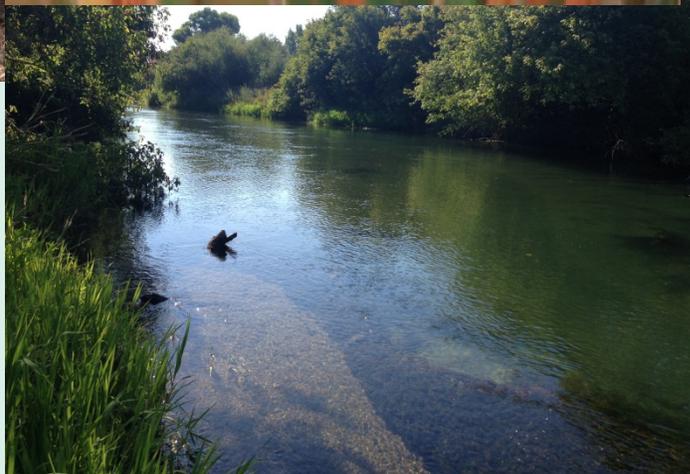


FINAL REPORT ◦ SEPTEMBER 2014

# User Guide: Mokelumne Riparian Benefits Quantification Tool



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**Cover photographs:**

Clockwise from upper left: Core team members testing the riparian bird habitat benefits quantification tool at a location along the Lower Mokelumne River, by Glen Leverich of Stillwater Sciences; Common yellowthroat, a riparian focal species, by Peter Knapp; Chinook salmon; and existing riparian habitat along the Lower Mokelumne River, by Amy Merrill of Stillwater Sciences.

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# 1 INTRODUCTION

Farms and ranches can provide many ecosystem services—clean air and water, biodiversity, carbon storage, and beautiful scenery. However, without a framework for valuing ecosystem services, the true value of benefits produced by healthy ecosystems is difficult to incorporate in land-use decisions. Market-based approaches to valuing ecosystem services provide a cost-effective means to achieve environmental results while sustaining and enhancing working, natural landscapes. In order to include the value of ecosystem services in our economy, we need to develop realistic, tractable and scientifically based tools for assessing ecosystem services provided by parcels of land and water. This guide is for the application of one such tool, developed to quantify changes in ecosystem services brought about through shifts in natural resources management on a parcel-by-parcel scale. The tool allows for varying levels of specificity in input information and resulting outputs. The Quantification Tool measures changes in four types of environmental benefits associated with healthy riparian corridors: riparian bird habitat, aquatic habitat, downstream flood attenuation, and stream shade. Instructions on how to use this Quantification Tool to estimate each of these four benefits are provided in Chapters 4–7 of this User Guide. Chapter 2 provides instructions on how to prepare to use the tool, and Chapter 3 provides instructions for gathering information on vegetation at the Project Area, which is used to help assess all four of the riparian benefits. Chapter 8 provides instructions on how to interpret the combined score for these four types of environmental benefits.

The final product of this Quantification Tool is a combined score for the quality of four riparian benefits provided by a site. As a percentage of potential, this score is multiplied by the site acres to generate the number of functional acre credits that can be assigned to a site under the Mokelumne Riparian Benefits Program.

## 1.1 Tool and User Requirements Include:

- Access to and familiarity with Excel 2003 or a more recent version
- Access to Google Earth or other similar Geographic Information System
- One to three days to gather and input information and to run the model, depending on the size and complexity of the Project Area
- User has a B.S. in Environmental Science or equivalent education and training and is experienced with basic landscape characterization and interpretation
- User is proficient at identifying both common woody plants to the genus level, given a list of potentially occurring tree and shrub species, and a handful of specified herbaceous plant species.
- User is proficient at performing topographic field surveys with a laser level or similar field equipment.

This User Guide is specific to the Riparian Benefits Quantification Tool and provides step-by-step instructions on tool application, including:

- Defining the Project Area
- In-the-office preparation and information collection
- In-the-field data collection

- Post-site visit data input to the tool
- Generating Ecosystem Service scores

### 1.2 Intended Use of Quantification Tool

This tool is intended to be accessible to landowners and/or agency staff so that baseline and potential increases in ecosystem services brought about through specific restoration and management actions at a site can be assessed. One to three days of effort, depending on site size and split fairly evenly between the field and office, should yield a score for ecosystem services provided by a particular site, along with potential changes in those services that could occur with changes in resources management. No destructive field techniques are involved. Ecosystem service scores are developed based on easily gathered field and landscape information linked to riparian benefits. Changes in riparian benefit scores for a site can be used to demonstrate increases in ecosystem services associated with restoration and/or changes in management practices. The scientific rationale for the field metrics and associated citations are summarized in Section 8. Reading and Understanding Habitat Scores.

### 1.3 Geographic Scope

This tool is designed to apply to lands along the Lower Mokelumne River in the Central Valley of California, shown within the red boundary in Figure 1-1.

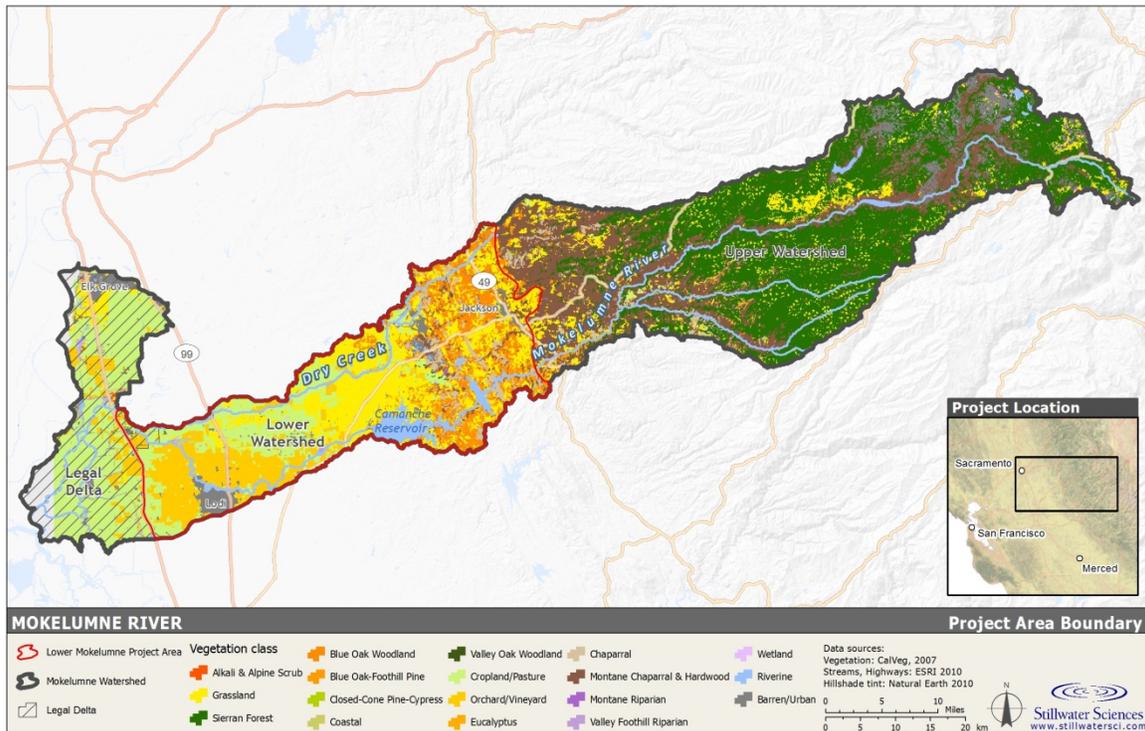


Figure 1-1. Geographic extent of the Mokelumne Riparian Benefits Quantification Tool applicability is shown by the red outline around the Lower Mokelumne River, excluding the legal Delta.

## 1.4 Model Structure

The surrounding landscape and historical context of a Project Area affects the importance and value of the services that site can provide. In particular, this ecosystem service quantification tool distinguishes between the landscape priority and site capacity of a Project Area, as described below:

- *Landscape Priority:* The extent to which the surrounding landscape currently provides, or could provide in the foreseeable future, the Project Area an opportunity to perform a particular ecosystem service (e.g., does the landscape act as a source of riparian birds and can it accommodate increased production of riparian bird populations?) and the whether or not that service is valuable in that place in the landscape.
- *Site Capacity:* The extent to which existing or potential physical and biological attributes of the site enable it to provide ecosystem services (e.g., does the Project Area itself provide good and sustainable habitat for riparian birds?).

A hypothetical example can be used to better illustrate these concepts. Site characteristics for a reach of floodplain, such as flooding width, vegetation and type and density, availability of special habitat features such as eroding cliffs (cliff swallows), emergent wetlands (redwing blackbirds), and dense ground cover (ground nesting species) will affect the degree to which that riparian area could support diverse and large native bird populations (site capacity). However, whether or not there are existing adjacent populations of riparian birds that could move into and use a newly created habitat is a characteristic of the surrounding lands rather than the project site itself. As another illustration, a site that has a large and frequently inundated floodplain might have the site capacity to substantially reduce downstream flooding; but reduced downstream flooding is only valuable if the value of downstream areas is reduced by floods. If the floodable downstream areas include only native floodplains and emergent wetlands, then there is no benefit from diminishing the flood flows to those areas. If the downstream floodable area includes a vineyard or residential area, then reducing downstream flooding would be very valuable.

A Project Area's Landscape Priority score is determined separately from the Site Capacity Score, and the two scores are combined into a total score for each benefit calculated (e.g., riparian bird habitat, aquatic habitat, shade, and downstream flood attenuation). These separate benefit scores are also bundled into a summary 'riparian benefit' score for the Project Area. The final scores are translated into habitat-acres by multiplying the score percent value as a fraction of one times the number of acres being restored or alternatively managed in the Project Area (e.g., a 5-acre Project Area that receives a score of 80% translates to  $0.80 * 5 \text{ acres} = 4 \text{ habitat-acres}$ ). More on how these scores are calculated and bundled is provided in Section 8. Reading and Understanding Habitat Scores.

The Quantification Tool also can be used to estimate future changes in site capacity based on growth of vegetation over time. A set of calculations, based on observations and best available

information on native and non-native plants common in the Central Valley, provides estimates of the change in height, crown diameter, and crown density through time so that a user can enter information on plant species composition and planting density for year 1 (Y1) and estimate increased riparian benefits for subsequent years using the Quantification Tool's 'Veggiematic' sub-routine.

The Quantification Tool is built in Excel software and includes data input sheets that reflect the structure and format of the field data sheets to ease data transfer from hard field copies to the

Excel tool spreadsheet. The actual ecosystem service scores and habitat-acres are calculated and provided to the user in the 'Summary Scores' worksheet of the Quantification Tool. There are a total of 14 worksheets (tabs) in the Quantification Tool spreadsheet that address riparian bird habitat, aquatic floodplain habitat, and downstream flood attenuation. Eight of these worksheets require user input to calculate the summary scores for riparian benefits, as outlined in Table 1-1. Shade benefits are calculated in a separate spreadsheet that also requires several steps using Arc GIS.

**Table 1-1.** List of Excel worksheets used for the Mokelumne Riparian Benefits Quantification Tool.

<b>Worksheet title</b>	<b>Description</b>	<b>User input required?</b>
Read Me	Provides general rules and guidelines for using Quantification Tool	N
Summary Scores	Provides a summary of the landscape priority, site capacity, and combined scores and habitat-acres for riparian bird habitat, aquatic floodplain habitat, flood attenuation, and riparian shade.	Y
Veg_Data	Vegetation specific data for assessing Site capacity through time; initial data gathered in field and/or restoration plans	Y
Bird_Office	Landscape priority input data for riparian bird habitat from online (Google Earth, websites), and manager interviews	Y
Bird_Field	Site capacity input data gathered in field on site capacity	Y
Bird_Score	Retrieves and scores information from other worksheets to calculate scores for riparian bird habitat	N
Fish_Office	Landscape priority input data for aquatic habitat from online (Google Earth, websites), and manager interviews	Y
Fish_Field	Site capacity input data gathered in field on site capacity for aquatic habitat	Y
Fish_Score	Retrieves and scores information from other worksheets to calculate scores for aquatic habitat	N
Flood_Office	Landscape priority input data for downstream flood attenuation from online (Google Earth, websites), and manager interviews	Y
Flood_Field	Site capacity input data gathered in field for downstream flood attenuation	Y
Flood_Score	Retrieves and scores information from other worksheets to calculate scores for downstream flood attenuation	N
Veg_Parameters	Source file used to estimate growth rates and extent by plant species and groups of species	N
FloodAttenLSSLandUse	Source file used to estimate land use and land value effects associated with flooding	N

## 2 PREPARATION

Application of the Quantification Tool requires:

- 1 to 3 days, depending on project size and complexity (approximately 1 day for <30 ac)
- Microsoft excel 2003 or higher
- Google Earth, GIS system
- Arc GIS 9.x for Shade tool
- Basic field knowledge in soils, rivers, and local plant species
- Information on proposed management or restoration
- Information on current management practices
- An electronic version of the Quantification Tool file (it is an Excel spreadsheet in version 2010), the Shade tool spreadsheet
- Electronic copies of the Flood Analysis Tools (two Excel files and one kml file)
- Hard copies of the Office and Field Data Sheets (Appendix B contains blank sheets)
- Imagery from April and June 2006 of Lower Mokelumne River (Arc GIS)
- A field map of the Project Area (approximate scale 1:1,500)

Suggestions for making your experience with the Quantification Tool (Data Entry) expeditious:

1. Take an hour to read the directions before following your intuition. It will save you time.
2. Take time to walk around and understand the Project Area before starting data collection.
3. Bring a large clean field map with clear, recent imagery to the field; scales of 1:1,500 to 1:2,500 are recommended.
4. Do not delete any of the rows in the Quantification Tool spreadsheets. That would break critical links among the worksheets that are required for developing the ecosystem services score for your site.
5. Only enter data into yellow cells. Do not enter any information or make any changes in cells that are gray or green as these include essential formulas and links.
6. Do not enter data in the Score worksheets.

**Table 2-1.** List of Data Sheets used to record data information in the Field or Office for Riparian Benefits Quantification Tool (copies provided in Appendix B).

<b>Data sheet title</b>	<b>Name referred to in text</b>	<b>Components of data sheet</b>	<b>Number data sheets</b>	<b>Number explanation sheets</b>
Office Data Sheet: Ecosystem Services Riparian Bird Habitat	Bird Office Data Sheet	Bird Office Data Sheets	2	0
Field Data Sheet: Ecosystem Services Riparian Bird Habitat	Bird Field Data Sheet	Project Overview Questions and Notes Page	1	0
		Map Unit Field Questions	1	0
		Field Question Explanations and Definitions Reference Sheet	0	1
Field Data Sheet: Ecosystem Services Riparian Vegetation	Vegetation Field Data Sheet	Project Overview Questions and Notes Page	1	0
		Map Unit Field Questions	1	0
		List of Vegetation Codes and Types Reference Sheet	0	2
Office Data Sheet: Ecosystem Services Aquatic and Fish Habitat	Fish Office Data Sheet	Fish Office Data Sheets	1	0
Field Data Sheet: Ecosystem Services Aquatic and Fish Habitat	Fish Field Data Sheet	Project Overview Questions and Notes Page	1	0
		Map Unit Field Questions	2	0
		Field Question Explanations and Definitions Reference Sheet	0	2
Office Data Sheet: Ecosystem Services Potential for Flood Attenuation	Flood Office Data Sheet	Flood Office Data Sheets	3	0
Field Data Sheet: Ecosystem Services Aquatic and Fish Habitat	Fish Field Data Sheet	Project Overview Questions and Notes Page	4	0
		Field Question Explanations and Definitions Reference Sheet	0	5
<b>TOTAL</b>			<b>12</b>	<b>10</b>

### 3 VEGGIEMATIC AND THE VEGETATION DATA SHEET

Estimating or ‘gaming’ changes in riparian vegetation through time and estimating the effects of these changes on the benefits provided by riparian vegetation is performed by the Veggiematic subroutine in the Quantification Tool. The Veggiematic can be used to simulate changes in existing vegetation 2 to 60 yrs from present. No changes will be apparent after that since all trees are assumed fully grown at 60 yrs. Information on vegetation at a project site is incorporated into scores for riparian bird habitat, fish and aquatic habitat, and downstream flood attenuation.

The Veggiematic can also be used to explore expected changes in riparian services through implementation of various restoration designs by inputting specific planting plan information (species density and distribution) and simulating plant growth over time. Changes in ecosystem service scores (and habitat-acres) will be generated with each time series, assuming all other variables remain the same (such as special habitat features, management, and landscape relationships). Vegetation Types recognized by the Veggiematic are listed in Appendix G, along with their codes and brief descriptions.

The Veggiematic runs on two worksheets in the Quantification Tool: the ‘Veg\_Data’ and the ‘Veg\_Parameters’ worksheets. Specific observations (data) are recorded in the field on the Vegetation Field Data Sheet (Appendix B), and input to the green ‘Veg\_Data’ worksheet of the Quantification Tool. Parameters, or constants, used to estimate change over time are stored in the ‘Veg\_Parameters’ worksheet, and presented in Appendix H of this document. The most important piece of equipment you take into the field will be a good Project Area Map and knowledge of the local ecology and land management practices.

#### **Field equipment list**

- Project Area Map
- Project Area boundary field markers or known extent in the field
- Field data sheets (see Appendix B)
- Local plant species list
- This User Guide
- Pencils, colored fine-tipped markers (2 to 3 colors recommended)
- Loggers tape
- Clipboard
- Camera (optional, photos are useful to remember site)
- Water, sun screen, snacks, and other field supplies

#### **3.1 Project Area Map**

A hard copy aerial photograph or image of the Project Area must be generated in the office before heading out to the field. A well labeled, accurate aerial photograph of the Project Area is an important piece of the Riparian Benefits Quantification Tool and will become the Project Area Map. This map will indicate the location and sizes of each area surveyed, and will be a useful

overall reference for assessing current and future conditions in the Project Area. Take care to record information on this image; the resulting map should be clean, well labeled and accurate.

The Project Area Map should be printed out on 11 x17” sized paper, and must:

- Show boundary of entire Project Area
- Be based on a recent aerial image, such as from NAIP or Google EarthEarth
- Show the month and year of the photograph in one corner of the image.

**Project Area Boundaries:** Use Google Earth or a similarly high resolution aerial image of the Project Area to clearly delineate the Project Area boundaries, either on Google Earth or on the hard copy using a brightly colored sharpie.

**Map Unit Boundaries:** Map Units are areas under 5.7 acres in size that are under the same management plan and subject to approximately the same frequency of flooding from the Mokelumne river, and that occupy the same side of the channel. Delineate these Map Units and assign unique numbers to each on the Project Area map. Site-specific information will be collected for each Map Unit on habitat features, vegetation, and management practices. Setting the maximum size for these assessment areas at 5.7 acres is intended to ensure that the entire Project Area is well described and characterized in the Quantification Tool. It is very important that these Map Units are clearly outlined and uniquely labeled on the Project Area map.

