SHASTA RIVER MESOHABITAT DELINEATION

1.0 Study Goals and Objectives

The primary goal of the geomorphology habitat study is to delineate by physical character and location all mesohabitat unit types (e.g. pools, riffles, runs, and others) present in reaches of the Shasta River mainstem and tributaries that may be studied with hydraulic habitat modeling. The resulting mesohabitat "map" will be used as a basis for selecting study sites and/or transects for one or two-dimensional hydraulic habitat analysis. The mesohabitat mapping data base will be of sufficient detail to also be used as baseline information for other studies.

The specific objective of the study is to:

- Create a computer spreadsheet database and summary of all mesohabitat unit characteristics by type and distance within designated reaches of the Shasta River (Figures 1 and 2).

2.0 Existing Information/Literature Review

NOTE: The following review of existing information may not include all potentially available sources and should be updated when specific reaches are to be mapped.

In the late 1980's, the USFS conducted an evaluation of fish habitat on a number of Klamath River tributaries, including the Shasta River (West et al. 1989). Habitat typing was completed on the Shasta River from the mouth upstream 10 miles and for 8 miles on Yreka Creek. The basis for typing was a system described in Bisson et al. (1982), consisting of 22 habitat types.

Jeffres et al. (2008) conducted a salmonid baseline habitat study on the Nelson Ranch, which occupies the mainstem Shasta River between River Miles 27.5 and 32.0. The original intention was to habitat map using the California Department of Fish and Wildlife (CDFW) typing methodology (Flosi et al. 1998), but during their initial field reconnaissance they concluded the CDFW habitat types were not sufficient for their study purpose in this low-gradient, spring-fed, meandering section of the Shasta River. They subsequently developed a system that used six habitat types based on channel morphology, aquatic vegetation, and instream cover. This approach is too detailed for use with more widely applicable habitat modeling methods.

Overall, only those portions of the Shasta River and Yreka Creek where mesohabitat mapping was done by the USFS (West et al. 1989) appear to contain the level of detail compatible with hydraulic habitat modeling. The 22 habitat types used are very similar to the current CDFW approach and could be merged. However, the USFS data files themselves would need to be acquired and field ground-truthed to determine whether the mesohabitat units can be relocated and if the data remain representative of existing physical river channel conditions. This latter step is needed due to the potential effects of intervening floods on the mapped units.

