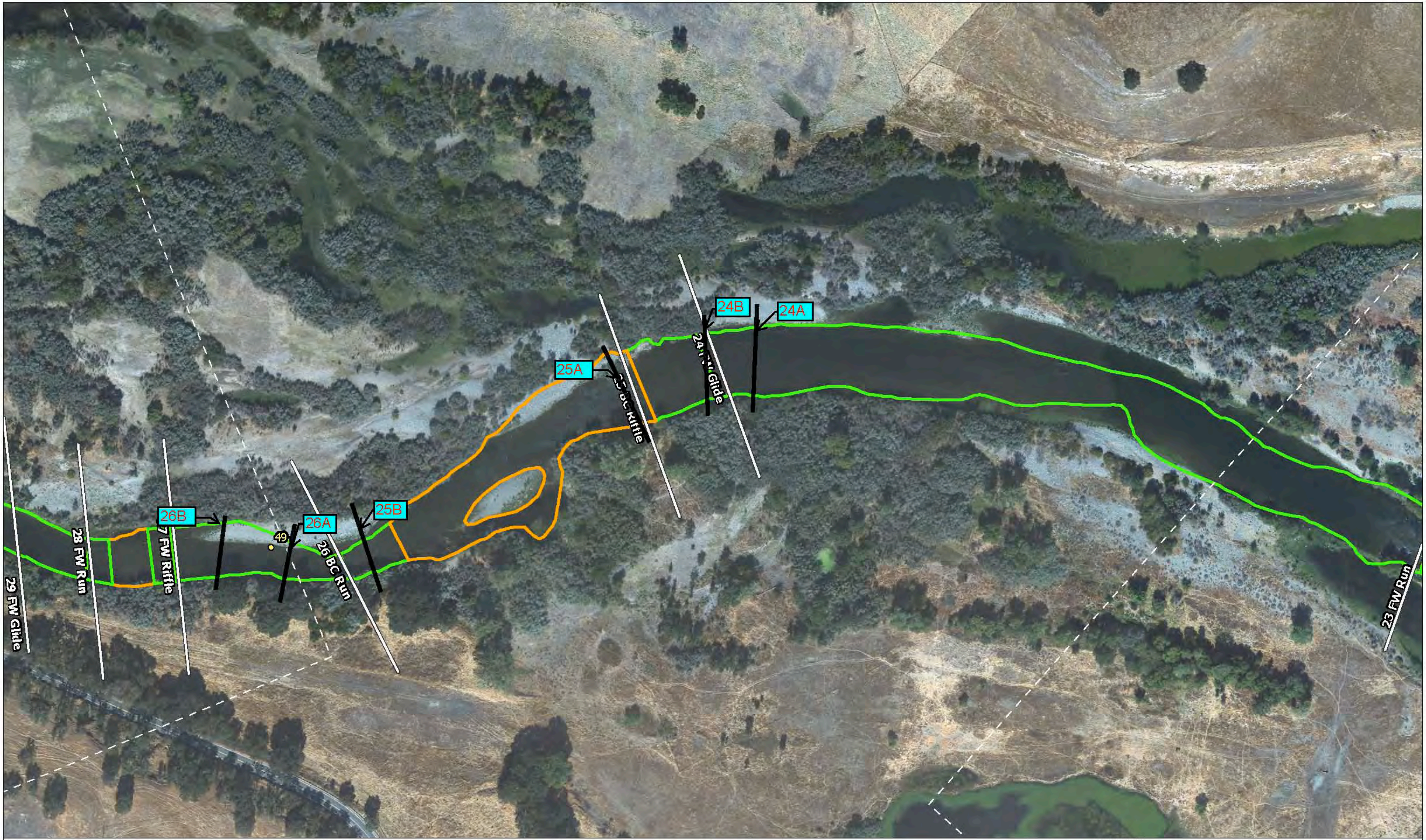
Appendix B-2

Attachment 2

IFIM Transect Placement Field Summary
November 18-19

Transect Placement Figures

Note: As documented in the November 28, 2012 workshop, transects 82a, 82b, and 83b were replaced with transects 159a, 159b, and 159c. Locations of transects 159a, 159b, and 159c are included in this attachment.



Tuolumne River - IFIM Mesohabitats, 2010

0 125 250 500 Feet

Stillwater Sciences
www.stillwatersci.com

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were fisrt based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 06

Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were fisrt based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 07

Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were first based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 16

Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were fisrt based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 17

Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were fisrt based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 31

Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were fisrt based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 32

Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

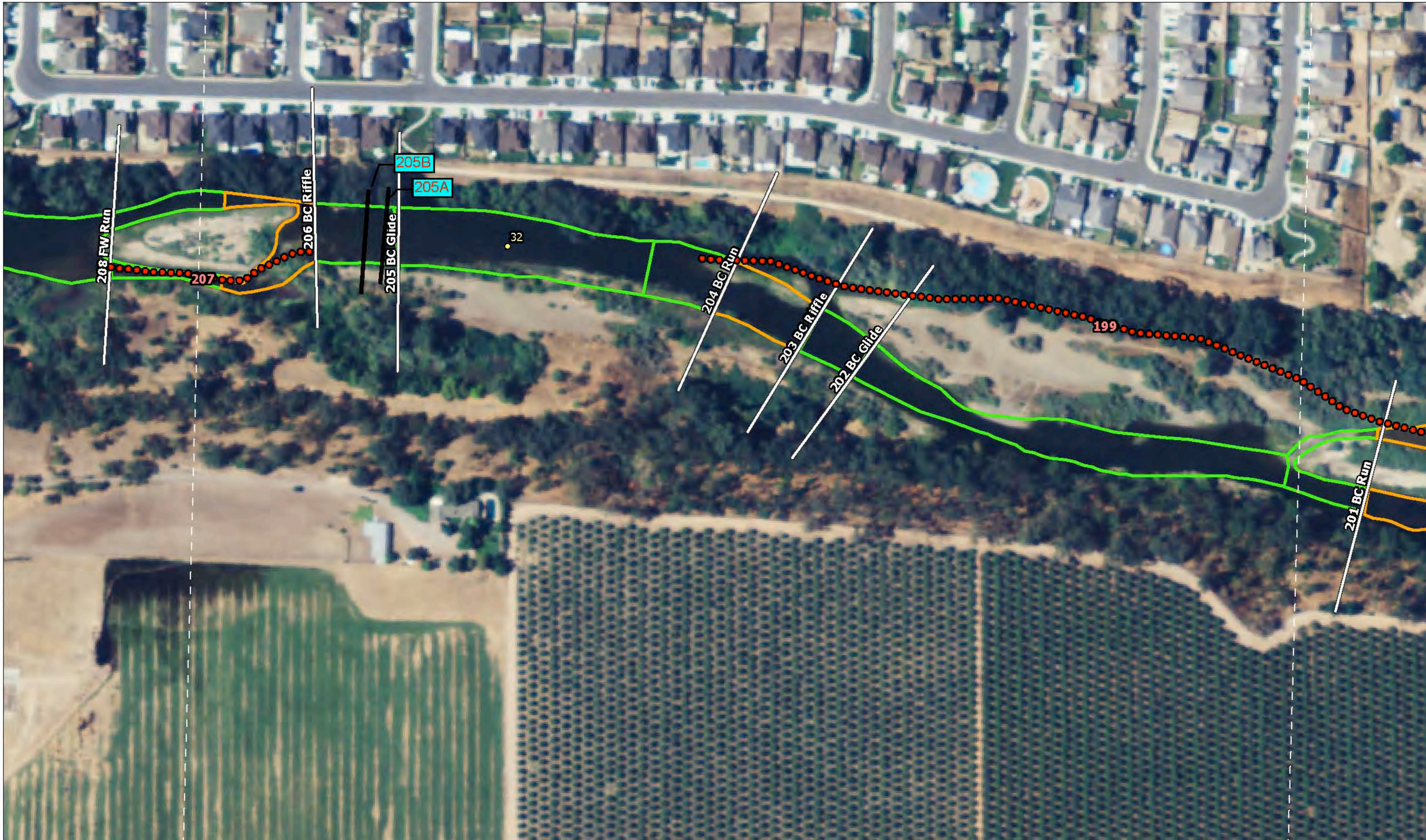
BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were fisrt based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 33



Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were first based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 42

Tuolumne River - IFIM Mesohabitats, 2010

Stillwater Sciences
www.stillwatersci.com

0 125 250 500 Feet

BCE Runs
BCE Riffles
BCE Pools

Meso Habitat reach
BC = Bar Complex
FW = Flatwater

Tile Boundary (shown white on the map)
River Miles
Side channel (ID labeled)

METADATA
Tiles 29 to 47: NAIP, 6/29/2009 (130 cfs)
Tiles 1 to 29: Sanborn imagery, 09/25/2005 (335 cfs)
Wetted perimeter were first based on EA_mapping data (90's) at 230 cfs, and later refined using 2005 & 2009 NAIP and field measurements from 2008 and 2009 surveys to adjust for channel migration.

Tile 46

Appendix C

PHABSIM Model Calibration Workshop Summary
November 28, 2012

Meeting Summary
Tuolumne River Instream Flow Study
PHABSIM Hydraulics Review Meeting
Wednesday, 28 November 2012, 9:00am
Stillwater Sciences, Davis, CA

Attendees: Robert Hughes (CDFG), Bill Cowan (CDFG), Jarvis Caldwell (HDR), Wayne Swaney (Stillwater), Scott Wilcox (Stillwater), Annie Manji (CDFG, briefly by phone)

Objectives

- Discuss feedback on review of hydraulic model from Lower Tuolumne River
- Determine if there are refinements to the existing model that can be made in a timely and cost-effective manner that will both 1) improve model performance, and 2) potentially affect habitat vs. flow results.
- Seek agreement on acceptability of the current/refined hydraulic model for its intended purpose.

Study Background

- Process
    i. Originated with FERC order to look at instream flows following prior 10-year study.
    ii. Convened series of workshops and field visits on reach and study site selection, transect selection, HSC selection
- Study Sites
    i. Selected in the field in November 2010
    ii. 40 transects grouped in 5 areas: Basso, Bobcat Flat, Santa Fe, Waterford and Delaware Rd.
    iii. Replicates of riffle, run, pool, glide, by two channel types (flat, bar complex)
- Field Efforts
    i. High flows in July 2011, mid flows in Sept 2011
    ii. High runoff precluded low flows in 2011, variance request for September 2011 unsuccessful, low flows measured in June 2012.

iii. HSC site specific surveys conducted in February, March, May, and July 2012 at 100 cfs, 350 cfs, and 2,000 cfs (573 obs [4,620 fish] at 1,095 locations)

PHABSIM Model Information

- Reviewed Summary Statistic Printouts
    i. WSL mean error, WSL obs vs. predicted, VAF
    ii. WSL table
    iii. Calibration Flow table
- Reviewed On-line Model screens

Detailed Model Review

The group proceeded to systematically 1) review all calibration flows to determine a "best Q" for use at each site, 2) rerun the model with the new calibration flows, 3) review each resulting stage/Q regression relationship, 4) decide on which hydraulic model to use at each transect, 5) review each velocity distribution graphic for anomalies.

The following action items and model refinements resulted from the detailed model review.

Calibration Flows

- Basso Bridge Site: Use the average of the three glide transects (24A, 24B, 29A) for the mid-flow calibration (276 cfs)
- Bobcat Flat Site: Use the average flow measurement at transects 85A, 83A, 82C for the mid-flow calibration (282 cfs). Following the new model run, consider WSL refinements (within the measured range) at pool transects 86A, 86B, 86C to improve the VAF.
- Santa Fe Site: No change in the current calibration flow of 319 cfs.
- Waterford Site: No change in the current calibration flow of 308 cfs.
- Delaware Site: No change in the current calibration flow of 306 cfs.

Stage-Discharge Regression

- All regression relationships looked acceptable after the calibration flow adjustments.

- Check for a possible profile error near Station 25 on Transect 156B.

Velocity Distributions

- Transect 155B, consider suppressing negative River Left velocities with specified Manning's 'n' values.
- Transect 155A, consider suppressing peak velocity near Station 45 with specified Manning's 'n' values.
- Transects 86A, 86B, 86C: Readjust Manning's 'n' values (and WSL) for better VAF results.
- Transect 84C: Modify Manning's 'n' near Station 140 to limit magnitude of negative velocity prediction
- Transect 84A: Modify Manning's 'n' near Station 68 to limit magnitude of the simulated negative velocity
- Transect 26B: Modify Manning's 'n' near Stations 75 and ~95 to cap the simulated high velocity spikes
- Transect 26A: Double check the velocity data at Station 62.5 and look for any error in the negative velocity, although the photos indicate it is plausibly accurate as currently recorded.
- Transect 25A: Readjust Manning's 'n' values for better VAF results, where needed.

Model Selection

As part of the stage-discharge regression data review, hydraulic model selections were made. The model of choice for transects 9-162A-BR, 17-156B-BR, 25-84C-FN, 26-84B-FN, 27-84A-FN, and 38-25A-BR was MANSQ. All other transects will be simulated using a Log-Log model (IFG-4).

Transect Locations

It was noted during the meeting that three transects for Unit 159 in the hydraulic model replaced three Unit 82 and Unit 83 transects initially selected in the field. This need became apparent during transect installation, when high flows were circumventing the main channel and water was flowing parallel to the transect line at the initially selected sites, preventing modelable conditions. The replacement transects were selected in the same habitat types, with an effort to make them as similar to the original locations as possible. The Interested Parties group was notified of the proposed change prior to data collection, and comments requested. No written comments were received.

Next Steps

Participants in the meeting agreed that, with the above modifications, the hydraulic model would be suitably calibrated for use in the next phases of the analysis. The refined model will be made available to meeting participants as soon as it is complete, but no formal re-evaluation of its acceptability is necessary.

Appendix D

HSC Workshop Summary
September 20, 2010

Lower Tuolumne River Instream Flow Study
Study Coordination Meeting #2 — Summary
Monday, September 20, 2010, 10 AM – 5 PM Stillwater Sciences
279 Cousteau Place, Davis, CA

Attendees:

Scott Wilcox (Stillwater)
Russ Liebig (Stillwater)
Bob Hughes (CDFG)
Ron Yoshiyama (CCSF-SF)
Allison Boucher (TRC)
Zac Jackson (USFWS)
Shaara Ainsley (FishBio)

The purpose of this meeting was to compile, review, and discuss available salmon and steelhead Habitat Suitability Criteria (HSC) for the lower Tuolumne River, select HSC where possible, identify additional HSC literature data gathering needs, and discuss related topics. Scott Wilcox provided a brief overview of HSC and why they were needed for the IFIM study.

The technical group sequentially reviewed HSC and associated metadata from various sources for each species and lifestage, and either (1) selected HSC, (2) reduced the sources of HSC being considered, and/or (3) identified data needs and next steps. Decisions and/or actions on HSC for each species and lifestage are noted below.

Chinook Salmon Spawning

- A wide range of HSC from various sources were reviewed, and the CDFG site-specific Tuolumne curves matched the central tendencies of the other data sets well.
- **Action Item**: confirm that the number of observations and the methodology used in the CDFG spawning study were sufficiently robust. [Subsequent data searches by Stillwater revealed that 318 observations were used for the curves, and 10 study sites were spread over 9.2 miles that represented all of the dominant spawning reach. Thus, there does not seem to be an issue with data robustness.]
- **Decision**: Use site-specific Tuolumne River data for depth and velocity, from the CDFG study conducted in ~1982.

Tuolumne River Chinook Salmon Spawning Depth and Velocity Criteria*

Depth	Suitability Index	Velocity	Suitability Index
0.00	0.00	0.00	0.00
0.50	0.00	0.70	0.00
0.60	0.12	0.80	0.06
0.70	0.23	0.90	0.17
0.80	0.27	1.05	0.36
0.90	1.00	1.25	0.42
2.60	1.00	1.40	1.00
2.70	0.15	2.60	1.00
2.80	0.12	2.70	0.62
2.90	0.08	2.80	0.56
3.00	0.00	2.90	0.45
		3.05	0.22
		3.20	0.17
		3.80	0.07
		4.40	0.00

*From CDFG 1982

- **Decision:** Adopt, with small modifications based on data from other streams, the site-specific substrate HSC from CDFG. Other streams indicated frequent use of 1-2 inch gravel, which the site-specific Tuolumne data did not (perhaps due to availability limitations). Final substrate criteria agreed to by the technical group are specified below.

Tuolumne River Chinook Salmon Spawning Substrate Criteria*

Substrate	Size (inches)	Suitability Index
Organic, silt, sand, small gravel	Up to 1.0	0.0
Medium gravel	1-2	0.5
Large gravel	2-3	1.0
Very small cobble	3 – 4.5	1.0
Small cobble	4.5-6	0.7
Medium Cobble	6-9	0.0
Large cobble, boulder, bedrock	>9	0.0

*Adapted from CDFG 1982 with minor expansion to indicate suitability of 1-2 inch gravel.

- The technical group agreed that additional site-specific data collection for spawning would not lead to a decision narrow the HSC curves, and that sufficient additional data to justify expanding the curves was not possible given the current size of the population. Therefore, given that the current data set is robust at 318 observations, and is already site-specific, no additional site-specific data collection for spawning is planned.

Chinook Salmon Juveniles

The Stanislaus velocity HSC provided good representation of the central tendencies of the larger data set. Stanislaus depth HSC curve peaked slightly more to the right of most of the rest of the data sets.

- **Decisions:** (1) Use the Stanislaus HSC for velocity. (2) Use the Stanislaus HSC for depth, with a minor modification to include the peaks of other curves in the 1.31 – 2.10 foot depth range. (3) Do not apply substrate criteria to juveniles, since they do not typically select habitat based on substrate and may occur over the entire range of substrate possibilities.

Tuolumne River Chinook Salmon Juvenile Depth and Velocity Criteria*

Depth	Suitability Index	Velocity	Suitability Index
0.00	0.00	0.00	0.92
0.10	0.01	0.10	0.96
0.20	0.02	0.20	1.00
0.30	0.05	0.30	0.99
0.40	0.10	0.40	0.99
0.50	0.17	0.50	0.98
0.60	0.27	0.60	0.97
0.70	0.36	0.70	0.97
0.80	0.42	0.80	0.96
1.31	1.00	0.90	0.96
2.10	1.00	1.00	0.95
2.20	0.93	1.10	0.94
2.30	0.86	1.20	0.94
2.40	0.78	1.30	0.93
2.50	0.71	1.40	0.92
2.60	0.64	1.50	0.92
2.70	0.57	1.60	0.91
2.80	0.49	1.70	0.79
2.90	0.42	1.80	0.68
3.00	0.41	1.90	0.56
3.10	0.39	2.00	0.44
3.20	0.38	2.10	0.33
3.30	0.36	2.20	0.28
3.40	0.35	2.30	0.24
3.50	0.34	2.40	0.19
3.60	0.32	2.50	0.15
3.70	0.31	2.60	0.10

3.80	0.29	2.70	0.06
3.90	0.28	2.80	0.01
4.00	0.25	3.40	0.01
4.10	0.18	3.50	0.00
4.20	0.12		
4.30	0.08		
4.40	0.05		
4.50	0.03		
4.60	0.03		
4.70	0.02		
7.00	0.02		
7.10	0.00		

*From Stanislaus River. Depth curve modified.

Chinook Salmon Fry
Site-specific Tuolumne River HSC for fry are available. These HSC were compared to the fry HSC from the Stanislaus River (Stanislaus River data were used for juvenile HSC). The similarity between the two data sets, and their similarity to the central tendency of other data sets, was not as great as the technical group had hoped, and some type of hybrid curve was considered. Decisions on depth and velocity HSC for this life stage were deferred to the next meeting, pending review of the reports and metadata that may provide some insight on reasons for the differences.

Decision: As specified for the juvenile life stage, do not apply substrate criteria to fry.

Steelhead Adults
The technical group reviewed a few HSC from the literature, and initially focused on resident rainbow trout curves provided by the USFWS that are being used for steelhead on the Merced project, since they already had some level of agency concurrence. Several questions were raised about the origin of the curves, and the rationale for their use.

Since the Tuolumne River O. mykiss population is almost entirely resident, the technical group concurred that review of some Central Valley rainbow trout curves should be considered as well.

Action: Zac Jackson will research the background and source of the HSC being used for the Merced Project. Stillwater will compile some rainbow trout HSC for consideration. These will all be reviewed at the next HSC meeting.

Upcoming meeting dates:

Site Selection Meeting, October 5, 2010
HSC development 2nd meeting, October 20, 2010 at Stillwater in Davis, 9:00.

Appendix E

HSC Workshop Summary
October 20, 2010

Lower Tuolumne River Instream Flow Study
Study Coordination Meeting #4 — Summary
Wednesday, October 20, 2010, 9 AM – 5 PM Stillwater Sciences
279 Cousteau Place, Davis, CA

Attendees:

Scott Wilcox (Stillwater)
Russ Liebig (Stillwater)
Bob Hughes (CDFG)
Ron Yoshiyama (CCSF-SF)
Allison Boucher (TRC)
Mark Gard (USFWS)
Jim Inman (FishBio)

The purpose of this workshop was to compile, review, and discuss available steelhead Habitat Suitability Criteria (HSC) for the lower Tuolumne River, select remaining HSC where possible, identify additional HSC literature data gathering needs, and discuss related topics. Chinook salmon HSC were discussed at the September 20, 2010 workshop. Scott Wilcox provided a brief overview of remaining action items from the September 20 workshop and introduced the revised *O. mykiss* HSC data packet, which was expanded to include additional rainbow trout curves following the September 20 meeting.

The technical group sequentially reviewed *O. mykiss* HSC and associated metadata from various sources for each lifestage, and either (1) selected HSC, (2) reduced the sources of HSC being considered, and/or (3) identified data needs and next steps. Decisions and/or actions on HSC for each species and lifestage are noted below.

O. mykiss Adults

- The technical group had reviewed HSC during the September 20, 2010 workshop and initially focused on resident rainbow trout curves provided by the USFWS that are being used for the Merced project (SF American logistic regression curve). However, since the Tuolumne River *O. mykiss* population is almost entirely resident, the technical group concurred that review of additional Central Valley rainbow trout curves should be considered as well. Stillwater subsequently compiled additional rainbow trout HSC for comparison and consideration, and Bob Hughes reviewed the origin of the Merced curves. All of these data were reviewed and discussed by the group on October 20.
- The process for HSC selection generally used the following steps: 1) review tabular metadata for all HSC; 2) "filter" HSC datasets to consider further based on selection criteria in the study plan such as number of observations, category of criteria, geography, stream similarity, elevation, etc.; 3) review

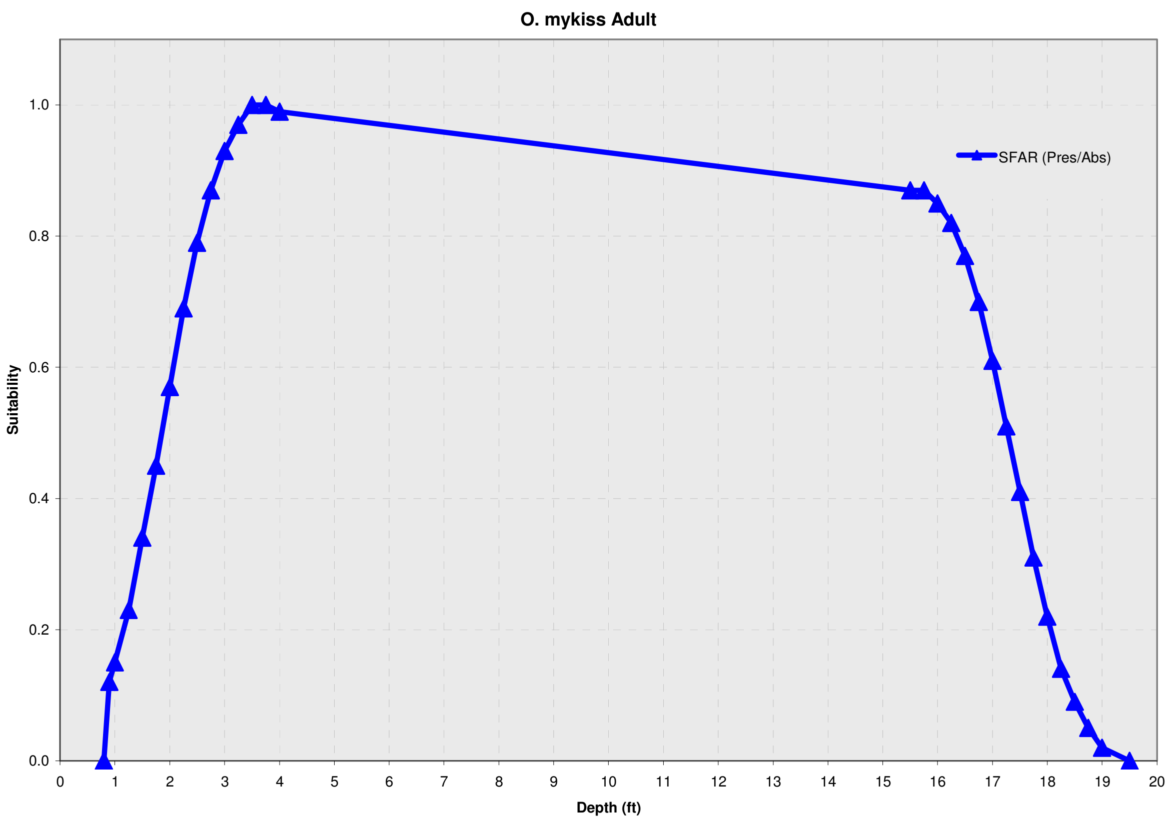
graphs of filtered HSC and discuss outliers, representative datasets, or development of a consensus curve.

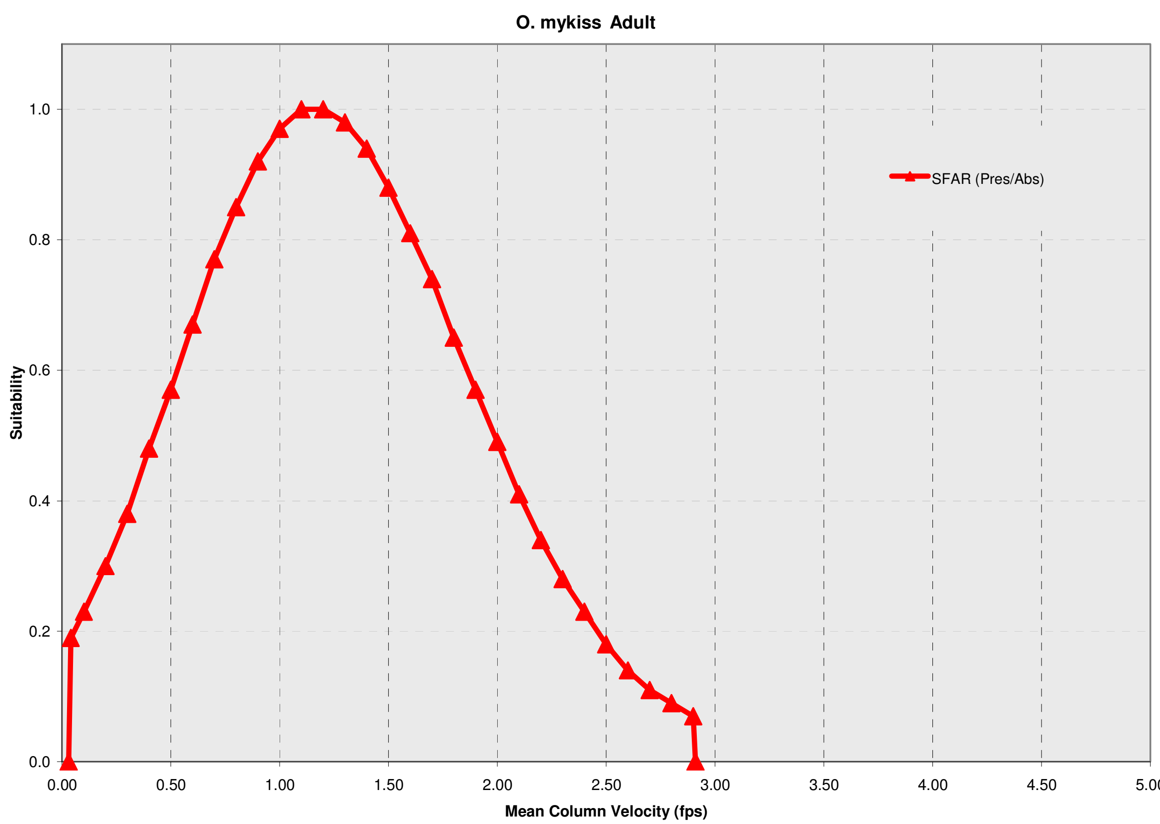
- **Decision**: The workshop group concurred on use the South Fork American River Logistic Regression (Pres/Abs) curves ("SFAR Pres/Abs") proposed by the USFWS for both velocity and depth.

