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# Habitat Typing

*Updated July 2017*

### *Purpose*

Habitat typing surveys involve the identification, description, and measurement of distinct fish habitats within the wetted channel. The *California Salmonid Stream Habitat Restoration Manual*, published by California Department of Fish and Wildlife (http://www.dfg.ca.gov/fish/Resources/HabitatManual.asp), provides detailed methods for conducting habitat typing surveys, which break stream habitats up into distinct types based on their physical and hydraulic characteristics. The minimum size of each habitat unit is equal to the width of the wetted stream channel.

Habitat surveys also document channel dimensions, substrate types, instream cover, tree canopy density, pool depth, bank conditions, fish passage barriers, and observations of aquatic and riparian species. The primary use of stream habitat data is to identify and prioritize specific sites or reaches in need of restoration.

Some important applications of habitat typing data include:

- Physically describe 100% of the stream habitat in a watershed
- Locate artificial and natural barriers to fish migration
- Provide baseline data to evaluate habitat responses to restoration efforts
- Determine transect and study locations for more focused studies

### *Habitat Type Hierarchy*

Habitat surveys can be conducted to varying degrees of detail (Figure 1). The *California Salmonid Stream Habitat Restoration Manual* provides the following hierarchy of habitat types depending on the level of survey detail required:

**Level 1** – Riffles / Pools

**Level 2** – Riffles / Flatwater / Pools

**Level 3** – Riffles / Cascades / Flatwater / Main Channel Pools / Scour Pools / Backwater Pools

**Level 4** – Highest level of detail (24 habitat types described in Figure 1 and Table 1).

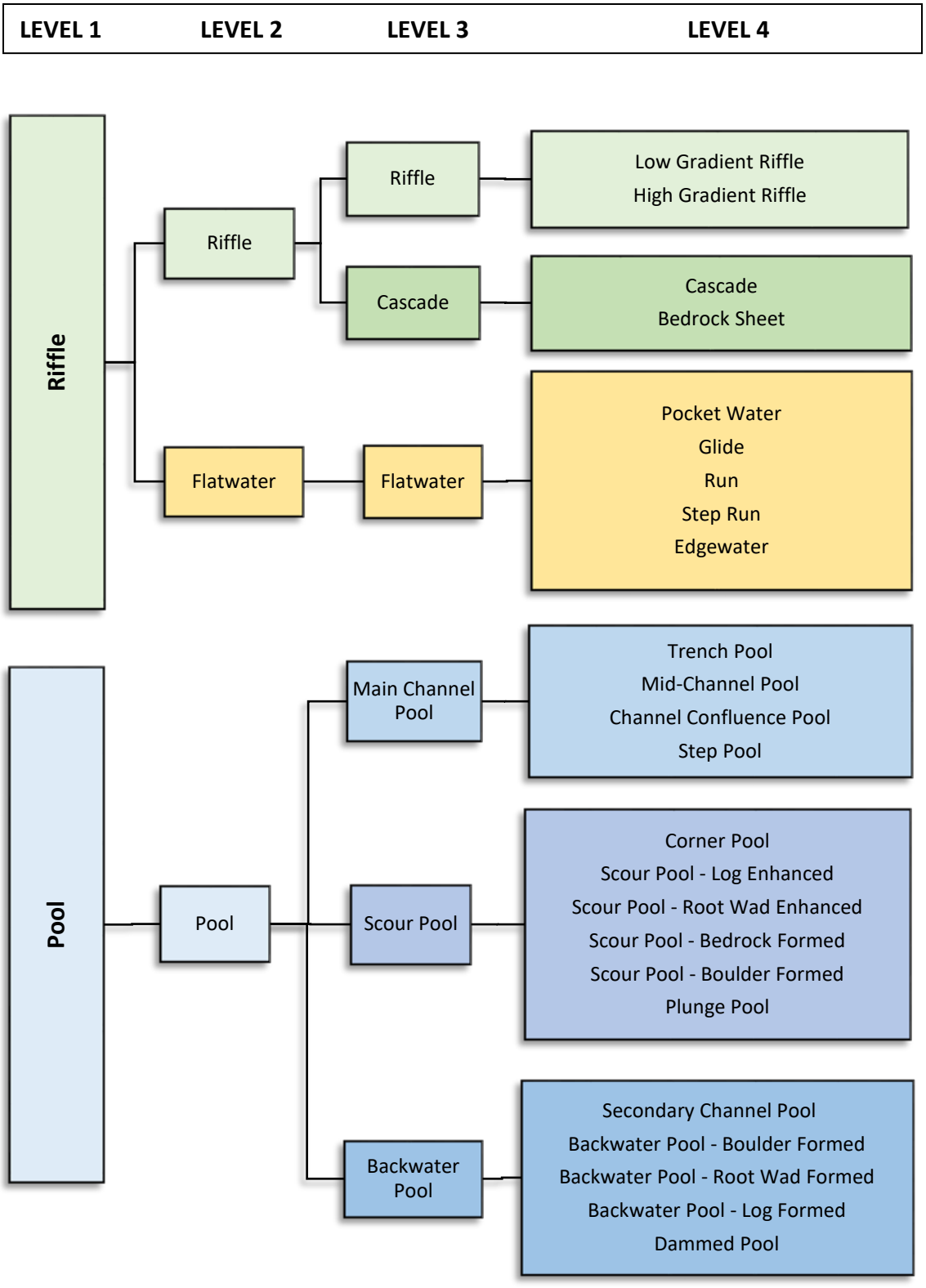