**Delineating Vegetation Polygons:** Delineate vegetation polygons within each Map Unit that supports a consistent set of vegetation. Keep the mapping as simple as possible while still reflecting changes in vegetation and management. Identifying and delineating areas (polygons) of different vegetation types is a matter of looking for areas that in general, are dominated by one or two plant species. We suggest a minimum mapping unit size of 300 ft<sup>2</sup>. This must be done in the field. Examples of delineated vegetation in Map Units are provided in Appendix I.

- Record the distribution of different vegetation in each Map Unit by outlining areas that support a consistent set of dominant plant species using the Project Area Map and a sharpie (silver works well on aerial photographs).
- Apply a unique identification number to each Map Unit and to each vegetation polygon on the Project Area Map (Figure 3-1).
- Record information for each unique polygon on the Vegetation Data Sheet.

Once delineated on the field map, take the field map and digitize these Map Unit areas and vegetation polygons into Arc GIS. The calculated areas of each vegetation polygon in square feet will be added to the veg\_data worksheet (see next section).

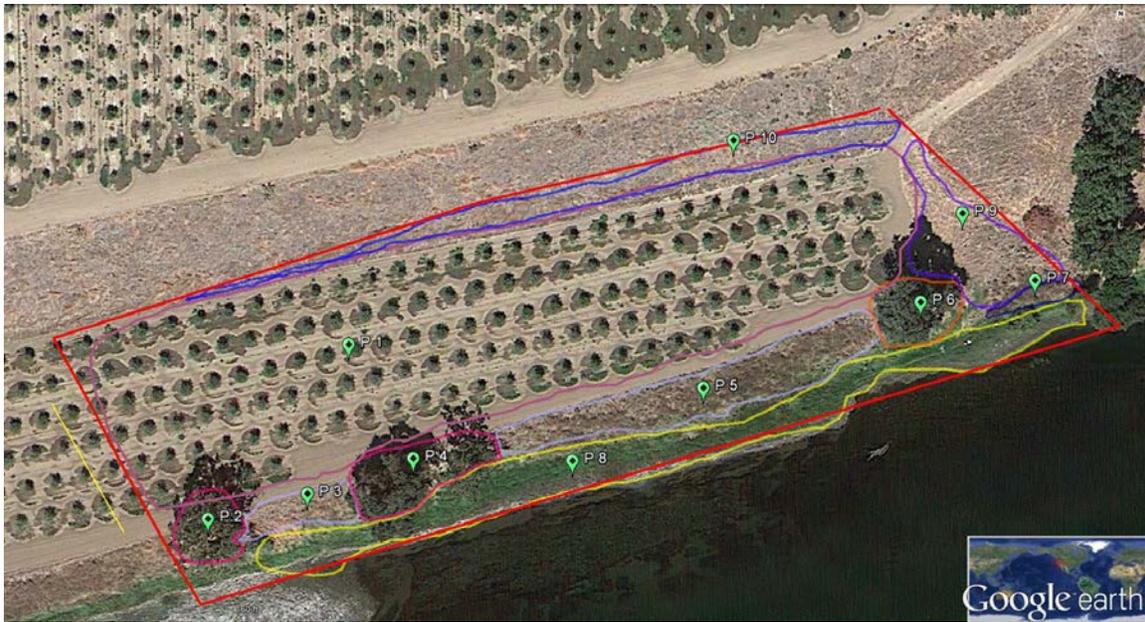


Figure 3-1. Hypothetical Map Unit with areas of consistent vegetation cover delineated and labeled into polygons (more examples provided in Appendix I).

### 3.2 Filling out Vegetation Field Data Sheet and the Veg\_Data Worksheet

You must record information on the vegetation in each vegetation polygon within each Map Unit. A list of common native riparian Central Valley plant species and vegetation types is provided in Appendix E, as well as a list of common invasive non-native species in Appendix F. You do not have to know every plant to the species level to fill out this data sheet, but you will need to be familiar with the common, dominant native woody riparian plants and invasive non-native weeds listed in Appendices E and F. Other woody and herbaceous plants can be recorded under some of the more generic vegetation types, such as ‘other shrub species’, or ‘herbaceous grasses and weeds’.

For each polygon you will need to fill out information on 13 to 18 variables in the Vegetation Field Data Sheet. **ONLY USE ONE LINE PER POLYGON.** If a vegetation polygon is a matrix of two different vegetation types, such as valley oak and annual grassland, these two types can be entered as vegetation type 1 and vegetation type 2 for a single polygon. Similarly, if there are two important vegetation layers, such as an upper forest canopy and a shrub or grass layer, then these two layers can be entered as vegetation types 1 and 2 for a single polygon. No distinction is made between if the two vegetation types are distributed horizontally or vertically in the polygon. It is not necessary to include a second vegetation type in every polygon; it is an option to enrich the description.

In the Veg\_Data worksheet, information on the set of polygons delineated in each Map Unit are entered in columns A to R. Information on the vegetation polygons in Map Unit 1 can be entered in lines 13 through 37, for a total of 25 possible polygons within Map Unit 1. Go to the next set, lines 43 through 67, to enter polygon information for Map Unit 2, etc. The Veg\_Data worksheet

has room for up to 10 Map Units within a single Project Area. If you have more Map Units, divide the Project Area into one or more smaller Project Areas.

Vegetation Field Data Sheet: Appendix B  
QT data entry worksheet: Veg\_Data

Each variable that must be recorded on the Vegetation Field Data Sheet and entered into the Veg\_Data worksheet is described below.

### 3.3 Project Area Overview Questions

- **Question 1.** Are you running a time series?

**Field Data Collection:**

Answer question on the Vegetation Field Data Sheet as Yes or No. Time series are run to estimate how existing or anticipated conditions at a Project Area could change the environmental benefits produced through time. Time series can be run for up to 60 yrs into the future, starting with year 0, as the year when a restoration action is initiated, or as the initial conditions for a site.

**Quantification Tool Data Entry:**

In Veg\_Data worksheet next to Question 1 enter “1” for ‘Yes’ or “0” for ‘No’ into Column O (yellow cell).

- **Question 2.** If yes to (1), enter year of time series since restoration here (this will be added to age of each species entered in tables below).

**Field Data Collection:**

Fill in years since restoration began on Vegetation Field Data Sheet. If Question number one was a yes, the number will be used in the veggimatic. For this question, you need to write down the how many years since the restoration or enhancement project was implemented. If it has not yet been implemented, then indicate this by assigning it a ‘0’ assessment year. If the project was implemented (e.g., planted) one growing season ago, then indicate it is year ‘1’; if two growing seasons have passed, then indicate year ‘2,’ etc. If it is a mature site with large trees you can either estimate the age of the most common trees, or indicate it is ‘mature’ by recording ‘60’. Sixty is the oldest age site recognized by the Riparian Bird Habitat Quantification Tool.

**Quantification Tool Data Entry:**

In Veg\_Data worksheet next to Question 2 enter number of years into Column O (yellow cell).

- **Question 3.** Are you targeting a period of high (H), medium (M), or low (L) precipitation or irrigation since last measure?

**Field Data Collection:**

Enter the water year type for the year under consideration, based on the percent of normal precipitation or on the degree to which the site will be irrigated. If irrigated to maintain high moisture, then indicate ‘High’; if irrigated infrequently for medium moisture levels, then indicate ‘Medium’. If there will be no supplemental irrigation, then answer based on the water year type. For past water years, this information can be obtained from the California Department of Water Resources website: <http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST> (Table 3-1).

Table 3-1. Cross-reference for DWR water year types and the water year classifications used in the Riparian Benefits Quantification Tool.

DWR water year type	Tool water year class
W= Wet year type	High
AN= Above normal year type	Medium
BN = Below normal year type	Medium
D = Dry year type	Low
C = Critical year type	Low

**Quantification Tool Data Entry:**

In the Veg\_Data worksheet next to Question 3 enter an H, M, or L into Column O (yellow cell).

### 3.4 Map Unit

Map Unit number

**Field Data Collection:**

Record the unique Map Unit numbers as assigned on the Project Area Map in the first column of the Vegetation Field Data Sheet.

**Quantification Tool Data Entry:**

In Veg\_Data worksheet enter the value into Column A. **It is important to enter the map unit whenever there is data entered for the other variables in Columns C to M.**

Direct or impeded flow from river? (D or I)

**Field Data Collection:**

If the Map Unit can receive direct flows from the river when flows are 5,000 cfs or less at the base of Camanche dam, enter “D” for direct. If the Map Unit only receives river flows through a levee failure of any sort, seepage through the levee, over topping a levee, from elevated ground water, or from uphill run off, enter an “I” for indirect. Record the value on the second column in the Vegetation Field Data Sheet.

**Quantification Tool Data Entry:**

In the Veg\_Data worksheet enter the value into Column B ‘Code’ in the first row for each map unit (yellow cell). The value will automatically apply to all vegetation polygons entered for that Map Unit.

Polygon number

**Field Data Collection:**

Record the unique polygon number as assigned on the Project Area Map in the Vegetation Field Data Sheet.

**Quantification Tool Data Entry:**

In the Veg\_Data worksheet enter the polygon numbers into Column C.

Polygon size (sq ft)

**Data Collection:**

Digitize Map Unit and vegetation polygon boundaries into a GIS shapefile. In the attribute table, record the Map Unit code, the vegetation polygon code, the vegetation type 1 code, and the dominant vegetation age (see below for further explanation of these variables). Use Arc GIS to calculate the polygon areas in square feet.

**Quantification Tool Data Entry:**

Record the size of each polygon in square feet on the fourth column of the Vegetation Field Data Sheet from Arc GIS.

Dominant Soil Texture Class

**Field Data Collection:**

Determine which general soil texture class is dominant in the vegetation polygon according to these descriptions:

Coarse: soil dominated by sand or with over 15% gravel or cobble by volume.

Medium: soil dominated by loams

Fine: soil dominated by clay or silt

**Quantification Tool Data Entry:**

In the Veg\_Data worksheet enter the single letter code for the Dominant Soil Texture Class (C=Coarse; M=Medium, F=Fine) into Column E

Tree Recruitment Class

**Field Data Collection:**

If there are no young native trees in the polygon with a stem diameter at 4.5 ft ht less than 3 inches, enter "0". If there are 1 or 2 small trees, then enter "L"; if there are 3 or 4 small trees, enter "M"; if there are 5 or more small trees, enter "H". If the tree is less than 4.5 ft tall, and the stem diameter at the soil surface is less than 2 inches, then consider it a young recruited tree.

**Quantification Tool Data Entry:**

In the Veg\_Data worksheet enter the one letter code, "0", "L", "M", or "H" for the tree Recruitment class into Column F.

Percent cover herbaceous vegetation (%)

**Field Data Collection:**

Estimate the percent cover of herbaceous (non-woody) vegetation in each polygon between 0 and 2 feet above ground using techniques described in Appendix D. Record this as a percent (e.g., 50 for 50%) on the Vegetation Field Data Sheet.

**Quantification Tool Data Entry:**

- In Veg\_Data worksheet enter the percent herbaceous cover into Column G. Do not enter a % sign.

Percent cover of mugwort, hedge nettle, Santa Barbara Sedge, and California Blackberry (%)

**Field Data Collection:**

Estimate the percent cover mugwort, hedge nettle, Santa Barbara Sedge, and California Blackberry vegetation in each polygon using techniques described in Appendix D. Record this as a percent (e.g., 50 for 50%) on the Vegetation Field Data Sheet.

**Quantification Tool Data Entry:**

In Veg\_Data worksheet enter the percent cover into Column H. Do not enter a % sign.

### 3.5 Dominant Vegetation (Veg 1 Type and Veg 2 Type)

Dominant Vegetation Type

**Field Data Collection:**

If a vegetation polygon is a matrix of two different vegetation types, such as valley oak and annual grassland, these two types can be entered as vegetation type 1 and vegetation type 2 for a single polygon. Similarly, if there are two important vegetation layers, such as an upper forest canopy and a shrub or grass layer, then these two layers can be entered as vegetation types 1 and 2 for a single polygon. No distinction is made between if the two vegetation types are distributed horizontally or vertically in the polygon. It is not necessary to include a second vegetation type in every polygon; it is an option to enrich the description.

**Veg 1 (V1) Type:** Look through the set of Vegetation Types provided in Appendix G. Determine which of these vegetation types most closely describes the dominant plants in each polygon and record this as the Veg 1 Type number Code on the Vegetation Field Data Sheet as provided in Appendix B.

**Veg 2 (V2) Type:** This is the same as for Veg 1 (V1), but for the secondary vegetation type, such as vegetation that is in the understory, or that covers less area than the Veg 1 Type.

**Note:** Do not make up new types because each type listed in Appendix G is linked to maximum growth rate and size values in the Veg\_Data worksheet that are used to model changes in vegetation over time.

**Quantification Tool Data Entry:**

Veg 1 Type:

- In Veg\_Data worksheet enter the Veg. 1 Code into Column I. The vegetation type name will automatically appear in Column S once you enter the Veg. 1 Type Code.

- Check to be sure the correct vegetation type name appears in Column T.

Veg 2 Type:

- In Veg\_Data worksheet enter the Veg. 2 Code into Column N. The vegetation type name will automatically appear in Column T once you enter the Veg. 1 Type Code.
- Check to be sure the correct vegetation type name appears in Column T.

Average age of dominant plants (V1 age and V2 age)

**Field Data Collection:**

Estimate the average age of the dominant plants in each polygon. If there is one tree that is far older than the rest of the woody plants, record the age of the majority rather than the average between the older tree and the other woody plants. Be as exact as possible, but if necessary use these age categories as a guide:

- 1 (seedling: <1yr or <1”dbh);
- 2 (sapling: 1–2yr or 1–3”dbh),
- 3 (pole: 2–4yr or 3–5” dbh),
- 5 (young-mature: 5–10 yr or 5–10”dbh),
- 20 (mid-mature: 10–40 yr or 10–20” dbh),
- 60 (mature: >40 yrs or >20” dbh),
- 100 (decadent: >40 yr or >10” with >25% of canopy dead/dying).

**Quantification Tool Data Entry:**

Veg 1 Type:

- In Veg\_Data worksheet enter the V1 age in years into Column J.
- OR
- If you are using the Quantification Tool to understand changes in a restored site over time, enter the ages at Year 1 here, and record the number of years since implementation under Question D in the Project Area Overview (“Assessment Year”). The Veggiematic will use the sum of Year 1 age and the Assessment Year as the age for the dominant plants in each polygon. In other words, for ‘gaming’ changes in a site through time, keep the Year 1 age constant, and change the “Assessment Year”. If you are matching a time-series for the Riparian Bird Habitat with that used for Riparian Shade Model, only use years 1, 2, 3, 4, 5, 10, 15, 20, 30, and 50. If you are not interested in matching a time sequence with the Riparian Shade model, you do not have constraints on what years are used.

Veg 2 Type:

- In Veg\_Data worksheet enter the V2 in years into Column O.
- OR
- If you are using the Quantification Tool to understand changes in a restored site over time, enter the ages at Year 1 here, as described for Veg 1 Type above.

Vegetation Height (V1 Ht and V2 Ht)

**Field Data Collection:**

This is an optional measurement. Only enter this information if you are able to make it with some accuracy using either a clinometer, a laser gun, or other appropriate instrument. Record the value, in feet, on the Vegetation Data Sheet for V1 Ht and V2 Ht. If this information is not entered, the veggimatic will automatically enter the vegetation height based on the vegetation type and age entered.

**Quantification Tool Data Entry:**

Veg 1 Type:

- In the Veg\_Data worksheet enter the V1 height in feet into Column K.

Veg 2 Type:

- In the Veg\_Data worksheet enter the V2 height in feet into Column N.

Number of woody stems in polygon

**Field Data Collection:**

Estimate the total number of woody plants or clumps per 1,000 feet in the polygon area. If the distribution of woody plants is consistent across the polygon, estimate the number of woody stems in a quarter or tenth of the area and multiply by 4 or 10. For multi-stemmed shrubs and vines, record only one stem for each multi-stemmed individual. This is important for estimating how much of the polygon is covered by vegetation over time.

**Quantification Tool Data Entry:**

Veg 1 Type:

- In the Veg\_Data worksheet enter the V1 # woody plants or clumps / 1,000 sq ft into Column L.

Veg 2 Type:

- In the Veg\_Data worksheet enter the V2 # woody plants or clumps / 1,000 sq ft into Column Q.

Number of different woody plant species (V1 and V2 # of different woody species)

**Field Data Collection:**

Record the number of different woody plant species, up to 5, that occur within the polygon, including shrubs, vines, and trees. The Quantification Tool gives maximum 'credit' for 5 different woody species in a polygon, so no differences over that number will be recognized.

**Quantification Tool Data Entry:**

- In the Veg\_Data worksheet enter the V1 number of different woody species into Column M and the V2 number of different woody species into Column R.

## 4 RIPARIAN BIRD HABITAT QUANTIFICATION

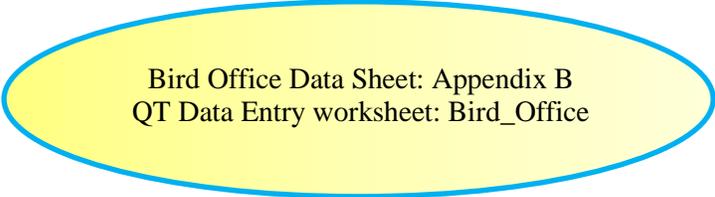
The quantification tool for riparian bird habitat requires information input from the office based on Google Earth and web accessible information that is entered during the ‘office assessment’ step. The tool also requires input from field observations and from interviews with the land manager during the ‘field assessment’ step.

### 4.1 Office Assessment, Riparian Bird Habitat

There are five questions that must be answered in Bird\_Office worksheet. You will need access to the internet and Google Earth or similar geographical information system and will also need the exact location of the Project Area so that you can locate it on Google Earth or in an aerial image. You can either:

- Enter answer directly into a saved copy of the Quantification Tool or
- Record responses on a hard-copy of the Office Data Sheet and then transfer those answers to the Quantification Tool spreadsheet.

When using the Quantification Tool (QT) spreadsheet, go to the blue tab, labeled ‘Bird\_Office’, and follow the directions below for entering data there.



Bird Office Data Sheet: Appendix B  
QT Data Entry worksheet: Bird\_Office

#### 4.1.1 Using the California Avian Data Center website

**Question 1.** Percent of area within 1.5-mile buffer around Project Area with a CADK Habitat Suitability Index of 40% or higher for riparian focal species (green-blue to blue).