Tuolumne River *O. mykiss* Adults Depth and Velocity Criteria*

Velocity (fps)	Suitability Index	Depth (ft)	Suitability Index
0.03	0.00	0.80	0.00
0.04	0.19	0.90	0.12
0.10	0.23	1.00	0.15
0.20	0.30	1.25	0.23
0.30	0.38	1.50	0.34
0.40	0.48	1.75	0.45
0.50	0.57	2.00	0.57
0.60	0.67	2.25	0.69
0.70	0.77	2.50	0.79
0.80	0.85	2.75	0.87
0.90	0.92	3.00	0.93
1.00	0.97	3.25	0.97
1.10	1.00	3.50	1.00
1.20	1.00	3.75	1.00
1.30	0.98	4.00	0.99
1.40	0.94	15.50	0.87
1.50	0.88	15.75	0.87
1.60	0.81	16.00	0.85
1.70	0.74	16.25	0.82
1.80	0.65	16.50	0.77
1.90	0.57	16.75	0.70
2.00	0.49	17.00	0.61
2.10	0.41	17.25	0.51
2.20	0.34	17.50	0.41
2.30	0.28	17.75	0.31
2.40	0.23	18.00	0.22
2.50	0.18	18.25	0.14
2.60	0.14	18.50	0.09
2.70	0.11	18.75	0.05
2.80	0.09	19.00	0.02
2.90	0.07	19.50	0.00
2.91	0.00		

* From USFWS 2004: Flow-habitat relationships for adult and juvenile rainbow trout in the Big Creek Project. USFWS Energy Planning and Instream Flow Branch. 31pp.


O. mykiss Adult
Suitability
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Depth (ft)
SFAR (Pres/Abs)


O. mykiss Adult
Suitability
1.0
0.8
0.6
0.4
0.2
0.0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Mean Column Velocity (fps)
SFAR (Pres/Abs)

O. mykiss Spawning

A wide range of HSC from various sources were reviewed; however, one single curve could not be identified to best fit the *O. mykiss* populations in the Tuolumne River. Therefore envelope curves were developed for depth and velocity, and a curve reflecting the central tendency of the data was developed for substrate, based on the Upper Trinity and Yuba curves.

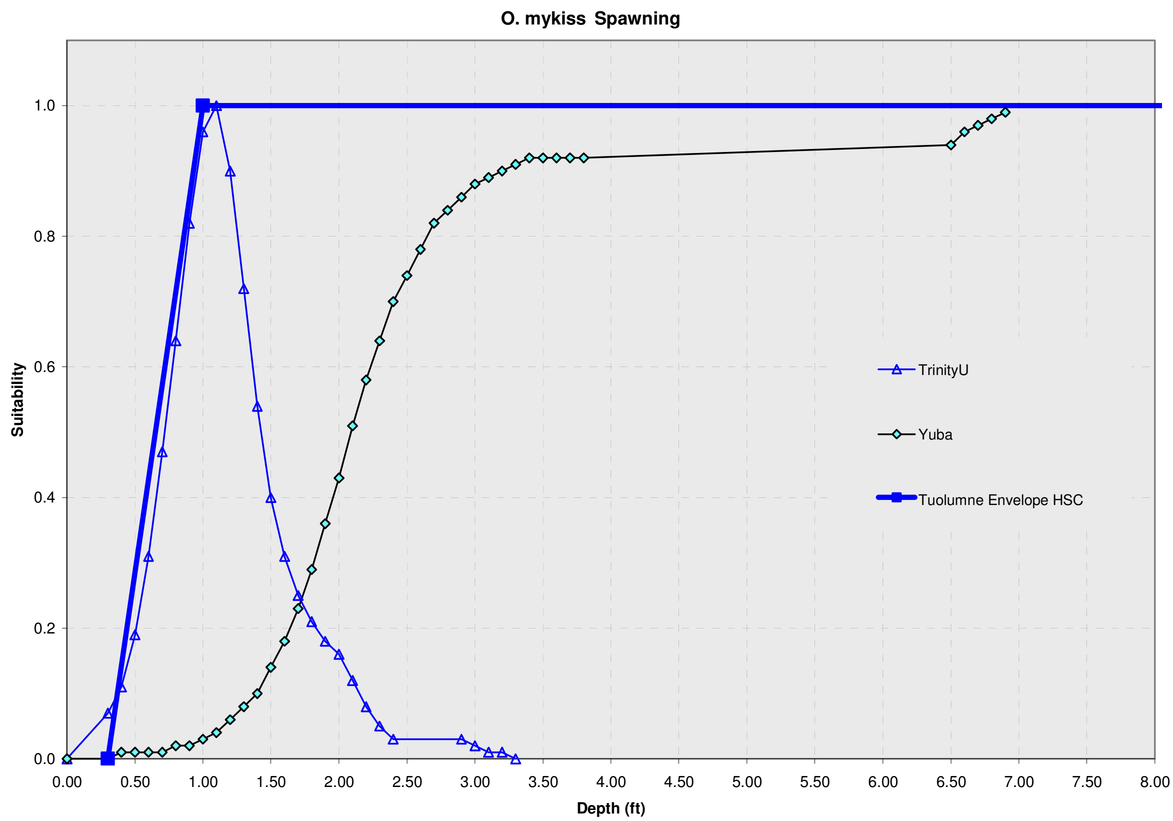
- **Decision:**
  - Velocity: Use an envelope curve including the ascending limb of the Upper Trinity curve to (x, y = 1.1, 1.0) over to (2.6, 1.0) of the Yuba curve, then straight-line down to (4.4, 0.0).
  - Depth: Use an envelope curve from (0.3, 0.0) to (1.0, 1.0) to (100.0, 1.0).
  - Substrate: Final substrate criteria agreed to by the technical group are specified below.

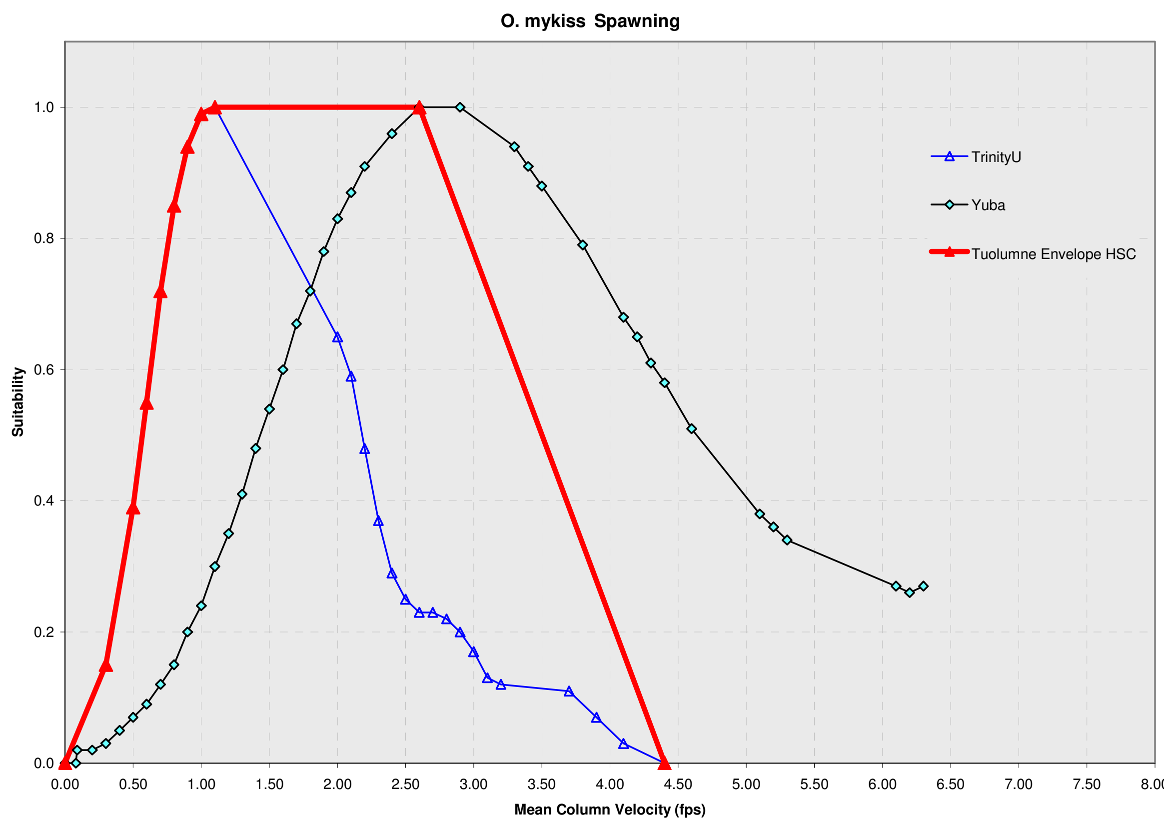
Tuolumne River _O. mykiss_ Spawning Depth and Velocity Criteria

Velocity (fps)	Suitability Index	Depth (ft)	Suitability Index
0.00	0.00	0.30	0.00
0.30	0.15	1.00	1.00
0.50	0.39	100.00	1.00
0.60	0.55		
0.70	0.72		
0.80	0.85		
0.90	0.94		
1.00	0.99		
1.10	1.00		
2.60	1.00		
4.40	0.00		

Tuolumne River _O. mykiss_ Spawning Substrate Criteria

Substrate	Size (inches)	Suitability Index
Organic, silt, sand, small gravel	Up to 1.0	0.38
Medium gravel	1-2	1.0
Large gravel	2-3	0.85
Very small cobble	3 – 4.5	0.28
Small cobble	4.5-6	0.05
Medium Cobble	6-9	0.00
Large cobble, boulder, bedrock	>9	0.00


O. mykiss Spawning
Suitability
Depth (ft)
TrinityU
Yuba
Tuolumne Envelope HSC
0.0
0.2
0.4
0.6
0.8
1.0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00


O. mykiss Spawning
Suitability
Mean Column Velocity (fps)
TrinityU
Yuba
Tuolumne Envelope HSC
0.0
0.2
0.4
0.6
0.8
1.0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00

O. mykiss **Fry**

A wide range of HSC from various sources were reviewed that displayed similar results for fry. USFWS Yuba River curves were presented in the "filtered" data sets, but they varied from the central tendency of the other curves due to the statistical approach used to generate them.

- **Action Item:** Mark Gard to provide the underlying histograms and report for the Yuba River *O. mykiss* HSC prior to the November 22 meeting for comparison to other data.

O. mykiss **Juveniles**

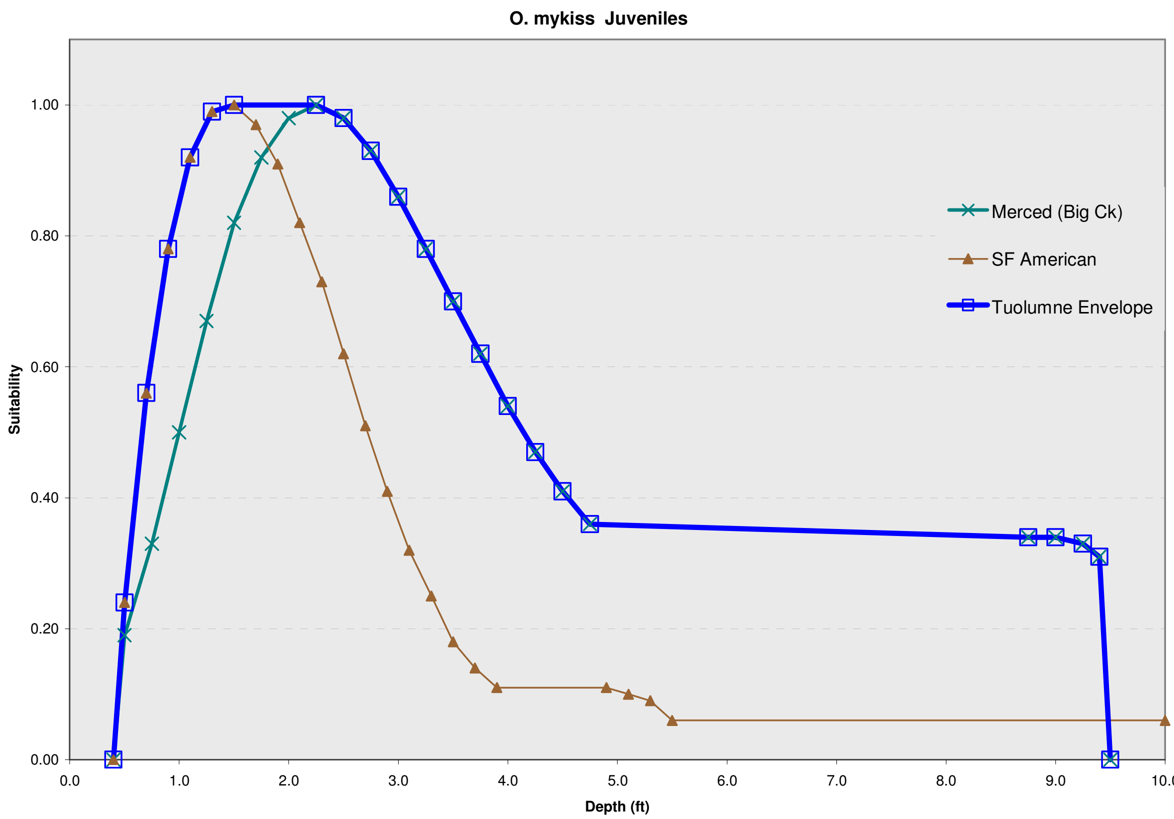
Decision: Recommended an envelope curve including the ascending limb of the SF American polynomial regression curve up to y=1, and across on y=1, following the descending limb of the SF American logistic regression curve. No substrate criteria to be applied to juveniles.

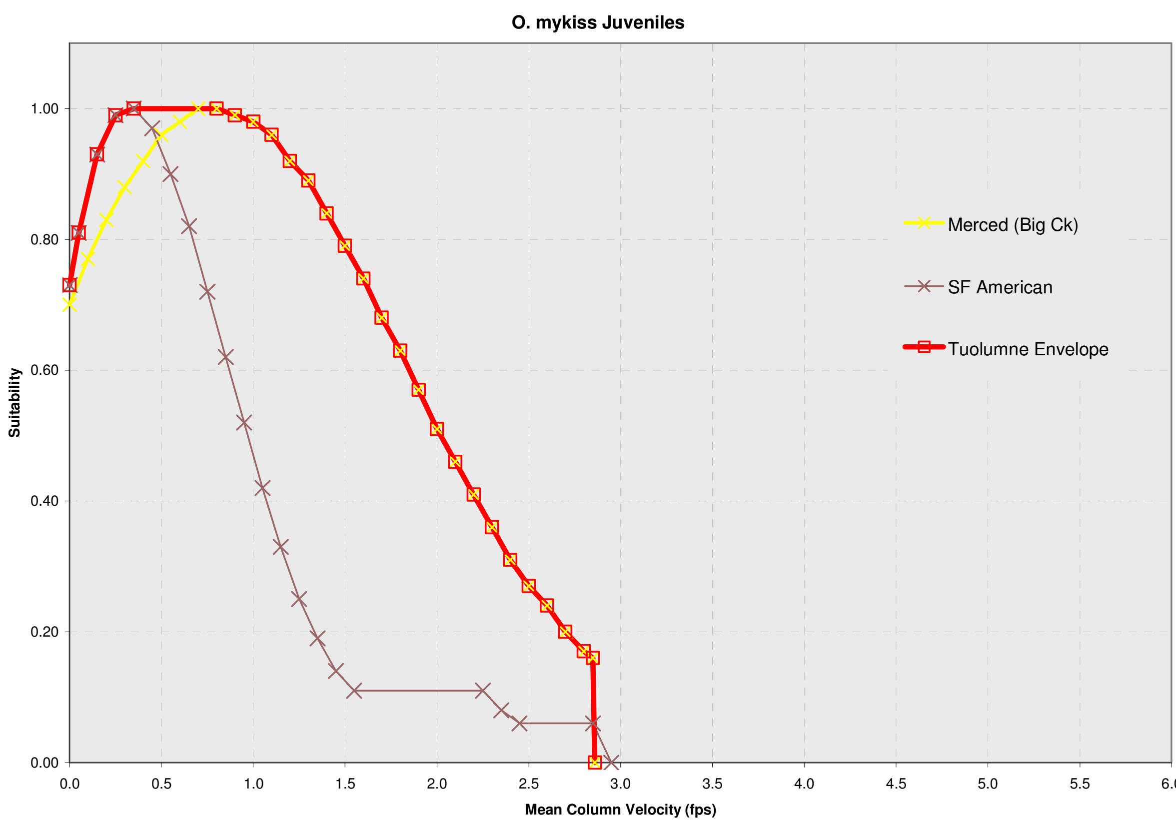
Upcoming meeting dates:

A third HSC development workshop was tentatively scheduled for November 22, 2010 at Stillwater in Davis, 9:00 AM, but was postponed due to subsequent scheduling and data availability conflicts. The next workshop is anticipated in early January.

Tuolumne River *O. mykiss* Juvenile Depth and Velocity Criteria

Velocity (fps)	Suitability Index	Depth (ft)	Suitability Index
0.00	0.73	0.40	0.00
0.05	0.81	0.50	0.24
0.15	0.93	0.70	0.56
0.25	0.99	0.90	0.78
0.35	1.00	1.10	0.92
0.80	1.00	1.30	0.99
0.90	0.99	1.50	1.00
1.00	0.98	2.25	1.00
1.10	0.96	2.50	0.98
1.20	0.92	2.75	0.93
1.30	0.89	3.00	0.86
1.40	0.84	3.25	0.78
1.50	0.79	3.50	0.70
1.60	0.74	3.75	0.62
1.70	0.68	4.00	0.54
1.80	0.63	4.25	0.47
1.90	0.57	4.50	0.41
2.00	0.51	4.75	0.36
2.10	0.46	8.75	0.34
2.20	0.41	9.00	0.34
2.30	0.36	9.25	0.33
2.40	0.31	9.40	0.31
2.50	0.27	9.50	0.00
2.60	0.24		
2.70	0.20		
2.80	0.17		
2.85	0.16		
2.86	0.00		


O. mykiss Juveniles
Suitability
Depth (ft)
Merced (Big Ck)
SF American
Tuolumne Envelope
0.00
0.20
0.40
0.60
0.80
1.00
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0


O. mykiss Juveniles
Suitability
Mean Column Velocity (fps)
Merced (Big Ck)
SF American
Tuolumne Envelope
0.00
0.20
0.40
0.60
0.80
1.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0

Appendix F

HSC Workshop Summary
February 3, 2011

Lower Tuolumne River Instream Flow Study
Study Coordination Workshop #5 — Summary
Thursday, February 3, 2011, 9:00
Stillwater Office, Davis, CA

Attendees:

Scott Wilcox (Stillwater)	Ron Yoshiyama (CCSF-SF)
Russ Liebig (Stillwater)	Allison Boucher (TRC)
Bob Hughes (CDFG)	Dave Boucher (TRC)
Jenny O'Brien (CDFG)	Mark Gard (USFWS)
Steve Tsao (CDFG)	Zac Jackson (USFWS)
Bill Cowan (CDFG)	Shaara Ainsley (FishBio)

The purpose of this workshop was to compile, review, and discuss available *O. mykiss* and Chinook salmon Habitat Suitability Criteria (HSC) for the lower Tuolumne River, select remaining HSC where possible, identify additional HSC literature data gathering needs, and discuss related topics. HSC for Chinook salmon and *O. mykiss* were previously selected at the September 20, 2010 and October 20, 2010 workshops where the group had come to consensus on suitability criteria for Chinook salmon spawning (depth, velocity, and substrate), and juvenile (depth and velocity) lifestages, and *O. mykiss* spawning (depth, velocity, and substrate), adult (depth and velocity), and juvenile (depth and velocity) life stages. The group had decided at the September 20, 2010 workshop to not apply substrate criteria to the juvenile and fry life stages.

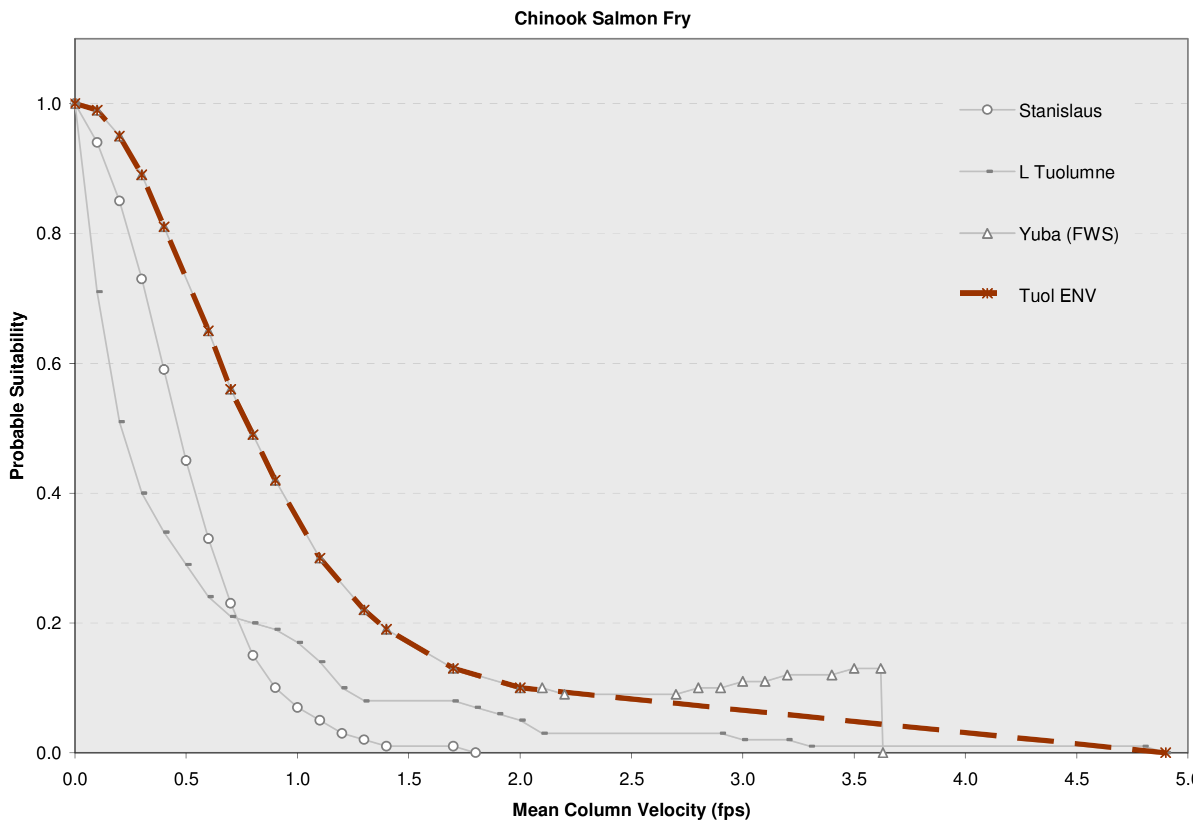
Scott Wilcox provided a brief overview of remaining action items from the previous workshops and introduced the revised Chinook salmon and *O. mykiss* HSC data packet compiled from USFWS data provided since the October workshop. The technical group reviewed Chinook salmon fry HSC and *O. mykiss* fry and adult HSC from various sources. The technical group also reviewed available cover HSC for Chinook salmon fry and *O. mykiss* fry provided by USFWS. Decisions and/or actions on HSC for each species and lifestage are noted below.

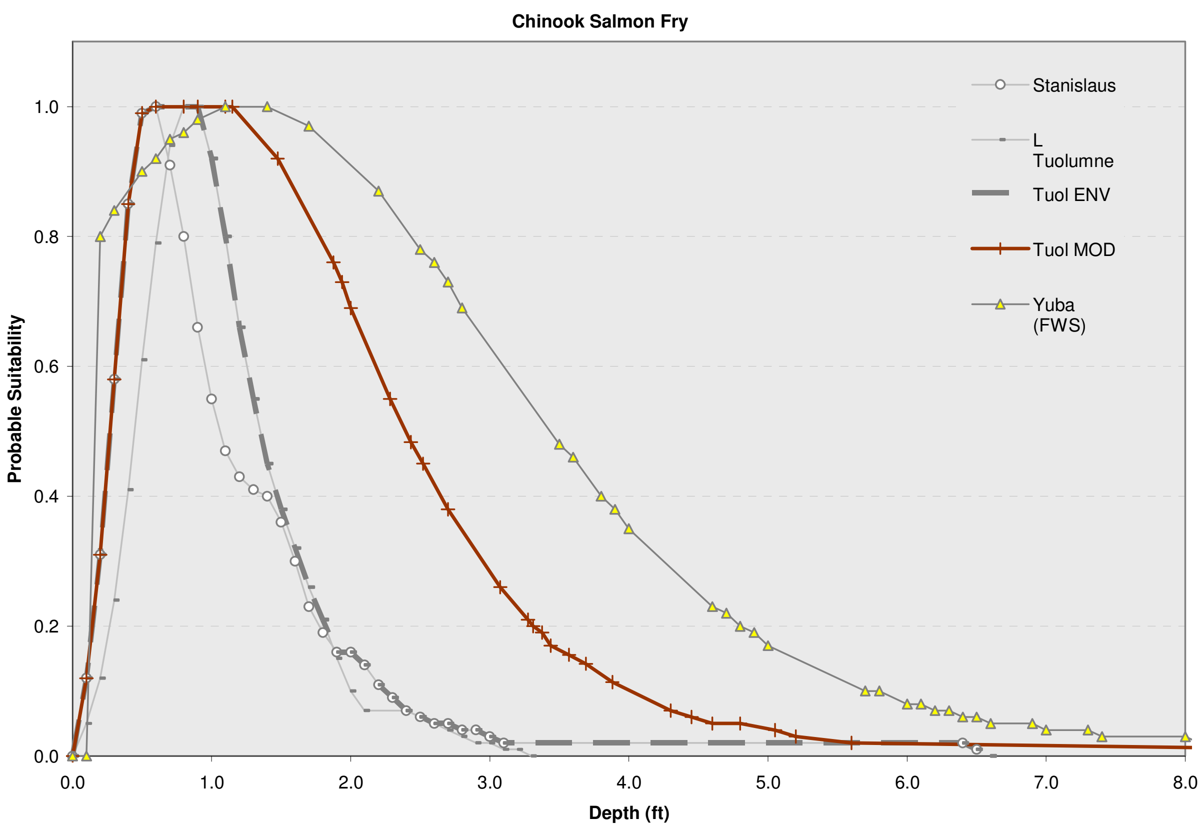
Chinook salmon fry

- The technical group had reviewed HSC during the September 20, 2010 workshop and initially narrowed the curve search to curves developed for the Tuolumne River and neighboring Stanislaus River. The similarity between the two data sets, and their similarity to the central tendency of other data sets, was not as great as the technical group had hoped, and some type of hybrid curve was considered. Decisions on depth and velocity HSC for this life stage had been deferred, pending review of the Tuolumne and Stanislaus reports that may provide some insight on reasons for the differences.