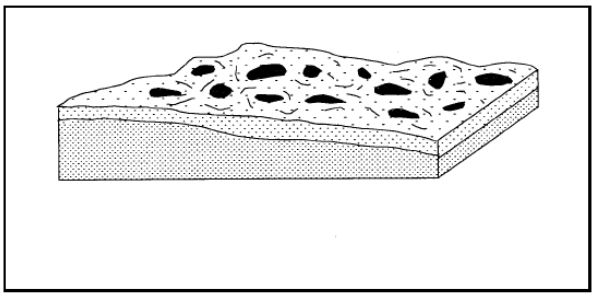

**Figure 1.** Habitat type hierarchy.
(Adapted from the *California Salmonid Stream Habitat Restoration Manual,* CDFW 2010)

**Table 1.** Standardized habitat types, abbreviations, and numeric codes adopted by CDFW. (Adapted from the *California Salmonid Stream Habitat Restoration Manual,* CDFW 2010)

| Habitat Type | Abbreviation | Code |
|---|---|---|
| ***RIFFLE*** | | |
| Low Gradient Riffle | (LGR) | [1.1] |
| High Gradient Riffle | (HGR) | [1.2] |
| | | |
| ***CASCADE*** | | |
| Cascade | (CAS) | [2.1] |
| Bedrock Sheet | (BRS) | [2.2] |
| | | |
| ***FLATWATER*** | | |
| Glide | (GLD) | [3.2] |
| Run | (RUN) | [3.3] |
| Step Run | (SRN) | [3.4] |
| | | |
| ***MAIN CHANNEL POOLS*** | | |
| Trench Pool | (TRP) | [4.1] |
| Mid-Channel Pool | (MCP) | [4.2] |
| Channel Confluence Pool | (CCP) | [4.3] |
| Step Pool | (STP) | [4.4] |
| | | |
| ***SCOUR POOLS*** | | |
| Corner Pool | (CRP) | [5.1] |
| Lateral Scour Pool - Log Enhanced | (LSL) | [5.2] |
| Lateral Scour Pool - Root Wad Enhanced | (LSR) | [5.3] |
| Lateral Scour Pool - Bedrock Formed | (LSBk) | [5.4] |
| Lateral Scour Pool - Boulder Formed | (LSBo) | [5.5] |
| Plunge Pool | (PLP) | [5.6] |
| | | |
| ***BACKWATER POOLS*** | | |
| Secondary Channel Pool | (SCP) | [6.1] |
| Backwater Pool - Boulder Formed | (BPB) | [6.2] |
| Backwater Pool - Root Wad Formed | (BPR) | [6.3] |
| Backwater Pool - Log Formed | (BPL) | [6.4] |
| Dammed Pool | (DPL) | [6.5] |
| | | |
| ***OTHER DESIGNATIONS*** | | |
| Dry | (DRY) | [7.0] |
| Culvert | (CUL) | [8.0] |
| Not Surveyed | (NS) | [9.0] |
| Not Surveyed due to a marsh | (MAR) | [9.1] |

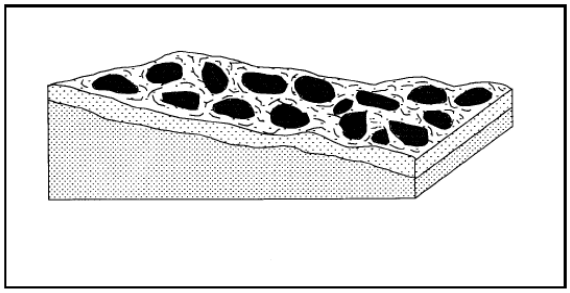
## *Habitat Type Definitions*

**LOW-GRADIENT RIFFLE (LGR) [1.1] {1}**



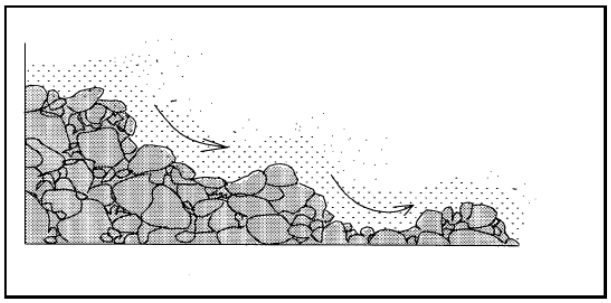
Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient < 4%, substrate is usually cobble dominated.