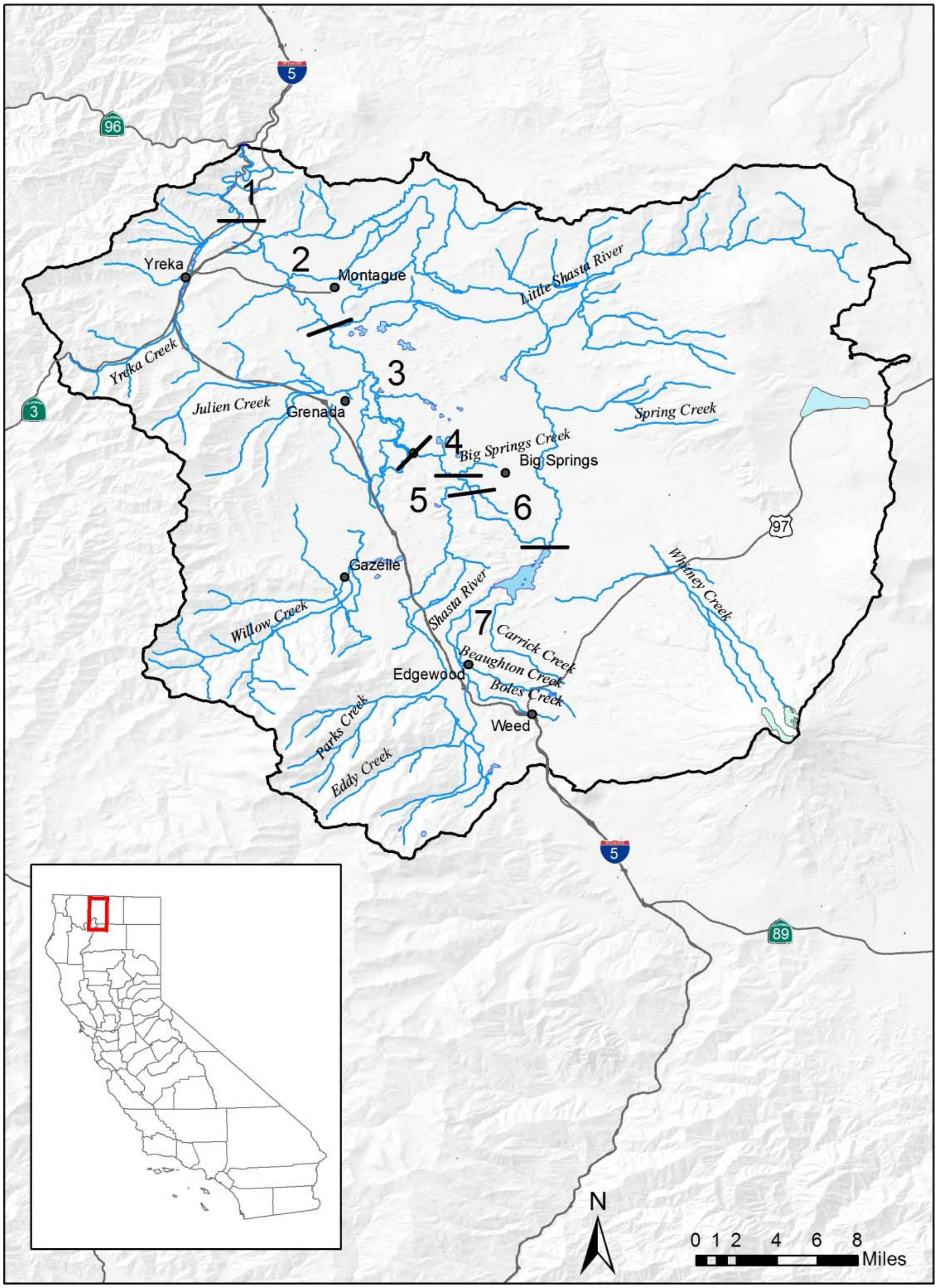

Figure 1. Shasta River Mainstem Reaches.