- Prior to the February 3, 2011 meeting, USFWS supplied additional background information for HSC they developed on the Yuba River, as well as additional unpublished HSC data they collected from Clear Creek.
- The group originally considered an "envelope" curve over the Stanislaus and Tuolumne curves, since the Stanislaus curve may have better correction for availability (being Category III curves), but the Tuolumne curve shows some greater utilization of higher velocities. When consensus was not reached, the group re-considered the Yuba River curves.
- **Velocity Decision**: The group concurred on the use of a modified Yuba River HSC curve for velocity (Tuol ENV). The modified curve was equal to the Yuba curve up to (2.0, 0.1), at which point the curve follows a straight line to (4.9, 0.0), the end point of the Tuolumne curve (see attached graphic and coordinate Table).
- **Depth**: The group did not come to consensus on the depth HSC curve. The most thoroughly discussed options included:
  1. An "envelope" over the Stanislaus and Tuolumne curves (Tuol ENV)
  2. Use an average between the envelope curve (Tuol ENV) and Yuba curves using the ascending limb of the Stanislaus curve, over to the Yuba curve at (1.1, 1.0) and down between the average of Tuol ENV and Yuba curves (Tuol MOD)
  3. Use the ascending limb of the Stanislaus curve, then the descending limb of the Yuba curve.

  Lacking consensus on this parameter, the Districts plan to apply option #2, since this option seemed to have the broadest support among the stakeholders present at the workshop.
- **Cover**: The group discussed the idea of using existing cover codes. Because of limited availability of published cover HSC and wide variation in codes, this item had been previously discussed as data to collect during field surveys in 2011, rather than trying to adapt other coding systems. Existing curves from the Yuba River and Clear Creek were presented by USFWS. The applicability, complexity, and sample size of the various cover code data were discussed. Possible use of Sacramento River cover codes was discussed, although the data were not presented or reviewed. Stillwater will consider combining cover data from various sources (including the USFWS Sacramento River Data) into a simplified cover code that could be circulated for comment.


Chinook Salmon Fry
Probable Suitability
Mean Column Velocity (fps)
Stanislaus
L Tuolumne
Yuba (FWS)
Tuol ENV
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

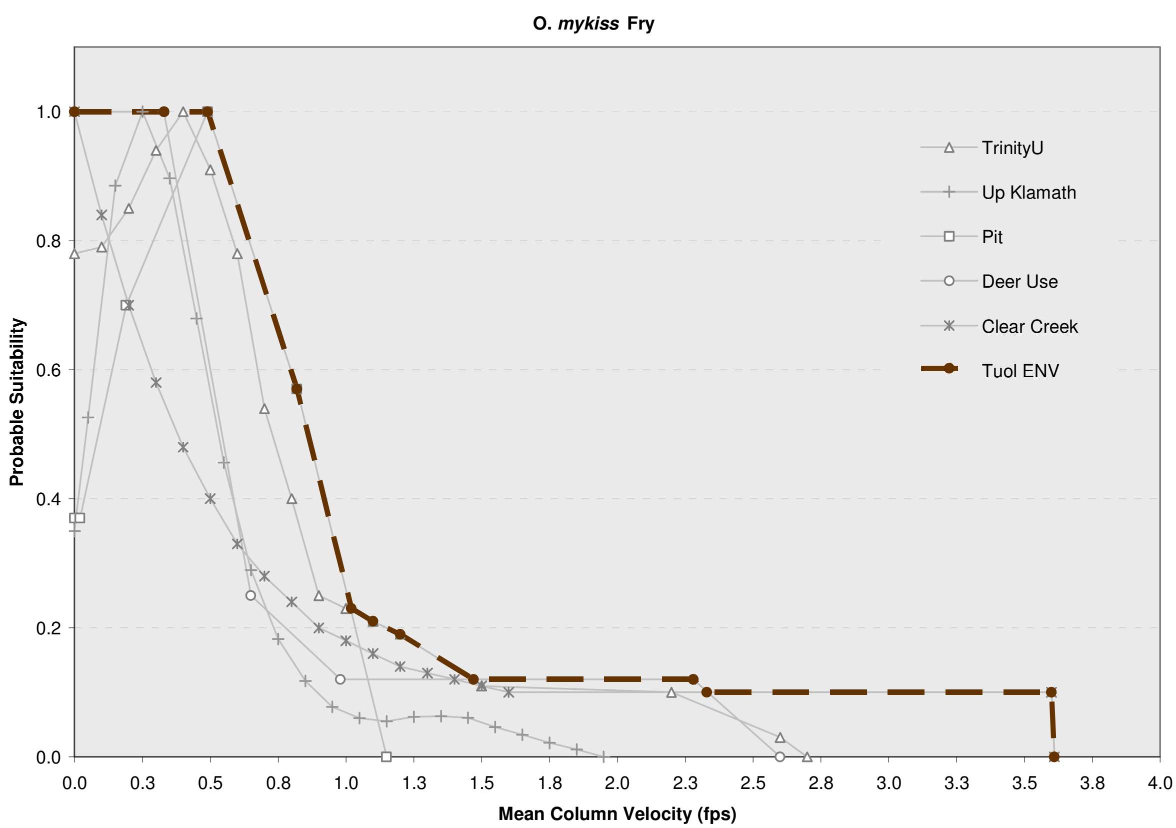

Chinook Salmon Fry
Probable Suitability
Depth (ft)
Stanislaus
L Tuolumne
Tuol ENV
Tuol MOD
Yuba (FWS)
0.0
0.2
0.4
0.6
0.8
1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0

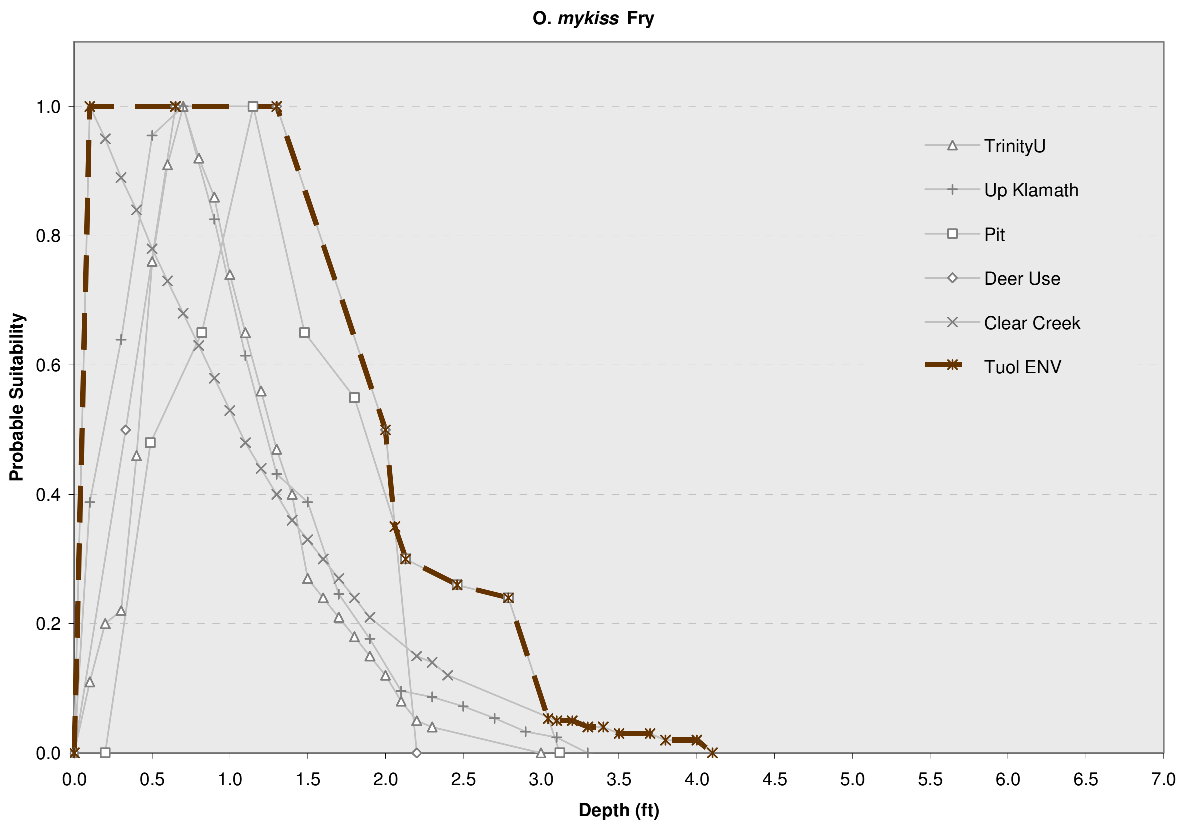
Chinook Salmon Fry: Velocity suitability criteria and three most discussed depth suitability criteria remaining following discussion on February 3, 2011

Tuol ENV		Tuol ENV		Tuol MOD		Yuba (FWS)	
Velocity	**Index**	**Depth**	**Index**	**Depth**	**Index**	**Depth**	**Index**
0	1	0.0	0.00	0.0	0.00	0.0	0.00
0.1	0.99	0.1	0.12	0.1	0.12	0.1	0.00
0.2	0.95	0.2	0.31	0.2	0.31	0.2	0.80
0.3	0.89	0.3	0.58	0.3	0.58	0.3	0.84
0.4	0.81	0.4	0.85	0.4	0.85	0.5	0.90
0.6	0.65	0.5	0.99	0.5	0.99	0.6	0.92
0.7	0.56	0.6	1.00	0.6	1.00	0.7	0.95
0.8	0.49	0.8	1.00	0.8	1.00	0.8	0.96
0.9	0.42	0.9	1.00	0.9	1.00	0.9	0.98
1.1	0.3	1.0	0.92	1.1	1.00	1.1	1.00
1.3	0.22	1.1	0.80	1.2	1.00	1.4	1.00
1.4	0.19	1.2	0.66	1.5	0.92	1.7	0.97
1.7	0.13	1.3	0.55	1.9	0.76	2.2	0.87
2	0.1	1.4	0.45	1.9	0.73	2.5	0.78
4.90	0.00	1.5	0.38	2.0	0.69	2.6	0.76
		1.6	0.32	2.3	0.55	2.7	0.73
		1.7	0.26	2.4	0.48	2.8	0.69
		1.8	0.21	2.5	0.45	3.5	0.48
		1.9	0.16	2.7	0.38	3.6	0.46
		2.0	0.16	3.1	0.26	3.8	0.40
		2.1	0.14	3.3	0.21	3.9	0.38
		2.2	0.11	3.3	0.2	4.0	0.35
		2.3	0.09	3.4	0.19	4.6	0.23
		2.4	0.07	3.4	0.17	4.7	0.22
		2.5	0.06	3.6	0.16	4.8	0.20
		2.6	0.05	3.7	0.14	4.9	0.19
		2.7	0.05	3.9	0.11	5.0	0.17
		2.8	0.04	4.3	0.07	5.7	0.10
		2.9	0.04	4.5	0.06	5.8	0.10
		3.0	0.03	4.6	0.05	6.0	0.08
		3.1	0.02	4.8	0.05	6.1	0.08
		6.4	0.02	5.1	0.04	6.2	0.07
		6.5	0.01	5.2	0.03	6.3	0.07
		6.6	0.00	5.6	0.02	6.4	0.06
				12.6	0.00	6.5	0.06
						6.6	0.05
						6.9	0.05
						7.0	0.04
						7.3	0.04
						7.4	0.03
						8.0	0.03
						8.1	0.02
						18.4	0.02
						18.5	0.00

O. mykiss Fry

- A wide range of HSC from various sources were reviewed during the October 20, 2010 HSC workshop that displayed similar results for fry. USFWS Yuba River curves were presented in the "filtered" data sets, but they varied from the central tendency of the other curves due to the statistical approach used to generate them. USFWS subsequently provided the report and curves with underlying fish utilization histograms for discussion.
- The USFWS suggested the workshop group drop the Yuba *O. mykiss* fry curves from consideration due to the limited number of observations, but to add USFWS unpublished Clear Creek fry curves instead.
- **Decision**: The workshop group concurred on the use of an envelope curve for both depth and velocity around the Trinity U., Up Klamath, Pit, Deer Use, and Clear Creek curves, generally following the most inclusive ("outside") parts of the curve.





Tuolumne River suitability criteria for *O. mykiss* fry

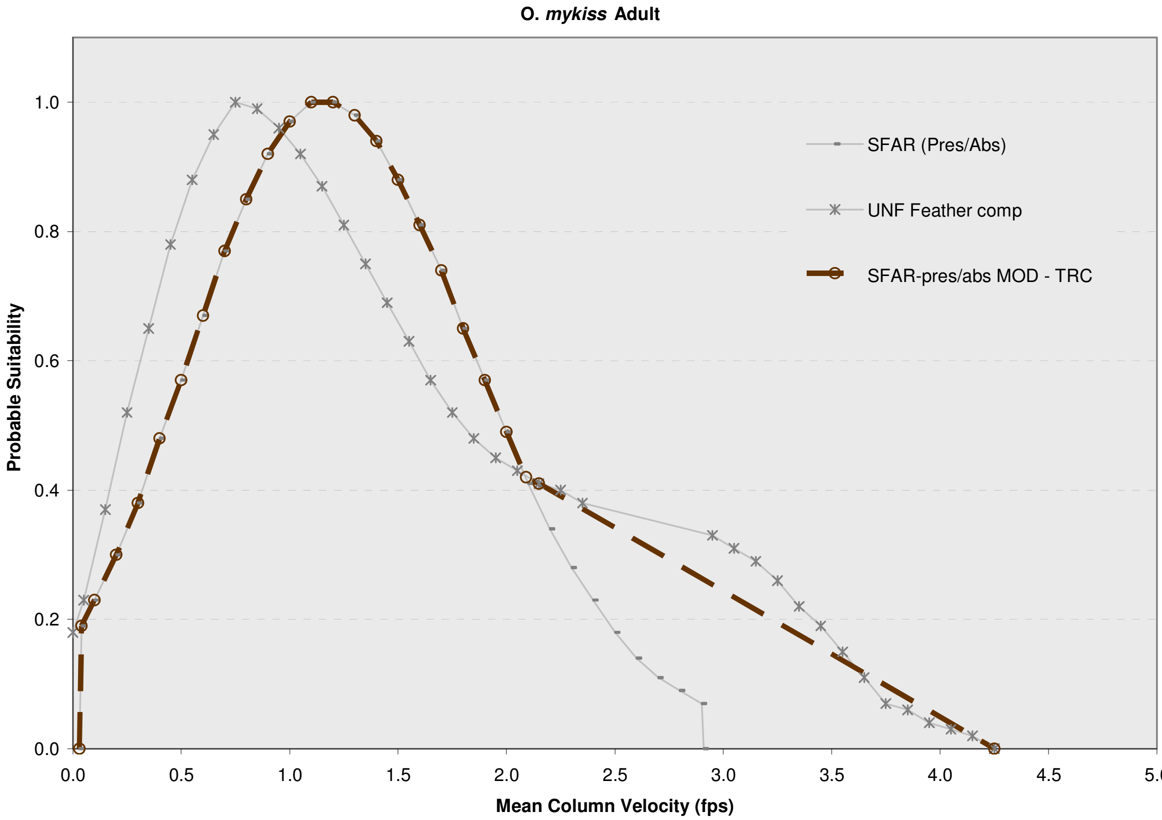
Velocity	Tuol ENV Index	Depth	Tuol ENV Index
0.00	1.00	0.00	0.00
0.33	1.00	0.10	1.00
0.49	1.00	0.65	1.00
0.82	0.57	1.30	1.00
1.02	0.23	2.00	0.50
1.10	0.21	2.06	0.35
1.20	0.19	2.13	0.30
1.47	0.12	2.46	0.26
2.28	0.12	2.79	0.24
2.33	0.10	3.05	0.05
3.60	0.10	3.10	0.05
3.61	0.00	3.20	0.05
		3.30	0.04
		3.40	0.04
		3.50	0.03
		3.70	0.03
		3.80	0.02
		4.00	0.02
		4.10	0.00

***O. mykiss* Adult**

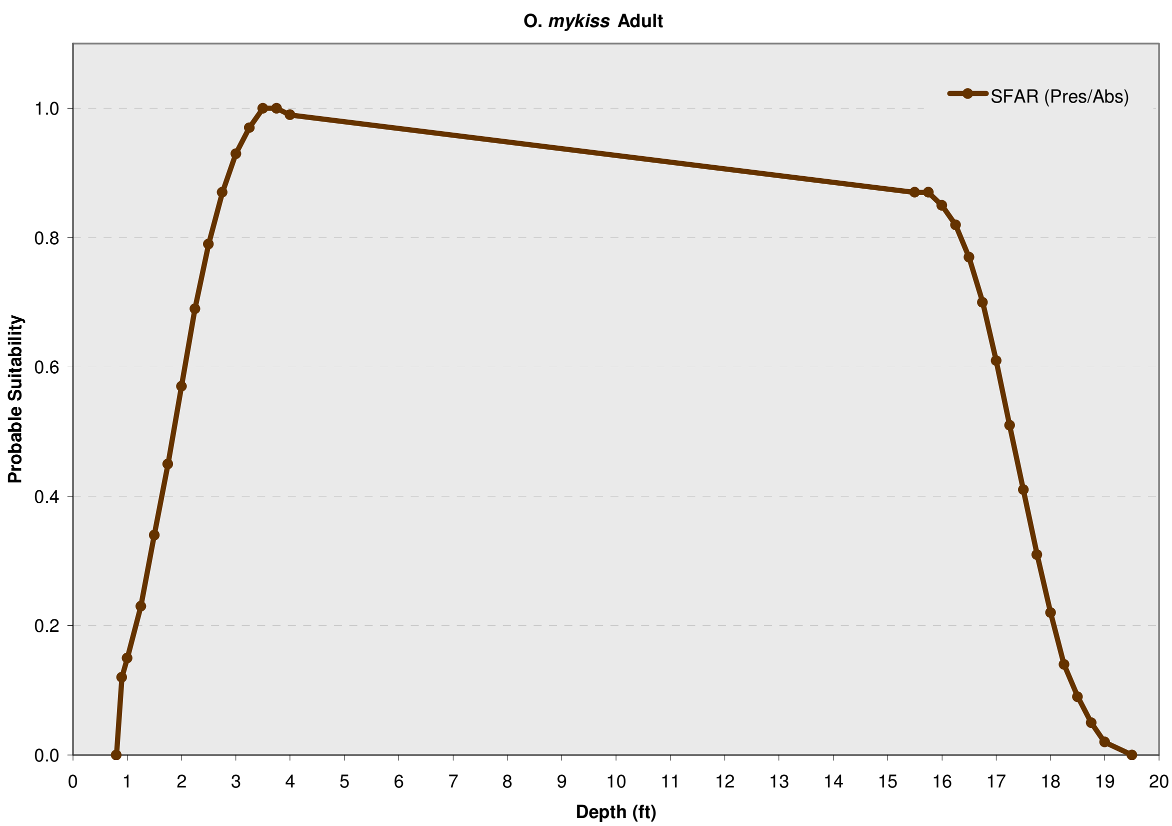
- The workshop group had previously discussed use of the South Fork American River Logistic Regression (Pres/Abs) curves (SFAR Pres/Abs) proposed by the USFWS for both velocity and depth, and concurrence of the group was reported in the October 20, 2010 meeting summary. TRC suggested that the reported concurrence was in error in regard to their opinion, so the group re-opened the discussion.
- **Decision**: In response to TRC requests, the workgroup agreed to keep the South Fork American River Logistic Regression (Pres/Abs) curve (SFAR Pres/Abs) for depth, and use a modified curve for velocity. The modified velocity curve (SFAR Pres/Abs MOD-TRC) was equal to the SFAR Pres/Abs curve up to its intersection with the Upper North Fork Feather River composite curve (2.09, 0.42), at which point the modified curve follows a straight line to (4.25, 0.0), the end point of the UNF Feather comp curve.

Post-Workshop Correspondence

Subsequent to this February 3, 2011 workshop, TRC transmitted the attached email (Attachment #1) dated March 20, 2011, withdrawing their support for *O. mykiss* decisions regarding habitat suitability criteria.



O. *mykiss* Adult
Probable Suitability
Mean Column Velocity (fps)
SFAR (Pres/Abs)
UNF Feather comp
SFAR-pres/abs MOD - TRC



O. *mykiss* Adult
Probable Suitability
Depth (ft)
SFAR (Pres/Abs)

Tuolumne River suitability criteria for *O. mykiss* adults

Velocity	SFAR pres/abs MOD-TRC Index	Depth	SFAR (Pres/Abs) Index
0.03	0.00	0.80	0.00
0.04	0.19	0.90	0.12
0.10	0.23	1.00	0.15
0.20	0.30	1.25	0.23
0.30	0.38	1.50	0.34
0.40	0.48	1.75	0.45
0.50	0.57	2.00	0.57
0.60	0.67	2.25	0.69
0.70	0.77	2.50	0.79
0.80	0.85	2.75	0.87
0.90	0.92	3.00	0.93
1.00	0.97	3.25	0.97
1.10	1.00	3.50	1.00
1.20	1.00	3.75	1.00
1.30	0.98	4.00	0.99
1.40	0.94	15.50	0.87
1.50	0.88	15.75	0.87
1.60	0.81	16.00	0.85
1.70	0.74	16.25	0.82
1.80	0.65	16.50	0.77
1.90	0.57	16.75	0.70
2.00	0.49	17.00	0.61
2.09	0.42	17.25	0.51
2.15	0.41	17.50	0.41
4.25	0.00	17.75	0.31
		18.00	0.22
		18.25	0.14
		18.50	0.09
		18.75	0.05
		19.00	0.02
		19.50	0.00

HSC development status

The following table summarizes sources of HSC curves to be used in the Tuolumne River Instream Flow Study.

Species	Life Stage	Depth	Velocity	Substrate[1]	Cover
Fall Chinook salmon	Spawning	L Tuolumne Sept 20, 2010	L Tuolumne Sept 20, 2010	Tuol/Wentworth Sept 20, 2010[2]	--
	Juvenile	Stanislaus (modified) Sept 20, 2010	Stanislaus Sept 20, 2010	--	TBD
	Fry	Tuol ENV[3] Feb 03, 2011	Tuol ENV Feb 03, 2011	--	TBD
O. mykiss	Adult	SFAR Pres/Abs Oct 20, 2010	SFAR Pres/Abs Oct 20, 2010 or SFAR Pres/Abs MOD-TRC Feb 2, 2011[4]	--	TBD
	Spawning	Tuolumne ENV Oct 20, 2010	Tuolumne ENV Oct 20, 2010	Tuolumne ENV Oct 20, 2010	--
	Juvenile	Tuolumne ENV Oct 20, 2010	Tuolumne ENV Oct 20, 2010	--	TBD
	Fry	Tuol ENV Feb 03, 2011	Tuol ENV Feb 03, 2011	--	TBD

1 The workgroup decided not to apply substrate criteria to fry and juvenile life stages since they do not typically select habitat based on substrate and may occur over a full range of possibilities.
2 Adapted from CDFG 1982 with minor expansion to indicate suitability of 1-2 inch gravel.
3 Lacking consensus on this parameter, the Districts plan to apply the Tuolumne Envelope curve (Tuol ENV) since this option seemed to have the broadest support among the stakeholders present at the workshop.
4 Although TRC subsequently withdrew their support for *O. mykiss* HSC curves, the Districts tentatively plan to use, or at least include, the *O. mykiss* adult curve (SFAR Pres/Abs MOD-TRC) modified at TRC's request.

Upcoming meeting dates:

There are no additional HSC meetings scheduled at this time. Additional meetings may be required following the collection of field data in 2011.

Appendix F

Attachment 1

HSC Workshop Summary
February 3, 2011

Resource Agency and Stakeholder Concurrence on Selection Summary

From: Allison Boucher [mailto:aboucher@bendbroadband.com]
Sent: Sunday, March 20, 2011 4:39 PM
To: Zachary_Jackson@fws.gov; wsears@sfwater.org; Whittaker, John; Wayne Swaney; walterw@mid.org; tramirez@sfwater.org; Tim O'Laughlin; theyne@dfg.ca.gov; stsao@dfg.ca.gov; steve@mlode.com; Shaara Ainsley; Scott@mcbaintrush.com; Scott Wilcox; Russell Liebig; Russ Kanz; Robert W. Hughes; rmyoshiyama@ucdavis.edu; rmnees@tid.org; rmasuda@calwaterlaw.com; Ramon_Martin@fws.gov; pbrantley@dfg.ca.gov; Patrick@tuolumne.org; Nsandkulla@bawsca.org; Noah Hume; Monica.Gutierrez@noaa.gov; Michelle_Workman@fws.gov; Mark_Gard@fws.gov; Maria Rea; kim_webb@fws.gov; Kelleigh Crowe; Karlha@tuolumne.org; jvick@sfwater.org; joyw@mid.org; john.devine@hdrinc.com; JMEANS@dfg.ca.gov; jkobrien@dfg.ca.gov; Jessie Raeder; Jesse.roseman@tuolumne.org; jen@riversandwater.com; Jarvis Caldwell; Greg Dias; Gantenbein@n-h-i.org; Erich Gaedeke; Eric@tuolumne.org; Donn Furman; dmarston@dfg.ca.gov; deltakeep@aol.com; deborah_giglio@fws.gov; Darren@mcbaintrush.com; Cindy@ccharles.net; chrissysonke@fishbio.com; Chris Shutes; andreafuller@fishbio.com; anadromous@bendbroadband.com; Alison_Willy@fws.gov; AJensen@bawsca.org; agengr6@aol.com
Cc: dave Boucher
Subject: IFIM O. mykiss

To all interested parties,

After much consideration, we are withdrawing our support for the IFIM O. mykiss decisions. We are not comfortable with the available studies and the resulting decisions.

We look forward to future meetings to discuss Tuolumne River O. mykiss, particularly steelhead.

Allison and Dave Boucher
Tuolumne River Conservancy, Inc.