**HIGH-GRADIENT RIFFLE (HGR) [1.2] {2}**



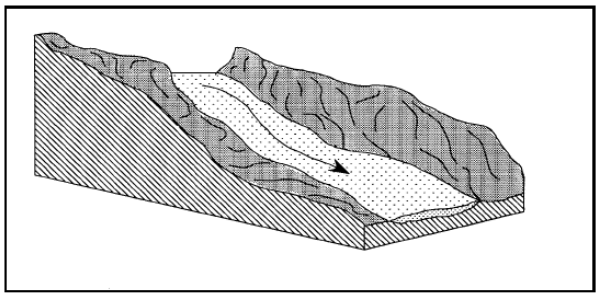
Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is > 4%, and substrate is boulder dominated.

**CASCADE (CAS) [2.1] {3}**



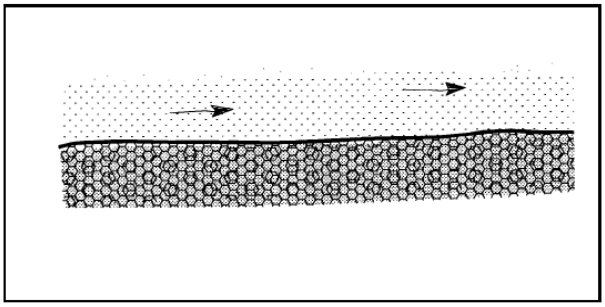
The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders.

**BEDROCK SHEET (BRS) [2.2] {24}**



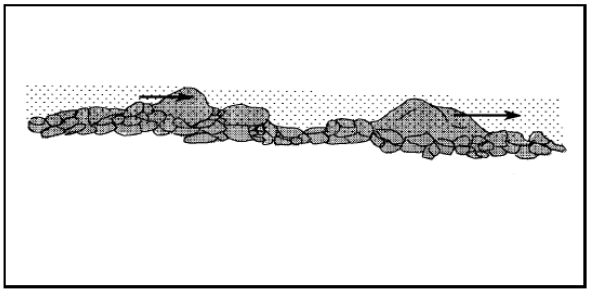
A thin sheet of water flowing over a smooth bedrock surface. Gradients are highly variable.

**GLIDE (GLD) [3.2] {14}**



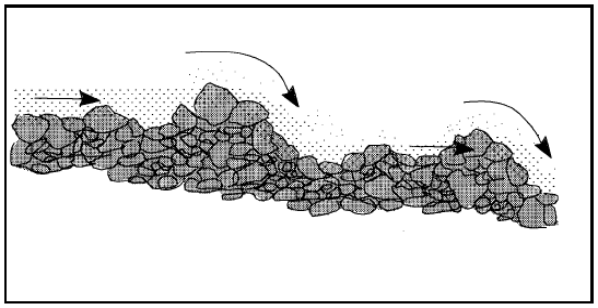
A wide, uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel, and sand.

**RUN (RUN) [3.3] {15}**



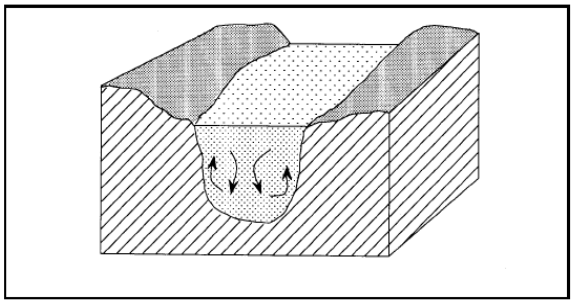
Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrate consists of gravel, cobble, and boulders.

**STEP RUN (SRN) [3.4] {16}**



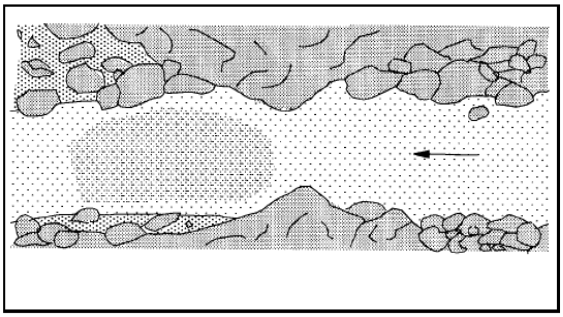
A sequence of runs separated by short riffle steps. Substrate is usually cobble and boulder dominated.