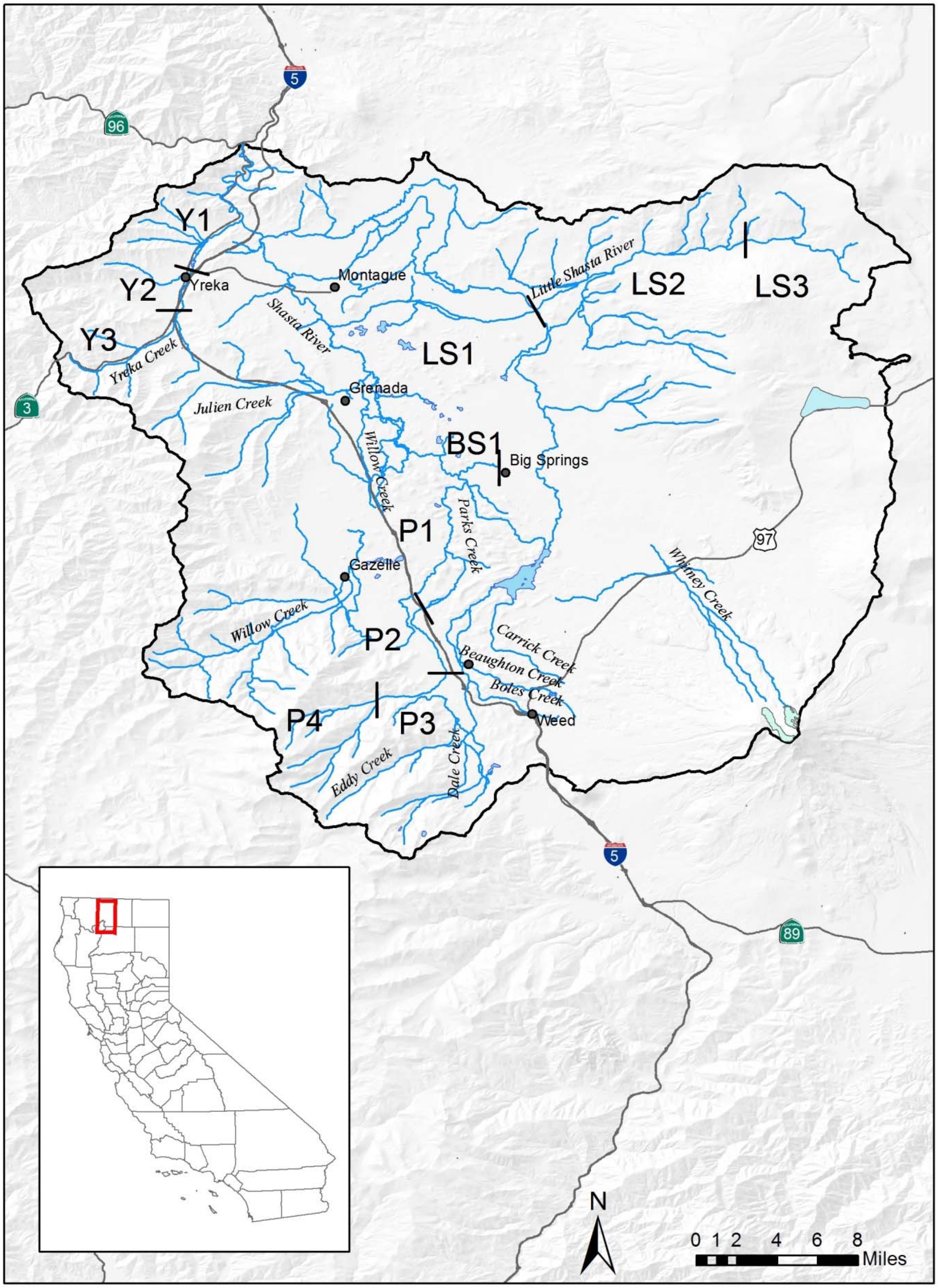

Figure 2. Shasta River Tributary Reaches. Little Springs Creek (Reach BS1a) is a tributary to Big Springs Creek and is not depicted due to its short relative length (0.7 miles).

3.0 Study Areas

During project scoping, the Shasta River was segmented into study reaches using criteria such as hydrology, length, geomorphology, and others (Normandeau Associates 2013). The study areas for geomorphic mesohabitat delineation encompass those mainstem and tributary reaches proposed to be assessed using hydraulic habitat modeling methods or related studies (Table 1; see Shasta River Potential Studies Matrix http://www.normandeau.com/scottshasta/project_materials.asp)

Table 1. Reaches of the Shasta River mainstem and tributaries showing known status of mesohabitat delineation.

Reach #	Reach Description	Reference	Status
1	Mainstem - Mouth to Yreka Creek	CDFG 1997, West et al. 1989	Completed
2	Mainstem - Yreka Creek to Little Shasta River	CDFG 1997, SVRCD 2013, West et al. 1989	Partial
3	Mainstem - Little Shasta River to the GID Diversion	CDFG 1997, Jeffres et al. 2008	Partial
4	Mainstem - GID Diversion to Big Springs	CDFG 1997, Jeffres et al. 2008	Partial
5	Mainstem - Big Springs to Parks Creek	CDFG 1997, SVRCD 2013	Unknown
6	Mainstem - Parks Creek to Dwinnell Dam	CDFG 1997, SVRCD 2013	Unknown
BS1	Big Springs Creek	CDFG 1997, SVRCD 2013	Unknown
BS1a	Little Springs Creek	CDFG 1997, SVRCD 2013	Unknown
LS1	Little Shasta Confluence to Lower Shasta Road	CDFG 1997, SVRCD 2013	Unknown
LS2	Little Shasta Lower Shasta Road to Cold Bottle Springs Creek	CDFG 1997, SVRCD 2013	Unknown
P1	Parks Creek, Shasta River to I-5	CDFG 1997, SVRCD 2013	Unknown
P2	I-5 to the MWCD Diversion	CDFG 1997, SVRCD 2013	Unknown
P3	MWCD Diversion to East Fork confluence	CDFG 1997, SVRCD 2013	Unknown
Y1	Yreka Creek, Confluence to Hwy 3	CDFG 1997, SVRCD 2013, West et al. 1989	Completed
Y2	Yreka Creek, Hwy 3 to Greenhorn Creek	CDFG 1997, SVRCD 2013, West et al. 1989	Completed
Y3	Yreka Creek, Greenhorn Creek to Headwaters	CDFG 1997, SVRCD 2013, West et al. 1989	Partial