##### Data Collection:

- Go to *California Avian Data Center* website hosted by the PRBO to access an existing model on predicted riparian bird species distribution. (<http://data.prbo.org/cadc2/index.php?page=predicted-bird-species-in-central-valley>).
- Navigate to the project location using known reference points in the landscape such as rivers, roads, buildings or distinct natural features. Click on the ‘Map’ or ‘Hybrid’ box in the upper right corner to see roads, towns, parks and other map features (Figure 4-1).

California Avian Data Center.

## Predicted Bird Species Distribution in California's Central Valley



Figure 4-1. California Avian Data Center website shown in 'Hybrid' mode.

<http://data.prbo.org/cadc2/index.php?page=predicted-bird-species-in-central-valley>

- Mark out a 1.5-mile buffer around the Project Area boundary (single click creates a point; double click removes it from the interactive map) (see Figure 4-2).

This can be done by bringing up Google Earth next to the Avian Data Center map and navigating to the Project Area in Google Earth (hybrid view). You can then use the Google Earth 'ruler' (found under the 'tools' menu if not already appearing in the ribbon across the top of the Google Earth view) to place a series of placemarks that are 1.5 miles from the Project Area boundaries, and then connect them with a path or polygon. Select 'line' (vs. path) in the ruler menu that pops up on your screen and ensure that the units are miles by clicking on the arrow next to the value in the right hand box and selecting 'miles' (Figure 4-2).

### Drawing Lines and Polygons on Google Earth

*Polygons and lines can be drawn into Google Earth to create and save site maps. After locating your Project Area in Google Earth, click on 'View' button along the top and in the pull down menu, check the 'tool bar' so that options are visible:*



*Use the push pin option to label lines and polygons or special locations. Use either the polygon or the line drawing option, located to the right of the push pin option, to create lines or polygons for things such as Project Area boundaries, channel location, or vegetation boundaries. In order to edit and save your drawings, click on the 'menu view' option, to the left of the push pin, to see a list of the items you are adding to the figure. Each item can be edited by right-clicking on it and selecting 'properties', where you will find options for changing the label or line color and contents, as well as moving its location. Save your work by going to 'file' along the top ribbon and 'Save place as' to save your 'temporary locations' (all the pieces you have added to the Google Earth image) as a give\_it\_a\_name.kmz file on your hard drive. This can be clicked upon in the future to open up Google Earth, go to your location and make any additions or edits.*

In the Avian Data Center website, look to the eight reference points ('X' end points) just created in the Google Earth map to create 'points', which will appear as red balloons, 1.5 mi from the Project Area on the Avian Data Center map. You must zoom in on Avian Data Center website such that the map scale reads 1000ft/200m or less to create these points; points will not be created at broader scales (Figure 4-2). Sometimes the points are not immediately created; click quickly, wait 5 to 10 seconds to see if point-balloon appears, and try again until you succeed (speed will depend in part on connection speed of your computer).

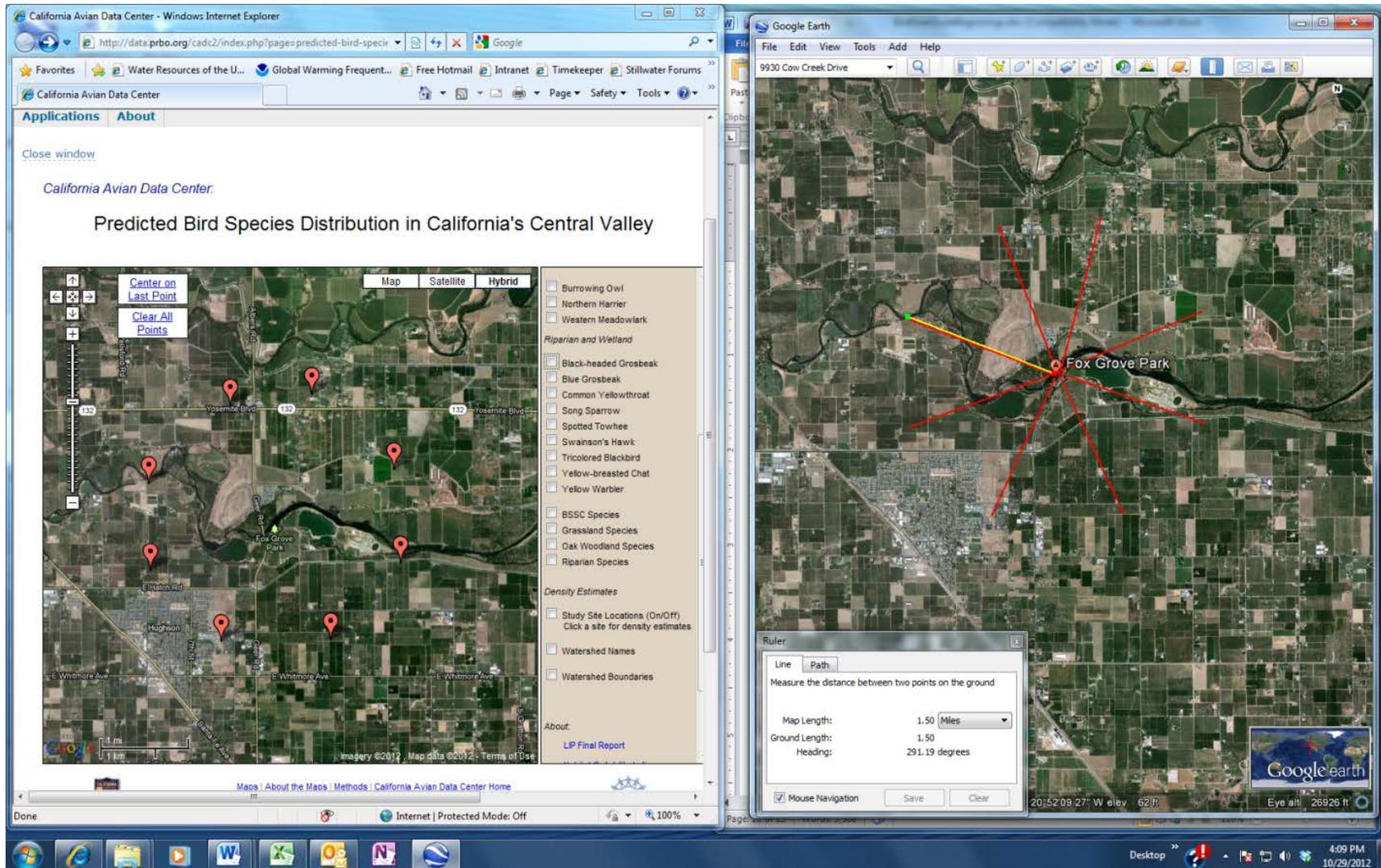


Figure 4-2. Screenshot showing California Avian Data Center website and Google Earth side-by-side.

Figure 4-2 shows a side-by-side shot of view of Fox Grove Park along the Lower Tuolumne River through the California Avian Data Center website on the left and Google Earth on the right. The 'ruler' tool is being applied in Google Earth to mark out a circle of points along a 1.5 miles buffer around the site; these points are then visually positioned in the California Avian Data Center viewer in order to answer the first set of questions on the surrounding habitat quality for:

- Select one riparian bird species at a time and record the percent cover of green-blue to blue area within the 1.5-mile buffer for that species. Record low end of range estimate and high end of range (e.g., 0, 0–5%, 6–15%, 15–24%, 25–50%, 50–100%). This indicates areas with Habitat Suitability Index of 40% or greater. Central Valley focal riparian bird species included in the Quantification include the Black-headed grosbeak, Bluegrosbeak, Common yellowthroat, Song sparrow, Spotted towhee, Swainson's hawk, Tri-colored blackbird, Yellow-breasted chat, and Yellow Warbler (see data entry screenshot in Figure 4-4-3).

In order to estimate the percent area within the 1.5-mile buffer around the Project Area that supports high quality habitat for each of the nine CV riparian focal species, navigate down to the full list of riparian and wetland focal species using the right hand slide bar, then select one species at a time by checking each box (Figure 4-3).

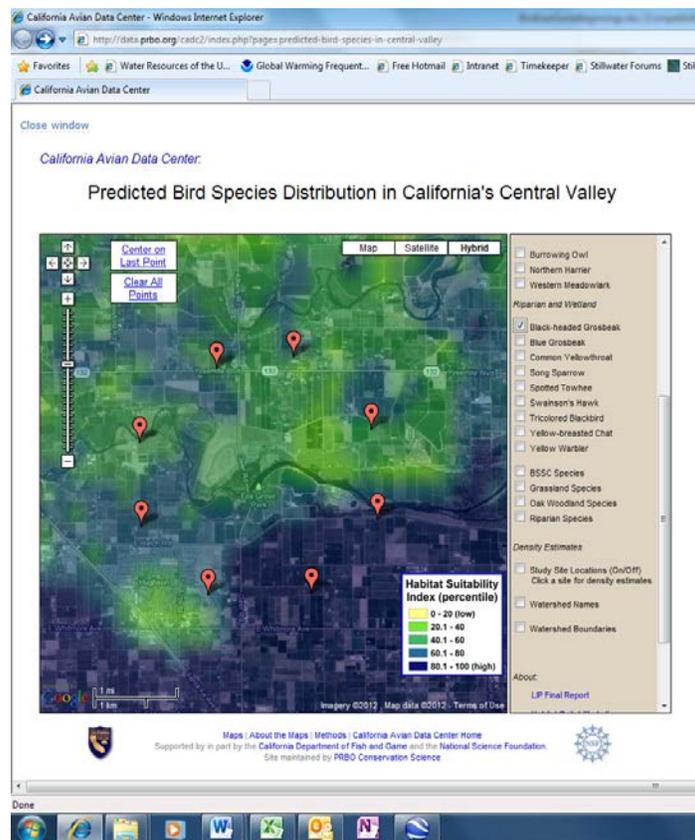


Figure 4-3. Screenshot of the California Avian Data Center website showing habitat suitability index values for black-headed grosbeak for areas around Fox Grove Park, CA.

Estimate the percent of area within the 1.5-mile buffer that is green-blue to blue, and therefore represents high quality Habitat Suitability areas for black-headed grosbeak. In the case of Figure

4-3, green-blue and blue covers just nearly all of the area within the 1.5-mile buffer, so that one would enter 80 for the minimum and 90 for the maximum values in columns E and F, respectively, for this species.

Click again on the Black-headed grosbeak box to remove the HIS overlay for this species on the California Avian Data Center website and click on the next species (blue grosbeak), and follow the same steps just described. Repeat for each of the seven focal riparian species.

*Tools and examples for estimating percent area are provided in Appendix D*

**Quantification Tool Data Entry:**

- In Bird\_Office worksheet, Question 1 enter the percent cover of green-blue, blue area within the 1.5-mile buffer for the corresponding species in the yellow cells. The low end of the range is entered in Column E ‘Min Value’ and high end of range in Column F ‘Max Value’. The average will be automatically entered into the grey cell in Column D ‘Value’ (Figure 4-4).

#	Variable	Measurement	Value	Min value	Max value
1	Percent of area within 1.5 mile buffer around Project Area with a CADC Habitat Suitability Index of 40% or higher for riparian focal species (green-blue to blue).	Black-headed grosbeak HSI (%)	3.5	2.0	5.0
		Blue grosbeak HSI (%)	0.0	0.0	0.0
		Common yellowthroat HSI (%)	0.0	0.0	0.0
		Song sparrow HSI (%)	0.0	0.0	0.0
		Spotted towhee HSI (%)	20.0	15.0	25.0
		Swainson's hawk HSI (%)	52.5	45.0	60.0
		Tri-colored blackbird HSI (%)	10.0	5.0	15.0
		Yellow-breasted chat HSI (%)	0.0	0.0	0.0
		Yellow warbler HSI (%)	3.5	2.0	5.0
		Diversity ranking, by extent of Suitable Habitat Area and number of species supported.	1.0		

Figure 4-4. Screenshot of Question 1 in Bird\_Office Worksheet of the Quantification Tool. Data will be entered in the yellow cells.

4.1.2 Other questions on Project surroundings

**Question 2.** Presence of intact riparian areas that are > 25 acres (10 ha) that overlap with 1.5-mile buffer around Project Area.

Riparian vegetation is any shrub, tree, wetland, grass and/or forb vegetation that is not farmed, gardened or otherwise managed, or grazed and occurs within the apparent floodplain or within 2 channel widths of the channel.

**Data Collection:**

- This is most easily done in Google Earth and using the same 1.5-mile buffer area created to answer Question 1 (Figure 4-5).

- Create a 'reference square' on Google Earth that is 25 acres in size. You can do this by creating a square that measures 1,000 x 1,000 feet on a side adjacent to the buffer area.
- Look within the 1.5 mile wide buffer for intact riparian areas that are roughly equal to or larger than your reference square. These can be recognized as natural areas with intact or scattered canopy cover and no obvious development.
- Record '1' for Yes or a '0' for No.

**Quantification Tool Data Entry:**

- In the Bird\_Office worksheet, Question 2: Enter '1' for Yes or a '0' for No in Column D 'Value' (yellow cell).

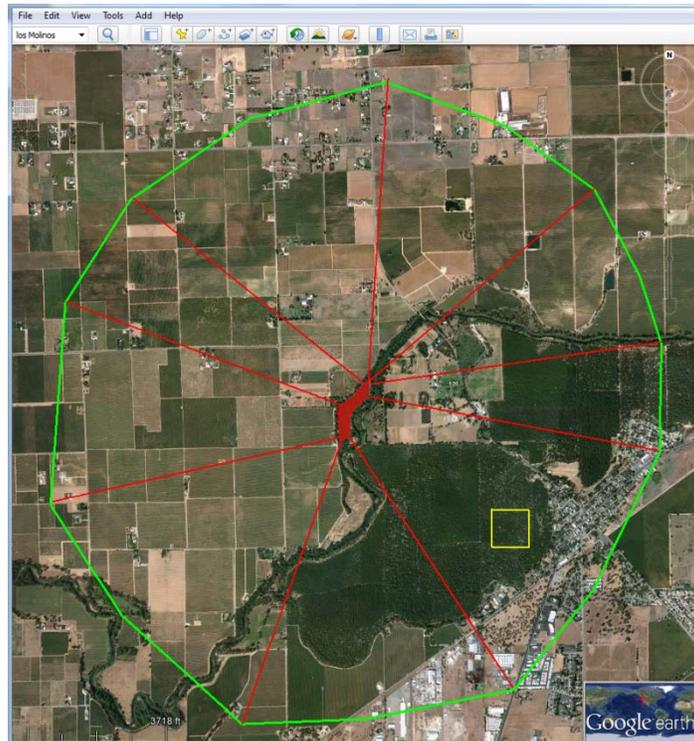


Figure 4-5. Reference square of ~25 acres used to identify similarly sized (not necessarily shaped) areas with intact riparian vegetation within 1.5 miles of the Project Area.

**Question 3.** Estimated percent of area within 0.5-mile buffer around Project Area that supports intact riparian vegetation (excluding Project Area itself). Estimate areas from 0 to 10% carefully.

- Riparian vegetation is any shrub, tree, wetland, grass and/or forb vegetation that is not farmed, gardened or otherwise managed, or grazed and occurs within the apparent floodplain or within 2 channel widths of the channel.

**Data Collection:**

- Follow the same procedure used for Question 1 this is most easily done in Google Earth.
- Create a series of points that form a 0.5-mile buffer around Project Area boundary.

- Identify unmanaged riparian areas within this boundary; this can include non-native as well as native riparian vegetation (see example in Figure 4-6 below).
- Estimate the percent of the 0.5-mile buffer area that supports intact riparian vegetation. Since many bird species are sensitive to patch size differences at the low end of the scale (1 to 2 acres), try to be precise. (One acre is approximately 210 x 210 feet)
- Record low end of range and high end of range estimate (e.g., 0, 0–1%, 2–4%, 5–10%, 11–20%, 20–50%, 51–100%).

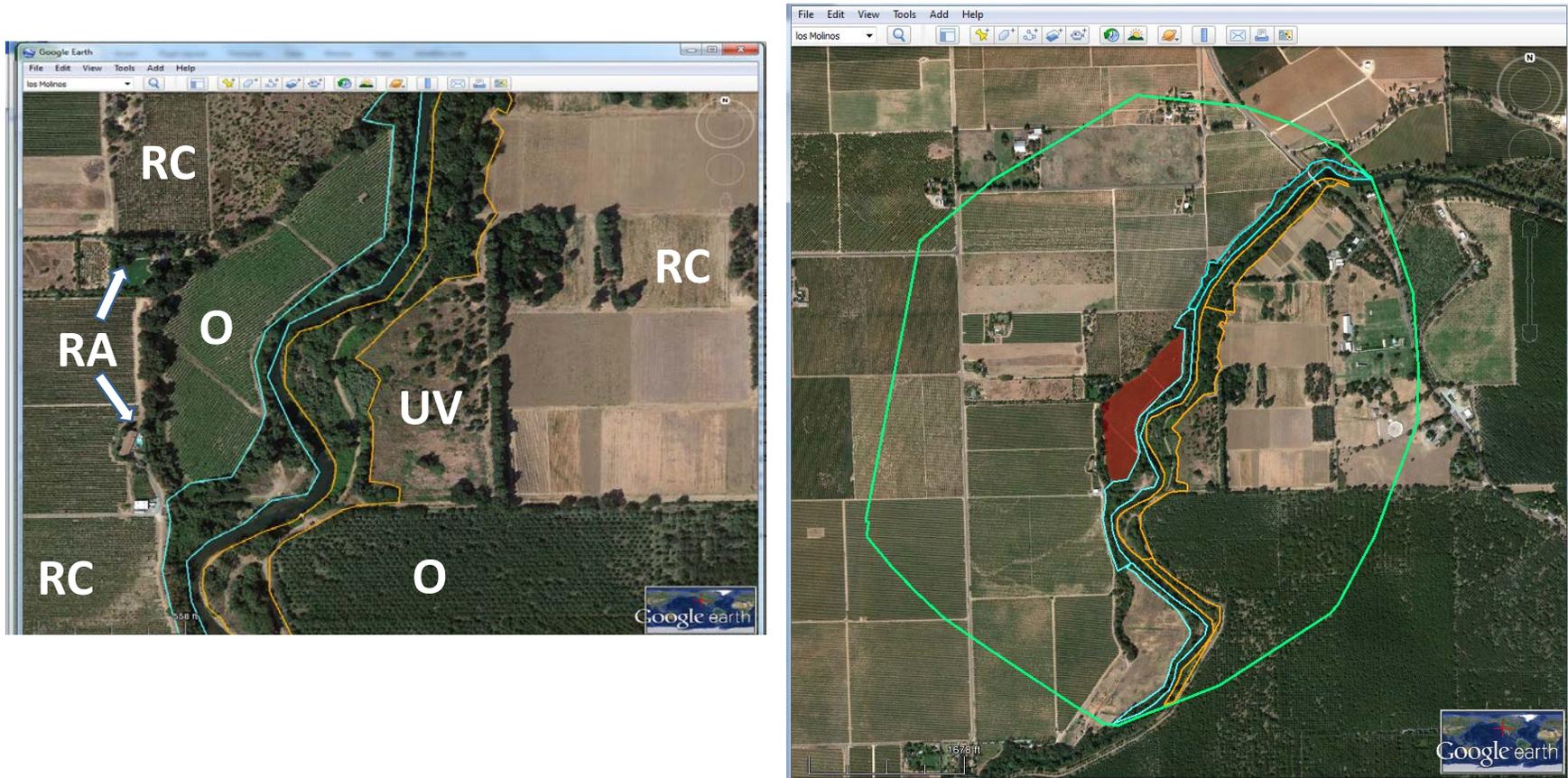


Figure 4-6. Intact riparian vegetation at two sites in the Central Valley.