**TRENCH POOLS (TRP) [4.1] {8}**



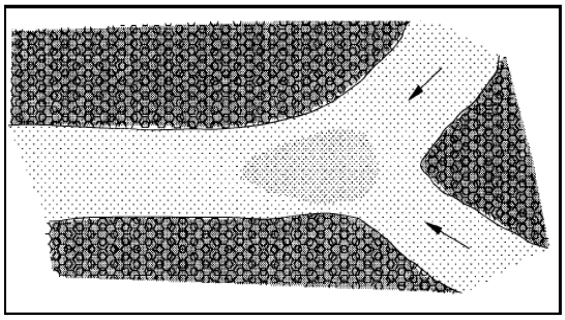
Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform.

**MID-CHANNEL POOL (MCP) [4.2] {17}**



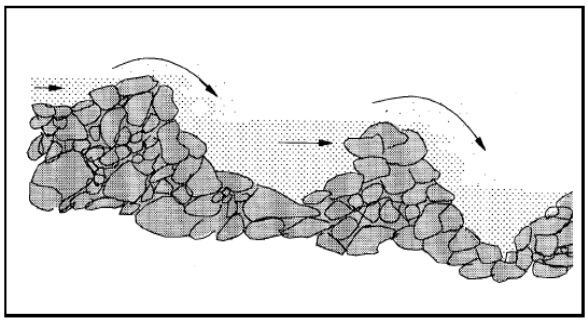
Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable.

**CHANNEL CONFLUENCE POOL (CCP) [4.3] {19}**



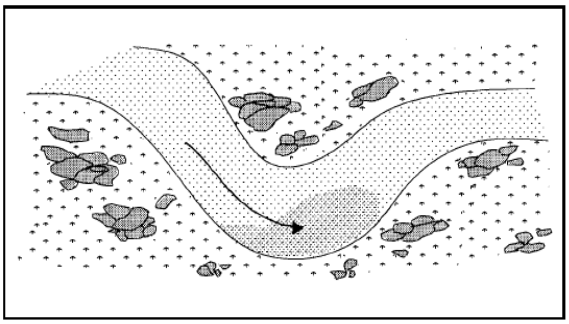
Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or scour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types.

**STEP POOL (STP) [4.4] {23}**



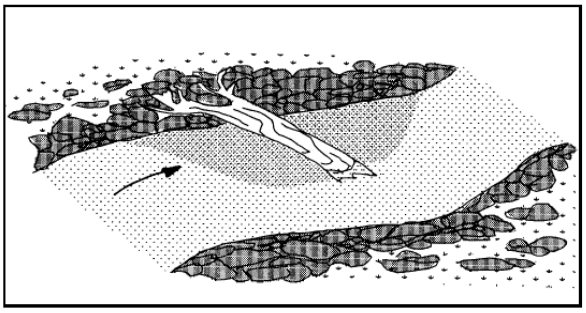
A series of pools separated by short riffles or cascades. Generally found in high-gradient, confined mountain streams dominated by boulder substrate.

**CORNER POOL (CRP) [5.1] {22}**



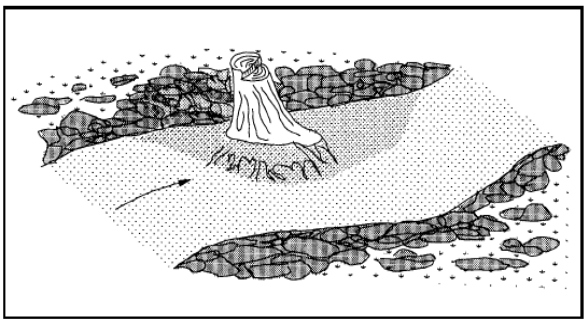
Lateral scour pools formed at a bend in the channel. These pools are common in lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions.

**LATERAL SCOUR POOL - LOG ENHANCED (LSL) [5.2] {10}**



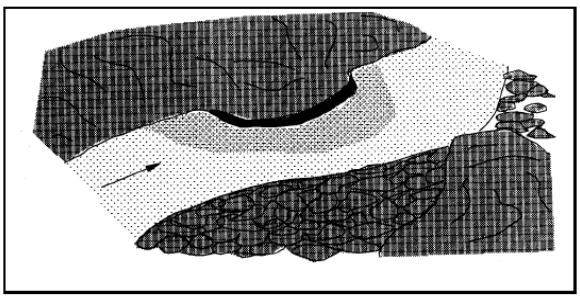
Formed by flow impinging against a partial channel obstruction consisting of large woody debris. The associated scour is generally confined to < 60% of the wetted channel width.