Appendix G

Supplemental Habitat Suitability Index Information

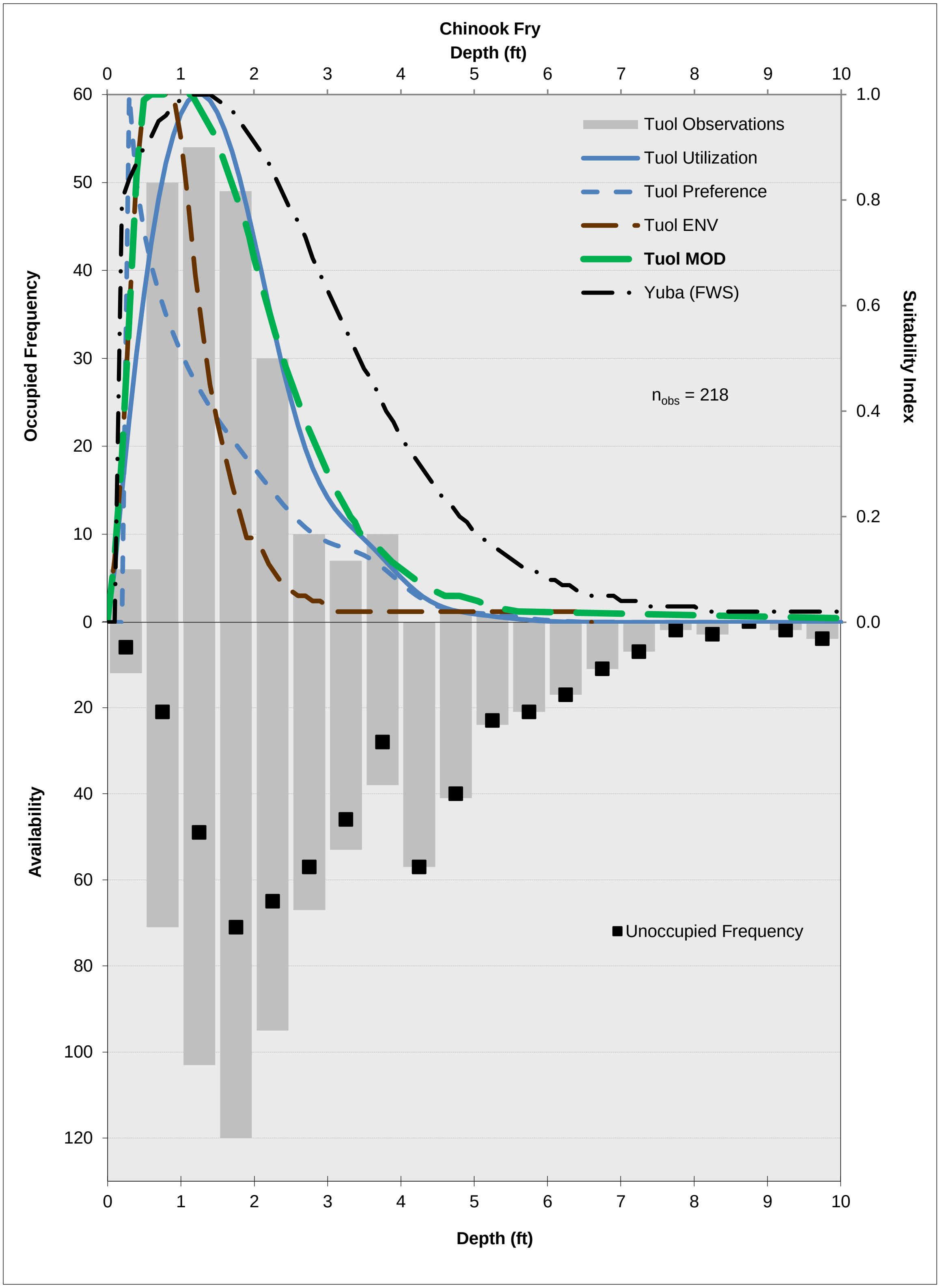


Figure G-1. Chinook salmon fry depth suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuol MOD.

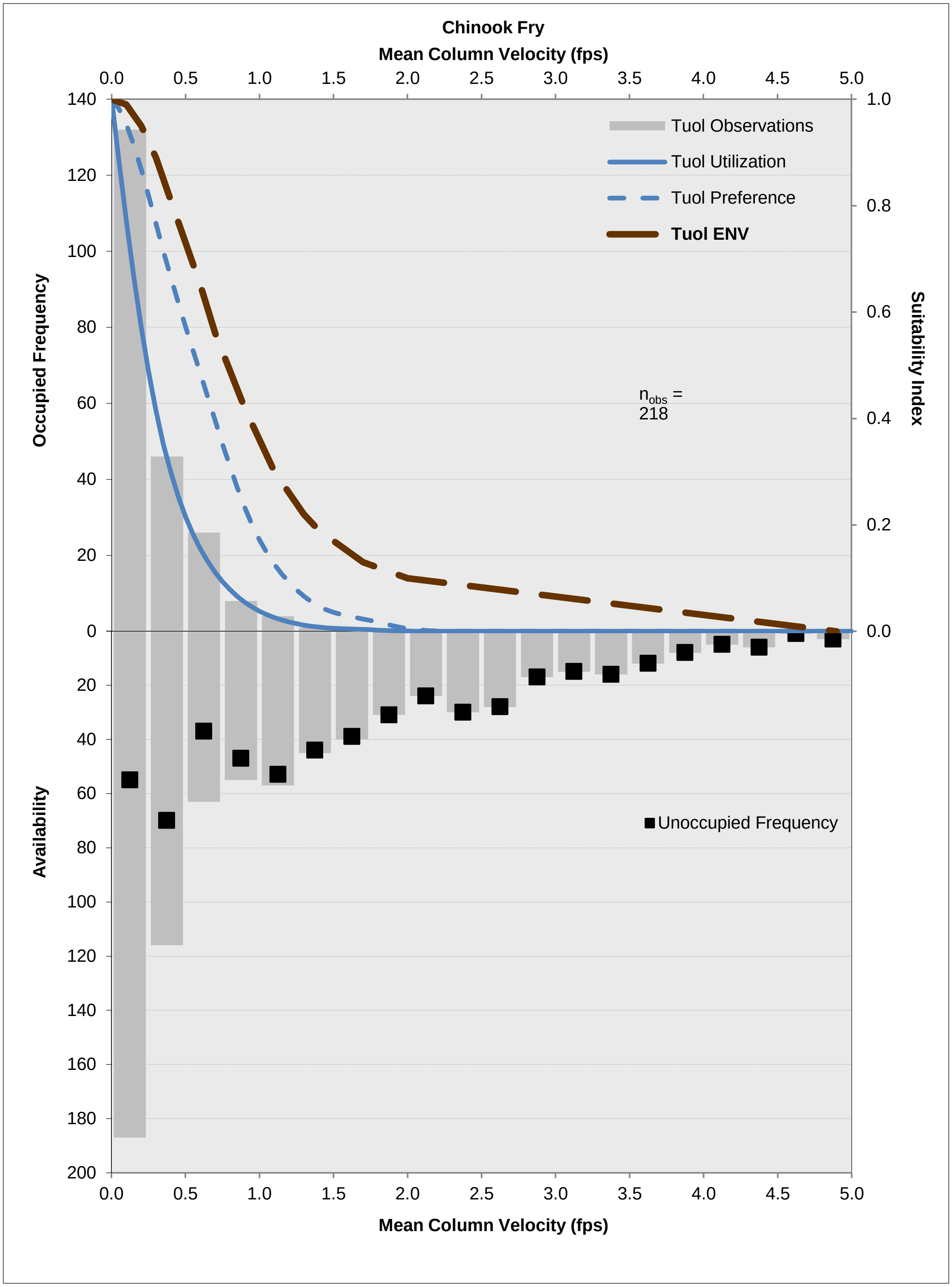


Figure G-2. Chinook salmon fry velocity suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuol ENV.

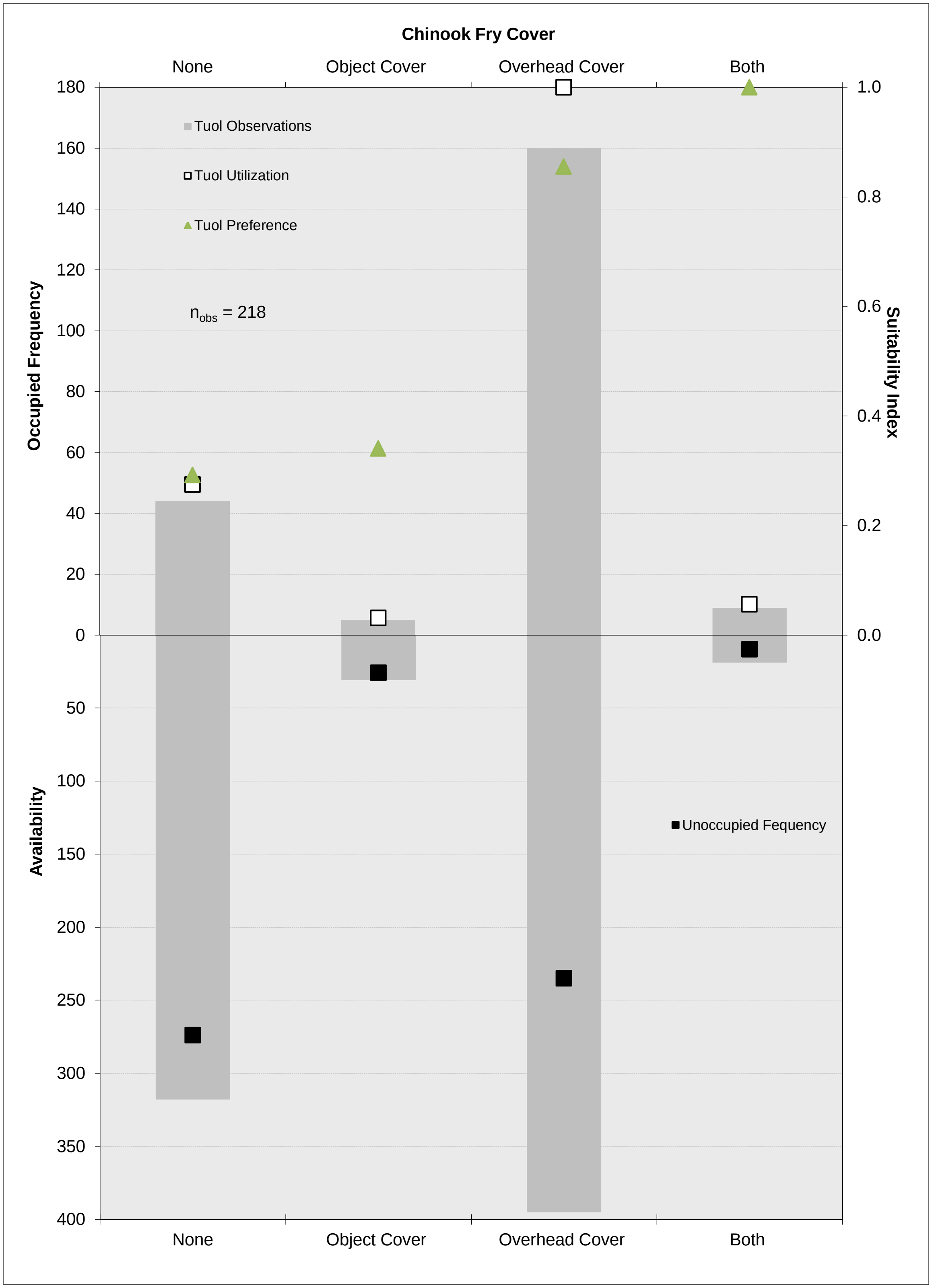


Figure G-3. Chinook salmon fry cover suitability criteria for the lower Tuolumne River.

Table G-1. Chinook fry habitat suitability criteria coordinates.

Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific			Tuolumne Env		Tuolumne MOD		Yuba (FWS)	
Not Used			Used		Not Used			Not Used		Used		Not Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**
0.00	1.00	1.00	0.0	1.00	0.0	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00
0.05	0.88	0.98	0.1	0.99	0.1	0.10	0.00	0.1	0.12	0.1	0.12	0.1	0.00
0.10	0.77	0.95	0.2	0.95	0.2	0.25	0.00	0.2	0.31	0.2	0.31	0.2	0.80
0.15	0.67	0.91	0.3	0.89	0.3	0.38	1.00	0.3	0.58	0.3	0.58	0.3	0.84
0.20	0.57	0.87	0.4	0.81	0.4	0.51	0.83	0.4	0.85	0.4	0.85	0.5	0.90
0.25	0.49	0.82	0.6	0.65	0.5	0.62	0.74	0.5	0.99	0.5	0.99	0.6	0.92
0.30	0.42	0.77	0.7	0.56	0.6	0.72	0.68	0.6	1.00	0.6	1.00	0.7	0.95
0.35	0.35	0.72	0.8	0.49	0.7	0.80	0.63	0.8	1.00	0.8	1.00	0.8	0.96
0.40	0.30	0.67	0.9	0.42	0.8	0.87	0.58	0.9	1.00	0.9	1.00	0.9	0.98
0.45	0.25	0.62	1.1	0.3	0.9	0.92	0.55	1.0	0.92	1.1	1.00	1.1	1.00
0.50	0.22	0.57	1.3	0.22	1.0	0.96	0.51	1.1	0.80	1.2	1.00	1.4	1.00
0.55	0.18	0.53	1.4	0.19	1.1	0.99	0.48	1.2	0.66	1.5	0.92	1.7	0.97
0.60	0.16	0.48	1.7	0.13	1.2	1.00	0.46	1.3	0.55	1.9	0.76	2.2	0.87
0.65	0.13	0.44	2.0	0.10	1.3	1.00	0.43	1.4	0.45	1.9	0.73	2.5	0.78
0.70	0.11	0.40	4.90	0.00	1.4	0.99	0.41	1.5	0.38	2.0	0.69	2.6	0.76
0.75	0.09	0.35			1.5	0.97	0.39	1.6	0.32	2.3	0.55	2.7	0.73
0.80	0.08	0.31			1.6	0.93	0.37	1.7	0.26	2.4	0.48	2.8	0.69
0.85	0.07	0.27			1.7	0.89	0.35	1.8	0.21	2.5	0.45	3.5	0.48
0.90	0.05	0.23			1.8	0.84	0.33	1.9	0.16	2.7	0.38	3.6	0.46
0.95	0.05	0.20			1.9	0.79	0.31	2.0	0.16	3.1	0.26	3.8	0.40
1.00	0.04	0.17			2.0	0.73	0.29	2.1	0.14	3.3	0.21	3.9	0.38
1.05	0.03	0.15			2.1	0.66	0.27	2.2	0.11	3.3	0.2	4.0	0.35
1.10	0.03	0.13			2.2	0.60	0.26	2.3	0.09	3.4	0.19	4.6	0.23
1.15	0.02	0.11			2.3	0.54	0.24	2.4	0.07	3.4	0.17	4.7	0.22
1.20	0.02	0.09			2.4	0.48	0.22	2.5	0.06	3.6	0.16	4.8	0.20
1.25	0.01	0.08			2.5	0.42	0.21	2.6	0.05	3.7	0.14	4.9	0.19
1.30	0.01	0.07			2.6	0.37	0.19	2.7	0.05	3.9	0.11	5.0	0.17
1.35	0.01	0.06			2.7	0.33	0.18	2.8	0.04	4.3	0.07	5.7	0.10
1.40	0.01	0.05			2.8	0.29	0.17	2.9	0.04	4.5	0.06	5.8	0.10
1.45	0.01	0.04			2.9	0.26	0.16	3.0	0.03	4.6	0.05	6.0	0.08

Table G-1. Chinook fry habitat suitability criteria coordinates.

Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific			Tuolumne Env		Tuolumne MOD		Yuba (FWS)	
Not Used			Used		Not Used			Not Used		Used		Not Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**
1.50	0.01	0.04			3.0	0.24	0.15	3.1	0.02	4.8	0.05	6.1	0.08
1.55	0.01	0.03			3.1	0.22	0.15	6.4	0.02	5.1	0.04	6.2	0.07
1.60	0.00	0.03			3.2	0.20	0.14	6.5	0.01	5.2	0.03	6.3	0.07
1.65	0.00	0.03			3.3	0.18	0.14	6.6	0.00	5.6	0.02	6.4	0.06
1.70	0.00	0.02			3.4	0.17	0.13			12.6	0.00	6.5	0.06
1.75	0.00	0.02			3.5	0.16	0.13					6.6	0.05
1.80	0.00	0.02			3.6	0.14	0.12					6.9	0.05
1.85	0.00	0.01			3.7	0.13	0.11					7.0	0.04
1.90	0.00	0.01			3.8	0.11	0.10					7.3	0.04
1.95	0.00	0.01			3.9	0.10	0.09					7.4	0.03
2.00	0.00	0.01			4.0	0.09	0.07					8.0	0.03
2.05	0.00	0.00			4.1	0.07	0.06					8.1	0.02
					4.2	0.06	0.05					18.4	0.02
					4.3	0.05	0.04					18.5	0.00
					4.4	0.04	0.04						
					4.5	0.03	0.03						
					4.6	0.03	0.03						
					4.7	0.02	0.02						
					4.8	0.02	0.02						
					4.9	0.02	0.02						
					5.0	0.02	0.02						
					5.1	0.01	0.02						
					5.2	0.01	0.02						
					5.3	0.01	0.01						
					5.4	0.01	0.01						
					5.5	0.01	0.01						
					5.6	0.01	0.01						
					5.7	0.00	0.01						
					5.8	0.00	0.01						
					5.9	0.00	0.00						

Table G-2. Chinook fry cover habitat suitability criteria developed during site-specific surveys on the lower Tuolumne River.

Cover Type	Utilization Index	Preference Index
None	0.28	0.29
Object Cover	0.03	0.34
Overhead Cover	1.00	0.86
Both	0.06	1.00

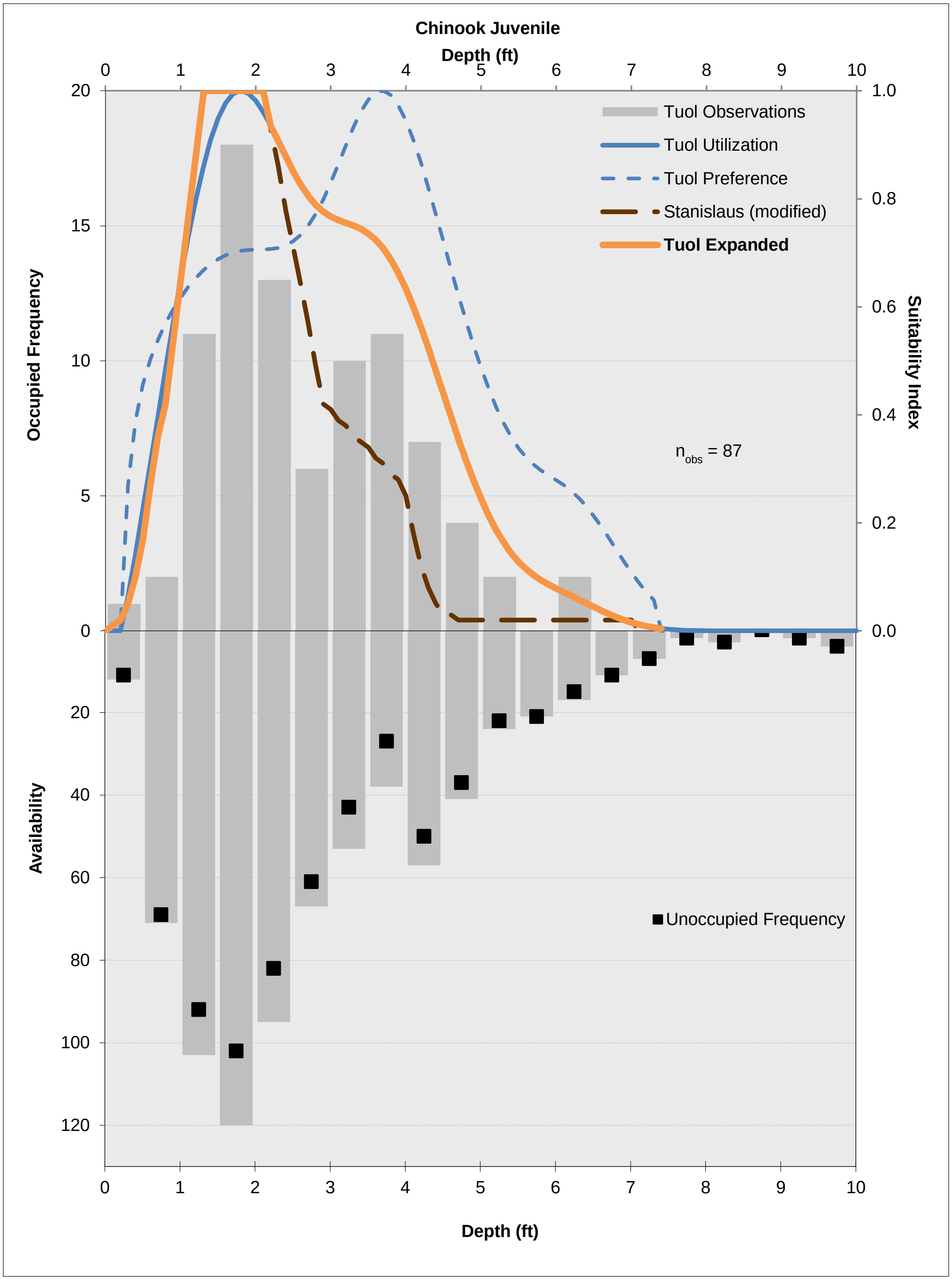


Figure G-4. Chinook salmon juvenile depth suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuol Expanded.

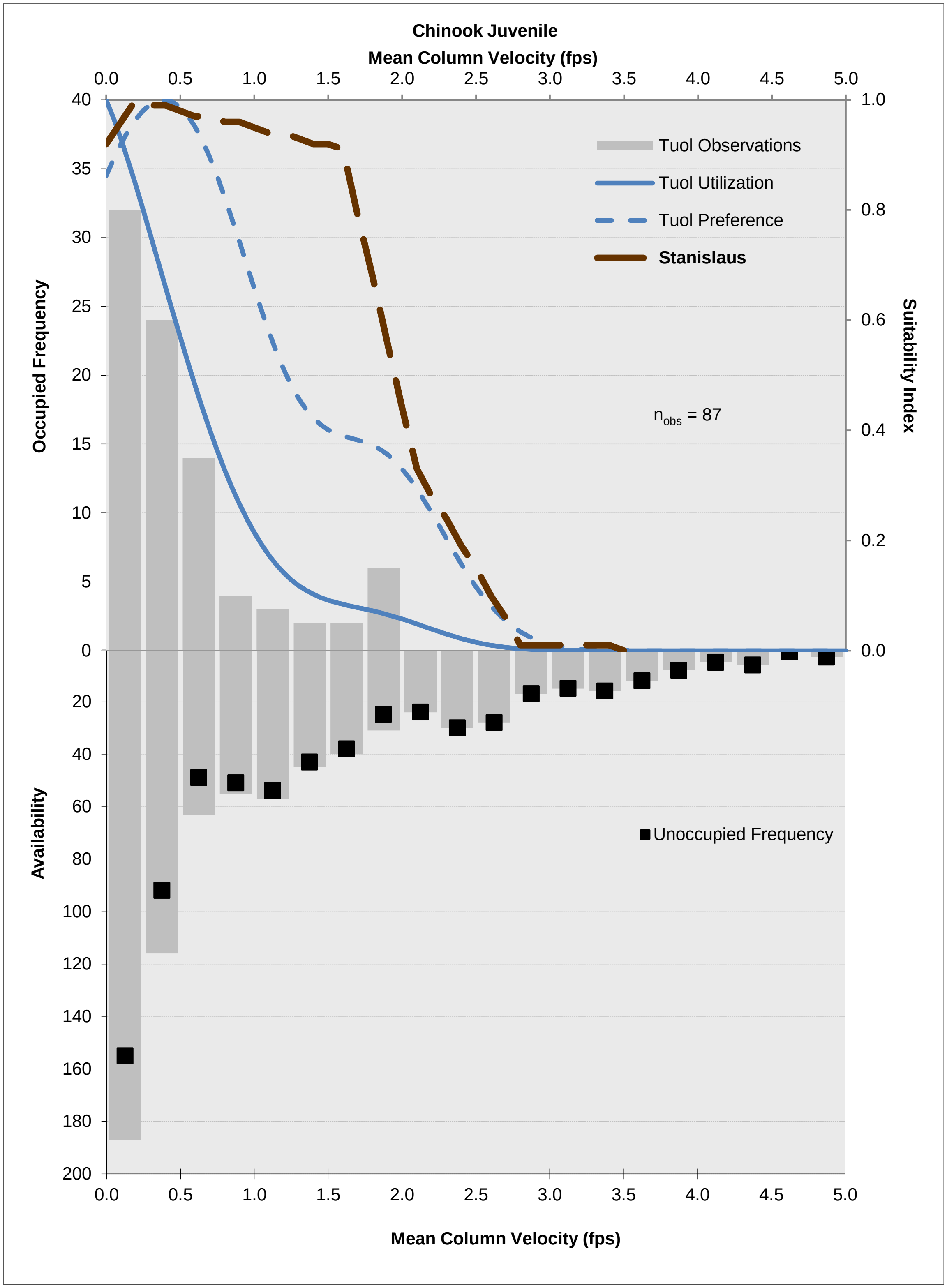


Figure G-5. Chinook salmon juvenile velocity suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Stanislaus.

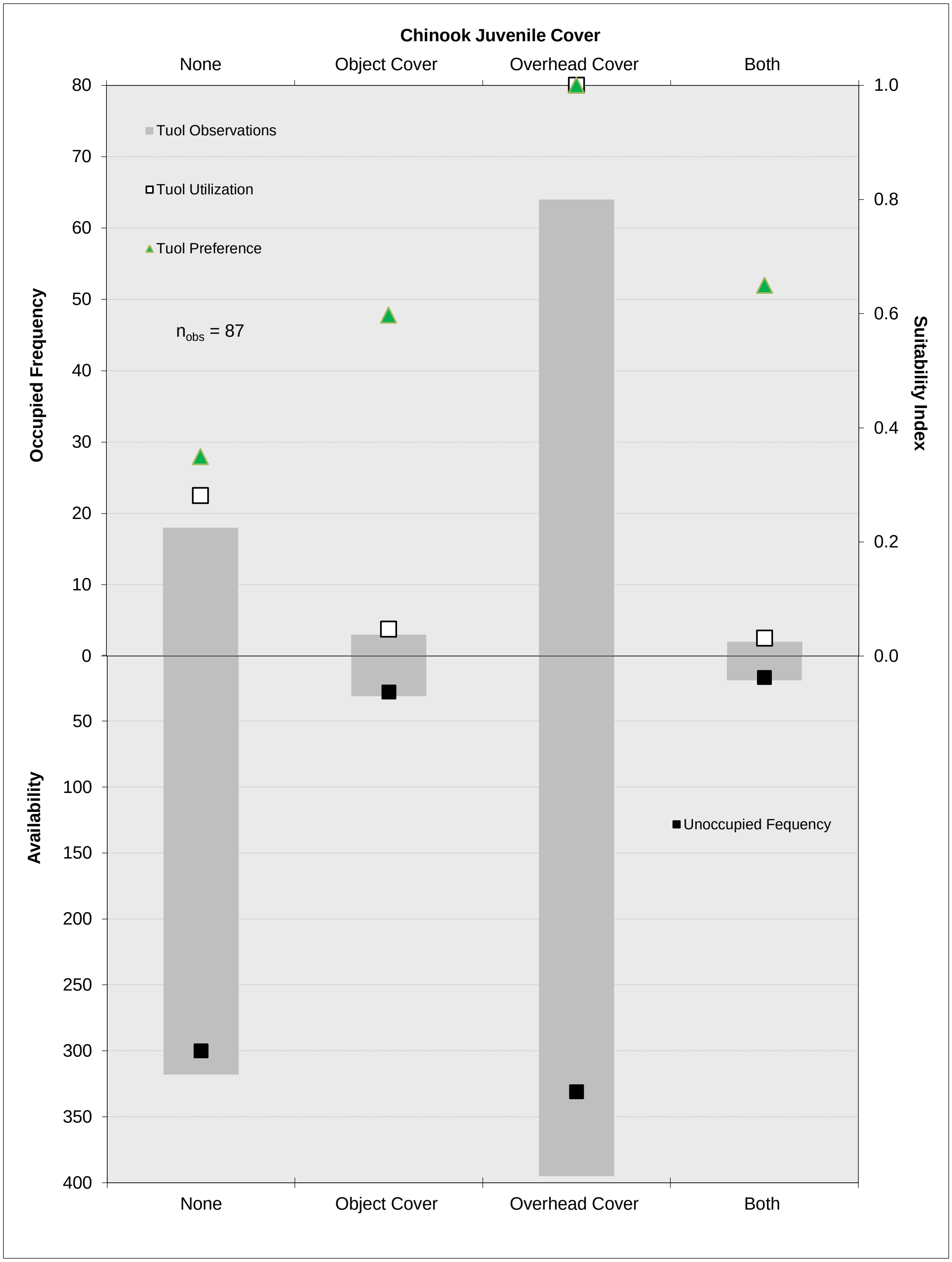


Figure G-6. Chinook salmon juvenile cover suitability criteria for the lower Tuolumne River.