Figure 4-6 shows intact riparian vegetation outlined in blue (west shore) and orange (right shore) along two reaches in the Central Valley. The left picture shows the hypothetical Project Area (red polygon) with a 0.5-mile buffer (turquoise circle). Right picture shows a close up of riparian vegetation and adjacent lands, which support orchards (“O”), upland natural vegetation (UV), residential areas (‘RA’), and row crops (‘RC’). Estimated percent of 0.5 mi buffer supporting natural riparian vegetation is approximately 6%.

**Quantification Tool Data Entry:**

- In Bird\_Office worksheet, Question 3. The low end of the range is entered in Column E ‘Min Value’ (yellow cell) and the high end of range in Column F ‘Max Value’ (yellow cell) (e.g., 0, 0–1%, 2–4%, 5–10%, 11–20%, 20–50%, 51–100%). The average will be automatically entered into Column D ‘Value’.

**Question 4.** Percent of Project Area that is adjacent to (within 150 feet of) native or undeveloped lands (including non-intensively managed uplands, wetlands, riparian habitat, and annual grasslands), that are at least 100 feet wide.

**Data Collection:**

This landscape characteristic addresses the accessibility from the Project Area to non-riparian foraging areas. "Undeveloped lands" includes shrub land, forest, native prairies, vegetated wetlands, untilled fields, lightly grazed pastures, and timber harvest areas. As used here, it does not include grain fields or row crops, golf courses, recreational fields, paved or bare soil, gravel pits, or dirt roads. Natural land cover is not the same as native vegetation. It may include areas of Himalayan blackberry or salt-cedar, for example. See Figure 4-7 for an example hypothetical Project Area with PA boundaries that are adjacent to undeveloped lands at least 150 feet in width. A fallow field along the NW edge ‘counts’, but residential areas and tilled fields to the west do not. This figure indicates that approximately 75% of the boundary borders undeveloped lands.

Estimate the percent of the Project Area boundary length that borders undeveloped lands that are at least 100 feet wide and no more than 150 feet from the project boundary.

Record low end of range and high end of range estimate (e.g., 0, 0–5%, 6–15%, 15–24%, 25–50%, 50–100%)

**Quantification Tool Data Entry:**

In Bird\_Office worksheet, Question 4 The low end of the range is entered in Column E ‘Min Value’ (yellow cell) and high end of range in Column F ‘Max Value’ (yellow cell). (e.g., 0, 0–5%, 6–15%, 15–24%, 25–50%, 50–100%). The average will be automatically entered into Column D ‘Value’ (grey cell).



Figure 4-7. Light blue outline of hypothetical Project Area indicates PA boundaries that are adjacent to undeveloped lands at least 150 feet in width.

**Question 5.** Percent of area within 0.5-mile buffer around Project Area that supports non-native nest predator and parasite populations (e.g., housecats, rats, corvids, cowbirds).

**Data Collection:**

Use the 0.5 mile boundary created for Question 3 to search for feedlots, residential areas, parks and picnic areas, and more urban areas. Estimate the percent of the buffer area occupied by each of these land uses. Record low end of range and high end of range estimate (e.g., 0, 0–5%, 6–15%, 15–24%, 25–50%, 50–100%)

**Quantification Tool Data Entry:**

In Bird\_Office worksheet, Question 4 The low end of the range is entered in Column E ‘Min Value’ (yellow cell) and high end of range in Column F ‘Max Value’ (yellow cell). (e.g., 0, 0–5%, 6–15%, 15–24%, 25–50%, 50–100%). The average will be automatically entered into Column D ‘Value’ with the total value at the bottom (grey cells).

## 4.2 Field Assessment, Riparian Bird Habitat

In this section, you are provided with step-by-step instructions on filling out the Bird Field Data Sheet form and entering the data into the Quantification Tool spreadsheet (Bird\_Field) model. All of the questions in this section need to be addressed for each Map Unit. For every map unit, you must answer a series of 8 questions. Sets of Map Unit Questions are first recorded in the field onto the Bird Field Datasheets (Appendix B). Make additional copies of page B-4 if you have more than 5 Map Units in your Project Area. If you have over ten, you will need to break the Project Area into two projects, and sum the ultimate habitat-acres calculated between the two. There is an Explanation and Definitions page (Appendix B) that can be looked at in the field to assist with answering questions.

Record responses to each of the 8 questions from the Riparian Bird Habitat Field Data sheet each for these Map Units in the spaces below.

Bird Field Data Sheet: Appendix B  
QT Data Entry worksheet: Bird\_Field

The first set of data for Map Unit 1 is recorded in the Quantification Tool spreadsheet, Bird\_Field worksheet (see example screenshot below), rows 7 through 14 in column G; the second set of data for Map Unit 2 is recorded in rows 7 through 14 in column H, through column P for Map Unit 10. Thus, there is room for ten Map Units for each Quantification Tool spreadsheet. If you have more than ten Map Units in one Project Area, you will need to divide the Project Area into two separate Project Areas and calculate the Ecosystem Service scores for each. If you have less than ten Map Units in one Project Area, enter data for the first set of Map Units in the worksheet. If for some reason, your Map Units numbers start at something greater than 1, start at Map Unit 1 anyway, and progress sequentially through the Map Unit entry sets provided in the 'Bird\_Field' worksheet. Do not skip down to Map Unit entry sets without filling in the sets above because the ecosystem service scores are bundled together sequentially in the Quantification Tool spreadsheet.

*Remember: Do not delete any of the rows in the Quantification Tool spreadsheet. That would break critical links among the worksheets that are required for developing the ecosystem services score for your site.*

For each Map Unit, 8 questions are broken out into two categories:

- Special habitat features (5 questions)
- Appropriate Management practices (3 questions)

*Tools and examples for estimating percent area are provided in Appendix D*

#### 4.2.1 Special habitat features in map unit

The three questions in this subsection identify special features that create good habitat for one or several of the Central Valley focal riparian bird species.

**Question 1.** Within the Map Unit, what percent of the banks have NOT been artificially altered within 60 ft of the channel edge? E.g., hardened, riprapped, revetment, channelization, etc.

##### Field Data Collection:

Examine the channel banks within the Map Unit and identify areas that have been artificially altered using hardening material such as riprap and revetment, or have been altered by channelization. Photographs of revetted channel banks are provided in Figure 4-8 below.



Figure 4-8. Riprap along Redwood Creek in Muir Woods photographed by Carolyn Shoulders, GGNRA of NPS (left) and along Sacramento River (photograph by Glen Leverich, Stillwater Sciences).

Estimate the percentage (estimated as the number of feet that are altered as a fraction of the total footage of channel in the Map Unit on that side of the bank that is in the Map Unit itself). Use the mid-point of the most appropriate range: 0–5% (enter 2.5), 6–15% (enter 10), 15–24% (enter 20), 25–50% (enter 37), 50–100% (enter 75). Record the percentage value on the Bird Field data sheet.

##### Quantification Tool Data Entry:

In Bird\_Field worksheet, Questions 1. Enter percent in the column appropriate to the map unit (E through N for Map Units 1 through 10).

**Question 2.** Are eroding banks present (at least 3 ft tall and 20 ft long) in the Map Unit?

**Field Data Collection:**

Large areas of eroding banks provide nesting habitat for bank swallows. Banks can be high eroding cliffs and banks, as depicted in the second photograph from Dry Creek, or can be low and long, as in the photograph in Figure 4-9 below from the Tuolumne River mainstem.



Figure 4-9. Eroding cliffs and banks along Dry Creek tributary to the Tuolumne River in Stanislaus County (left); eroding banks along the mainstem of the Tuolumne River (photos by A.G. Merrill of Stillwater Sciences 2012).

On the Bird field data sheet, record Yes or No, as appropriate.

**Quantification Tool Data Entry**

In Bird\_Field worksheet, Questions 2. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 3.** Are off-channel oxbows present in Map Unit?

**Field Data Collection:**

An off-channel oxbow is an arc or crescent shaped body of water formed by an abandoned or intermittently flowing river channel formed when the water "takes a short cut" through meanders, in the river, cutting the oxbow off completely or partially from the main channel. These areas provide valuable 'slow water' wetland habitat for many bird species. An example of such a side channel located along the lower Tuolumne River is provided in Figure 4-10, along with a graphic showing idealized formation of oxbow channels and lakes.



Figure 4-10. Left figure shows a side channel along the Lower Tuolumne River shown in the foreground, flowing into the main channel (photo by A.G.Merrill of Stillwater Sciences 2012). The right figure shows an idealized progression of ox bow lake formation.

On the Bird Field Sheet, record Yes or No, as appropriate.

#### Quantification Tool Data Entry

In Bird\_Field worksheet, Questions 3. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 4.** Are fresh gravel/cobble bars (unvegetated or sparsely vegetated) that are at least 100 square feet present in Map Unit?

#### Field Data Collection:

Sparsely or unvegetated gravel and cobble bars can occur as mid-channel or channel edge deposits of stones that are less than ten inches in diameter, as exemplified in the photograph in Figure 4-11. The spatial extent can be paced out in the field or estimated based on the Project Area Map.



Figure 4-11. Sparsely vegetated gravel and cobble bars along the Lower Tuolumne River provide potential habitat for the spotted sandpiper, killdeer (photo by A.G. Merrill, Stillwater Sciences).

#### **Quantification Tool Data Entry**

In Bird\_Field worksheet, Questions 4. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

#### **Question 5.** Presence of snags w/DBH > 12 inches in the Map Unit?

##### **Field Data Collection:**

A 'snag' is a standing tree with a crown that is all or at least over 75% dead. DBH stands for 'diameter at breast height', where breast height is 4.5 feet above the ground. Diameter can be directly measured using a DBH tape (available from forestry supply companies) or by ocular estimates, which if done conservatively (e.g., err on the small side), should be sufficiently accurate for the purpose of this Quantification Tool.

On the Bird Field Data Sheet record the presence of one or more large snags in the Map Unit.

##### **Quantification Tool Data Entry:**

In Bird\_Field worksheet, Questions 5. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

#### **4.2.2 Appropriate management practices**

An interview with the manager to determine what the most common management practices are pertaining to these three categories (ground disturbing activities, insecticide application, and range management), how often they are applied, and during what season, will enable you to

answer these three important management questions. Variation in management is likely from one year to the next; try to identify the most common management pattern to address these questions.

**Question 6.** Are there ground disturbance activities during breeding season (April through August) in Map Unit?

**Field Data Collection:**

Examples of ground disturbing activities include mowing hay, tilling, herbicide applications for weed control, and grazing during nesting periods. Nesting periods for riparian birds in the Central Valley extend April through August.

On the Bird Field Data Sheet, record Yes or No, as appropriate.

**Quantification Tool Data Entry:**

In Bird\_Field worksheet, Questions 6. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 7.** Is there application of insecticides within the Map Unit?

**Field Data Collection:**

On the Bird Field Data Sheet, record Yes or No, as appropriate.

**Quantification Tool Data Entry:**

In Bird\_Field worksheet, Questions 7. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 8.** What percent of the Map Unit is currently grazed in a manner that has visibly and persistently altered the vegetation structure and/or composition (i.e., incomplete recovery between years)?

**Field Data Collection:**

Intensive localized grazing is common in water-access areas and can result in patches of bare ground and low herbaceous cover, stunted and reduced diversity of herbaceous plant species, stunted woody vegetation due to herbivory, and local erosion and/or focused runoff associated with hoof marks and livestock trails. If such indicators that grazing is out of balance with the site's capacity are common and/or extreme in over one-quarter of the Map Unit, then record a 'Yes' in the field data sheet. If indicators of over-grazing are evident in an area of one-quarter or less of the Map Unit or absent altogether, then enter a 'No' in the field data sheet.

On the Bird Field Data Sheet, record Yes or No, as appropriate.

**Quantification Tool Data Entry:**

In Bird\_Field worksheet, Questions 8. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

## 5 FISH AND AQUATIC HABITAT QUANTIFICATION

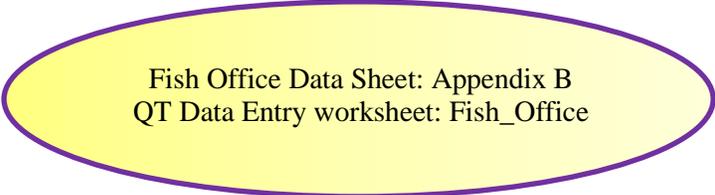
Like the riparian bird habitat quantification tool, the quantification tool for fish and aquatic habitat requires information input from the office as well as from the field. The office assessment is short, and the field assessment largely tracks the format of the riparian bird habitat tool.

### 5.1 Office Assessment, Riparian Bird Habitat

There are two questions that must be answered in Fish\_Office worksheet. You can either:

- Enter answer directly into a saved copy of the Quantification Tool or
- Record responses on a hard-copy of the Office Data Sheet and then transfer those answers to the Quantification Tool spreadsheet.

When using the Quantification Tool (QT) spreadsheet, go to the purple tab, labeled 'Fish\_Office', and follow the directions below for entering data there.



Fish Office Data Sheet: Appendix B  
QT Data Entry worksheet: Fish\_Office

**Question 1.** Presence of salmonid species and/or listed or candidate native fish species, or species federally classified as Species of Concern (Central Valley fall Chinook salmon and Central Valley steelhead).

#### **Data Collection:**

For all of the Lower Mokelumne, central valley steelhead, federally listed as threatened, and central valley fall run Chinook, classified as a federal Species of Concern as of summer 2014, are present. Unless there has been a change in status or distribution for these or other species in the interim, enter 'yes'.

For rivers other than the Lower Mokelumne, determine the answer to this question by following these three steps:

1. Refer to literature, published agency reports, or expert communication.
2. Create list of species, life-stages, and periodicity of occurrence.
3. Record '1' for Yes or a '0' for No.

#### **Quantification Tool Data Entry:**

- In Fish\_Office worksheet, Question 1, record '1' for Yes or a '0' for No.

**Question 2.** Implementation of all BMPs within "zone of influence" defined as any area within 1,000 ft of project boundary on the same side of the river.

**Data Collection:**

Best management practices (BMPs) include: (1) annual invasive plant species removal without herbicide application; (2) no pesticide application within past 2 yrs; (3) minimizing surface erosion from bare soil; (4) stockpiling any fertilizers, manure, pesticides, petrochemicals or fuels under secure roofs to prevent runoff; and (5) regular pumping and proper maintenance of any local septic tanks. If all of these BMPs are implemented for the Project Area, then record '1' for Yes or a '0' for No.

**Quantification Tool Data Entry:**

- In the Fish\_Office worksheet, Question 2: Enter '1' for Yes or a '0' for No in Column D.

## 5.2 Field Assessment, Fish and Aquatic Habitat

In this section, you are provided with step-by-step instructions on filling out the Fish Field Data Sheet form and entering the data into the Quantification Tool spreadsheet (Fish\_Field) model. There are 16 questions to address for each Map Unit under this section.

Sets of Map Unit Questions are first recorded in the field onto the Bird Field Datasheets (Appendix B). Make additional copies of page B-4 if you have more than 5 Map Units in your Project Area. If you have over ten, you will need to break the Project Area into two projects, and sum the ultimate habitat-acres calculated between the two. There is an Explanation and Definitions page (Appendix B) that can be looked at in the field to assist with answering questions.

Record responses to each of the 16 questions from the Riparian Fish and Aquatic Habitat Field Data sheet each for these Map Units in the spaces below.

Fish Field Data Sheet: Appendix B  
QT Data Entry worksheet: Fish\_Field

The first set of data for Map Unit 1 is recorded in the Quantification Tool spreadsheet, Fish\_Field worksheet (see example screenshot below), rows 8 through 23 in column G; the second set of data for Map Unit 2 is recorded in rows 8 through 23 in column H, and so on through column P for Map Unit 10. Thus, there is room for ten Map Units for each Quantification Tool spreadsheet. If you have more than ten Map Units in one Project Area, you will need to divide the Project Area into two separate Project Areas and calculate the Ecosystem Service scores for each. If you have less than ten Map Units in one Project Area, enter data for the first set of Map Units in the worksheet. If for some reason, your Map Units numbers start at something greater than 1, start at Map Unit 1 anyway, and progress sequentially through the Map Unit entry sets provided in the 'Fish\_Field' worksheet. Do not skip down to Map Unit entry sets without filling in the sets above because the ecosystem service scores are bundled together sequentially in the Quantification Tool spreadsheet.

For each Map Unit, 16 questions are broken out into four categories:

- Map Unit size, river length and connectivity (3 questions)
- Vegetation characteristics (5 questions)
- Floodplain dynamics (4 questions)
- Best Management practices (5 questions)

### 5.2.1 Map unit size, river length and connectivity

The three questions in this subsection are critical for fish habitat quality and can be estimated from the desk top and validated in the field.

**Question 1.** What is the length of river along the Map Unit? (feet)

**Field Data Collection:**

River length is the full length of the river bank in the Map Unit, not as the crow flies, but rather to include the length in any river bends and meanders that occur within the Map Unit. River length can be measured with sufficient resolution using Google Earth using the ruler tool (convert units to feet).

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 1. Enter percent in the column appropriate to the map unit (E through N for Map Units 1 through 10).

**Question 2.** Percent of Map Unit supporting active floodplain?

**Field Data Collection:**

Active floodplain includes areas that are flooded at least once every three years. One way to determine this is to use the imagery provided of the Lower Moklumne for June 2006, when flows at the Comanche Dam were approximately 2,600 cfs. If some or all of the Map Unit is flooded in that imagery, and clearly not draining from the higher flows from earlier that year, then estimate the percent of the Map Unit covered with flood waters under the 2,600 cfs flows. See Appendix D for instructions on estimating percent cover. On the Fish field data sheet, record the percent of the Map Unit flooded.

**Quantification Tool Data Entry**

In Fish\_Field worksheet, Questions 2. Enter the percent cover (0 to 100) in Column E through N, as appropriate for the Map Unit.