**LATERAL SCOUR POOL - ROOT WAD ENHANCED (LSR) [5.3] {11}**



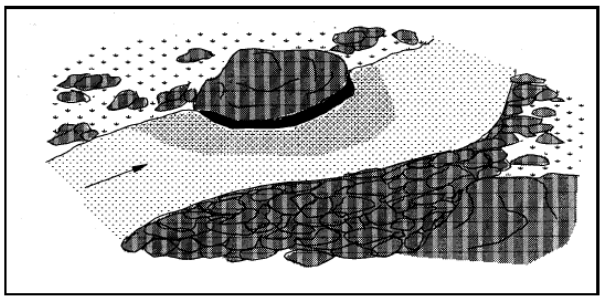
Formed by flow impinging against a partial channel obstruction consisting of a root wad. The associated scour is generally confined to < 60% of the wetted channel width.

**LATERAL SCOUR POOL - BEDROCK FORMED (LSBk) [5.4] {12}**



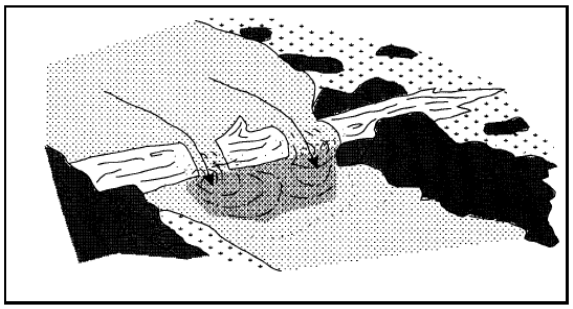
Formed by flow impinging against a bedrock stream bank. The associated scour is generally confined to < 60% of the wetted channel width.

**LATERAL SCOUR POOL - BOULDER FORMED (LSBo) [5.5] {20}**



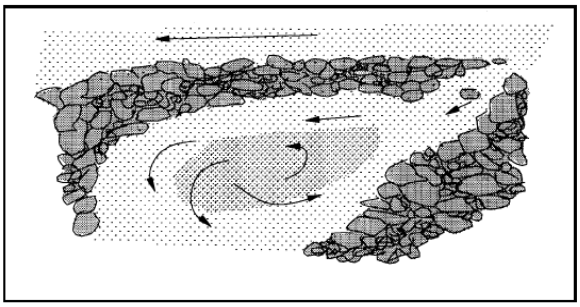
Formed by flow impinging against a partial channel obstruction consisting of a boulder. The associated scour is generally confined to < 60% of the wetted channel width.

**PLUNGE POOL (PLP) [5.6] {9}**



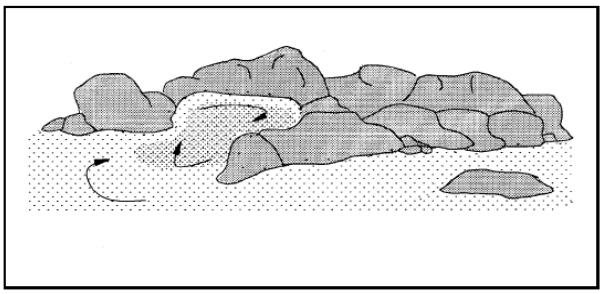
Found where the stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable.

**SECONDARY CHANNEL POOL (SCP) [6.1] {4}**



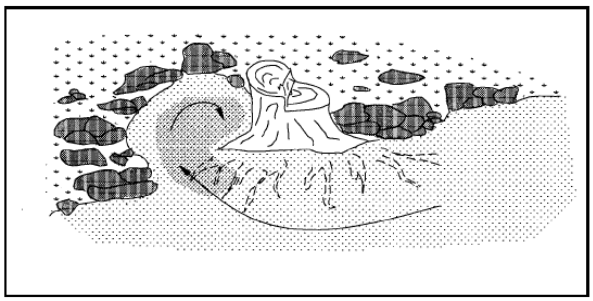
Pools formed outside of the average wetted channel width. During summer, these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrate.

**BACKWATER POOL - BOULDER FORMED (BPB) [6.2] {5}**



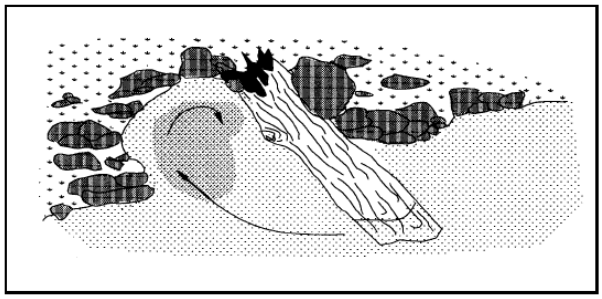
Found along channel margins and caused by eddies around a boulder obstruction. These pools are usually shallow and are dominated by fine-grain substrate. Current velocities are quite low.