Table G-3. Chinook salmon juvenile habitat suitability criteria coordinates.

Tuolumne Site-specific			Stanislaus		Tuolumne Site-specific			Stanislaus (modified)		Tuolumne Site-specific Expanded	
Not Used			Used		Not Used			Not Used		Used	
Velocity (fps)	Utilization Index	Preference Index	Velocity (fps)	Index	Depth (ft)	Utilization Index	Preference Index	Depth (ft)	Index	Depth (ft)	Index
0.00	1.00	0.86	0.0	0.92	0.0	0.00	0.00	0.00	0.00	0.0	0.00
0.05	0.97	0.89	0.1	0.96	0.1	0.00	0.00	0.10	0.01	0.1	0.01
0.10	0.93	0.92	0.2	1.00	0.2	0.00	0.00	0.20	0.02	0.2	0.02
0.15	0.89	0.94	0.3	0.99	0.3	0.06	0.27	0.30	0.05	0.3	0.05
0.20	0.84	0.96	0.4	0.99	0.4	0.14	0.39	0.40	0.10	0.4	0.10
0.25	0.80	0.98	0.5	0.98	0.5	0.23	0.46	0.50	0.17	0.5	0.17
0.30	0.75	0.99	0.6	0.97	0.6	0.31	0.50	0.60	0.27	0.6	0.27
0.35	0.71	1.00	0.7	0.97	0.7	0.40	0.54	0.70	0.36	0.7	0.36
0.40	0.66	1.00	0.8	0.96	0.8	0.48	0.57	0.80	0.42	0.8	0.42
0.45	0.61	1.00	0.9	0.96	0.9	0.57	0.59	1.31	1.00	1.3	1.00
0.50	0.57	0.99	1.0	0.95	1.0	0.65	0.62	2.10	1.00	2.1	1.00
0.55	0.52	0.97	1.1	0.94	1.1	0.73	0.64	2.20	0.93	2.2	0.94
0.60	0.48	0.95	1.2	0.94	1.2	0.80	0.65	2.30	0.86	2.3	0.91
0.65	0.44	0.93	1.3	0.93	1.3	0.86	0.67	2.40	0.78	2.4	0.88
0.70	0.40	0.90	1.4	0.92	1.4	0.91	0.68	2.50	0.71	2.5	0.85
0.75	0.36	0.86	1.5	0.92	1.5	0.95	0.69	2.60	0.64	2.6	0.83
0.80	0.33	0.82	1.6	0.91	1.6	0.98	0.70	2.70	0.57	2.7	0.81
0.85	0.30	0.78	1.7	0.79	1.7	0.99	0.70	2.80	0.49	2.8	0.79
0.90	0.27	0.74	1.8	0.68	1.8	1.00	0.70	2.90	0.42	2.9	0.78
0.95	0.24	0.70	1.9	0.56	1.9	1.00	0.71	3.00	0.41	3.0	0.77
1.00	0.21	0.66	2.0	0.44	2.0	0.98	0.71	3.10	0.39	3.1	0.76
1.05	0.19	0.62	2.1	0.33	2.1	0.96	0.71	3.20	0.38	3.2	0.76
1.10	0.17	0.58	2.2	0.28	2.2	0.94	0.71	3.30	0.36	3.3	0.75
1.15	0.16	0.54	2.3	0.24	2.3	0.91	0.71	3.40	0.35	3.4	0.74
1.20	0.14	0.51	2.4	0.19	2.4	0.88	0.71	3.50	0.34	3.5	0.74
1.25	0.13	0.48	2.5	0.15	2.5	0.85	0.72	3.60	0.32	3.6	0.72
1.30	0.12	0.46	2.6	0.10	2.6	0.83	0.73	3.70	0.31	3.7	0.71
1.35	0.11	0.44	2.7	0.06	2.7	0.81	0.75	3.80	0.29	3.8	0.69

Table G-3. Chinook salmon juvenile habitat suitability criteria coordinates.

Tuolumne Site-specific			Stanislaus		Tuolumne Site-specific			Stanislaus (modified)		Tuolumne Site-specific Expanded	
Not Used			Used		Not Used			Not Used		Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**
1.40	0.10	0.42	2.8	0.01	2.8	0.79	0.77	3.90	0.28	3.9	0.66
1.45	0.10	0.41	3.4	0.01	2.9	0.78	0.80	4.00	0.25	4.0	0.63
1.50	0.09	0.40	3.5	0.00	3.0	0.77	0.83	4.10	0.18	4.1	0.60
1.55	0.09	0.39			3.1	0.76	0.86	4.20	0.12	4.2	0.56
1.60	0.08	0.39			3.2	0.76	0.90	4.30	0.08	4.3	0.52
1.65	0.08	0.39			3.3	0.75	0.93	4.40	0.05	4.4	0.48
1.70	0.08	0.38			3.4	0.74	0.96	4.50	0.03	4.5	0.44
1.75	0.08	0.38			3.5	0.74	0.98	4.60	0.03	4.6	0.40
1.80	0.07	0.37			3.6	0.72	1.00	4.70	0.02	4.7	0.36
1.85	0.07	0.37			3.7	0.71	1.00	7.00	0.02	4.8	0.32
1.90	0.07	0.36			3.8	0.69	0.99	7.10	0.00	4.9	0.28
1.95	0.06	0.34			3.9	0.66	0.97			5.0	0.24
2.00	0.06	0.33			4.0	0.63	0.94			5.1	0.21
2.05	0.05	0.31			4.1	0.60	0.91			5.2	0.19
2.10	0.05	0.29			4.2	0.56	0.87			5.3	0.16
2.15	0.04	0.27			4.3	0.52	0.82			5.4	0.14
2.20	0.04	0.25			4.4	0.48	0.77			5.5	0.13
2.25	0.03	0.23			4.5	0.44	0.72			5.6	0.11
2.30	0.03	0.20			4.6	0.40	0.67			5.7	0.10
2.35	0.03	0.18			4.7	0.36	0.62			5.8	0.09
2.40	0.02	0.16			4.8	0.32	0.57			5.9	0.09
2.45	0.02	0.14			4.9	0.28	0.53			6.0	0.08
2.50	0.02	0.12			5.0	0.24	0.49			6.1	0.07
2.55	0.01	0.10			5.1	0.21	0.45			6.2	0.06
2.60	0.01	0.08			5.2	0.19	0.41			6.3	0.06
2.65	0.01	0.07			5.3	0.16	0.38			6.4	0.05
2.70	0.01	0.05			5.4	0.14	0.36			6.5	0.04
2.75	0.00	0.04			5.5	0.13	0.34			6.6	0.04
2.80	0.00	0.03			5.6	0.11	0.32			6.7	0.03

Table G-3. Chinook salmon juvenile habitat suitability criteria coordinates.

Tuolumne Site-specific			Stanislaus		Tuolumne Site-specific			Stanislaus (modified)		Tuolumne Site-specific Expanded	
Not Used			Used		Not Used			Not Used		Used	
Velocity (fps)	Utilization Index	Preference Index	Velocity (fps)	Index	Depth (ft)	Utilization Index	Preference Index	Depth (ft)	Index	Depth (ft)	Index
2.85	0.00	0.03			5.7	0.10	0.31			6.8	0.03
2.90	0.00	0.02			5.8	0.09	0.30			6.9	0.02
2.95	0.00	0.02			5.9	0.09	0.29			7.0	0.02
3.00	0.00	0.01			6.0	0.08	0.28			7.1	0.01
3.05	0.00	0.01			6.1	0.07	0.27			7.2	0.01
3.10	0.00	0.01			6.2	0.06	0.26			7.3	0.01
3.15	0.00	0.00			6.3	0.06	0.25			7.4	0.00
					6.4	0.05	0.23				
					6.5	0.04	0.21				
					6.6	0.04	0.19				
					6.7	0.03	0.17				
					6.8	0.03	0.15				
					6.9	0.02	0.13				
					7.0	0.02	0.11				
					7.1	0.01	0.09				
					7.2	0.01	0.07				
					7.3	0.01	0.06				
					7.4	0.00	0.00				

Table G-4. Chinook salmon juvenile cover habitat suitability criteria developed during site-specific surveys on the lower Tuolumne River.

Cover Type	Utilization Index	Preference Index
None	0.28	0.35
Object Cover	0.05	0.60
Overhead Cover	1.00	1.00
Both	0.03	0.65

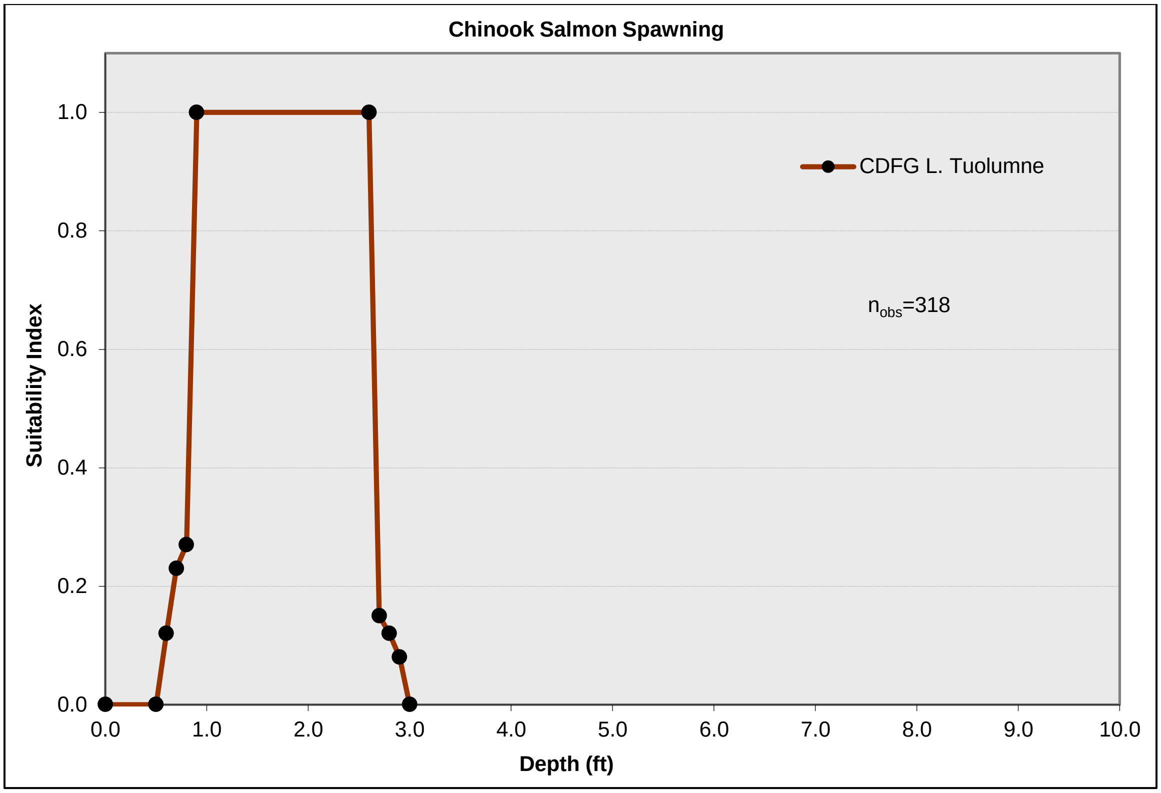


Figure G-7. Chinook salmon spawning depth suitability criteria for the lower Tuolumne River.

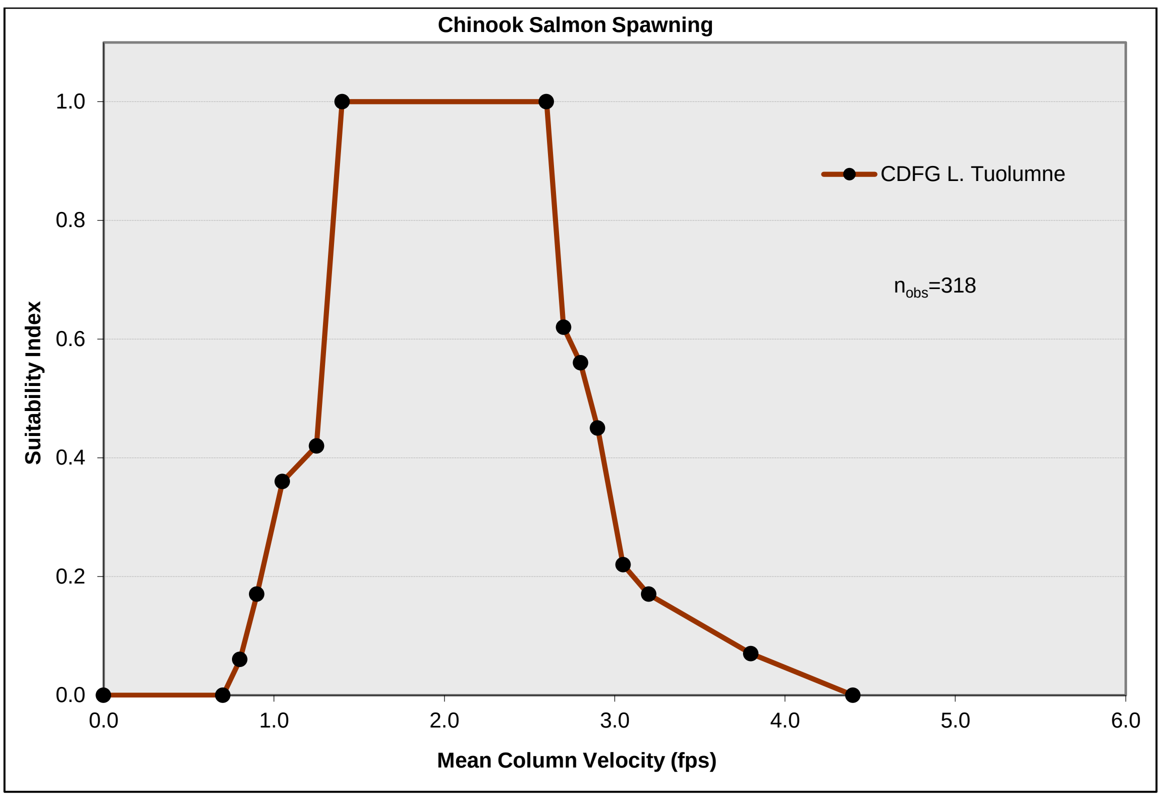


Figure G-8. Chinook salmon spawning velocity suitability criteria for the lower Tuolumne River.

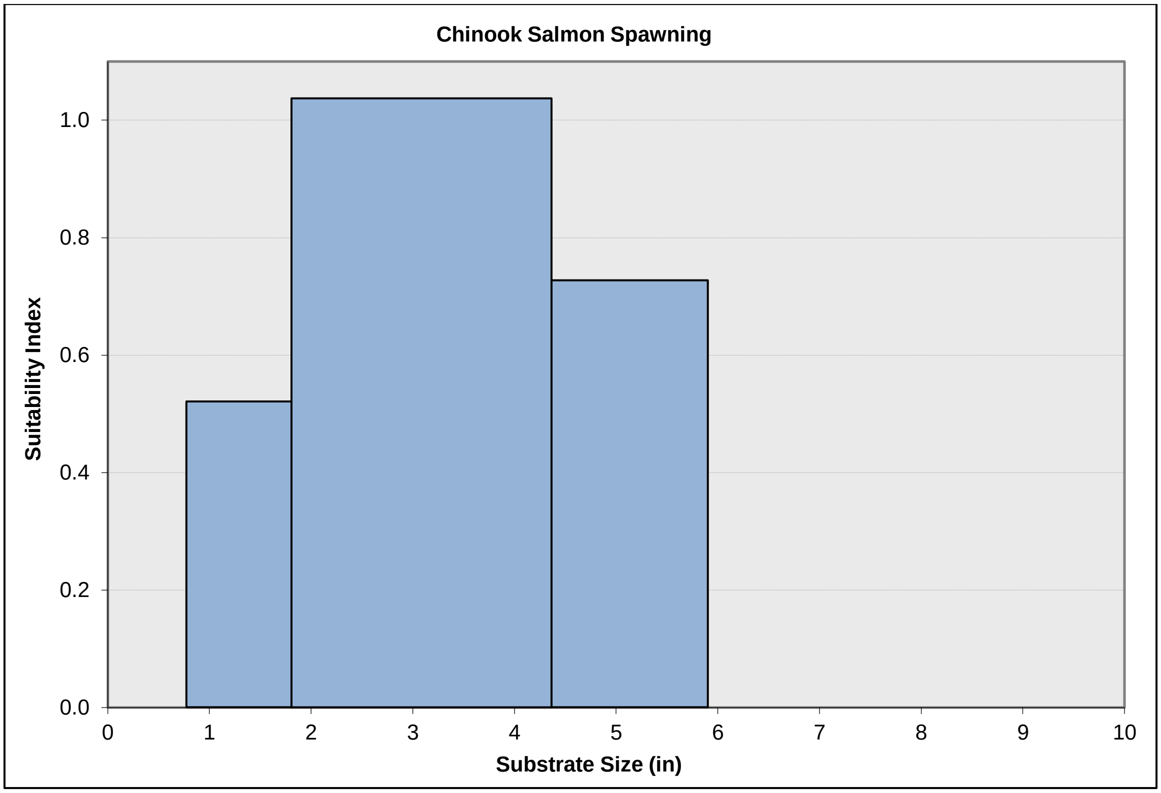


Figure G-9. Chinook salmon spawning substrate suitability criteria for the lower Tuolumne River.

Table G-5. Chinook spawning habitat suitability criteria.

L. Tuolumne CDFG		L. Tuolumne CDFG		Tuol/Wentworth*	
Used		Used		Used	
Velocity (fps)	**Index**	**Depth (ft)**	**Index**	**Substrate Size (in)**	**Index**
0.00	0.00	0.00	0.00	Up to 1.0	0.00
0.70	0.00	0.50	0.00	1-1.99	0.50
0.80	0.06	0.60	0.12	2-2.99	1.00
0.90	0.17	0.70	0.23	3 – 4.49	1.00
1.05	0.36	0.80	0.27	4.5-5.99	0.70
1.25	0.42	0.90	1.00	6-8.99	0.00
1.40	1.00	2.60	1.00	>9	0.00
2.60	1.00	2.70	0.15		
2.70	0.62	2.80	0.12		
2.80	0.56	2.90	0.08		
2.90	0.45	3.00	0.00		
3.05	0.22				
3.20	0.17				
3.80	0.07				
4.40	0.00				

* Adapted from CDFG 1982 with minor expansion to indicate suitability of 1-2 inch gravel.

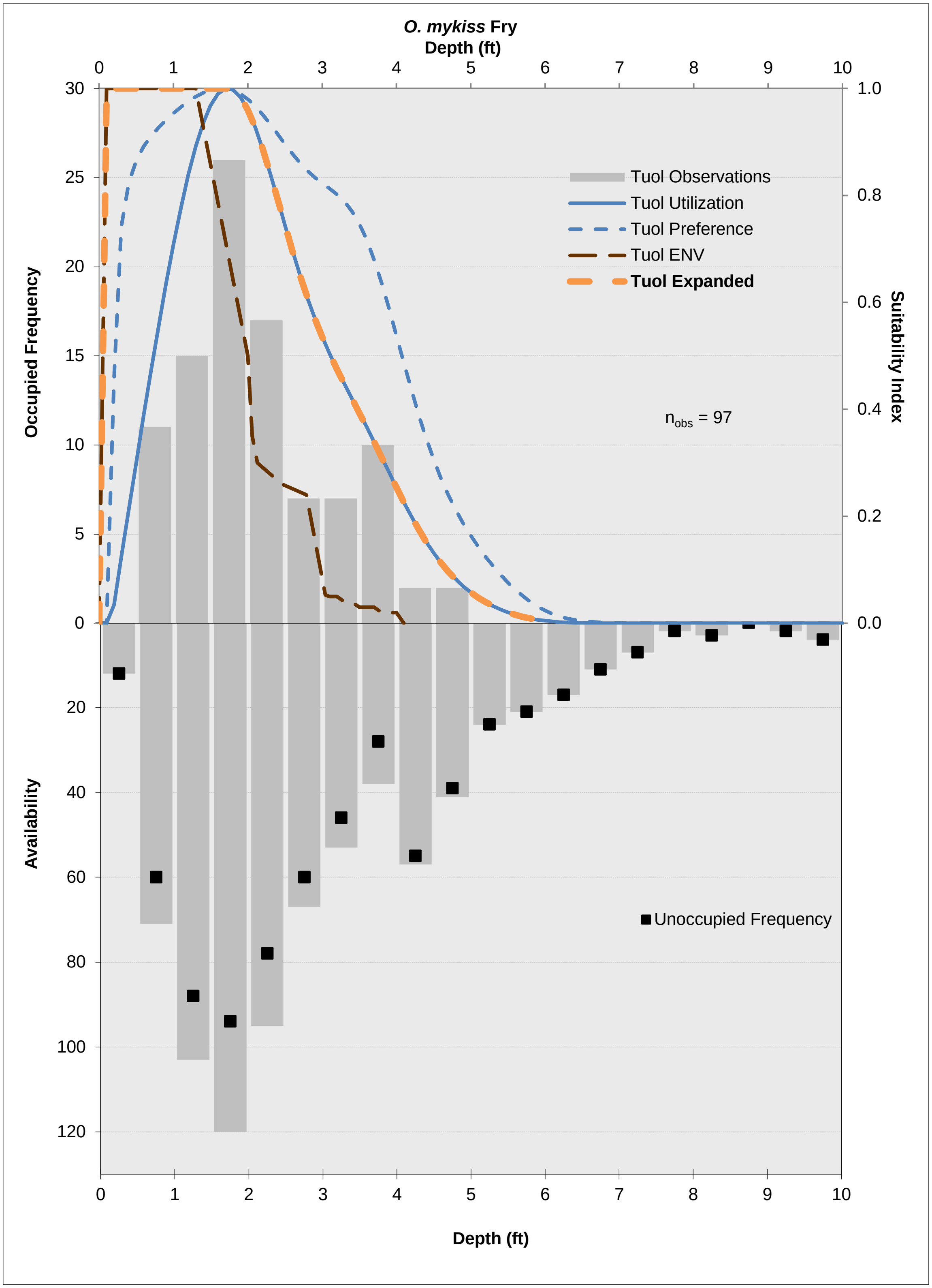


Figure G-10. *O. mykiss* fry depth suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuol Expanded.

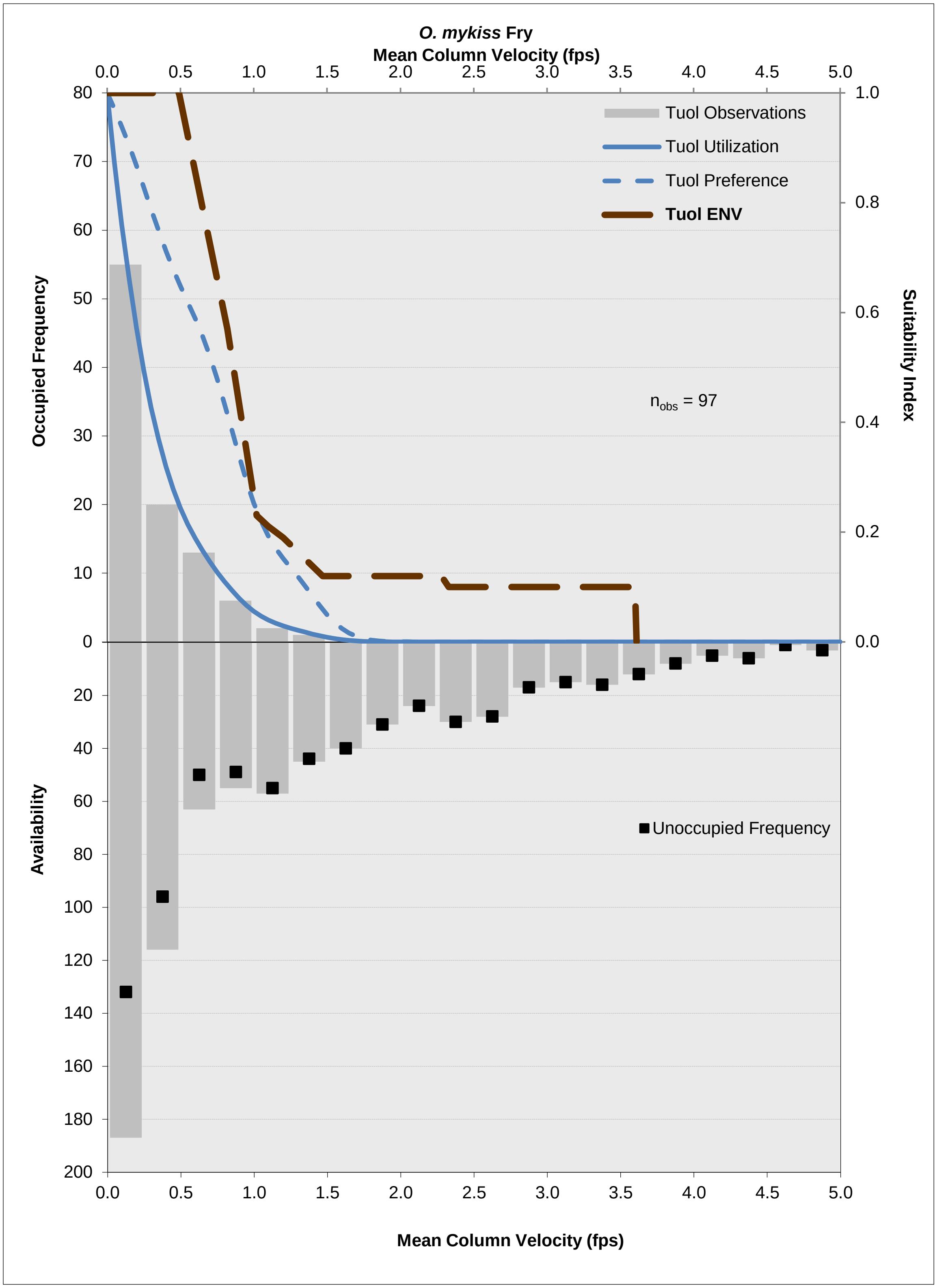


Figure G-11. *O. mykiss* fry velocity suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuol ENV.