### 5.2.2 Riparian vegetation characteristics

**Question 3.** Within the area of the Map Unit, is there diversity in the vegetation types (forested vs. open grassy and herbaceous patches)?

**Field Data Collection:**

Diversity in vegetation types is defined as a minimum of 25% of the area having patches of grassland vegetation types (excluding invasive exotic plant species) with patches large enough to let sunlight reach the ground and support persistent grassy/herbaceous open areas. On the Fish Field Sheet, record Yes or No, as appropriate.

**Quantification Tool Data Entry**

In Fish\_Field worksheet, Questions 3. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 4.** Percentage of channel margin with overhanging vegetation?

**Field Data Collection:**

Enter total percent of channel margin length on the Project Area side of the channel that is covered with overhanging vegetation within the Map Unit. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten).

**Quantification Tool Data Entry**

In Fish\_Field worksheet, Questions 4. Enter the percentage as a value between 0 and 100 in Column E through N, as appropriate for the Map Unit.

**Question 5.** What percent of the channel margin area, if the map unit has any, is covered by riparian woody vegetation (trees) within ~60 ft of the channel?

**Field Data Collection:**

Enter the percent of map unit that is within ~60 ft of the channel edge that includes trees and shrubs. This can be estimated in Google Earth by measuring 60 ft perpendicular distance from the channel using the ruler tool, and estimating the percent cover of woody vegetation within that area in the Map Unit. This can be ground truthed in the field by pacing out 60 ft from the stream's edge for the area in each Map Unit and estimating percent cover of woody vegetation in that area from the ground. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten). If the map unit does not include area within 60 ft of the channel margin, enter '0'.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 5. Enter the percent as a number from 0 to 100 in Column E through N, as appropriate for the Map Unit.

**Question 6.** Of the trees within ~60 ft of the channel, what percentage has a DBH  $\geq$  20–24 in?

**Field Data Collection:**

Enter the percent of the riparian forest, including dead snags, with a DBH  $\geq$  20–24 in within ~60 ft of the channel edge. DBH is diameter of tree trunk at 4.5 ft above the ground (i.e., diameter breast height). If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten).

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 6. Enter the percent as a number from 0 to 100 in Column E through N, as appropriate for the Map Unit.

**Question 7.** Noninvasive vs. Invasive species composition: total percent area occupied by non-invasive (woody and herbaceous plant) species within the Map Unit?

**Field Data Collection:**

Enter total percent area occupied by priority invasive plant species observed in the Map Unit. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten). A list of priority invasive plant species is provided in Appendix F.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 7. Enter the percent as a number from 0 to 100 in Column E through N, as appropriate for the Map Unit.

5.2.3 Floodplain dynamics

**Question 8.** Within the Map Unit, what percent of the banks have NOT been artificially altered (e.g., leveed, hardened, riprapped, revetment, channelization, etc, within ~60 ft of channel edge)?

**Field Data Collection:**

Enter the percent of the bank length within the Map Unit that has NOT been artificially altered within ~60 ft of the channel edge. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten). A GIS map layer that shows the extent of levees in the Lower Mokelumne is available through the Mokelumne Benefits Program and can be used to make an initial estimate from the office. Ground truth the existence and approximate extent of the levees during the field visit. Rip rap or other man-made materials placed along the bank as reinforcement against flooding are included.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 8. Enter the percent as a value between 0 and 100 in Column E through N, as appropriate for the Map Unit.

**Question 9.** Within the area of the Map Unit that is inundated at least every 3 years, is there a combination of both woody vegetation and. open grassy and herbaceous patches?

**Field Data Collection:**

- The area that is inundated at least every 3 years is based on photo-documentation during flood events of 2,600 cfs or less at Camanche dam, or verification of flooding during such an event at a known elevation within the Map Unit. The aerial imagery of the Lower Mokelumne for June 2006, when flows were at ~2,600 cfs can also be used to identify the boundaries of the frequently flooded area within the Map Unit. For the June 2006 imagery, the photo-interpreter must realize and take into account that these images are not of an annual peak flow but of the declining flows from a much higher (5,000 cfs) peak flow. Therefore some areas that would not flood at 2,600 peak flow are show to be draining the earlier higher waters in the June 2006 imagery.

Within that frequently flooded area, determine whether or not there are consolidated patches of land that support only herbaceous vegetation and other consolidated patches, at least 300 ft<sup>2</sup> in size, dominated by woody vegetation. If both types are represented, answer 'yes'; if only one or neither type is represented, enter 'no'.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 9. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 10.** Within the area of the Map Unit that is inundated at least every 3 years, are there areas that cover at least one-quarter of the Map Unit area where the elevation is at least 3 ft below the rest of the area?

**Field Data Collection:**

Refer to instructions to Question 9 to determine the area of the Map Unit subject to frequent inundation. From the desk top at the office, use topographic maps to determine if there are large portions (e.g., at least one-fourth) of the Map Unit that where the land elevation at least 3 ft below the rest of the Map Unit. Back channels, ponds, and wetlands can reflect such local depressions.

On the Fish Field Data Sheet, record Yes or No, as appropriate.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 10. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

#### 5.2.4 Best Management practices

Information needed for this section can be obtained through an interview with the manager to determine what the most common management practices are pertaining to these five categories (weed and erosion management, pesticide use, stockpiling, and septic tank maintenance). Since variation in management is likely from one year to the next; try to identify the most common management pattern to address these questions.

**Question 11.** Are priority invasive plant species manually removed annually without herbicides?

**Field Data Collection:**

In order to qualify as an area implementing best management practices for aquatic species, weeds should be managed through hand removal, competitive planting of natives, mowing, or other non-chemical methods. This information can be gathered by interviewing the land manager, specifically regarding each Map Unit, or the Project Area overall.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 11. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 12.** Have pesticides been applied within the Map Unit since the last evaluation, or if not, then within the last two years?

**Field Data Collection:**

In order to qualify as an area implementing best management practices for aquatic species, pesticides and herbicides should not be used in riparian project areas. This information can be gathered by interviewing the land manager, specifically regarding each Map Unit or the Project Area overall.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 12. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 13.** What percent of the map unit is vegetated as opposed to bare soil?

**Field Data Collection:**

Survey the Map Unit via aerial imagery from the office and make a percent cover estimate from the field using the same methods described in Appendix D. The extent of bare soil has the greatest impact on water quality during the rainy season, from approximately October 1 through April 15. Assessments during this time are preferred but areas with permanently bare soil or eroding head cuts and culverts can be observed at any time of year.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 13. Enter the percent cover of bare soil, as a number between 0 and 100, in Column E through N, as appropriate for the Map Unit.

**Question 14.** Are all stockpiles of fertilizers, manure, pesticides, or petrochemicals and fuels stored in the Map Unit under secured roofs to prevent run-off?

**Field Data Collection:**

Interview the land manager to determine if there are stockpiles in the Project Area and in each specific Map Unit. During the site visit, locate these areas and ascertain whether or not the stockpiles are under intact roves and that runoff from the stockpiles to adjacent lands and waters is prevented. Survey the Map Unit via aerial imagery from the office along with the land manager interview to locate potential stock pile areas on the site.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 14. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

**Question 15a.** Are there any septic tanks and fields with the Map Unit?

**Question 15b.** If so, are they pumped and maintained regularly and in proper working order?

**Field Data Collection:**

Interview the land manager to determine if there are septic tanks and fields in the Project Area and in each specific Map Unit. If there are (this might also be available through the City or County government), then inquire if these systems are maintained every year.

**Quantification Tool Data Entry:**

In Fish\_Field worksheet, Questions 15a. Enter '1' for Yes or a '0' for No in Column E through N, as appropriate for the Map Unit.

## 6 QUANTIFICATION OF POTENTIAL FOR FLOOD ATTENUATION

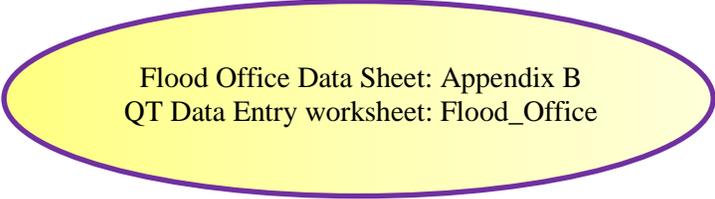
Like the other riparian benefit quantification tools, the tool to quantify the potential a site has to attenuate downstream flooding requires information input from the office as well as from the field. The office assessment is only slightly shorter than the field assessment but can be done completely from the desktop.

### 6.1 OFFICE ASSESSMENT, POTENTIAL FOR FLOOD ATTENUATION

There are 24 questions that must be answered in Flood\_Office worksheet. You can either:

- Enter answer directly into a saved copy of the Quantification Tool or
- Record responses on a hard-copy of the Office Data Sheet and then transfer those answers to the Quantification Tool spreadsheet.

When using the Quantification Tool (QT) spreadsheet, go to the dark blue tab, labeled 'Flood\_Office', and follow the directions below for entering data there. As with the other worksheets in the Mokelumne Riparian Benefits Quantification Tool, only enter data in the yellow highlighted fields. Do not enter data, delete, or otherwise manipulate any of the other cells, rows or columns in the Excel version of the tool; this can break calculation linkages in the tool and result in errors in cells where results should appear.



Flood Office Data Sheet: Appendix B  
QT Data Entry worksheet: Flood\_Office

You will also need to open the Mokelumne Benefits Program "Flood Analysis Layers" kml provided with the Quantification Tool.

**Questions 1 and 2.** These questions are automatically filled from the Veg\_Data and the Fish\_Field worksheets, respectively. Check to be sure the auto-filled answers are correct. If incorrect, then go to the original source point to determine where data was incorrectly entered and re-enter data correctly.

**Question 3.** Is Project Area within the Dry Creek or mainstem Mokelumne River contributing area?

#### **Data Collection:**

Open up Google Earth and the Flood Analysis Layers kml file provided with the Quantification Tool and navigate to your Project Area. Locate the confluence area (shared flooding area) above Bear Slough and about 2 miles east of highway 5. Determine if the Project Area is in the Mokelumne mainstem contributing area, including below the confluence with Dry Creek, or if the Project Area is in the Dry Creek contributing area.

**Quantification Tool Data Entry:**

- In Flood\_Office worksheet, Question 3, record 'M' for Mokelumne mainstem and 'D' for in the Dry Creek drainage.

**Question 4.** Are there urban lands within 5 miles downstream of site and 0.5 miles of the river that are outside of the 100 yr FEMA flood area?

**Data Collection:**

1. Using Google Earth and the Flood Analysis Layers kml file provided with the Quantification Tool, navigate to your Project Area.
2. Click the boxes to the left of the layers titled:
  - RiverMiles,
  - 100-year Floodplain Analysis Units, and
  - NLCD06\_vAOI
3. Use the ruler tool in Google Earth to measure 0.5 miles perpendicular to the river at the downstream end of the Project Area (see Figure 6-1), on both sides of the river.
4. Use the RiverMile values, full miles in yellow, one-tenth values in white, to measure 5 miles downstream of the downstream end of the Project Area.
5. As above, use the ruler to measure 0.5 miles perpendicular to the river on both sides 5 miles downstream of the Project Area.
6. Review the Google Earth imagery to determine whether or not there are urban or otherwise developed lands (including homes, businesses, or other buildings) within the swath of land outlined by the 0.5 mile bars. The answer would be 'yes' for the example shown in Figure 6-1.

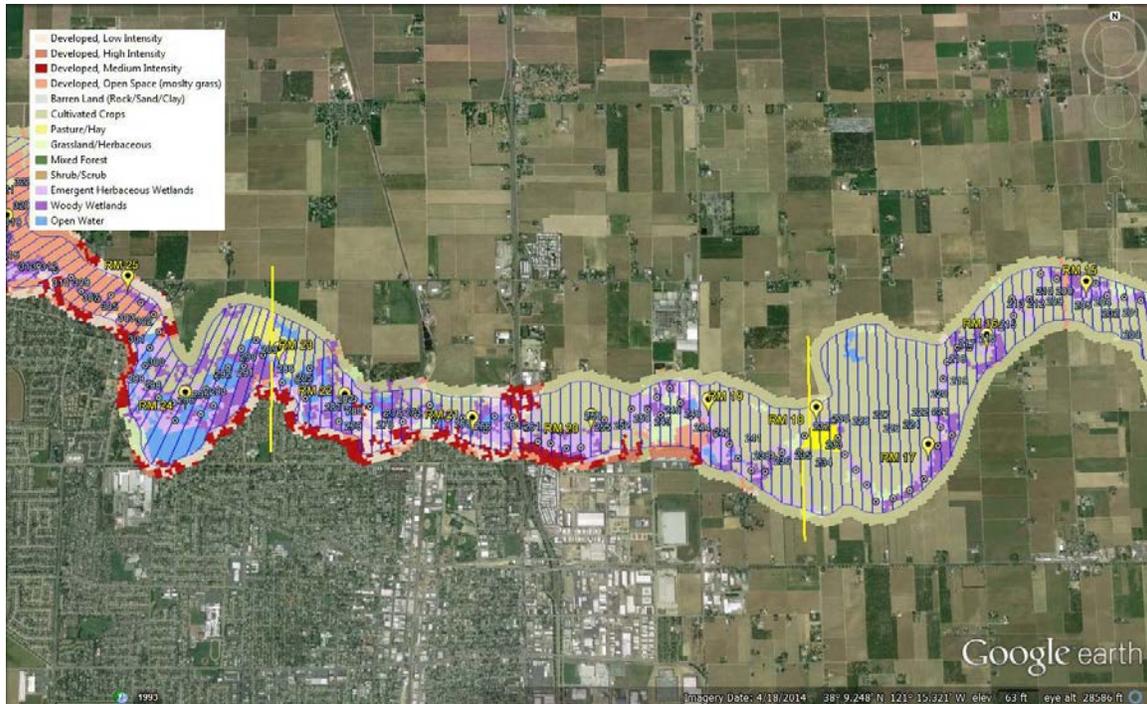


Figure 6-1. Screenshot of example Project Area (yellow polygon) with 0.5 mile lines drawn perpendicular to the river at the downstream end of the Project Area and 5 miles downstream of the Project Area.

#### Quantification Tool Data Entry:

- In the Flood\_Office worksheet, Question 4: Enter “Y” for Yes or a “N” for No in Column F.

**Question 5.** What is the River Slice code just downstream of the Project Area?

#### Data Collection:

1. Using Google Earth and the Flood Analysis Layers kml file provided with the Quantification Tool, navigate to your Project Area.
2. Locate the River Slice, outlined in blue and labeled with 3-digit codes, that is just downstream of the Project Area (see Figure 6-2).

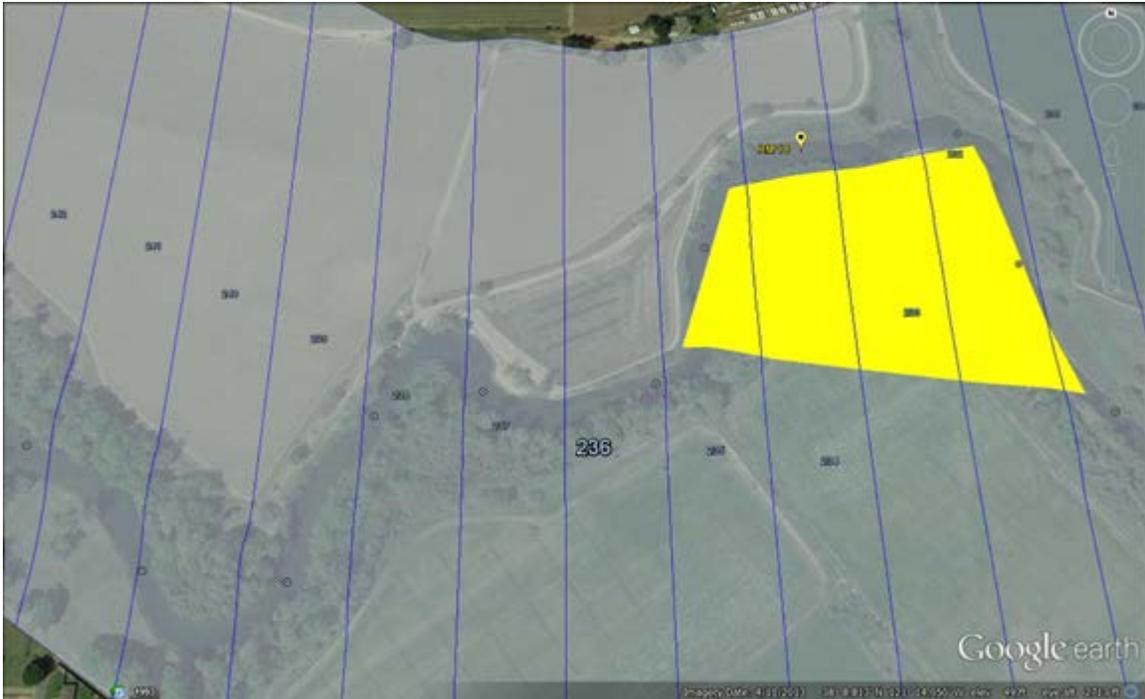


Figure 6-2. Example Project Area (yellow polygon) with the River Slices overlay and 3-digit River Slice codes. The code for River Slice just downstream of this Project Area is "236".

**Quantification Tool Data Entry:**

- In the Flood\_Office worksheet, Question 5: Enter the 3-digit River Slice code for the downstream end of the Project Area in Column F.

**Questions 6 through 10.** These will be auto-filled from the FloodAttenLSLandUse reference worksheet. Do not enter anything here and do not manipulate the FloodAttenLSLandUse reference worksheet

**Questions 11 through 14.** These will be auto-filled from the FloodAttenLSLandUse reference worksheet. Do not enter anything here and do not manipulate the FloodAttenLSLandUse reference worksheet

For the following questions, GIS imagery on the Lower Mokelumne during a 2,600 and 5,000 cfs release from Camanche dam, available through the Mokelumne Environmental Benefits Program, should be used. These images can be viewed using Arc GIS.

**Questions 15–17.** Proximity of this Project Area to other areas likely to provide flood attenuation at (a) 2,600 cfs flows, (b) 5,000 cfs flows, and (c) in a 100 yr flood (1% chance of occurrence in any given year).

**Data Collection:**

1. Using GIS imagery on the Lower Mokelumne during a 2,600 and 5,000 cfs release from Camanche dam, provided with the Quantification Tool, measure stream length (feet) between either the up or downstream end of the Project Area and the closest end of other areas of at least 10 acres in size that flood at the three listed flow levels:
  - 2,600 cfs flow: see GIS imagery dated June 2006. For the June 2006 imagery, the photo-interpreter must realize and take into account that these images are not of an annual peak flow but of the declining flows from a much higher (5,000 cfs) peak flow. Therefore some areas that would not flood at 2,600 peak flow are show to be draining the earlier higher waters in the June 2006 imagery.
  - 5,000 cfs flows: see GIS imagery dated April 2006
  - 100 yr flood: see lateral extent of FEMA 100-yr flood in GIS data provided or Flood Analysis Layers kml file provided with the Quantification Tool

**Quantification Tool Data Entry:**

In the Flood\_Office worksheet, Questions 15–17, enter distance in feet in column F.