4.0 Study Methods

The preferred mapping approach is by on-the-ground survey, consisting of identification of habitat types using specified criteria, along with measurements of habitat unit lengths, channel width, average or maximum depth, road crossings, streambank alterations, and any other attributes necessary to acquire a complete inventory of existing mesohabitat conditions. In some instances where lack of access or heavily vegetated areas cause ground mapping to be infeasible, alternative methods may be used. In open channels, low-altitude video surveys or recent orthographic photos can provide sufficient detail to type mesohabitats where the units and characteristics are clearly visible. Mapping not done on-the-ground, however, cannot accurately determine depth or gradient, and water reflection may obscure even obvious features (such as transitions between similar habitat types), among other limitations. In some smaller or heavily vegetated, limited-access channels, sub-segments of a reach may be mapped and their extent of representativeness evaluated using aerial photography or other visual means.

4.1. Mesohabitat Types

Mesohabitats mapped using the on-the-ground method should be typed to the most detailed level IV typing outlined in Table 2 and Appendix A, as described in Flosi et al. (2010), Section III. This level of habitat delineation allows data to be used for other studies such as *Floodplain Connectivity*, or aggregated into less detailed levels depending on the needs of individual studies (e.g. hydraulic habitat modeling). Aerial or videographic methods will only apply to turbulent (riffles and run), non-turbulent (glide), and pool types, due to their inherent lack of resolution. In addition to the types in Table 2, each unit should be characterized as modelable or non-modelable according to the limitations of standard (i.e. 1-D or 2-D) hydraulic modeling methods. This characterization is necessary for the data set to be compatible with stratified random study site and transect selection, where unusable mesohabitat units must be rejected prior to the selection process.

Table 2. Mesohabitat type hierarchy adopted from Flosi et al. (2010) showing three levels.

Mesohabitat Type Descriptions - Level IV		Level III	Level II
TRP	trench pool	Pools	Pools
MCP	mid-channel pool	(Main Channel)	(PL)
CCP	channel confluence pool		
STP	step pool		
CRP	corner pool		
LSL	lateral scour pool - log enhanced	Pools	
LSR	lateral scour pool - root wad enhanced	(Scour)	
LSBk	lateral scour pool - bedrock formed		
LSBo	lateral scour pool - boulder formed		
PLP	plunge pool		
DPL	dammed pool		
BWP	backwater pools (lumped four types)		
POW	pocketwater	Flatwaters	Flatwaters
GLD	glide	(FW)	(FW)
RUN	run		
SRN	step run		
EDW	edgewater		
LGR	low gradient riffle	Riffles	Riffles
HGR	high gradient riffle	(LGR, HGR)	(RF)
CAS	cascade	Cascades	

BRS	bedrock sheet	(CAS, BRS)	

An example of habitat type aggregation is shown below. Here habitat types have been classified into a modified Level III with sufficient detail for the purpose of transect placement, hydraulic data collection, and transect weighting consistent with river stratification for hydraulic habitat modeling.

The following mesohabitat types are generally considered modelable and should be retained for study site and transect selection:

- Pools (Mid-Channel, Trench, Lateral, Plunge)
- Glide
- Run/Step-run
- Pocket Water
- Low Gradient Riffle

The following mesohabitat types are generally considered non-modelable and should be excluded from study site and transect selection:

- Cascade
- Chute
- High Gradient Riffle

For hydraulic data collection cascade and chute types are not sampled. High gradient riffles can sometimes be sampled but must be determined on a case by case basis.

4.2. Field Techniques

On-the-ground mesohabitat mapping will be done following procedures described in Flosi et al. (2010), Section III by wading within or adjacent to the reach from downstream to upstream measuring distance with either biodegradable hip chain string or hand-held GPS waypoint technology. The required data will be recorded on pre-printed or copies of a standardized form (Appendix A). Instructions for filling out the form can be found in Flosi et al. (2010), section III, pages 43-47. A 10 percent random sampling protocol described in Flosi et al. (2010), Appendix O, will be followed.

Under this protocol the following data will be collected on all habitat units:

- Unit Type
- Length
- Substrate Composition (dominant\subdominant)

In addition to above the following data will be collected in all pools:

- Maximum Depth
- Depth of Pool Tail Crest
- Pool Tail Embeddedness
- Pool Tail Substrate (dominant)

In addition to the above the following will be collected on the first occurrence of each habitat type and subsequent randomly selected units:

- Mean Width
- Mean Depth
- Shelter Rating
- Percent Exposed Substrate
- Percent Canopy
- Bank Composition

In instances where the number of habitat units is known to be low or the reach is short, a 20% random sample may be necessary to acquire a sufficient data set.