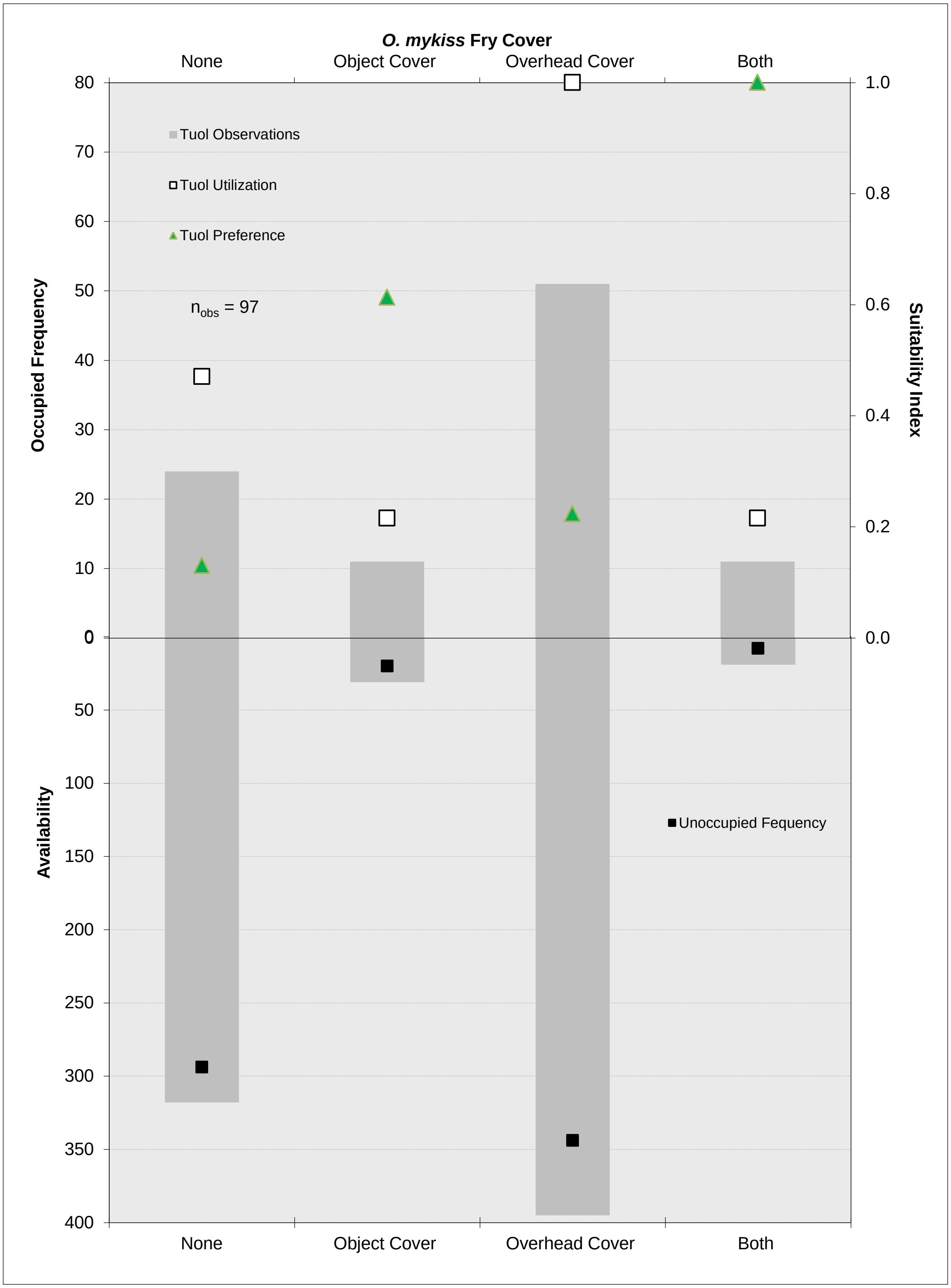


Figure G-12. *O. mykiss* fry cover suitability criteria for the lower Tuolumne River.

Table G-6. *O. mykiss* fry habitat suitability criteria coordinates.

Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific Expanded	
Not Used			Used		Not Used			Not Used		Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**
0.00	1.00	1.00	0.00	1.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00
0.05	0.87	0.97	0.33	1.00	0.1	0.00	0.00	0.10	1.00	0.10	1.00
0.10	0.76	0.94	0.49	1.00	0.2	0.03	0.46	0.65	1.00	1.7	1.00
0.15	0.66	0.90	0.82	0.57	0.3	0.12	0.74	1.30	1.00	1.8	1.00
0.20	0.57	0.87	1.02	0.23	0.4	0.21	0.82	2.00	0.50	1.9	0.98
0.25	0.49	0.83	1.10	0.21	0.5	0.30	0.87	2.06	0.35	2.0	0.96
0.30	0.43	0.79	1.20	0.19	0.6	0.39	0.89	2.13	0.30	2.1	0.93
0.35	0.37	0.75	1.47	0.12	0.7	0.47	0.91	2.46	0.26	2.2	0.89
0.40	0.32	0.71	2.28	0.12	0.8	0.56	0.93	2.79	0.24	2.3	0.84
0.45	0.28	0.68	2.33	0.10	0.9	0.63	0.94	3.05	0.05	2.4	0.79
0.50	0.24	0.65	3.60	0.10	1.0	0.71	0.95	3.10	0.05	2.5	0.74
0.55	0.21	0.62	3.61	0.00	1.1	0.78	0.97	3.20	0.05	2.6	0.70
0.60	0.19	0.59	0.00	1.00	1.2	0.84	0.98	3.30	0.04	2.7	0.65
0.65	0.17	0.56	0.33	1.00	1.3	0.89	0.98	3.40	0.04	2.8	0.61
0.70	0.15	0.52	0.49	1.00	1.4	0.94	0.99	3.50	0.03	2.9	0.57
0.75	0.13	0.48	0.82	0.57	1.5	0.97	1.00	3.70	0.03	3.0	0.54
0.80	0.11	0.43	1.02	0.23	1.6	0.99	1.00	3.80	0.02	3.1	0.50
0.85	0.09	0.39	1.10	0.21	1.7	1.00	1.00	4.00	0.02	3.2	0.48
0.90	0.08	0.34	1.20	0.19	1.8	1.00	1.00	4.10	0.00	3.3	0.45
0.95	0.07	0.29	1.47	0.12	1.9	0.98	0.99			3.4	0.42
1.00	0.06	0.25	2.28	0.12	2.0	0.96	0.98			3.5	0.39
1.05	0.05	0.22	2.33	0.10	2.1	0.93	0.97			3.6	0.37
1.10	0.04	0.19	3.60	0.10	2.2	0.89	0.95			3.7	0.34
1.15	0.03	0.17	3.61	0.00	2.3	0.84	0.93			3.8	0.31
1.20	0.03	0.15			2.4	0.79	0.92			3.9	0.28
1.25	0.02	0.14			2.5	0.74	0.90			4.0	0.25
1.30	0.02	0.12			2.6	0.70	0.88			4.1	0.23
1.35	0.02	0.10			2.7	0.65	0.86			4.2	0.20
1.40	0.01	0.08			2.8	0.61	0.85			4.3	0.18

Table G-6. *O. mykiss* fry habitat suitability criteria coordinates.

Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific Expanded	
Not Used			Used		Not Used			Not Used		Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**
1.45	0.01	0.07			2.9	0.57	0.83			4.4	0.15
1.50	0.01	0.05			3.0	0.54	0.82			4.5	0.13
1.55	0.01	0.04			3.1	0.50	0.81			4.6	0.11
1.60	0.00	0.02			3.2	0.48	0.80			4.7	0.10
1.65	0.00	0.02			3.3	0.45	0.79			4.8	0.08
1.70	0.00	0.01			3.4	0.42	0.77			4.9	0.07
1.75	0.00	0.01			3.5	0.39	0.75			5.0	0.06
1.80	0.00	0.00			3.6	0.37	0.72			5.1	0.05
					3.7	0.34	0.68			5.2	0.04
					3.8	0.31	0.64			5.3	0.03
					3.9	0.28	0.59			5.4	0.03
					4.0	0.25	0.54			5.5	0.02
					4.1	0.23	0.49			5.6	0.02
					4.2	0.20	0.44			5.7	0.01
					4.3	0.18	0.39			5.8	0.01
					4.4	0.15	0.35			5.9	0.01
					4.5	0.13	0.31			6.0	0.00
					4.6	0.11	0.27				
					4.7	0.10	0.24				
					4.8	0.08	0.21				
					4.9	0.07	0.19				
					5.0	0.06	0.16				
					5.1	0.05	0.14				
					5.2	0.04	0.12				
					5.3	0.03	0.11				
					5.4	0.03	0.09				
					5.5	0.02	0.08				
					5.6	0.02	0.06				
					5.7	0.01	0.05				

Table G-6. *O. mykiss* fry habitat suitability criteria coordinates.

Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific Expanded	
Not Used			Used		Not Used			Not Used		Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**	**Depth (ft)**	**Index**
					5.8	0.01	0.04				
					5.9	0.01	0.03				
					6.0	0.00	0.02				
					6.1	0.00	0.02				
					6.2	0.00	0.01				
					6.3	0.00	0.01				
					6.4	0.00	0.01				
					6.5	0.00	0.00				

Table G-7. *O. mykiss* fry cover habitat suitability criteria developed during site-specific surveys on the lower Tuolumne River.

Cover Type	Utilization Index	Preference Index
None	0.47	0.13
Object Cover	0.22	0.61
Overhead Cover	1.00	0.22
Both	0.22	1.00

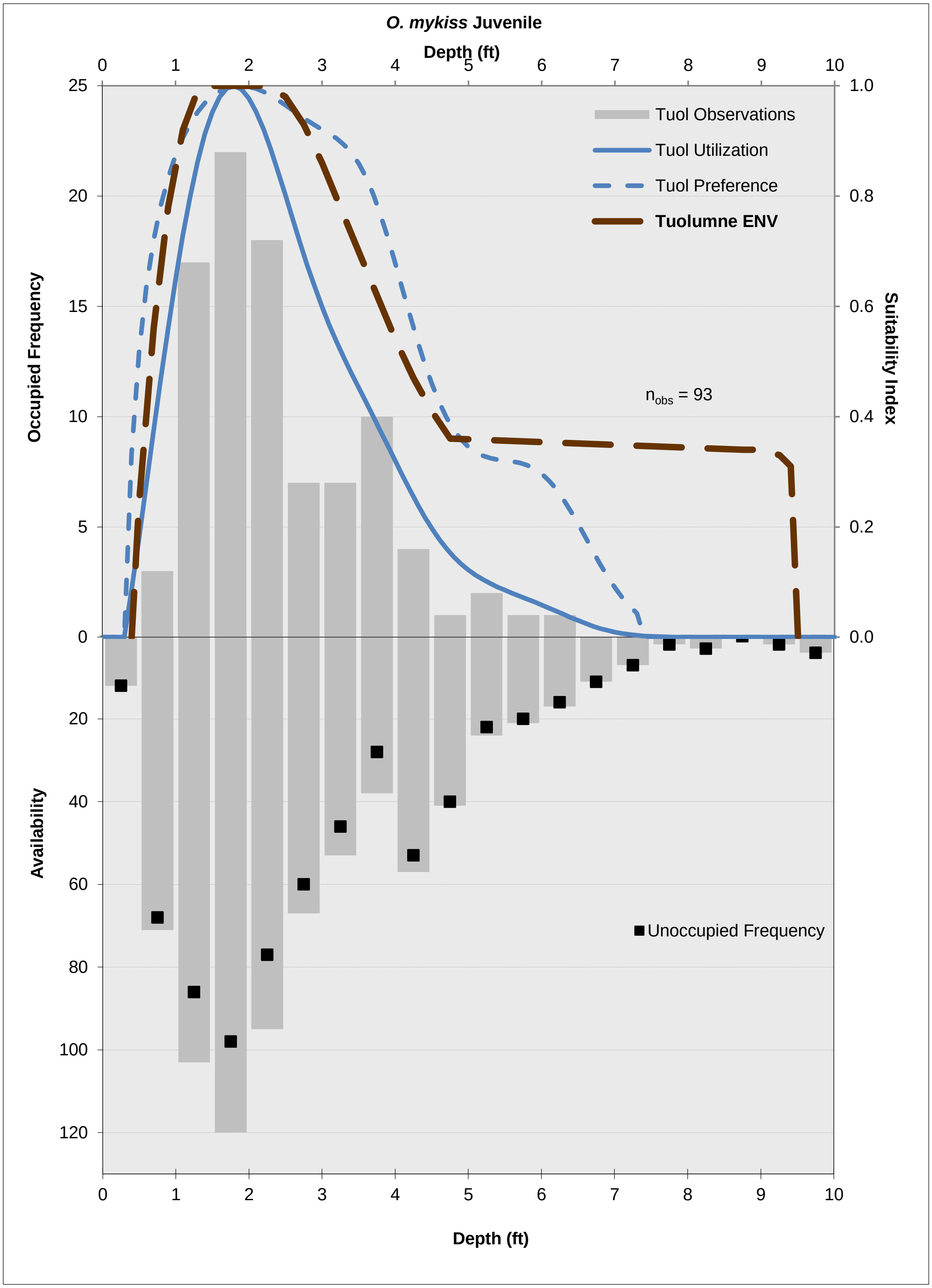


Figure G-13. *O. mykiss* juvenile depth suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuol ENV.

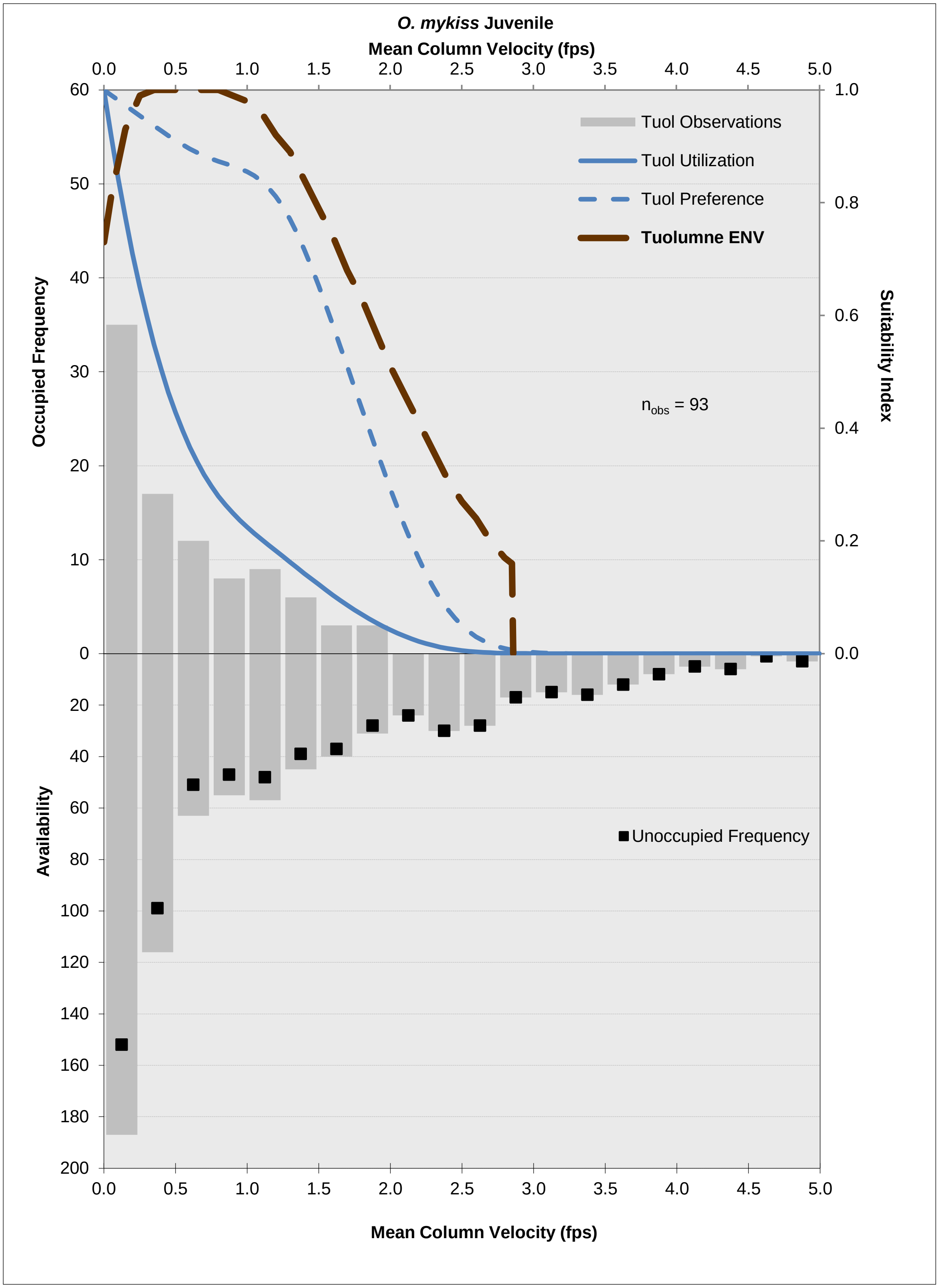


Figure G-14. *O. mykiss* juvenile velocity suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuol ENV.

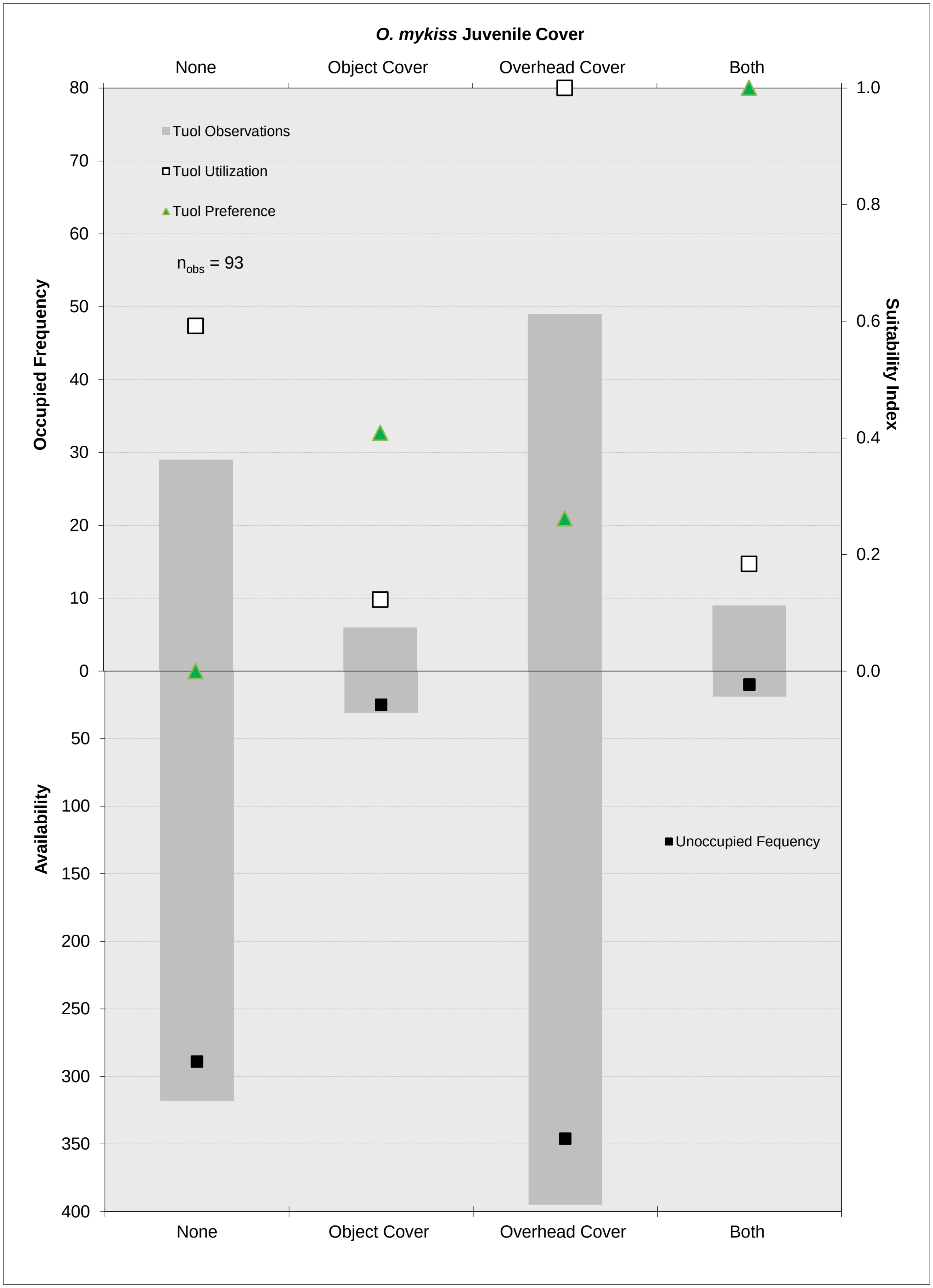


Figure G-15. *O. mykiss* juvenile cover suitability criteria for the lower Tuolumne River.

Table G-8. *O. mykiss* juvenile habitat suitability criteria coordinates.

Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific			Tuolumne Env	
Not Used			Used		Not Used			Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**
0.00	1.00	0.86	0.00	0.73	0.0	0.00	0.00	0.40	0.00
0.05	0.97	0.89	0.05	0.81	0.1	0.00	0.00	0.50	0.24
0.10	0.93	0.92	0.15	0.93	0.2	0.00	0.00	0.70	0.56
0.15	0.89	0.94	0.25	0.99	0.3	0.00	0.00	0.90	0.78
0.20	0.84	0.96	0.35	1.00	0.4	0.09	0.33	1.10	0.92
0.25	0.80	0.98	0.80	1.00	0.5	0.18	0.52	1.30	0.99
0.30	0.75	0.99	0.90	0.99	0.6	0.28	0.63	1.50	1.00
0.35	0.71	1.00	1.00	0.98	0.7	0.37	0.72	2.25	1.00
0.40	0.66	1.00	1.10	0.96	0.8	0.47	0.78	2.50	0.98
0.45	0.61	1.00	1.20	0.92	0.9	0.56	0.83	2.75	0.93
0.50	0.57	0.99	1.30	0.89	1.0	0.65	0.87	3.00	0.86
0.55	0.52	0.97	1.40	0.84	1.1	0.73	0.91	3.25	0.78
0.60	0.48	0.95	1.50	0.79	1.2	0.80	0.93	3.50	0.70
0.65	0.44	0.93	1.60	0.74	1.3	0.86	0.95	3.75	0.62
0.70	0.40	0.90	1.70	0.68	1.4	0.91	0.97	4.00	0.54
0.75	0.36	0.86	1.80	0.63	1.5	0.95	0.98	4.25	0.47
0.80	0.33	0.82	1.90	0.57	1.6	0.98	0.99	4.50	0.41
0.85	0.30	0.78	2.00	0.51	1.7	1.00	1.00	4.75	0.36
0.90	0.27	0.74	2.10	0.46	1.8	1.00	1.00	8.75	0.34
0.95	0.24	0.70	2.20	0.41	1.9	0.99	1.00	9.00	0.34
1.00	0.21	0.66	2.30	0.36	2.0	0.98	1.00	9.25	0.33
1.05	0.19	0.62	2.40	0.31	2.1	0.95	0.99	9.40	0.31
1.10	0.17	0.58	2.50	0.27	2.2	0.92	0.99	9.50	0.00
1.15	0.16	0.54	2.60	0.24	2.3	0.88	0.98		
1.20	0.14	0.51	2.70	0.20	2.4	0.84	0.97		
1.25	0.13	0.48	2.80	0.17	2.5	0.80	0.96		
1.30	0.12	0.46	2.85	0.16	2.6	0.76	0.96		
1.35	0.11	0.44	2.86	0.00	2.7	0.72	0.95		
1.40	0.10	0.42			2.8	0.67	0.94		
1.45	0.10	0.41			2.9	0.64	0.93		

Table G-8. *O. mykiss* juvenile habitat suitability criteria coordinates.

Tuolumne Site-specific Not Used			Tuolumne Env Used		Tuolumne Site-specific Not Used			Tuolumne Env Used	
Velocity (fps)	Utilization Index	Preference Index	Velocity (fps)	Index	Depth (ft)	Utilization Index	Preference Index	Depth (ft)	Index
1.50	0.09	0.40			3.0	0.60	0.92		
1.55	0.09	0.39			3.1	0.57	0.91		
1.60	0.08	0.39			3.2	0.54	0.90		
1.65	0.08	0.39			3.3	0.51	0.89		
1.70	0.08	0.38			3.4	0.48	0.88		
1.75	0.08	0.38			3.5	0.45	0.86		
1.80	0.07	0.37			3.6	0.43	0.83		
1.85	0.07	0.37			3.7	0.40	0.80		
1.90	0.07	0.36			3.8	0.37	0.77		
1.95	0.06	0.34			3.9	0.35	0.72		
2.00	0.06	0.33			4.0	0.32	0.68		
2.05	0.05	0.31			4.1	0.29	0.63		
2.10	0.05	0.29			4.2	0.27	0.58		
2.15	0.04	0.27			4.3	0.24	0.54		
2.20	0.04	0.25			4.4	0.22	0.50		
2.25	0.03	0.23			4.5	0.20	0.46		
2.30	0.03	0.20			4.6	0.18	0.43		
2.35	0.03	0.18			4.7	0.16	0.40		
2.40	0.02	0.16			4.8	0.15	0.38		
2.45	0.02	0.14			4.9	0.13	0.36		
2.50	0.02	0.12			5.0	0.12	0.34		
2.55	0.01	0.10			5.1	0.11	0.34		
2.60	0.01	0.08			5.2	0.10	0.33		
2.65	0.01	0.07			5.3	0.10	0.32		
2.70	0.01	0.05			5.4	0.09	0.32		
2.75	0.00	0.04			5.5	0.09	0.32		
2.80	0.00	0.03			5.6	0.08	0.32		
2.85	0.00	0.03			5.7	0.07	0.32		
2.90	0.00	0.02			5.8	0.07	0.31		
2.95	0.00	0.02			5.9	0.06	0.31		

Table G-8. *O. mykiss* juvenile habitat suitability criteria coordinates.

Tuolumne Site-specific			Tuolumne Env		Tuolumne Site-specific			Tuolumne Env	
Not Used			Used		Not Used			Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**
3.00	0.00	0.01			6.0	0.06	0.30		
3.05	0.00	0.01			6.1	0.05	0.28		
3.10	0.00	0.01			6.2	0.05	0.27		
3.15	0.00	0.00			6.3	0.04	0.25		
					6.4	0.04	0.23		
					6.5	0.03	0.20		
					6.6	0.02	0.18		
					6.7	0.02	0.16		
					6.8	0.02	0.13		
					6.9	0.01	0.11		
					7.0	0.01	0.09		
					7.1	0.01	0.07		
					7.2	0.00	0.06		
					7.3	0.00	0.04		
					7.4	0.00	0.00		

Table G-9. *O. mykiss* juvenile cover habitat suitability criteria developed during site-specific surveys on the lower Tuolumne River.