**Question 18.** 100-yr flood inundation in Project Area.

**Data Collection:**

See lateral extent of FEMA 100-yr flood in GIS data provided or Flood Analysis Layers kml file provided with the Quantification Tool within the Project Area and either using GIS or other means, determine the number of acres within the Project Area that would be inundated during a 100-yr flood.

**Quantification Tool Data Entry:**

- In Flood\_Office worksheet, Question 18, record the number of acres within the Project Area inundated during a 100-yr flood.

**Question 19.** 5,000 cfs flood inundation in Project Area.

**Data Collection:**

Using GIS imagery on the Lower Mokelumne during a 5,000 cfs release from Camanche dam, provided with the Quantification Tool, determine the number of acres within the Project Area that would be inundated during the 5,000 cfs flow (April 2006 imagery).

**Quantification Tool Data Entry:**

- In Flood\_Office worksheet, Question 19, record the number of acres within the Project Area inundated during the 5,000 cfs flow.

**Question 20.** 2,600 cfs flood inundation in Project Area.

**Data Collection:**

Using GIS imagery on the Lower Mokelumne during a 2,600 cfs release from Camanche dam, provided with the Quantification Tool, determine the number of acres within the Project Area that would be inundated during the 2,600 cfs (June 2006 imagery) flows.

Care should be taken in interpreting extent of the 2,600 cfs flow using the 2006 imagery since this image was collected as flood water receded from a much higher annual peak flow (5,000 cfs). Because of the earlier higher flows in 2006, some areas are inundated not because of the high flows at that time, but because flood water from earlier in the year have not finished draining back into the river. Areas that have a direct connection to the river in the image are most likely to be areas that flood during the 2,600 cfs flow.

**Quantification Tool Data Entry:**

- In Flood\_Office worksheet, Question 20, record the number of acres within the Project Area inundated during a 2,600 cfs flow.

**Question 21.** Has river access to the floodplain(s) within the Project Area changed for the long term since 2006?

**Data Collection:**

Indicate yes with a 'y' and no with an 'n'. Long-term permanent changes can include removal or movement of levees, notches in levees or similar changes affecting flood access to Project Area.

**Quantification Tool Data Entry:**

- In Flood\_Office worksheet, Question 21, Indicate yes with a 'y' and no with an 'n'.

**Question 22–24.** Are there man-made impediments to floodplain inundation in Project Area during a 100-yr flood, 5,000 cfs flood, or 2,600 cfs flood?

**Data Collection:**

- Question 22. Estimate the probable extent (acres) of a 100-year floodplain within Project Area if levees or other man-made impediments to flooding within the site were removed.
- Question 23. Estimate the probable extent (acres) of a flood within Project Area at 5,000 cfs if levees or other man-made impediments to flooding within the site were removed.
- Question 24. Estimate the probable extent (acres) of a flood within Project Area at 2,600 cfs if levees or other man-made impediments to flooding within the site were removed.

**Quantification Tool Data Entry:**

- Enter the number of acres estimated for Questions 22–24 in Column F of the Flood\_Office worksheet.

## 6.2 Field Assessment, Potential for Flood Attenuation

In this section, you are provided with step-by-step instructions on filling out the Flood Field Data Sheet form and entering the data into the Quantification Tool spreadsheet (Flood\_Field) model. There are up to 29 questions to address for the entire Project Area under this section. Map units are not used for the flood assessment tool.

Record responses to each of the 29 questions from the Riparian Potential for Flood Attenuation Field Data sheet for the Project Area in the hard copy data sheet provided and, once completed,

transfer the information to the Flood\_Field worksheet in the Excel version of the Riparian Benefits Quantification Tool.

As with the other datasheets in the Quantification Tool, only enter data into the yellow-highlighted cells. Do not alter any of the other cells, rows, or columns in the tool.

Flood Attenuation Field Data Sheet: Appendix B  
QT Data Entry worksheet: Flood\_Field

For the Project Area, the 29 questions are broken out into four categories:

- Flood observations (land owner/manager observations or other sources) (questions 1–4)
- Channel width-to-depth ratio (questions 5–11)
- Existing Floodplain with Direct Access to River Flow (questions 12–21)
- Existing Floodplain with Impeded Access to River Flow (questions 22–29)

#### 6.2.1 Flood observations (land owner/manager observations or other sources)

The four questions in this subsection provide important background information for interpreting tool results. They are to be gathered through an interview with the land owner or land manager.

**Question 1.** Has flooding from the river, or a tributary to the river, occurred in the Project Area?

**Field Data Collection:**

It could be helpful to prompt the land manager with years when high flows were known to occur. These years include 1983, 1986, 1997, 2006, and 2011 (all years when flows at Camanche exceeded 5,000 cfs).

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 1, enter “Y” for 'yes', and “N” for 'no'.

**Question 2a–c.** If flooding has been observed in the Project Area, record the lowest annual peak flow at which flooding occurred, the percent of the Project Area flooded at that time, and the average depth of flooding that occurred.

**Field Data Collection:**

- If 5% or more of the Project Area floods, record the flow at which this occurs. If the land owner only knows the data of this flow level, actual flows at Camanche dam on that date can be found in the ‘CamancheFlowRecord.xls’ spreadsheet supplied with the with the Quantification Tool or at the USGS website for gage #11323500.
- Percent of Project Area flooded at that time. Estimate or if possible measure the percent of the Project Area flooded during the low flow event. The land manager can point out these

areas in the field and on the field map. A percentage estimate will provide advisory information for interpreting the tool results.

- Average depth of high water in flooded portion of the Project Area during lowest flooding (feet)? Again, estimate or if possible measure the water depth of flooding during the low flow event. The land manager might point to tree or fence lines where high waters reached as a marker of flood water depth. An estimate is sufficient for providing advisory information for interpreting the tool results.

**Quantification Tool Data Entry:**

- In Flood\_Field worksheet, Questions 1a, enter in cfs the lowest annual peak flow at which flooding has occurred.
- In Flood\_Field worksheet, Questions 1b, enter in percent (e.g., 50 for 50%) the percent of area flooded during the low flood event.
- In Flood\_Field worksheet, Questions 1c, enter depth of flood water in feet for the lowest flow at which flooding has occurred.

**Question 3.** If flooding has been observed in the Project Area, record the highest annual peak flow at which flooding occurred, the percent of the Project Area flooded at that time, and the average depth of flooding that occurred.

**Field Data Collection:**

Instructions for these questions are identical to those for Questions 2a–c, except that this is for the highest, rather than the lowest, floodwater that has flooded at least 5% of the Project Area.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 3a–3c, enter answers as cfs (a), percent number (e.g., 50 for 50%), and feet (c).

**Question 4.** What hydrologic processes have been observed at the project site during flooding (Mark Y or N in the column to the right).

**Field Data Collection:**

Six ways in which river water can access a floodplain are outlined in questions 4a through 4f. Any number of these processes could have been observed in a Project Area. Discuss these alternative pathways with the land manager to understand how flooding can occur in the Project Area. Viewing the site together in the field and with a field map is helpful.

- Floodplain inundation directly from river channel flow. This is most evidenced by observed direct flows from the river to the floodplain without going over, under or through structures such as levees.
- Floodplain inundation from flow entering Project Area from adjacent property. This can occur from both upstream and through downstream backflows.
- Flow overtopped levee. This is a common means of river access to floodplains and could occur only during very high flows.

- Seepage through levee. Seepage is not as obvious as overtopping flows but can be observed where standing water appears behind a levee during periods of high flow with no other observable flow path between the channel and flooded area.
- Flow through gaps or breaches in levee that were subsequently fixed. These gaps or breaches pertain to levee length in the Project Area. If the breaches or gaps were from downstream or upstream areas, then respond positively to 4b.
- Flow through gaps or breaches in levee that were left as is.

**Quantification Tool Data Entry:**

Enter “y” for each of the six hydrologic processes that have been observed at the Project Area and a “n” for those that have not been observed there. These will be tallied and automatically summarized in the Quantification Tool.

### 6.2.2 Channel and floodplain characteristics

In order to answer the remaining questions in the Flood Field Datasheet, field surveys must be performed to obtain distances and elevations along well placed transects. Before doing so, identify areas that are directly flooded by the river, and areas that do or could be flooded if existing structures were altered. Estimate differences in elevation between non-flooding areas and known areas with direct access to river flooding, as well as location in relation to the river, to judge whether or not a potential floodplain could flood if existing impediments, such as a levee, were changed or removed.

Map this or these areas out on the Field Map and the vegetation map, indicating which areas have direct vs. indirect flooding from the river (I vs. D in the vegetation field data sheet). Enter these data into the Veg\_Data worksheet so that the vegetation polygons in floodplains with direct (D) vs. indirect (I) flooding are clearly identified. This flood and vegetation cover information accurately captured in the Veg\_Data worksheet will automatically be brought into the Potential for Flood Attenuation Quantification Tool.

For each floodplain identified, locate three transects at the upper, mid, and lower (as the river flows) ends. You will perform longitudinal surveys between these cross-sections, and survey elevations from the channel to the floodplain at each of the three cross-sections. Thus, if a floodplain that has direct access lies upstream of a second floodplain with only impeded (e.g., blocked by a levee) access to floodwaters, a total of five cross-sections might be necessary (see Figure 6-3). Alternatively, if there is only one large and only indirectly accessible floodplain in the Project Area, then three cross-sections will suffice (see Figure 6-4).

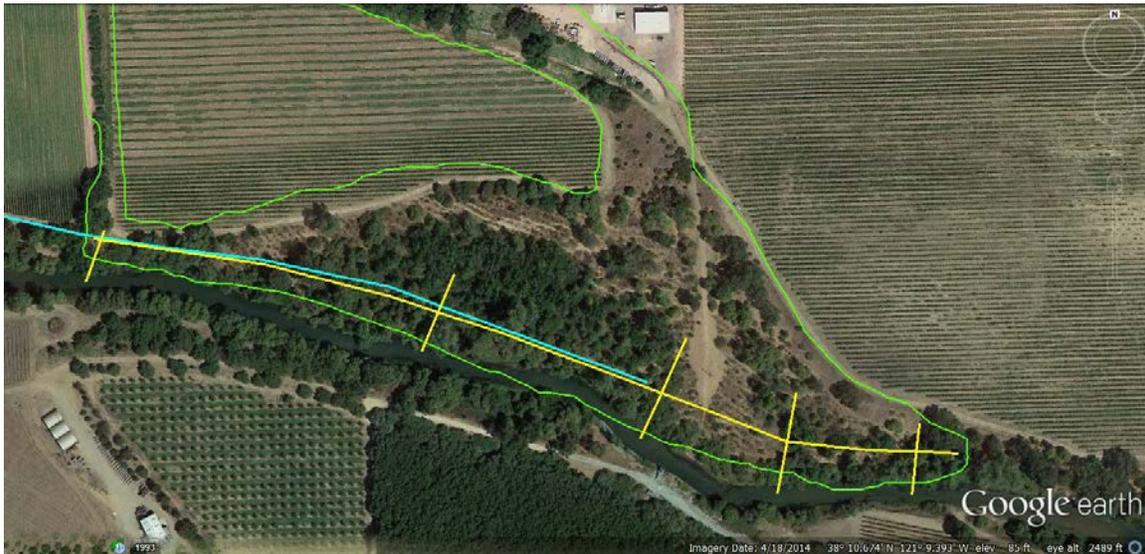
The recommended precision range is  $\pm 0.5$  ft for these survey questions. These questions must be answered using field survey equipment at the site. Correct use of this equipment requires some training regarding how to collect elevation data and how to use these values in order to accurately calculate specific elevations and distances. It is important to read through all of these questions and carefully consider the data needs before and while setting up the field surveys.

This section also requires some field experience in identifying bankfull and the low flow water surface. Appendix K provides instructions on bankfull identification. All elevations must be provided either as feet above mean sea level (MSL) or in relation to a permanently marked position. If using a permanently marked position, the exact location must also be recorded with the Project documentation on a map.

At each cross-section, the following information is needed:

- Elevation of low flow water surface (e.g., water surface elevation in August or September)
- Elevation of bankfull (see Appendix K)
- Elevation of levee
- Elevation of floodplain with direct access to the channel
- Elevation of floodplain with indirect access (e.g., blocked by levee or other structure) to channel

The easiest way to do this is to establish the upper, mid, and lower cross-section locations, and then starting from the upper cross-section, perform both the cross section surveys and the longitudinal survey at the same time (in the form of a triple-crossed 't'), so that the distance between cross-sections are also measured. This is most easily done if the cross sections are linked along an easily accessed trail or road (e.g., levee road) adjacent to the river. An example of field survey data collection points is provided in Figure 6-4, in which the upper, mid, and lower cross-sections were surveyed along a 'backbone' longitudinal survey performed along a levee road adjacent to the channel.



**Figure 6-3.** Example of Project Area with a directly accessible floodplain along the upstream (right) end, and a levee-impeded floodplain in the mid and lower ends of the area. The blue line is the levee and the yellow lines reflect the longitudinal and cross-section survey paths used to collect elevation and distance data for the Flood Quantification Tool.



Figure 6-4. Example of surveyed lines collected for a site along the Lower Mokelumne River, where only one levee-impeded floodplain of substantial size exists. Survey lines in yellow show the upper, mid, and lower cross-sections and the line connecting them along the levee road (used to provide the river length between each cross-section).

### 6.2.3 Channel width-to-depth ratio

**Question 5.** Bankfull channel elevation at the upper, mid, and lower cross-sections in the Project Area (ft). All elevations surveyed in relation to a single bench mark, which can have a real above MSL elevation, or an arbitrary elevation of 100 feet, with a known location and permanent marker for future surveys.

#### Field Data Collection:

These surveys require bankfull identification for each cross-section, and all elevations must be provided either as feet above mean sea level (MSL) or in relation to a permanently marked position. If using a permanently marked position, the exact location must also be recorded with the Project documentation on a map.

#### Quantification Tool Data Entry:

In Flood\_Field worksheet, Questions 5a–5c, enter answers in feet above MSL or a permanently marked location.

- Enter in feet in column E for the upstream cross section bank full elevation
- Enter in feet in column E for the mid cross section bank full elevation
- Enter in feet in column E for the lower cross section bank full elevation

**Questions 6 and 7.** Distance along channel between upstream and mid cross section (feet) and between the mid and lower cross section.

**Field Data Collection:**

During the field surveys, measure this as the distance along the channel (vs. as the crow flies) between the upstream and mid-cross sections, and between the mid and lower cross sections. As with question 5, collection of this data requires basic knowledge and experience in collecting elevation survey data and in using the required equipment.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 6 and 7, enter the distance from the upstream to the mid cross section, and from the mid to the lower cross section in feet.

**Question 9.** Elevation difference between low flow water surface and bankfull indicators at the upper, mid, and lower cross-section of the Project Area (feet).

**Field Data Collection:**

These data are collected by surveying in the elevation of the low flow water surface in the field. Subtract the low flow water surface elevation from the bankfull elevation to get the difference in feet for the upper, mid, and lower cross sections.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 9, enter the difference in elevation for the upstream, mid, and lower cross sections in column E.

**Question 10.** Bankfull width at the upper, mid, and lower cross-section of the Project Area (feet).

**Field Data Collection:**

Bankfull width measurements require surveying across the channel and therefore either getting very wet by walking/swimming the channel or access to the property on the opposite side of the river. Although less precise, sufficiently precise information on bankfull width for the quantification tool can be obtained by estimating the location of bankfull using either Google Earth or GIS imagery and measuring the distance across the channel using those software products (e.g., the ruler tool in Google Earth or Arc GIS). All measurements need to be made in feet and collected at the same locations as the field surveyed upper, mid and lower cross sections.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet Questions 10, enter the bankfull channel width for the upstream, mid, and lower cross sections in column E.

#### 6.2.4 Existing floodplain with direct access to river flow

**Question 12.** Length of channel margin levee (where levee is < 30 feet from low flow channel) on project side of river.

**Field Data Collection:**

In the field locate the upstream and downstream ends of any levees located within 30 ft of the low flow channel edge. Record these locations on the field map and then transfer the information to either Arc GIS or Google Earth once back in the office. Again, sufficiently precise information on the channel margin levee length for the quantification tool can be obtained by estimating the length using either Google Earth or GIS imagery and measuring with the ruler tool.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 12, enter the levee length in column E.

**Question 13.** Length of setback levee (where levee is >30 feet from low flow channel) on project side of river.

**Field Data Collection:**

As for question 12, locate the upstream and downstream ends of any levees located greater than 30 ft of the low flow channel edge in the field. Record these locations on the field map and then transfer the information to either Arc GIS or Google Earth once back in the office. Again, sufficiently precise information on the channel margin levee length for the quantification tool can be obtained by estimating the length using either Google Earth or GIS imagery and measuring with the ruler tool.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 13, enter the levee length in column E.

**Question 14.** Is there a floodplain that inundates at 2,600 and/or 5,000 cfs that has unimpeded connection to the river? E.g., If a levee is present, this floodplain would be on the river-side of the levee. If no, skip to question 37

**Field Data Collection:**

Use aerial imagery that can be viewed on Arc GIS for April 2006 (5,000 cfs flows) and June 2006 (2,600 cfs flows) in order to answer this question. View the images and identify areas that are flooded—e.g., have visible standing water. Determine if the water in these areas has a direct link to the river channel at that flow level, or if the water reached the flooded area by either a levee breach, seepage below or through the levee. If the flooded surface has direct access at either of these flow levels, then answer “yes” to for the appropriate flow. For the June 2006 imagery, the photo-interpreter must realize and take into account that these images are not of an annual peak flow but of the declining flows from a much higher (5,000 cfs) peak flow. Therefore some areas that would not flood at 2,600 peak flow are show to be draining the earlier higher waters in the June 2006 imagery.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 14a, enter “y” for yes if the river water has direct access to a flooded area at 2,600 cfs flows (June 2006 imagery).

In Flood\_Field worksheet, Questions 14b, enter “y” for yes if the river water has direct access to a flooded area at 2,600 cfs flows (April 2006 imagery).

**Question 16.** Elevation of floodplain that receives unimpeded flow from the river.

**Field Data Collection:**

Use the field cross-section survey data to respond to this question.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 15, enter the floodplain elevation in column E in feet for the upper, mid, and lower cross section surveys.