**BACKWATER POOL - ROOT WAD FORMED (BPR) [6.3] {6}**



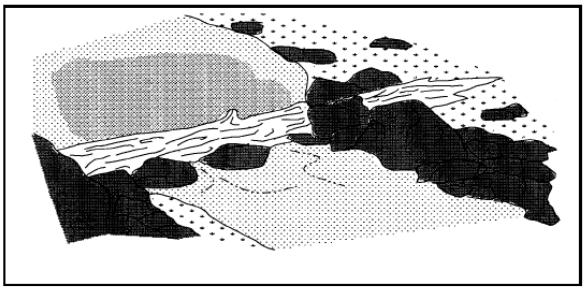
Found along channel margins and caused by eddies around a root wad obstruction. These pools are usually shallow and are dominated by fine-grained substrate. Current velocities are quite low.

**BACKWATER POOL - LOG FORMED (BPL) [6.4] {7}**



Found along channel margins and caused by eddies around a large woody debris obstruction. These pools are usually shallow and are dominated by fine-grained substrate. Current velocities are quite low.

**DAMMED POOLS (DPL) [6.5] {13}**



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.

## *Survey Methods*

*Field Equipment*

- Waders/boots
- Field tape (200-300 ft.)
- Stadia rod
- Spherical densiometer
- Flagging
- Field tablet (GPS, camera, maps, datasheet)

Habitat typing is conducted by a trained two-person crew, with the lead surveyor being qualified to identify local aquatic and riparian species. The lead surveyor typically records data and makes observations while the second surveyor collects physical measurements. The lead surveyor is responsible for designating the beginning and end of each habitat unit and assigning it a habitat type. The survey proceeds upstream according to the following sampling rules:

- 100% of units are assigned a habitat type code and measured for length
- Every time a unique habitat type is encountered (including the first occurrences at the beginning of the survey), the unit is fully measured for all metrics and characteristics on the field form
- Every third pool encountered is fully measured (~ 33% of all pools)
- Every third glide or run encountered is fully measured (~ 33% of all glides and runs)
- Every fifth riffle encountered is fully measured (~ 20% of all riffles)
- Canopy cover is measured in every 4$^{th}$ unit (~25% of all units)
- Bankfull width is measured at approximately every 10$^{th}$ unit (~ 10% of all units)
- Water and air temperature is measured at approximately every 10$^{th}$ unit (~10% of all units)

The length of each habitat unit is measured by stretching a field tape along the approximate center-line of the channel between the two surveyors. Water depths and habitat unit widths are measured with a stadia rod. Bankfull widths are measured with either a stadia rod or field tape, depending on the size of the channel. Canopy cover is measured using a convex spherical densiometer.

Additional survey details, including GPS waypoints and photographs are collected at the beginning and end of each survey and at other points of interest (fish passage barriers, potential restoration sites, biological observations, etc.).

Due to budgetary and time constraints, streamflow is generally not measured for habitat surveys. If suitable streamgage data are available for the stream being surveyed**,** the flow should be recorded in cubic feet per second at the beginning and the end of each survey day. If flow is not measured, a visual estimate of flow conditions can be made.

Habitat surveys are broken down into reaches based on channel type, management considerations, or landmarks and other physical features (e.g. bridges, trail crossings, slope breaks, property boundaries, etc.). Reach breaks are best determined following fieldwork during the data analysis and post-processing phase using GIS software.

The *California Salmonid Stream Habitat Restoration Manual* provides a habitat typing survey field form template. The Napa RCD uses a modified version of this form (Figure 2).

| Habitat Unit Number | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Habitat Unit Type | | | | | | | | | | | |
| Length (ft) | | | | | | | | | | | |
| Maximum Depth (ft) | | | | | | | | | | | |
| Average Depth (ft) | | | | | | | | | | | |
| Width (ft) | | | | | | | | | | | |
| Canopy | % Cover | | | | | | | | | | |
| | % Hardwood | | | | | | | | | | |
| | % Conifer | | | | | | | | | | |
| Substrate (Primary) | | | | | | | | | | | |
| Substrate (Secondary) | | | | | | | | | | | |
| Pool Tail Substrate | | | | | | | | | | | |
| Spawning Quality | | | | | | | | | | | |
| LWD Count (>1.5'D x 6'L) | | | | | | | | | | | |
| Shelter Value | | | | | | | | | | | |
| % Unit Covered | | | | | | | | | | | |
| Shelter Types | Undercut bank/ledges | | | | | | | | | | |
| | SWD | | | | | | | | | | |
| | LWD | | | | | | | | | | |
| | Roots | | | | | | | | | | |
| | Terrestrial Vegetation | | | | | | | | | | |
| | Aquatic Vegetation | | | | | | | | | | |
| | Boulders | | | | | | | | | | |
| | Bubbles/White-water | | | | | | | | | | |
| Streambanks | RB Composition | | | | | | | | | | |
| | RB Dominant Veg. | | | | | | | | | | |
| | RB % Vegetated | | | | | | | | | | |
| | LB Composition | | | | | | | | | | |
| | LB Dominant Veg. | | | | | | | | | | |
| | LB % Vegetated | | | | | | | | | | |
| Restoration Potential | | | | | | | | | | | |
| Bankfull Width (ft) | | | | | | | | | | | |
| Comments | | | | | | | | | | | |

**Figure 2.** Electronic field form

## *Data Fields*

**Habitat Unit Number** - Record habitat unit numbers in sequential order, beginning with "001" at the downstream end of the survey. If significant side channels are encountered, they should be surveyed on a separate data form. Side channel unit numbers should begin with the number of the unit where the split or divide begins (downstream end), and continue sequentially by adding a ".1", ".2", etc. to each habitat unit number as the side channel progresses upstream.