Cover Type	Utilization HSC	Preference HSC
None	0.59	0.00
Object Cover	0.12	0.41
Overhead Cover	1.00	0.26
Both	0.18	1.00

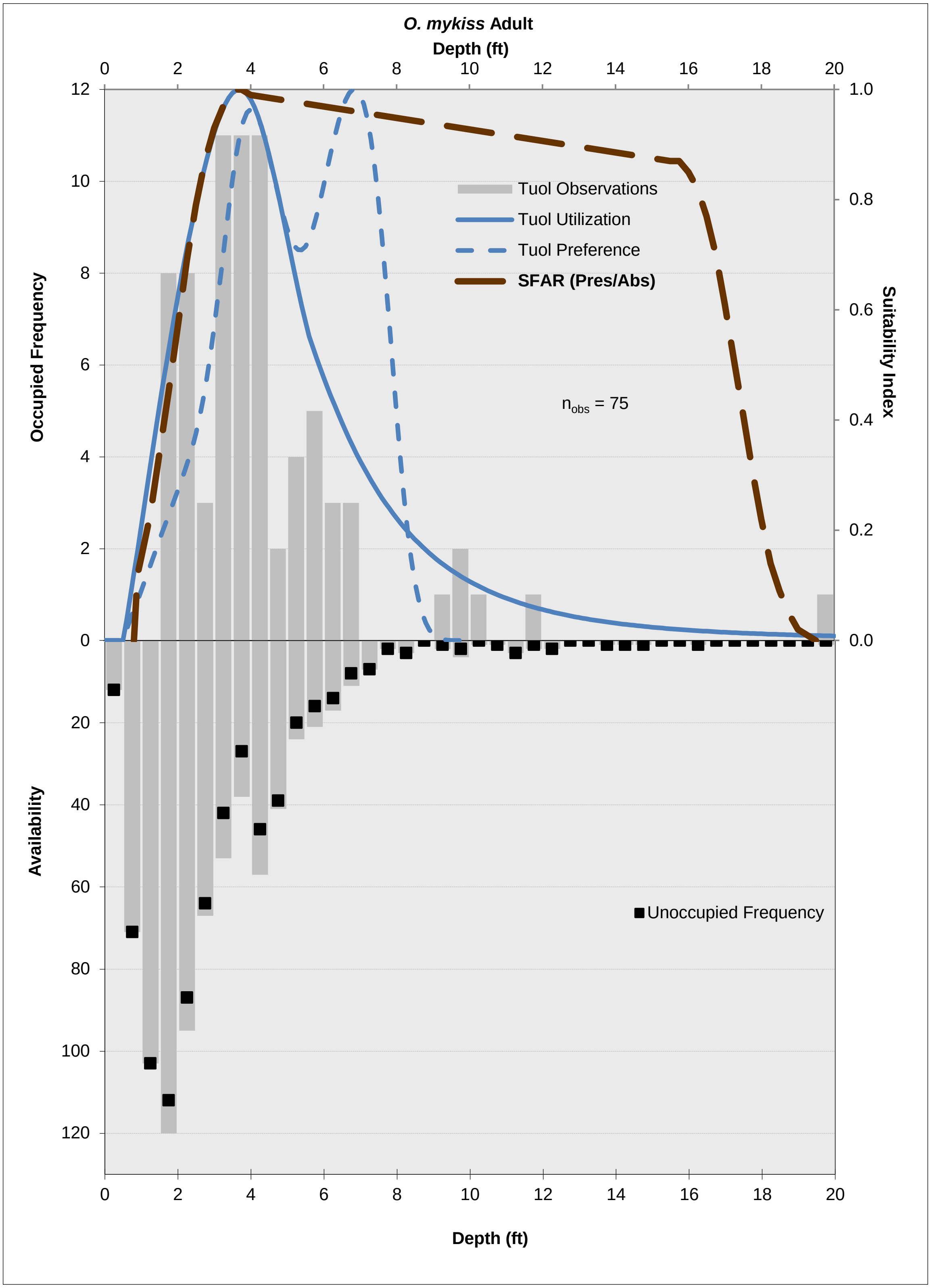


Figure G-16. *O. mykiss* adult depth suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was SFAR (Pres/Abs).

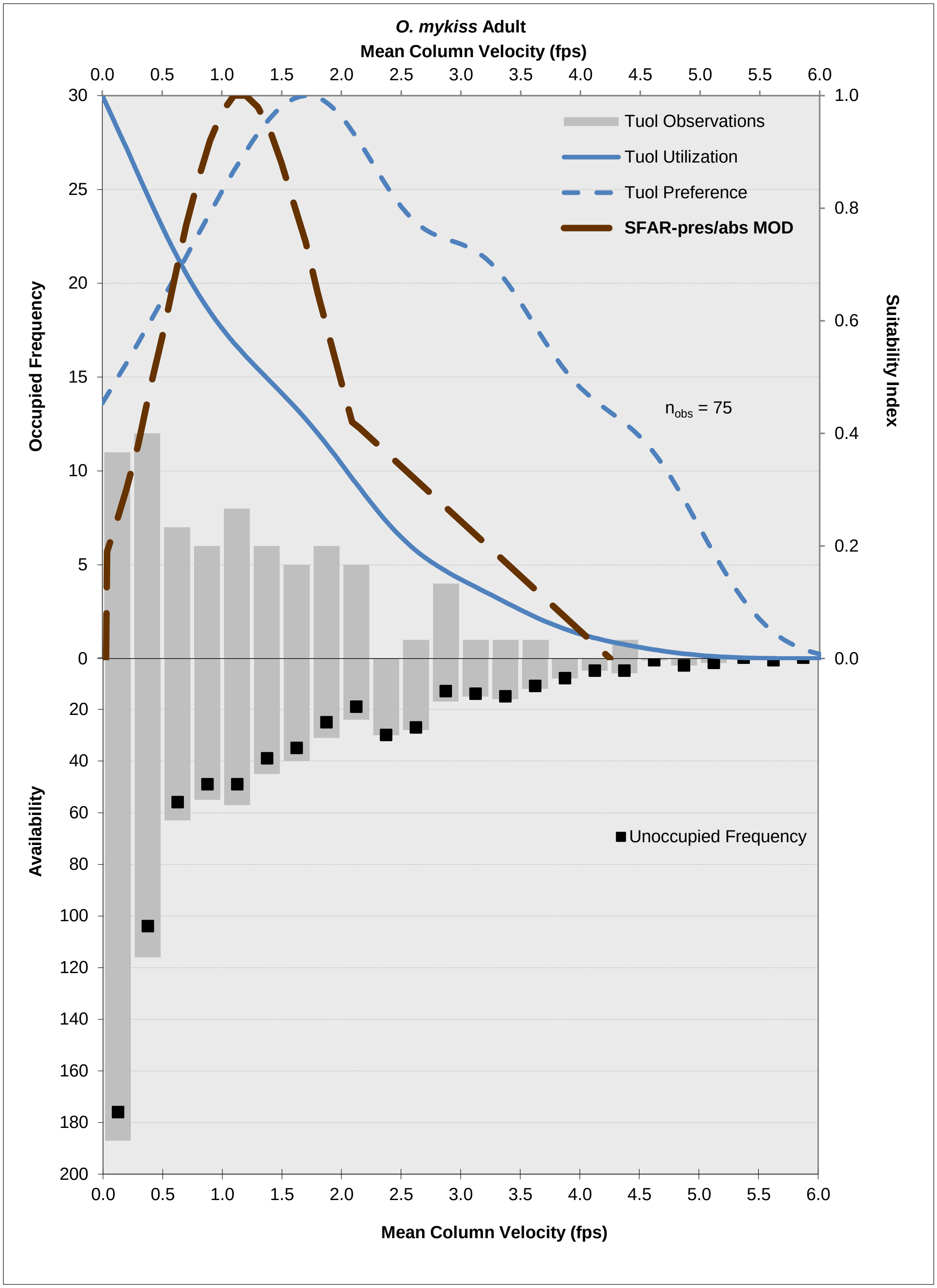


Figure G-17. *O. mykiss* adult velocity suitability criteria for the lower Tuolumne River; curve applied in PHABSIM model was SFAR pres/abs MOD).

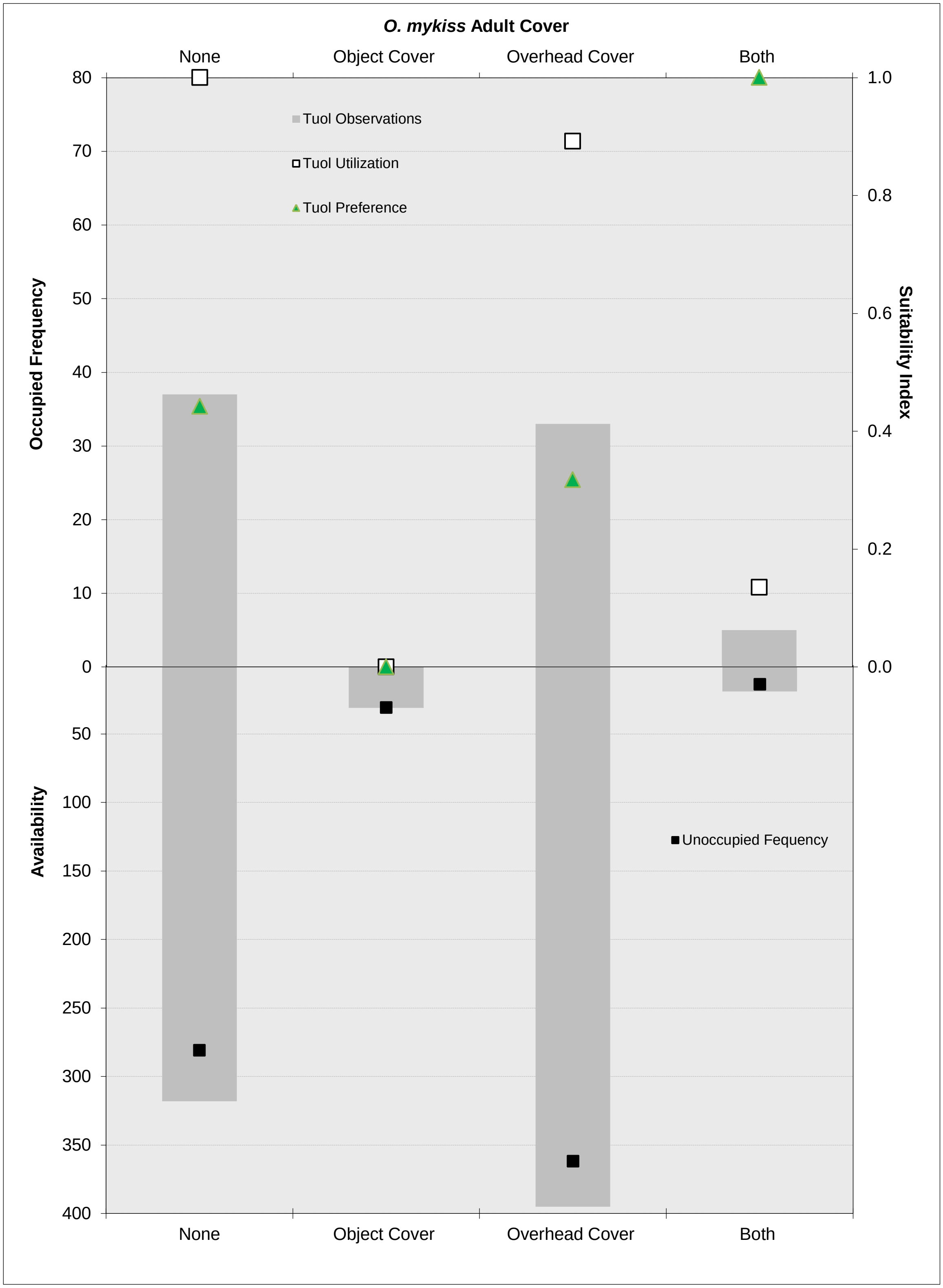


Figure G-18. *O. mykiss* adult cover suitability criteria for the lower Tuolumne River.

Table G-10. *O. mykiss* adult habitat suitability criteria coordinates.

Tuolumne Site-specific			SFAR Pres/Abs MOD		Tuolumne Site-specific			SFAR Pres/Abs	
Not Used			Used		Not Used			Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**
0.00	1.00	0.45	0.03	0.00	0.0	0.00	0.00	0.80	0.00
0.05	0.98	0.47	0.04	0.19	0.1	0.00	0.00	0.90	0.12
0.10	0.95	0.49	0.10	0.23	0.2	0.00	0.00	1.00	0.15
0.15	0.93	0.51	0.20	0.30	0.3	0.00	0.00	1.25	0.23
0.20	0.91	0.52	0.30	0.38	0.4	0.00	0.00	1.50	0.34
0.25	0.88	0.54	0.40	0.48	0.5	0.00	0.00	1.75	0.45
0.30	0.86	0.56	0.50	0.57	0.6	0.02	0.02	2.00	0.57
0.35	0.84	0.58	0.60	0.67	0.7	0.04	0.04	2.25	0.69
0.40	0.81	0.60	0.70	0.77	0.8	0.07	0.06	2.50	0.79
0.45	0.79	0.62	0.80	0.85	0.9	0.11	0.07	2.75	0.87
0.50	0.77	0.64	0.90	0.92	1.0	0.15	0.09	3.00	0.93
0.55	0.75	0.66	1.00	0.97	1.1	0.19	0.11	3.25	0.97
0.60	0.72	0.67	1.10	1.00	1.2	0.24	0.13	3.50	1.00
0.65	0.70	0.69	1.20	1.00	1.3	0.29	0.15	3.75	1.00
0.70	0.68	0.71	1.30	0.98	1.4	0.34	0.16	4.00	0.99
0.75	0.67	0.73	1.40	0.94	1.5	0.38	0.18	15.50	0.87
0.80	0.65	0.75	1.50	0.88	1.6	0.43	0.20	15.75	0.87
0.85	0.63	0.77	1.60	0.81	1.7	0.47	0.22	16.00	0.85
0.90	0.62	0.79	1.70	0.74	1.8	0.51	0.24	16.25	0.82
0.95	0.60	0.81	1.80	0.65	1.9	0.55	0.25	16.50	0.77
1.00	0.59	0.83	1.90	0.57	2.0	0.58	0.27	16.75	0.70
1.05	0.57	0.85	2.00	0.49	2.1	0.60	0.29	17.00	0.61
1.10	0.56	0.87	2.09	0.42	2.2	0.63	0.31	17.25	0.51
1.15	0.55	0.88	2.15	0.41	2.3	0.64	0.33	17.50	0.41
1.20	0.54	0.90	4.25	0.00	2.4	0.66	0.35	17.75	0.31
1.25	0.53	0.92			2.5	0.68	0.38	18.00	0.22
1.30	0.51	0.93			2.6	0.70	0.41	18.25	0.14
1.35	0.50	0.95			2.7	0.72	0.44	18.50	0.09
1.40	0.49	0.96			2.8	0.75	0.48	18.75	0.05
1.45	0.48	0.97			2.9	0.77	0.52	19.00	0.02

Table G-10. *O. mykiss* adult habitat suitability criteria coordinates.

Tuolumne Site-specific			SFAR Pres/Abs MOD		Tuolumne Site-specific			SFAR Pres/Abs	
Not Used			Used		Not Used			Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**
1.50	0.47	0.98			3.0	0.80	0.57	19.50	0.00
1.55	0.46	0.99			3.1	0.84	0.62		
1.60	0.45	0.99			3.2	0.87	0.67		
1.65	0.44	1.00			3.3	0.90	0.73		
1.70	0.43	1.00			3.4	0.93	0.78		
1.75	0.41	1.00			3.5	0.96	0.84		
1.80	0.40	1.00			3.6	0.98	0.88		
1.85	0.39	0.99			3.7	0.99	0.92		
1.90	0.37	0.98			3.8	1.00	0.94		
1.95	0.36	0.97			3.9	1.00	0.96		
2.00	0.35	0.96			4.0	0.99	0.96		
2.05	0.33	0.95			4.1	0.97	0.96		
2.10	0.32	0.93			4.2	0.95	0.95		
2.15	0.30	0.92			4.3	0.91	0.93		
2.20	0.29	0.90			4.4	0.87	0.91		
2.25	0.28	0.88			4.5	0.82	0.88		
2.30	0.26	0.87			4.6	0.77	0.85		
2.35	0.25	0.85			4.7	0.72	0.82		
2.40	0.24	0.83			4.8	0.67	0.80		
2.45	0.23	0.82			4.9	0.62	0.77		
2.50	0.22	0.80			5.0	0.57	0.75		
2.55	0.21	0.79			5.1	0.53	0.73		
2.60	0.20	0.78			5.2	0.49	0.72		
2.65	0.19	0.77			5.3	0.46	0.71		
2.70	0.18	0.76			5.4	0.44	0.71		
2.75	0.17	0.76			5.5	0.41	0.71		
2.80	0.16	0.75			5.6	0.40	0.73		
2.85	0.16	0.75			5.7	0.38	0.75		
2.90	0.15	0.74			5.8	0.37	0.77		
2.95	0.15	0.74			5.9	0.36	0.80		

Table G-10. *O. mykiss* adult habitat suitability criteria coordinates.

Tuolumne Site-specific			SFAR Pres/Abs MOD		Tuolumne Site-specific			SFAR Pres/Abs	
Not Used			Used		Not Used			Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**
3.00	0.14	0.74			6.0	0.35	0.83		
3.05	0.14	0.73			6.1	0.35	0.86		
3.10	0.13	0.73			6.2	0.34	0.89		
3.15	0.12	0.72			6.3	0.33	0.91		
3.20	0.12	0.71			6.4	0.32	0.94		
3.25	0.11	0.70			6.5	0.31	0.96		
3.30	0.11	0.69			6.6	0.29	0.98		
3.35	0.10	0.68			6.7	0.28	0.99		
3.40	0.10	0.66			6.8	0.26	1.00		
3.45	0.09	0.65			6.9	0.24	1.00		
3.50	0.09	0.63			7.0	0.22	0.99		
3.55	0.08	0.62			7.1	0.20	0.97		
3.60	0.08	0.60			7.2	0.18	0.95		
3.65	0.07	0.58			7.3	0.15	0.91		
3.70	0.07	0.56			7.4	0.13	0.86		
3.75	0.06	0.55			7.5	0.11	0.80		
3.80	0.06	0.53			7.6	0.09	0.73		
3.85	0.05	0.52			7.7	0.07	0.66		
3.90	0.05	0.50			7.8	0.06	0.58		
3.95	0.05	0.49			7.9	0.04	0.49		
4.00	0.04	0.48			8.0	0.03	0.41		
4.05	0.04	0.47			8.1	0.02	0.33		
4.10	0.04	0.46			8.2	0.02	0.26		
4.15	0.04	0.45			8.3	0.01	0.20		
4.20	0.03	0.45			8.4	0.01	0.15		
4.25	0.03	0.44			8.5	0.01	0.11		
4.30	0.03	0.43			8.6	0.00	0.07		
4.35	0.03	0.42			8.7	0.00	0.05		
4.40	0.02	0.41			8.8	0.00	0.03		
4.45	0.02	0.40			8.9	0.00	0.02		

Table G-10. *O. mykiss* adult habitat suitability criteria coordinates.

Tuolumne Site-specific			SFAR Pres/Abs MOD		Tuolumne Site-specific			SFAR Pres/Abs	
Not Used			Used		Not Used			Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**
4.50	0.02	0.39			9.0	0.00	0.01		
4.55	0.02	0.38			9.1	0.00	0.01		
4.60	0.02	0.37			9.2	0.00	0.00		
4.65	0.01	0.36							
4.70	0.01	0.34							
4.75	0.01	0.32							
4.80	0.01	0.31							
4.85	0.01	0.29							
4.90	0.01	0.27							
4.95	0.01	0.25							
5.00	0.01	0.23							
5.05	0.01	0.21							
5.10	0.00	0.19							
5.15	0.00	0.17							
5.20	0.00	0.16							
5.25	0.00	0.14							
5.30	0.00	0.12							
5.35	0.00	0.11							
5.40	0.00	0.09							
5.45	0.00	0.08							
5.50	0.00	0.07							
5.55	0.00	0.06							
5.60	0.00	0.05							
5.65	0.00	0.04							
5.70	0.00	0.03							
5.75	0.00	0.03							
5.80	0.00	0.02							
5.85	0.00	0.02							
5.90	0.00	0.01							
5.95	0.00	0.01							

Table G-10. *O. mykiss* adult habitat suitability criteria coordinates.

Tuolumne Site-specific			SFAR Pres/Abs MOD		Tuolumne Site-specific			SFAR Pres/Abs	
Not Used			Used		Not Used			Used	
Velocity (fps)	**Utilization Index**	**Preference Index**	**Velocity (fps)**	**Index**	**Depth (ft)**	**Utilization Index**	**Preference Index**	**Depth (ft)**	**Index**
6.00	0.00	0.01							

Table G-11. *O. mykiss* adult cover habitat suitability criteria developed during site-specific surveys on the lower Tuolumne River.

Cover Type	Utilization Index	Preference Index
None	1.00	0.44
Object Cover	0.00	0.00
Overhead Cover	0.89	0.32
Both	0.14	1.00

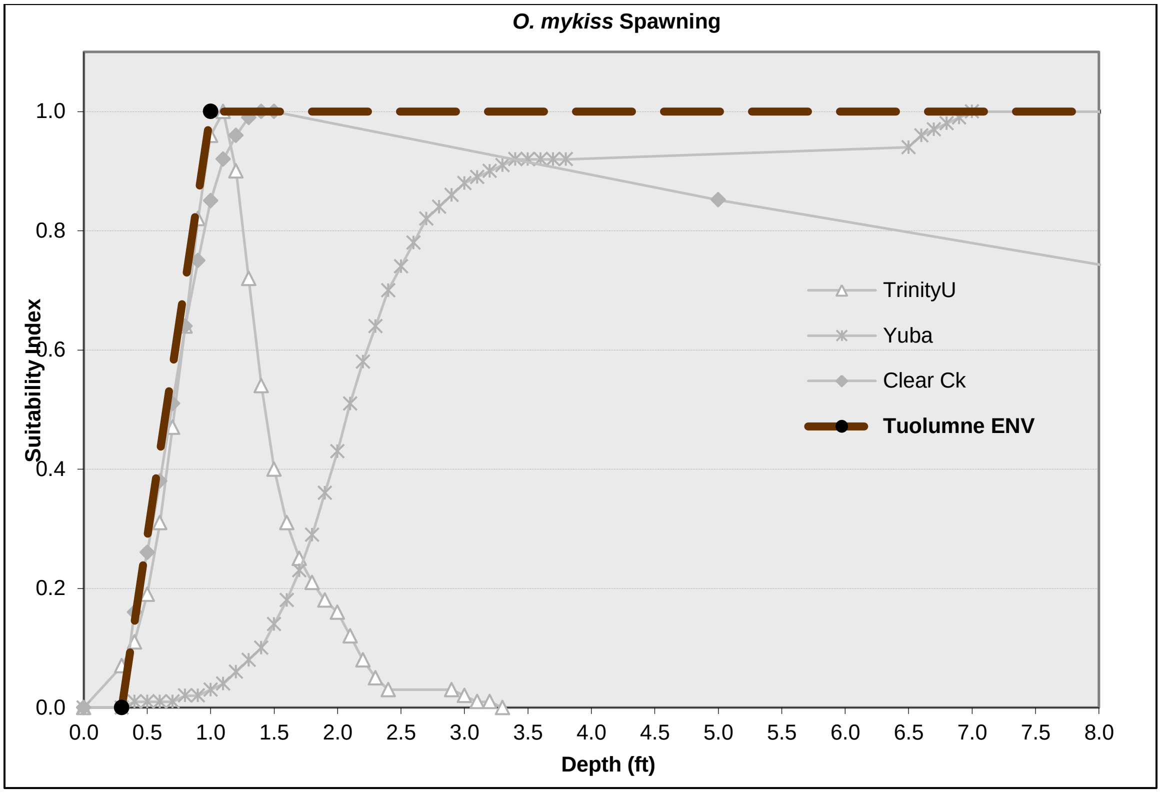


Figure G-19. *O. mykiss* spawning depth suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuolumne ENV.

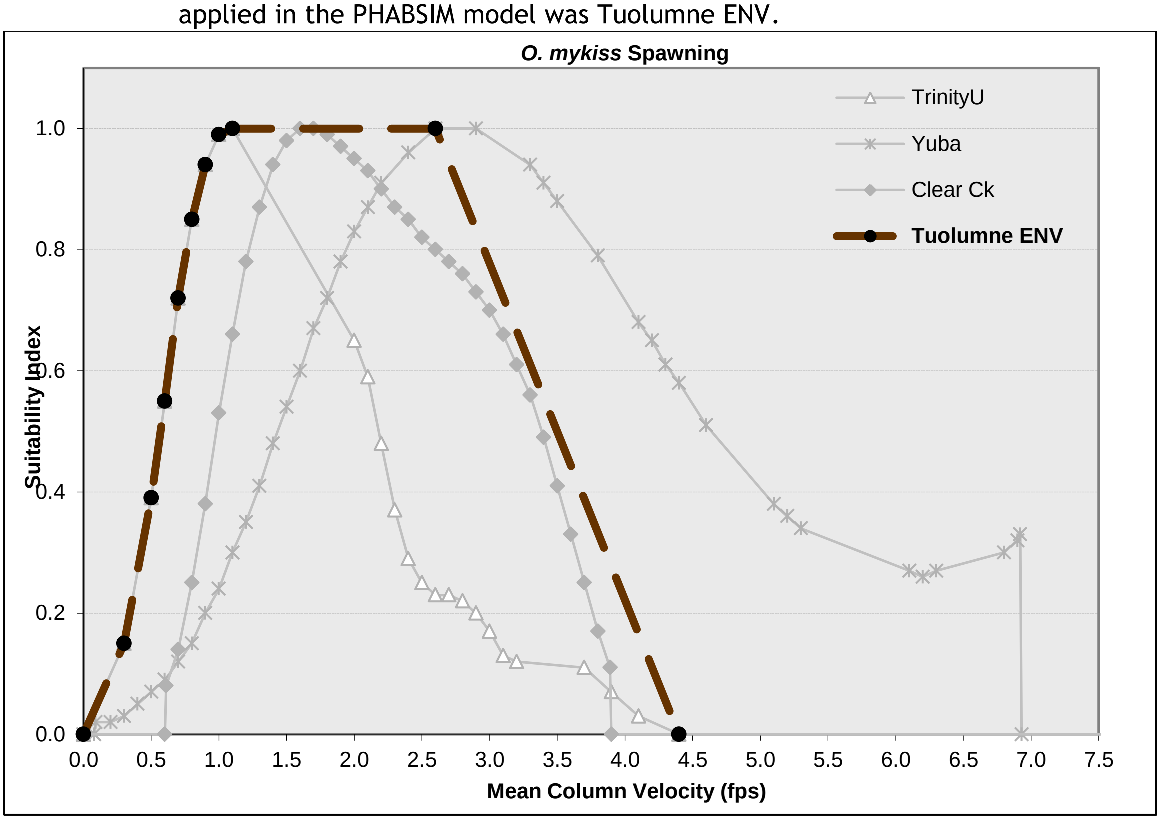


Figure G-20. *O. mykiss* spawning velocity suitability criteria for the lower Tuolumne River; curve applied in the PHABSIM model was Tuolumne ENV.