**Question 17.** Width of floodplain that receives unimpeded flow from the river, ft.

**Field Data Collection:**

Use aerial imagery that can be viewed on Arc GIS for April 2006 (5,000 cfs flows) and June 2006 (2,600 cfs flows) in order to answer this question. View the images and identify areas that are flooded—e.g., have visible standing water. Determine if the water in these areas has a direct link to the river channel at that flow level, or if the water reached the flooded area by either a levee breach, seepage below or through the levee. If the flooded surface has direct access at either of these flow levels, then answer “yes” to for the appropriate flow.

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Questions 15, enter the floodplain elevation in column E in feet for the upper, mid, and lower cross section surveys.

**Question 18.** Distance 'as a crow flies' from upper to lower end of a floodplain that receives unimpeded flow from the river (ft).

**Field Data Collection:**

Record upper and lower end cross-sections on Field Map or GPS and measure direct distance in Google Earth or GIS in office, as illustrated by the red line in Figure 6-5 below.



Figure 6-5. The redline from the upper (right-most) cross-section to the lower most cross section within a floodplain with unimpeded flow is measured in feet as the shortest flood flow path across a floodplain (red line).

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Question 18, enter the length of the line connecting the upper and lower ends of the floodplain in feet.

**Question 20.** Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas?

**Field Data Collection:**

20a. Elevational difference common to the floodplain area (ft): Walk around the floodplain in question, and identify high and low topographic areas that occupy at least 10% of the floodplain area. Estimate the difference in elevation between these areas and the majority of the floodplain in feet.

20b. Areal extent of swale or local depression (acres): This can be done by outlining any back channels, ponded areas, or other topographic depressions on the field map and digitizing this information in GIS (along with the vegetation polygons) at the office. In many cases, topographic depressions support vegetation types that differ from surrounding areas, and a vegetation polygon also represents the outline of the depressional area.

**Quantification Tool Data Entry:**

20a. In Flood\_Field worksheet, Question 20a, enter the average difference in elevation observed in the floodplain as feet.

20b. In Flood\_Field worksheet, Question 20b, enter the size of any swales or depressional areas in the acres.

### 6.2.5 Existing floodplain with indirect access to river flow

**Question 22.** Is there a floodplain or relatively flat area from which river flow is regularly impeded by a levee, but that has a similar surface elevation to the areas flooded at 2,600 or 5,000 cfs on the river side of the levee? E.g., a floodplain on the land-side of a levee.

**Field Data Collection:**

Estimate differences in elevation between non-flooding areas and known areas with direct access to river flooding, as well as location in relation to the river, to judge whether or not a potential floodplain could flood if existing impediments, such as a levee, were changed or removed.

Map this or these areas out on the Field Map and for the vegetation map, indicated which areas have direct vs. indirect flooding from the river (I vs. D in the vegetation field data sheet). Enter these data into the Veg\_Data worksheet so that the areas and vegetation cover information gets accurately captured for the Quantification Tool.

**Quantification Tool Data Entry:**

Enter 'y' for yes and 'n' for no. If no, skip the following questions.

**Question 24.** Difference in elevation between low flow water surface and top of levee at the upper, mid, and lower cross-section of the Project Area (ft) .

**Field Data Collection:**

Use cross-section field survey information to respond to this question in feet.

**Quantification Tool Data Entry:**

Enter answer in feet in column E of the Flood\_Field worksheet for the upper (a), mid (b), and lower (c) cross sections associated with this floodplain.

**Question 26.** Distance 'as a crow flies' from upper to lower end of a levee-impeded floodplain (ft).

**Field Data Collection:**

Record upper and lower end cross-sections on Field Map or GPS and measure direct distance in Google Earth or GIS in office, as illustrated by the red line in Figure 6-6 below.

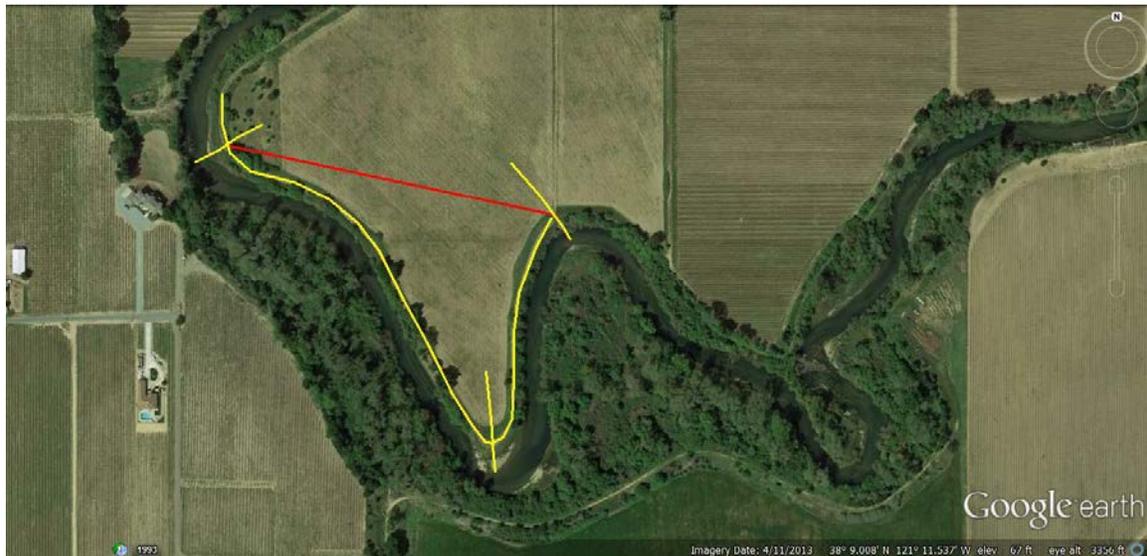


Figure 6-6. The redline from the upper (right-most) cross-section to the lower most cross section within a floodplain with levee-impeded flow is measured in feet as the shortest flood flow path across a floodplain (red line).

**Quantification Tool Data Entry:**

In Flood\_Field worksheet, Question 26, enter the length of the line connecting the upper and lower ends of the floodplain in feet.

**Question 28.** Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas?

**Field Data Collection:**

28a. Elevational difference common to the floodplain area (ft): Walk around the floodplain in question, and identify high and low topographic areas that occupy at least 10% of the floodplain area. Estimate the difference in elevation between these areas and the majority of the floodplain in feet.

28b. Areal extent of swale or local depression (acres): This can be done by outlining any back channels, ponded areas, or other topographic depressions on the field map and digitizing this information in GIS (along with the vegetation polygons) at the office. In many cases, topographic

depressions support vegetation types that differ from surrounding areas, and a vegetation polygon also represents the outline of the depressional area.

**Quantification Tool Data Entry:**

28a. In Flood\_Field worksheet, Question 20a, enter the average difference in elevation observed in the floodplain as feet.

28b. In Flood\_Field worksheet, Question 20b, enter the size of any swales or depressional areas in the acres.

## 7 QUANTIFICATION OF STREAM SHADE

Like the other riparian benefit quantification tools, the tool to quantify the potential a site has to attenuate downstream flooding requires information input from the office as well as from the field. The office assessment is only slightly shorter than the field assessment but can be done completely from the desktop.

### 7.1 Office Assessment for Landscape Priority: a step by step guide

There are up to six questions that must be answered in the Office Assessment Form, depending on the regulatory status of the stream channel under the Clean Water Act. You will need access to the internet or other source of information on the current regulatory status and relevant conditions of the channel. Address questions 1 through 6 as instructed, based on knowledge of the regulatory and aquatic conditions of the watershed associated with the Project Area. You can either:

- Enter answer directly into a saved copy of the Quantification Tool or
- Record responses on a hard-copy of the Office Data Sheet and then transfer those answers to the Quantification Tool spreadsheet.

When using the Quantification Tool spreadsheet, go to the second tab, labeled 'OfficeForm', and follow the directions below for entering data there. A blank Office Data sheet is provided in Appendix B of this User Guide.

Office Data Sheet  
QT: second worksheet: OfficeForm

**Project Information.** Project Site, Reviewer Name, Date, and Project Acres.

Be sure to fill out the Project Information at the top of this worksheet, including 'Project Site', 'Reviewer name', 'Date' and in particular 'Project Acres'. Enter the number of acres included in the Project Area (to the nearest 100<sup>th</sup> of an acre) in cell B4.

**Question 1.** Does the Basin Water Quality Control Plan identify COLD freshwater habitat as a beneficial use for the project reach (or for the reach to which it is a significant tributary)?

See the EPA Central Valley Regional Water Quality Control Board website for the most up to date version the Central Valley Plan:

[http://www.swrcb.ca.gov/rwqcb5/water\\_issues/basin\\_plans/index.shtml](http://www.swrcb.ca.gov/rwqcb5/water_issues/basin_plans/index.shtml).

As of this writing, it was last updated in November 2011 for the Sacramento-San Joaquin Basin. The map in the Plan provides reach code numbers and subsequent table lists the beneficial uses per reach. Find the reach where your project area is located and look up its beneficial uses to answer this question.

Enter 1 for 'Yes' and 0 for 'No' in column C.

**Question 2.** Is reach listed or being considered for listing in EPA Section 303(d) for temperature?

See the EPA website for the Central Valley Regional Water Quality Control Board ([http://www.swrcb.ca.gov/rwqcb5/water\\_issues/tmdl/impaired\\_waters\\_list/index.shtml](http://www.swrcb.ca.gov/rwqcb5/water_issues/tmdl/impaired_waters_list/index.shtml)) for a table of current Section 303(d) listed water bodies in the Central Valley Region. The table lists water bodies alphabetically—find the water body on which your project area is located. Look at Column L to see if it is listed for Temperature and Column O to see the TMDL requirement status (see top of table for code definitions). Respond to Question 2 accordingly.

2a. Enter '1' for yes it is now listed and enter '0' for no it is not listed in Column C.

2b. Enter '1' for yes, the reach is under consideration for listing and enter '0' for no, it is not under consideration for listing OR enter '0' if it is already listed as indicated in answer 2a.

If the answer to 2a is Yes, stop here; Otherwise continue

**Question 3.** Is there a current, or in the reasonably foreseeable future, state or federally listed as threatened or endangered cold freshwater species that uses this reach or adjacent reaches as part of its habitat at some stage in its life?

To get the most up-to-date information, call the local office for the California Department of Fish and Wildlife and the National Fish and Wildlife Service to find out whether or not any potential listings exist or can reasonably be expected.

Enter 1 for 'Yes' and 0 for 'No' in Column C.

*Provide data or information sources as attachments.*

**Question 4.** Do current/recent water temperature measurements exist for the project reach or nearby reach during mid to late summer?

Reports on the water body where your project is located might be available if there is a large upstream dam which has recently undergone relicensing. Relevant reports on water temperature changes are developed in support of TMDL listings. The local Water Quality Control Board Office should be able to tell you whether or not this type of information is available. If possible, use findings from such recent and existing peer-reviewed or agency approved reports.

If you or your office has the technical capacity and a nearby USGS and DWR maintained gauge exists, raw temperature data over time can be downloaded from the Department of Water Resources California Data Exchange Center: <http://cdec.water.ca.gov/selectQuery.html>

Enter 1 for 'Yes' and 0 for 'No' in Column C.

*Provide data sources as attachments.*

**Question 5.** If so, does the historical weekly average temperature during the warmest part of the year (late August to late September) significantly exceed current levels ( $p < 0.10$ )?

Reports on the water body where your project is located might be available if there is a large upstream dam which has recently undergone relicensing. Relevant reports on water temperature changes are developed in support of TMDL listings. The local Water Quality Control Board Office should be able to tell you whether or not this type of information is available. If possible, use findings from such recent and existing peer-reviewed or agency approved reports.

If you or your office has the technical capacity and a nearby USGS and DWR maintained gauge exists, raw temperature data over time can be downloaded from the Department of Water Resources California Data Exchange Center: <http://cdec.water.ca.gov/selectQuery.html>

Enter the appropriate number in Column C:

1. Yes, <10% higher
2. Yes, 10–30% higher
3. Yes, >30% higher

*Provide data sources as attachments.*

**Question 6.** Are stream flows during the growing season of an average water year lower than under historical (pre-1930) conditions?

Reports on the water body where your project is located might be available if there is a large upstream dam which has recently undergone relicensing. The local Water Quality Control Board Office should be able to tell you whether or not this type of information is available. If possible, use findings from such recent and existing peer-reviewed or agency approved reports.

If you or your office has the technical capacity and a nearby USGS and DWR maintained gauge exists, raw stream flow data over time can be downloaded from the Department of Water Resources California Data Exchange Center: <http://cdec.water.ca.gov/selectQuery.html>

Enter the appropriate letter in Column C:

1. Yes, >30% lower
2. Yes, 10–30% lower
3. Yes, <10% lower

*Provide data sources as attachments.*

## 7.2 Shade-A-lator Data Entry and Analysis for Site Capacity

For the office half of applying the Riparian Shade Quantification Tool, the following materials are needed:

Office equipment list:

- Project Area Map, marked up from the field
- Field data sheets, completed
- Arc GIS 9.x
- DEM of Project Area or LiDar (bare earth) raster file
- Blank version of the Riparian Shade Quantification Tool (Excel file)
- Blank version of the ShadeBlank.mxd file, with TTools
- This User Guide

Several steps must be taken to prepare the field data for use in the Riparian Shade Quantification Tool:

- Load TTools into the Arc GIS
- Create and digitize features and polygons
- Create attribute tables that match Vegetation types provided in Appendix I
- Convert vegetation type polygons to a raster data set
- Acquire a DEM raster file of the area, or LiDAR bare earth raster file

### 7.2.1 Load TTools into ArcGIS

This is simply done by opening up the TTools\_Blank\_Arc93.mxd file and saving the new project \*.mxd with the name of your project site. The TTools functions will then be carried forth into new \*.mxd folders.

### 7.2.2 Create and digitize stream and vegetation features

Use the Arc tool ‘create feature class’ in order to digitize the following features for each Map Unit, based on information recorded in the Project Area Map:

- Stream right bank polyline
- Stream left bank polyline
- Stream centerline polyline

Dissolve any separate right bank polylines into a single right bank line—being sure there are not any extra line segments. Do the same with the other left and center polylines for each Map Unit. Keep the Map Units separate because they will be run separately in the Riparian Shade Quantification Tool. Thus, you will need to go through these steps for each Map Unit that is part of a Project Area (creating shape and raster files, running TTools, and importing and running the Shade-A-Lator). An example of these features digitized into a hypothetical Project Area is provided in Figure 7-1 below.

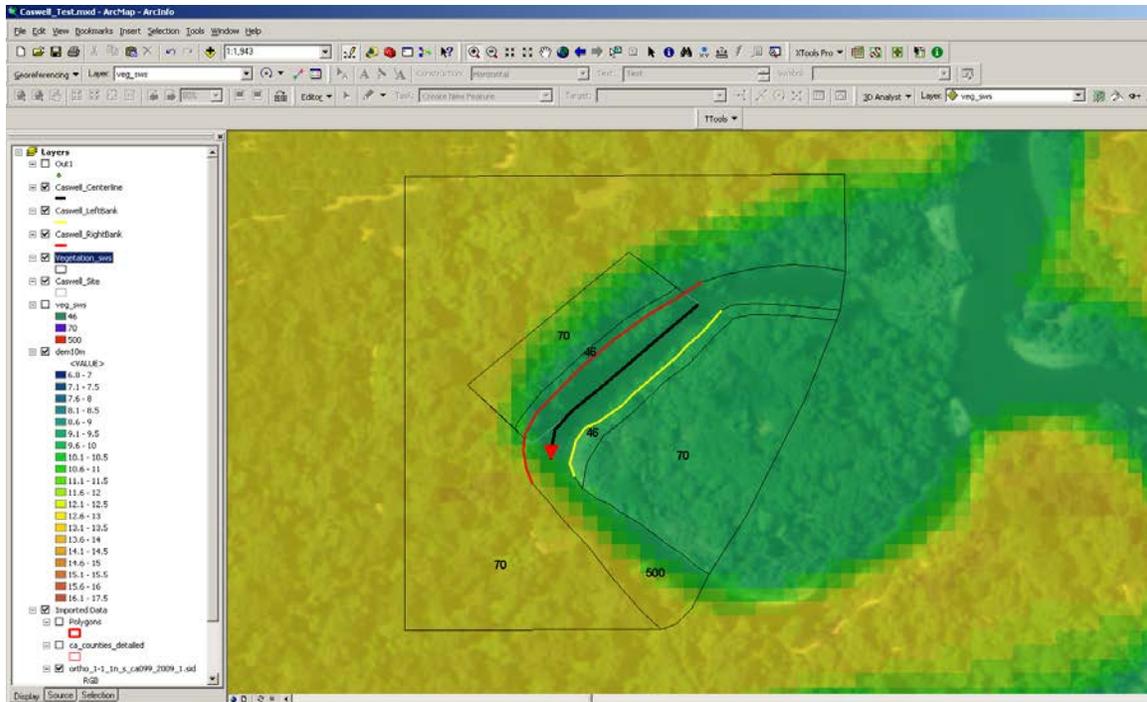


Figure 7-1. Stream right, left and centerline features are digitized along a reach of the Stanislaus River in Caswell State Park.

Next, digitize or scan vegetation type polygons as drawn in the field as new features for each Map Unit. Attribute each polygon with the Map Unit, field polygon number, vegetation type name, and vegetation type code, as listed in Appendix I. An example of digitized vegetation types is presented in Figure 7-1 above.

The vegetation type codes must be refined to include information on the vegetation age. The vegetation types are indicated by the first two digits of the four digit code used in the Veg\_Data worksheet; the last two digits for the Veg\_Data worksheet are always “00”. In the Shade-A-lator, vegetation age is indicated by the last two digits. Ages recognized by the Shade-A-Lator include 1, 2, 3, 4, 5, 10, 15, 20, 30, and 50 yrs. These ages, per vegetation type, match up to an assumed height, as indicated in Appendix I. The codes and ages recorded in the field for the vegetation field data sheet must be translated to Shade-A-Lator codes before entering as attributes in the vegetation shape file. If you are unsure of the vegetation age, use the field recorded height to find the appropriate age listed by vegetation type in Appendix I.

### 7.2.3 Convert vegetation type polygons to a raster data set

Once you have completed digitizing the vegetation types and stream lines, use the ArcTool ‘Feature to Raster’ to convert your vegetation cover polygons into a raster dataset. This function can be found by clicking on the toolbox symbol along the top-of-screen ribbon, and then clicking on ‘conversion tools’ to reveal 8 conversion tools. Select the tool called ‘to raster’, and under that (at one of the hammer symbols) select ‘Feature to raster’ (Figure 7-2). Set the output cell size to be about 1 meter, or if your projection or map units are set to feet, use 3.28 as the cell size. Be sure all projections are consistent. Select Vegetation type code to carry forward into the raster

layer; vegetation type names will be grabbed later by the Shade-A-Lator from the Riparian Codes worksheet.