**Habitat Unit Type -** Determine the habitat type and record the corresponding numeric code.

**Length (ft)** - Measure the length of the habitat unit to the nearest whole foot along the channel centerline.

**Maximum Depth (ft) -** Measure the maximum water depth to the nearest 0.1 foot.

**Average Depth (ft)** - Take several representative water depth measurements throughout the unit with a stadia rod and record the average of these values to the nearest 0.1 foot.

**Width (ft)** - Measure two or more wetted channel widths within the habitat unit and record the average of these values.

**Canopy % Cover -** Measure the riparian canopy density using a spherical densiometer in the approximate center of the habitat unit.

**Canopy % Hardwood -** Estimate the percentage of the total canopy consisting of hardwood trees.

**Canopy % Conifer -** Estimate the percentage of the total canopy consisting of conifers.

**Substrate, Primary and Secondary –** Estimate the two most dominant substrates on the streambed of the unit from the following substrate classes:

| *Class* | *Size* |
|---|---|
| Silt/Sand | <2mm (0.1 inch) |
| Gravel | 2 - 64mm (.1 - 2.5 inch) |
| Cobble | 64 - 254mm (2.5-10 inch) |
| Boulder | > 254mm (10 inch) |
| Bedrock | |
| Concrete | |
| Other | |

**Pool Tail Substrate** - Estimate the dominant substrate in the pool tail-out where a salmonid is likely to spawn using the substrate classes listed above.

**Spawning Quality -** Assess the area of the pool tail-out where a salmonid is likely to spawn, and record a qualitative ranking using the following scale:

| *Ranking* | *Criteria* |
|---|---|
| Excellent | Highly favorable substrate size, topographic convergence, and water depth/velocity |
| Good | Suitable substrate size, topographic convergence, and water depth/velocity |
| Moderate | Lacking one or more spawning habitat requirement |
| Poor | Not suitable |

**LWD Count -** Enter the number of pieces of large woody debris within the habitat unit with a diameter of at least 18 inches and a length of at least 6 feet.

**Shelter Value -** Enter the number code (0 to 3) that corresponds to the dominant structural shelter type that exists in the unit using the following guidelines:

| *Value* | *Instream Shelter Complexity Value Examples:* |
|---|---|
| 0 | - No shelter |
| 1 | - One to five boulders<br>- Bare undercut bank or bedrock ledge<br>- Single piece of LWD (>18" dia. and 6' long) |
| 2 | - One or two pieces of LWD associated with any amount of SWD<br>- Six or more boulders per 50 feet<br>- Stable undercut bank with root mass, and less than 12" undercut<br>- A single root wad lacking complexity<br>- Branches in or near the water<br>- Limited submerged vegetative fish cover<br>- Bubble curtain/white water |
| 3 | Combinations of (must have at least two cover types):<br>- LWD/boulders/root wads<br>- Three or more pieces of LWD combined with SWD<br>- Three or more boulders combined with LWD/SWD<br>- Bubble curtain combined with LWD or boulders<br>- Stable undercut bank with >12" undercut with roots or LWD<br>- Extensive submerged vegetative fish cover |

**% Unit Covered** - Enter the percentage of the unit occupied by the structural shelter. Classify 100 percent of the shelter by the types indicated on the field form. Note: bubble curtain includes white water.

**Shelter Types and Abundance** - Assess whether each of the following shelter types are present within the unit

*Undercut bank/ledges* - generally only counted if horizontal extent is greater than 12 inches
*SWD* - small woody debris with a diameter of less than 18 inches
*LWD* - large woody debris with a diameter of at least 18 inches and a length of at least 6 feet
*Roots* - must be touching or overhanging water
*Terrestrial Vegetation* - must be touching or overhanging water
*Aquatic Vegetation* - rooted or floating vascular plants - not filamentous algae
*Boulders* - minimum diameter of 10 inches and must below bankfull elevation
*Bubbles/White-water* - must be sufficient to provide cover for 6-inch trout

For each shelter type present, assign a value of relative abundance from the following scale:

*Abundant* - present in multiple areas of the unit
*Moderate* - present in one area of the unit and covers a significant portion of that area
*Sparse* - present in one area of the unit and does not cover a significant portion of that area

**Bank Composition** – Observe both banks at the estimated bankfull discharge level. Banks are designated right or left when facing downstream. Select the substrate from the list below that is most dominant for each bank.