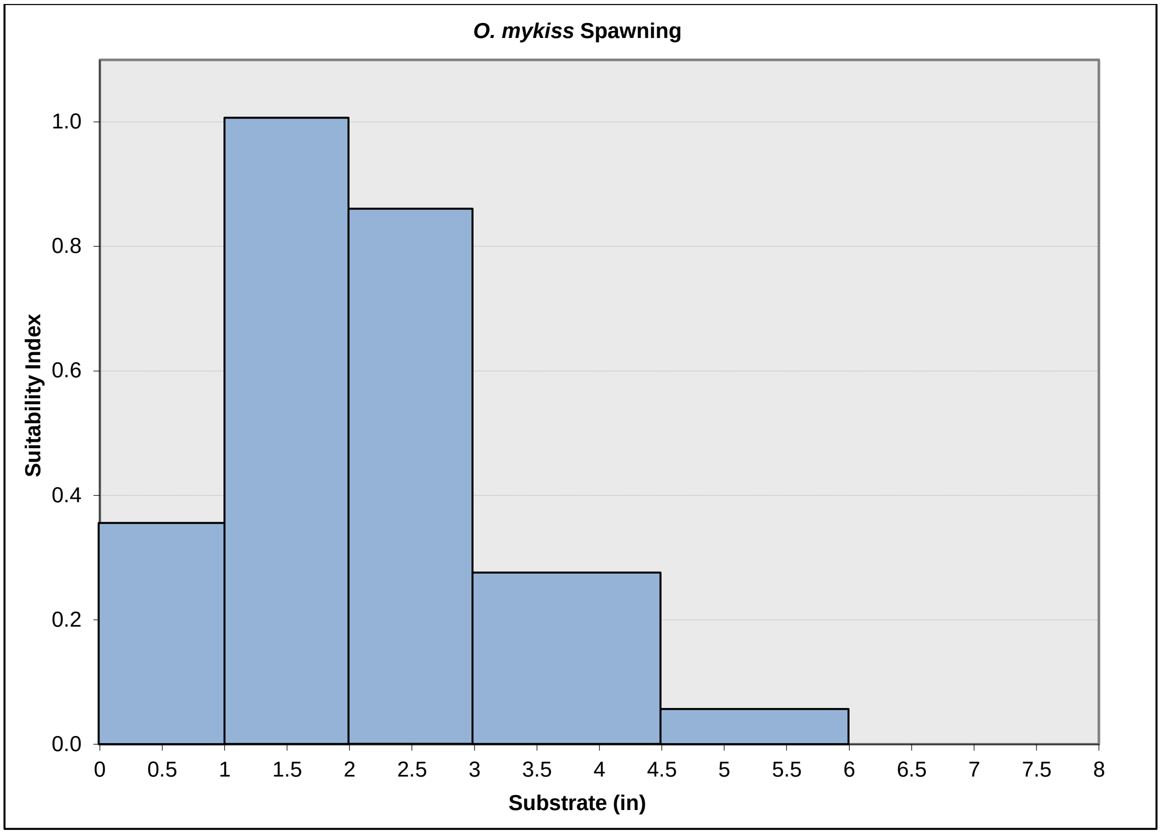


Figure G-21. *O. mykiss* spawning substrate suitability criteria for the lower Tuolumne River.

Table G-12. *O. mykiss* spawning habitat suitability criteria coordinates.

Tuolumne ENV		Tuolumne ENV		Tuolumne ENV	
Used		Used		Used	
Velocity (fps)	**Index**	**Depth (ft)**	**Index**	**Substrate Size (in)**	**Index**
0.00	0.00	0.30	0.00	Up to 1.0	0.38
0.30	0.15	1.00	1.00	1-1.99	1
0.50	0.39	100.00	1.00	2-2.99	0.85
0.60	0.55			3 – 4.49	0.28
0.70	0.72			4.5-5.99	0.05
0.80	0.85			6-8.99	0
0.90	0.94			>9	0
1.00	0.99				
1.10	1.00				
2.60	1.00				
4.40	0.00				
0.00	0.00				
0.30	0.15				
0.50	0.39				
0.60	0.55				
0.70	0.72				
0.80	0.85				
0.90	0.94				
1.00	0.99				
1.10	1.00				
2.60	1.00				
4.40	0.00				

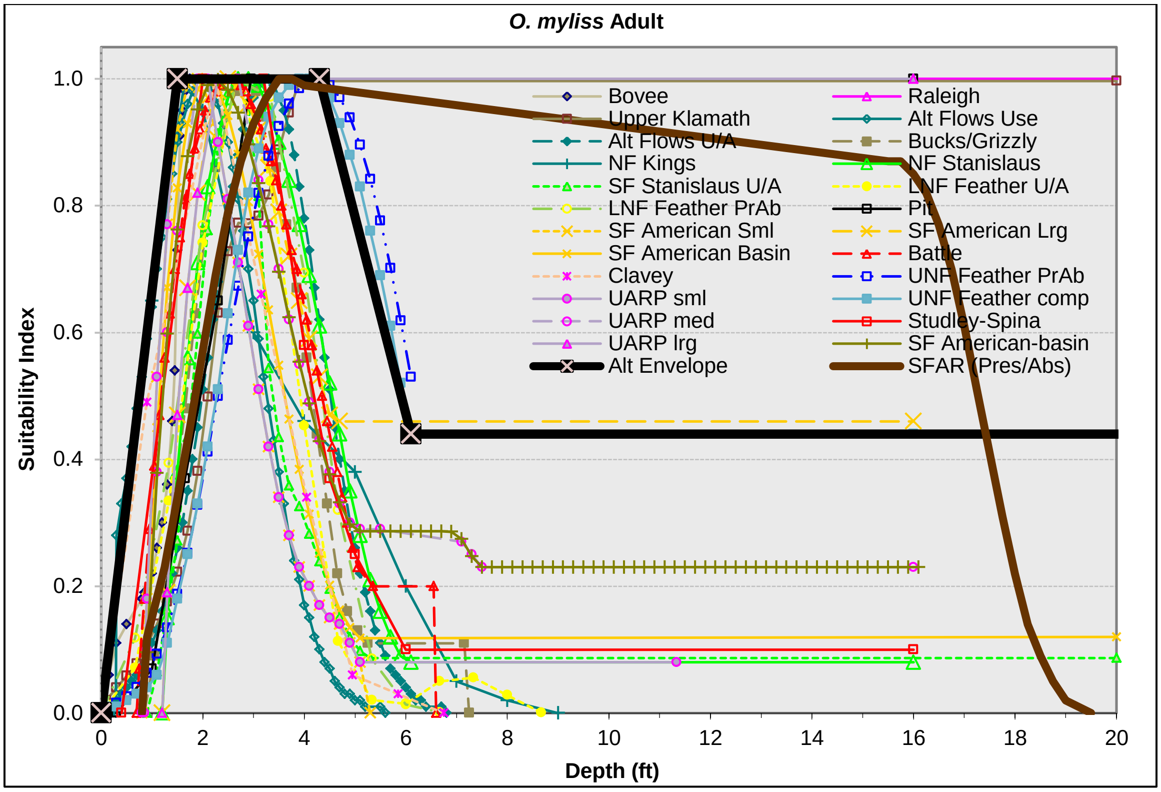


Figure G-22. Alternate depth-limited HSC envelope curve (Alt Envelope) for *O. mykiss* adults.

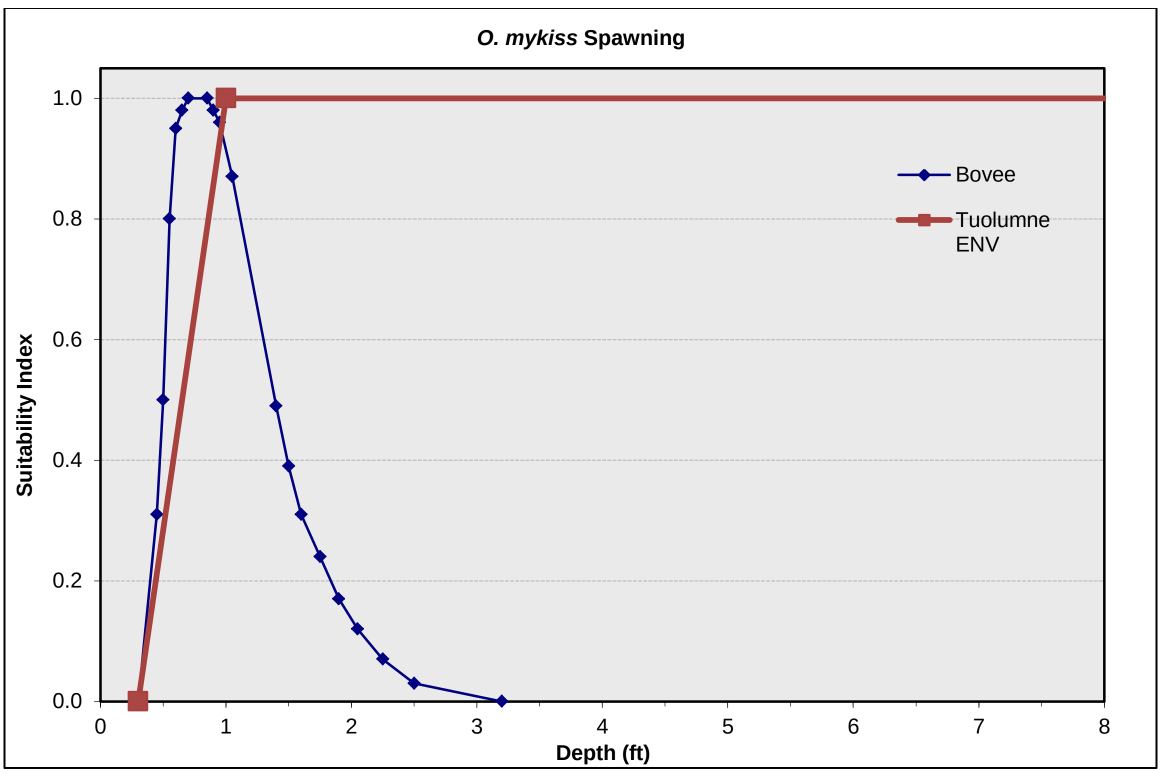


Figure G-23. Alternate depth-limited HSC curve (Bovee 1978) for *O. mykiss* spawning.

Appendix H

Supplemental Weighted Usable Area (WUA) Results

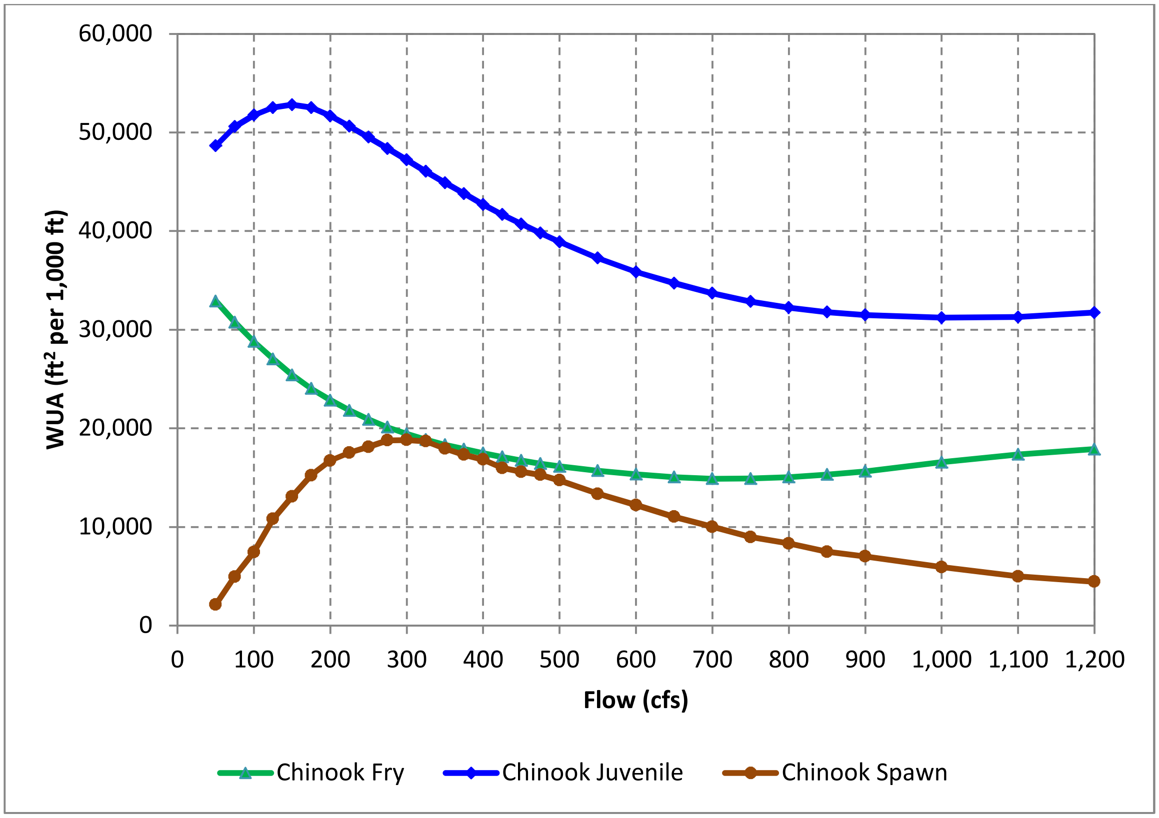


Figure H-1. Chinook salmon WUA for the lower Tuolumne River.

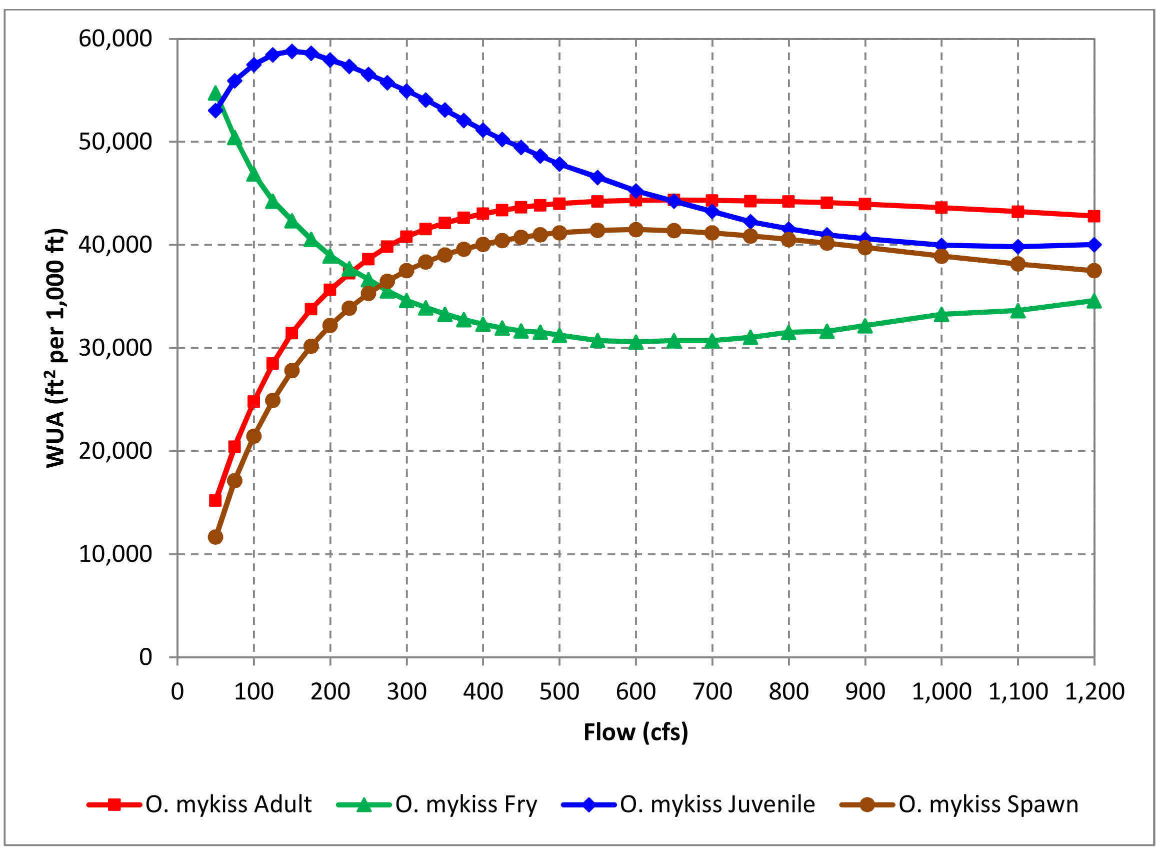


Figure H-2. *O. mykiss* WUA for the lower Tuolumne River.

Table H-1. Weighted Usable Area (WUA) Results for Chinook salmon

Simulated Discharge (cfs)	Chinook Juvenile	Chinook Fry	Chinook Spawning
50	48648.28	32897.03	2116.32
75	50596.55	30762.01	4950.27
100	51759.16	28799.02	7447.46
125	52516.33	27025.69	10807.84
150	52814.11	25415.04	13071.88
175	52526.09	24032.45	15233.00
200	51672.91	22847.85	16715.36
225	50618.49	21821.38	17532.14
250	49513.25	20907.80	18116.91
275	48370.69	20116.93	18788.06
300	47223.19	19427.09	18816.55
325	46052.38	18840.34	18687.83
350	44902.80	18335.55	17938.96
375	43795.04	17896.66	17321.83
400	42697.20	17480.39	16838.83
425	41665.85	17094.99	15973.93
450	40714.04	16744.73	15593.00
475	39786.06	16417.48	15275.23
500	38897.96	16137.46	14734.60
550	37261.25	15695.59	13349.39
600	35857.26	15349.23	12212.15
650	34713.81	15059.83	11024.56
700	33694.37	14891.10	10010.47
750	32852.21	14910.34	8975.34
800	32230.26	15056.86	8327.79
850	31779.36	15312.26	7479.93
900	31486.06	15642.33	7015.36
1000	31222.62	16553.40	5918.44
1100	31285.92	17354.90	4988.08
1200	31733.53	17894.26	4455.03

Table H-2. Weighted Usable Area (WUA) Results for *O. mykiss*

Simulated Discharge (cfs)	*O. mykiss* Adult	*O. mykiss* Juvenile	*O. mykiss* Fry	*O. mykiss* Spawning
50	15204.23	53029.98	54751.06	11648.21
75	20427.83	55934.07	50438.41	17137.87
100	24811.70	57493.70	46884.87	21449.10
125	28513.29	58459.15	44259.05	24938.94
150	31455.03	58803.13	42362.45	27813.79
175	33793.80	58594.14	40543.54	30187.09
200	35650.73	57943.69	38948.50	32190.74
225	37258.87	57339.70	37709.09	33876.89
250	38640.99	56555.18	36641.38	35297.01
275	39846.86	55752.38	35538.80	36497.83
300	40802.07	54951.57	34610.77	37512.27
325	41540.48	54073.44	33906.77	38341.84
350	42124.86	53088.40	33297.90	39040.29
375	42633.89	52086.89	32741.19	39594.69
400	43037.06	51131.27	32311.32	40055.69
425	43373.23	50231.29	31937.37	40433.29
450	43646.17	49456.44	31654.45	40738.98
475	43853.57	48619.69	31541.98	40987.72
500	44011.77	47845.36	31241.46	41182.09
550	44231.72	46549.31	30722.10	41418.38
600	44337.16	45230.46	30584.38	41490.77
650	44369.13	44239.98	30707.28	41385.58
700	44319.93	43244.78	30704.63	41171.44
750	44251.88	42255.11	31042.70	40869.42
800	44203.56	41549.14	31517.53	40529.14
850	44096.76	40986.94	31621.97	40166.12
900	43969.54	40592.09	32174.18	39751.73
1000	43625.76	39968.53	33270.24	38919.78
1100	43227.02	39831.84	33632.42	38155.59
1200	42801.13	40035.80	34594.15	37502.13

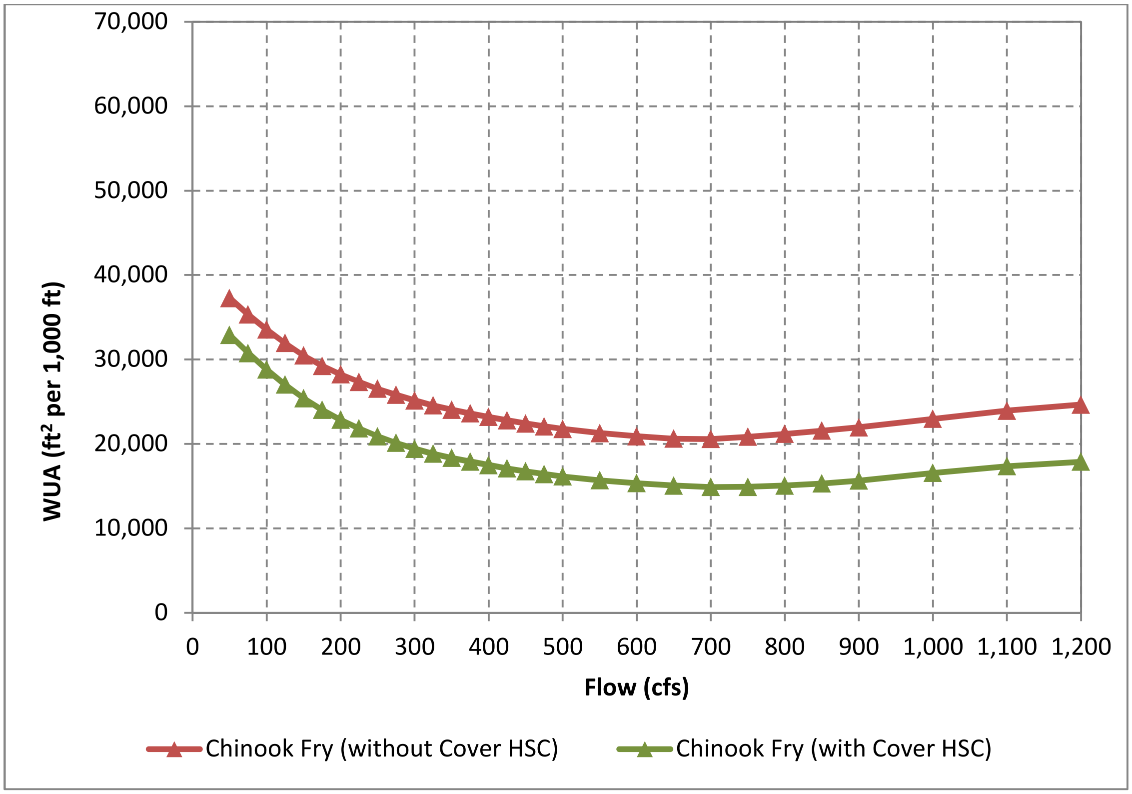


Figure H-3. Chinook salmon fry WUA comparison with and without cover criteria for the lower Tuolumne River.

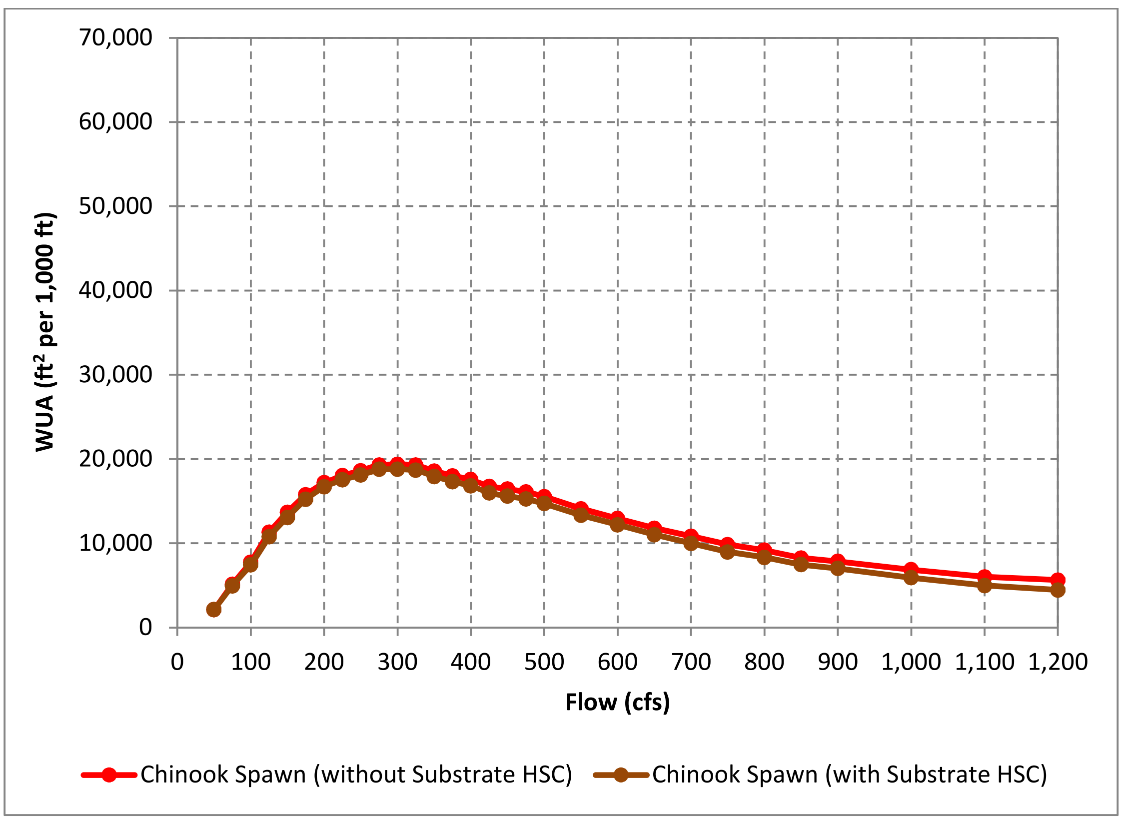


Figure H-4. Chinook salmon spawning WUA comparison with and without substrate criteria for the lower Tuolumne River.

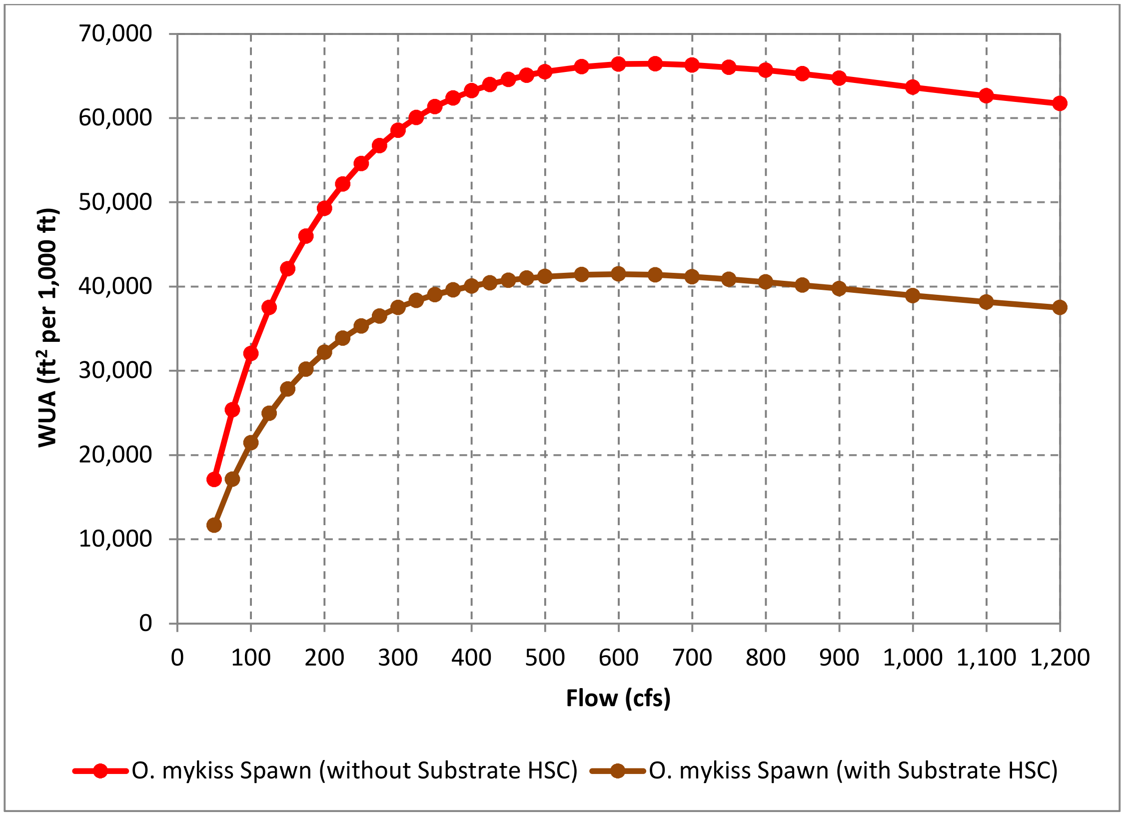


Figure H-5. *O. mykiss* spawning WUA comparison with and without substrate criteria for the lower Tuolumne River.