In addition to identifying and noting the boundary of each mesohabitat unit, locations and areas of spawning gravel (0.25”-3.0”, <40% fines) should be noted. In mesohabitat units too deep to wade, a depth sounder or stadia rod will be used to measure maximum pool depth. Hand-held GPS units or hip chain distances should be used to record reference locations and notable features such as high flow channels, tributaries, access points, bridges. For bridges or other artificial structures, it should be noted if they appear to have created backwater effects and upstream bedload deposition. In shallow areas, the survey should generally follow the thalweg (deepest part of the channel). In long pools and runs, the survey crews should attempt to locate and record the deepest portion of the channel within the units. In instances of islands or split channels, both channels will be mapped. If hip chain alone is used for mapping, flagging or other monumenting should be established at regular intervals (e.g. 500 feet), so that individual mesohabitat units can be subsequently relocated. Reference photographs should also be taken at similar regular intervals. All hip chain string is to be retrieved and retained for recycling or disposal.

All field surveys or aerial evaluations will be conducted under flow conditions at which the mesohabitat types are readily apparent. That is, not when flows are so high that all types are either run or riffle or so low that there is only pool with undifferentiated riffles in between. Typically suitable target flows for surveys will be in the range of 10-30% median annual flow. For safety purposes, field surveys should be conducted by teams of at least two technicians familiar with salmonid habitat requirements, either already with experience or with recent training in this type of mapping. Biological technicians (or higher) are specified due to their ability to recognize habitat features important to rearing and spawning salmon and steelhead. At least one member of each mapping team should be sufficiently experienced with hydraulic habitat modeling to describe each mesohabitat unit as modelable or non-modelable, irrespective of mesohabitat unit type from Section 4.1 above.

4.3. Data Entry

Upon completion of habitat mapping, all data will be entered into spreadsheets for quality control review and summary. Examples of spreadsheets and summary tables are provided in Flosi et al. (2010), Part V. At a minimum, the total count and the total length for each mesohabitat unit should be summarized as shown in Table 3.

Table 3. Typical spreadsheet reporting format for geomorphic mesohabitat delineations.

Unit #	WP #	Dist (ft)	Hab Type	Len (ft)	PooL Depth	Model?	Lat	Long	Comments
1	75	155	LGR	22		Y	N35.25.638	W122.42.637	orange flags labeled "ID
2	76	250	MCP	95	>3	N	N35.25.626	W122.42.625	waypts at TOP of unit
3	77	273	GLD	23		Y	N35.25.622	W122.42.624	short neck btw pools
4	78	452	LSBk	179	>4	Y	N35.25.595	W122.42.610	tree in MC
5	79	518	LGR	66		Y	N35.25.587	W122.42.619	
6	80	689	MCP	171	<4	N	N35.25.56	W122.42.631	trees/debris LB

5.0 Deliverables

Study products will include: a) a study report that includes a summary of field methods, data analysis, and results; b) all transcribed or digital data on CD; and c) a spreadsheet-based interactive analytical tool containing all mesohabitat mapping data.

6.0 Literature Cited

Bisson, P.A., J.L. Nielsen, R.A. Palmason, and L.E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low streamflow. Pages 62-73 in N.B. Armantrout, editor. Acquisition and utilization of aquatic habitat inventory information. Proceedings of a symposium organized by the Western Division, American Fisheries Society. 28-30 October 1981, Portland, Oregon. 376pp.

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West, J.R., O.J. Dix, A.D. Olson, M.V. Anderson, S.A. Fox, and J.H. Power. 1989. Evaluation of Fish Habitat Condition and Utilization in Salmon, Scott Shasta, and Mid-Klamath Sub-basin Tributaries 1988/1989: Klamath National Forest. Annual Report For Interagency Agreement 14-16-0001-89508. United States Department of Agriculture, Forest Service, Pacific Southwest Region.

Appendix A. Flosi et al. (2010) Level IV habitat type descriptions, taken from the Pacific Southwest Region Habitat Typing Field Guide, USDA-USFS.

LGR – Low Gradient Riffle. Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient < 4%, substrate is usually cobble dominated.

HGR – High Gradient Riffle. Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is > 4%, and substrate is boulder dominated.

CAS – Cascade. The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders.