*Clay-Sand* - material comprised of particles <2mm (0.1 inch)
*Gravel-Cobble* - diameters from 2 - 254mm (0.1 - 10 inch)
*Boulder* - diameters >254 (10 inch)
*Bedrock* - natural solid material
*Concrete* - solid concrete
*Rip-rap* - placed rock

**Bank Dominant Vegetation** - Observe both banks from the estimated bankfull discharge level upslope approximately 20 feet. Banks are designated right or left when facing downstream. Select the vegetation type from the list below that is most dominant for each bank.

*Grass* - includes grasses and sedges
*Brush* - woody shrubs and bushes
*Hardwoods* - hardwood tree species (e.g. - maple, bay, oak, ash, willow, etc.)
*Conifers* - conifer tree species (e.g. - pine, fir, redwood, etc.)
*No Veg*. - no or very sparse vegetation present

**Percent Bank Vegetated** - Estimate the total percentage of the bank covered with vegetation from approximately bankfull to 20 feet upslope. Banks are designated right or left when facing downstream.

**Restoration Potential** - Note whether the habitat unit contains areas that would benefit from future restoration efforts. Categories include the following:

| *Restoration Category* | *Description* |
|---|---|
| Erosion | Streambanks are exposed, unstable, and likely contribute fine sediment |
| Structure | Fish passage obstruction or other structure instream or on banks |
| Exotic Vegetation | Significant area of non-native or invasive plant species |
| Other | Any other restoration recommendations |

**Bankfull Width -** Measure the bankfull width of approximately every 10$^{th}$ habitat unit. Measurements should be taken at representative areas of the channel, preferably at riffle crests.

### *GIS Data*

Habitat typing data are converted to spatial line features using ArcGIS software by linking the "TO" and "FROM" fields for each unit to an existing hydrography layer. The resulting GIS layer is calibrated using points collected in the field during the habitat survey - typically GPS waypoints and landmarks including buildings, fence lines, bridges, and tributary junctions. These points provide a set of "known" distances along the survey route. The final GIS habitat layer is fully attributed with all data from the survey (Table 2).

**Table 2.** GIS field names and descriptions.

| Field Name | Field Description |
|---|---|
| STREAM | Stream name |
| CREW | Survey crew members |
| DATE | Survey date in month/day/year |
| FLOW | Stream flow in cubic feet per second |
| WAT_TEMP | Water temperature in degrees Celsius |
| AIR_TEMP | Air temperature in degrees Celsius |
| REACH | Stream reach number |
| UNITNUM | Habitat unit number |
| HABTYPE | Habitat type as defined in CDFW manual |
| LENGTH_FT | Length of habitat unit in feet |
| FROM | Cumulative survey distance at downstream end of unit in feet |
| TO | Cumulative survey distance to upstream end of unit in feet |
| MAXDEP_FT | Maximum water depth in feet |
| AVGDEP_FT | Average water depth in feet |
| WIDTH_FT | Average wetted width in feet |
| CANOPY_PCT | Percent canopy in center of unit |
| HARDWD_PCT | Percentage of canopy comprised of hardwood trees |
| CONFR_PCT | Percentage of canopy comprised of coniferous trees |
| SUBSTRATE1 | Most dominant stream substrate |
| SUBSTRATE2 | Second most dominant stream substrate |
| POOLTAILSU | Substrate of pool tail-out where salmonids are likely to spawn |
| SPAWNQUAL | Spawning habitat quality at pool tail-out |
| LWD_COUNT | Number of Large Woody Debris pieces in unit |
| SHELTERVAL | Shelter value code as defined in CDFW manual |
| PCT_COVER | Percent of unit providing fish cover |
| UNDERCUT | Abundance of undercut banks in unit |
| SWD | Abundance of small woody debris in unit |
| LWD | Abundance of large woody in unit |
| ROOTS | Abundance of roots in unit |
| TERR_VEG | Abundance of terrestrial vegetation in unit |
| AQUA_VEG | Abundance of aquatic vegetation in unit |
| BOULDERS | Abundance of boulders in unit |
| WHITEWATER | Abundance of whitewater or bubbles in unit |
| RBCOMP | Right-bank composition |
| RBVEG | Right-bank dominant vegetation type |
| RBVEG_PCT | Percentage of right bank covered by vegetation |
| LBCOMP | Left-bank composition |
| LBVEG | Left-bank dominant vegetation type |
| LBVEG_PCT | Percentage of left bank covered by vegetation |
| REST_POT | Restoration potential |
| BFW | Bankfull width in feet |
| NOTES | Observations or notes |