BRS – Bedrock Sheet. A thin sheet of water flowing over a smooth bedrock surface. Gradients are highly variable.

POW – Pocket Water. A section of swift-flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions.

GLD – Glide. A wide, uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel, and sand.

RUN – Run. Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrate consists of gravel, cobble, and boulders.

SRN – Step Run. A sequence of runs separated by short riffle steps. Substrate is usually cobble and boulder dominated.

EDW – Edgewater. Quiet, shallow area found along the margins of the stream, typically associated with riffles. Water velocity is low and sometimes lacking. Substrate varies from cobbles to boulders.

TRP – Trench Pool. Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform.

MCP – Mid-Channel Pool. Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable.

CCP – Channel Confluence Pool. Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or scour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types.

STP – Step Pool. A series of pools separated by short riffles or cascades. Generally found in high gradient, confined mountain streams dominated by boulder substrate.

CRP – Corner Pool. Lateral scour pools formed at a bend in the channel. These pools are common in lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions.

LSL – Lateral Scour Pool, Log Enhanced. Formed by flow impinging against a partial channel obstruction consisting of large woody debris. The associated scour is generally confined to < 60% of the wetted channel width.

LSR – Lateral Scour Pool, Root Wad Enhanced. Formed by flow impinging against a partial channel obstruction consisting of a root wad. The associated scour is generally confined to < 60% of the wetted channel width.

LSBk – Lateral Scour Pool, Bedrock Formed. Formed by flow impinging against a partial channel obstruction consisting of a root wad. The associated scour is generally confined to < 60% of the wetted channel width.

LSBo – Lateral Scour Pool, Boulder Formed. Formed by flow impinging against a partial channel obstruction consisting of a boulder. The associated scour is generally confined to < 60% of the wetted channel width.

PLP – Plunge Pool. Found where the stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable.

DPL – Dammed Pool. Water impounded from a complete or nearly complete channel blockage (log debris jams, rock landslides or beaver dams). Substrate tends to be dominated by smaller gravel and sand.

BWP – Backwater Pool (four types combined). Found along channel margins and caused by eddies around a gravel bar, boulder, root wad, or large woody debris obstruction. These pools are usually shallow and are dominated by fine-grained substrate. Current velocities are quite low.

HABITAT INVENTORY DATA FORM

Form # ____ of ____

Date / /	Stream Name:		T:	R:	S:
Surveyors:		Lat:		Long:	
Quad:	Channel Type:	Reach:	BFW:	@HU#:	
Time:	H_2O F°:	Air F°:	Flow:	Pg Length:	Total Length:

Habitat Unit Number										
Habitat Unit Type										
Side Channel Type										
Mean Length										
Mean Width										
Mean Depth										
Maximum Depth										
Depth Pool Tail Crest										
Pool Tail Embeddedness										
Pool Tail Substrate										
LWD Count D>1&L6to20										
LWD Count D>1&L>20										
Shelter Rating: Shelter Value										
Shelter Rating: % Unit Covered										
Shelter Rating: % undercut bank										
Shelter Rating: % swd (d<12")										
Shelter Rating: % lwd (d>12")										
Shelter Rating: % root mass										
Shelter Rating: % terr. vegetation										
Shelter Rating: % aqua. vegetation										
Shelter Rating: % bubble curtain										
Shelter Rating: % boulders										
Shelter Rating: % bedrock ledges										
Substrate Composition 2 Most Dominant: A) Silt/Clay										
B) Sand										
C) Gravel (0.08-2.5")										
D) Sm Cobble										
E) Lg Cobble (5-10")										
F) Boulder (>10")										
G) Bedrock										
Percent Exposed Substrate										
Percent Total Canopy										
% Hardwood Trees										
% Coniferous Trees										
Bank Composition & Vegetation: Rt Bk Composition										
Rt Bk Dominant Vg										
% Rt Bk Vegetated										
Lft Bk Composition										
Lft Bk Dominant Vg										
% Lft Bk Vegetated										

Bank Composition Types	Comments: **S**tructures **C**hannel **D**iversions **T**ribs **E**rosion **B**iota **P**assage **A**ccess **GPS** **O**ther
1) Bedrock 2) Boulder 3) Cobble /Gravel 4) Silt/Clay/Sand	
Vegetation Types 5) Grass 6) Brush 7) Hardwood Trees 8) Coniferous Trees 9) No Vegetation	