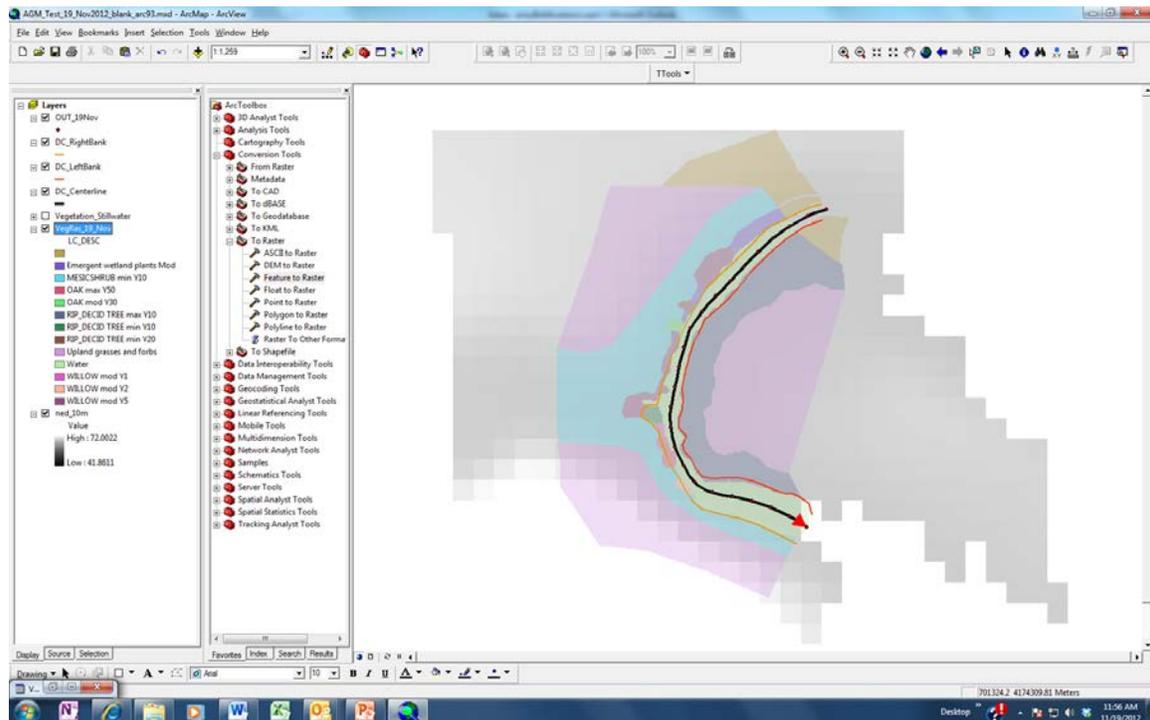


Figure 7-2. Screenshot of ArcToolbox menu showing 'Feature to raster' tool.

### 7.2.4 Import topographic information

Import a DEM raster file of the Project Area, or if available, a LiDAR bare earth raster file. This information will be critical for implementing the Quantification Tool. Again, ensure that all projections are consistent.

Checklist for Initiating the Riparian Shade Quantification Tool, per Map Unit:

- Stream Right Bank polyline (dissolved single part version)
- Stream Left Bank polyline (dissolved single part version)
- Stream Center polyline (dissolved single part version)
- Vegetation polygon raster (or LIDAR land cover height raster)
- DEM raster (or LiDAR bare earth raster)

### 7.3 Riparian Quantification Tool Application

Application of the Quantification Tool requires two steps, each of which is detailed in the sections below:

1. Generation of spatial shade data through Arc GIS TTools
2. Running model in Excel spreadsheet

### 7.3.1 Using TTools to generate data for riparian shade quantification tool

At this point, you have loaded TTools into your 9.x ArcGIS software and (2) have prepared the data needs from the field and other GIS data, including streamlines, vegetation polygons and topographic data. TTools was created for ArcGIS to use these data to generate spatial data for the Shade-A-Lator, including a series of cross-sections along which spatial data on channel bank aspect, local topography, channel width, and vegetation are automatically collected and catalogued. These data are then put into output tables that can be copied and pasted from ArcGIS directly into the Shade-A-Lator worksheets in order to generate estimates of topographic and riparian shade. The TTool involves following 5 simple steps that are prompted by a pull-down menu in the Arc GIS ribbon across the top of the computer screen (Figure 7-3).

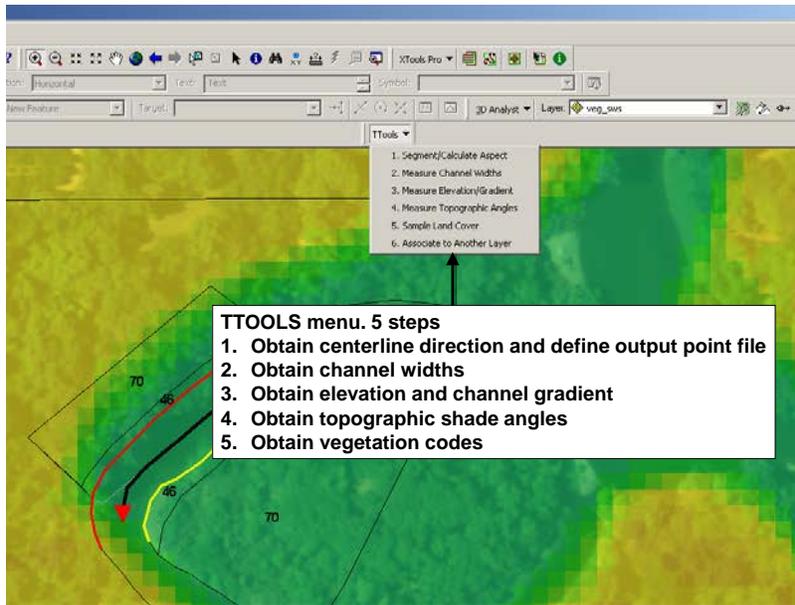


Figure 7-3. TTools enables the user to prepare ready to use data tables for the Shade-A-Lator in five steps, once required field data have been brought into the GIS project.

#### 7.3.1.1 Obtain centerline direction and define output point file

Select the first option 'Segment/Calculate Aspect' in the TTools drop down menu. You will then be prompted to select the stream centerline file created in Section 7.4.2 (Figure 7-4 below).

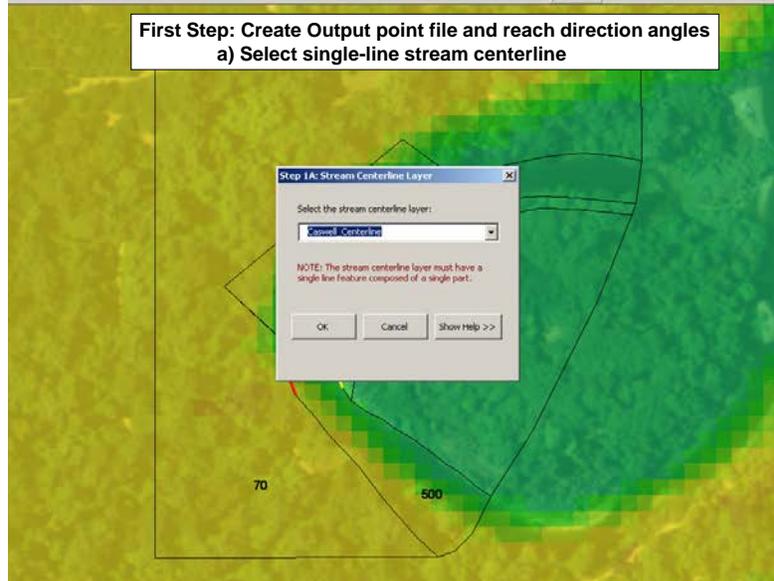


Figure 7-4. The first step in TTools is to select the stream centerline file.

Once this is selected, you will be prompted to determine whether or not the channel flow direction has been correctly identified in the software, as indicated by a red triangle that appears on one end of the stream centerline (Figure 7-5). Answer yes or no. If you answer no, the software will assume the opposite direction.

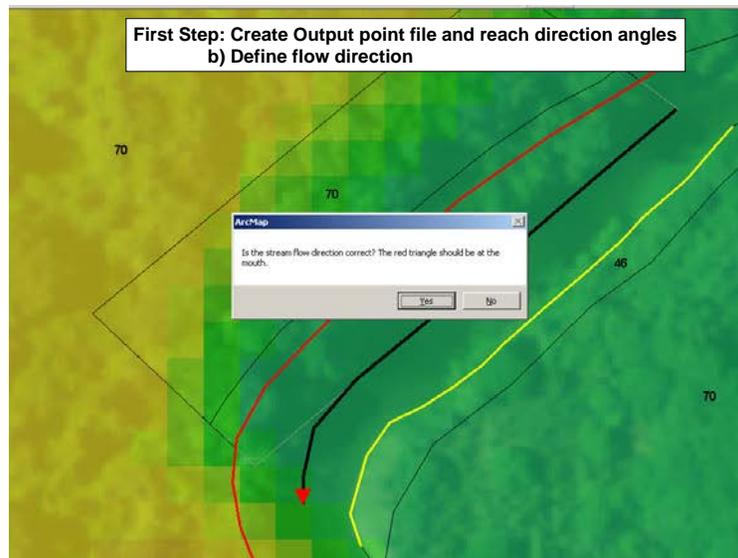


Figure 7-5. Second prompt in the first step of the TTools menu is to ascertain the flow direction.

Once the stream centerline and flow direction are defined, the user must input the number of equal length segments to create along the stream centerline. If your centerline is 100 feet long, and you want cross-section samples collected every 10 ft., then input '10' for the number of stream segments (Figure 7-6).

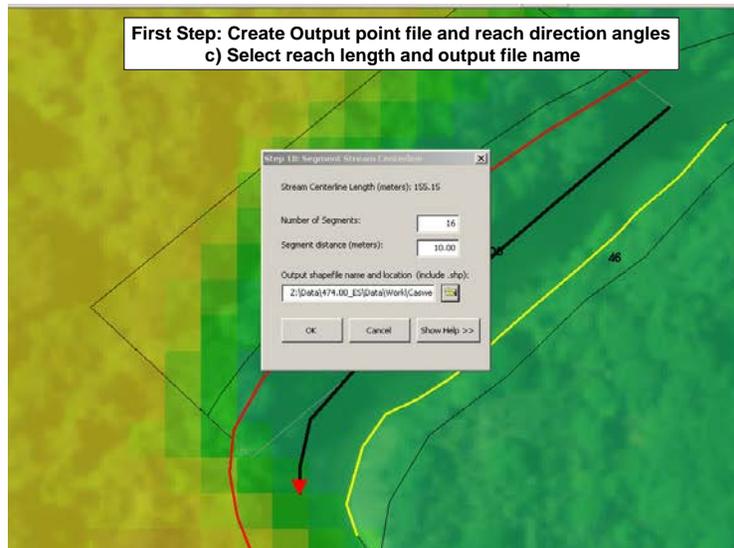


Figure 7-6. Select the number of stream segments based on the distance you would like between cross-section sample lines.

Once these three questions have been addressed, you need to create/name a new output shapefile which will include one row for each segment created along the stream centerline; in TTools, this file will subsequently be referred to as the 'Stream Centerline Point Layer'. At each of the subsequent TTools steps, additional data will be added to the rows in the attribute table of this output shape file. Once these queries are answered, TTools will generate channel segments along the stream centerline (Figure 7-7).

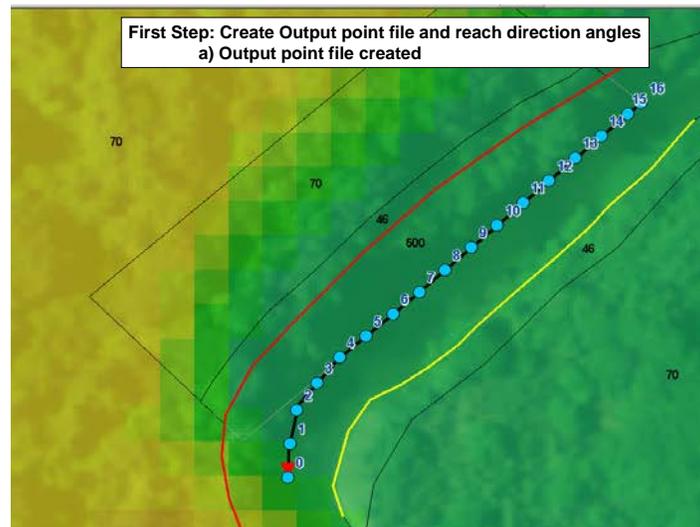


Figure 7-7. Channel segments are generated through step 1 of TTools.

### 7.3.1.2 Obtain channel widths

To initiate the second step in TTools, select the second option in the TTools draw down menu. You will be asked to select the polyline files for the left and right channel banks, as well as the Stream Centerline Point Layer (the output file created in Step 1). Figure 7-8 shows a screenshot of this step for a reach in Caswell State Park along the Stanislaus River.

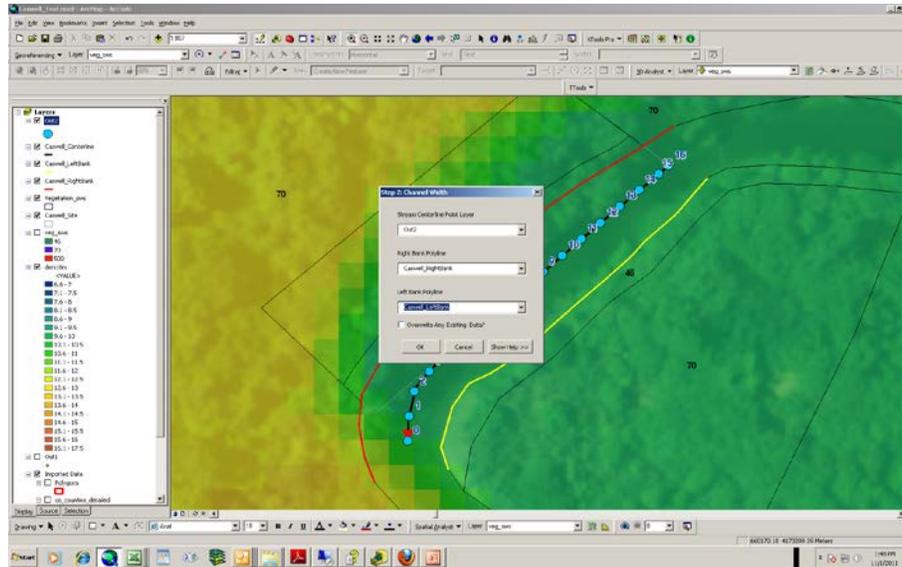


Figure 7-8. Step 2 of TTools requires selection of the left and right bank polyline layers created from field data (see Section 7.4).

### 7.3.1.3 Obtain elevation and channel gradient

In the third step of the TTools pull-down menu, 'Measure elevation and gradient', elevation data is pulled into the project with proper units (Figure 7-9). This is done by responding to three queries:

- Select output point file: if you are using a 10m DEM, select the 1 cell (elevation value at a point). If you are using LiDAR (1 to 2m resolution), select the 9 cell sample correction method.
- Select DEM grid: pull down arrow and select elevation layer to be used (either a DEM or LiDAR layer)
- Define elevation units of grid: use the pull down arrow to select the units for the elevation layer

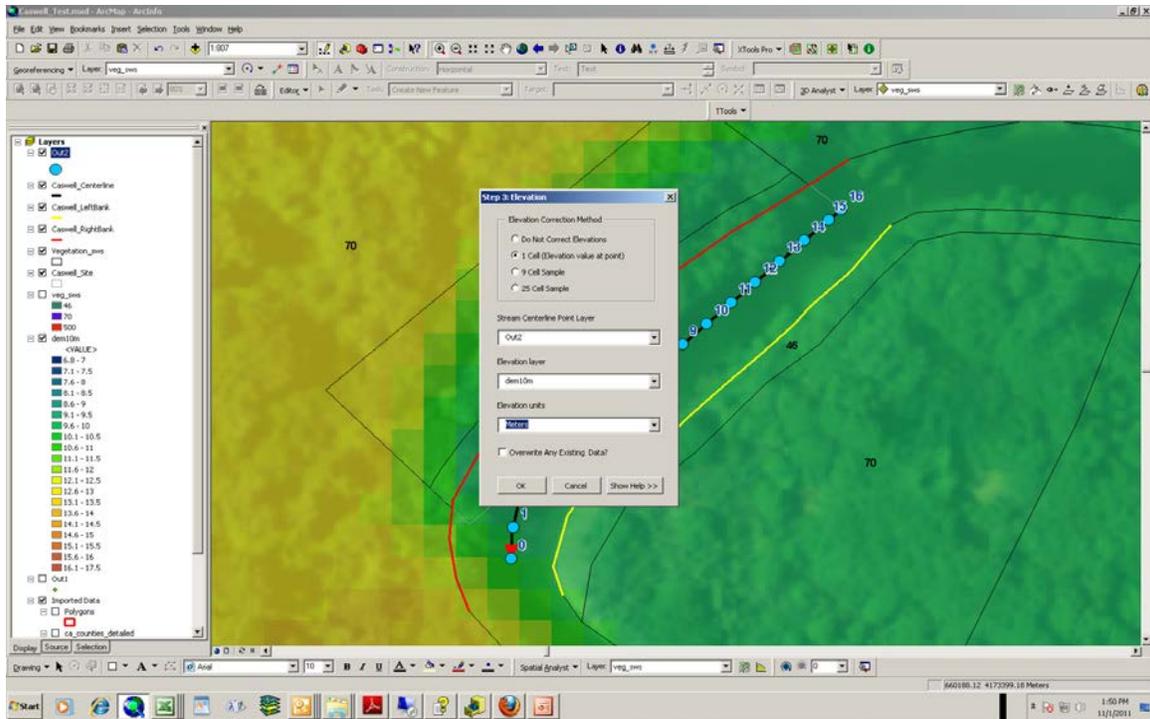


Figure 7-9. The third step in TTools involves obtaining and defining units for the project elevation data.

#### 7.3.1.4 Obtain topographic shade angles

In the fourth step of the TTools menu, ‘Sample topographic shade’, the user sets up the program to sample topographic shade based on the sun’s projected position on the given date in relation to site topography. The requirements for setting up this process are met by responding to the following four queries (Figure 7-10):

- Select output point file: this is the same output file used in the previous steps.
- Select DEM grid: again, select DEM or LiDAR file with topographic data
- Define elevation units of grid: as in step three, select the units for the topographic data.
- Define maximum sample distance: this is for maximum distance perpendicular to the channel that is used in the topographic shade cross-section. Set this as a large value to ensure that all topographic shade effects are accounted for, such as 1 km.
- State number of directions: here there appears to be an option to use three or seven compass directions for sampling topographic shade effects; however the Shade-A-Lator only uses the three cardinal directions (West, East, and South). Select ‘3’.

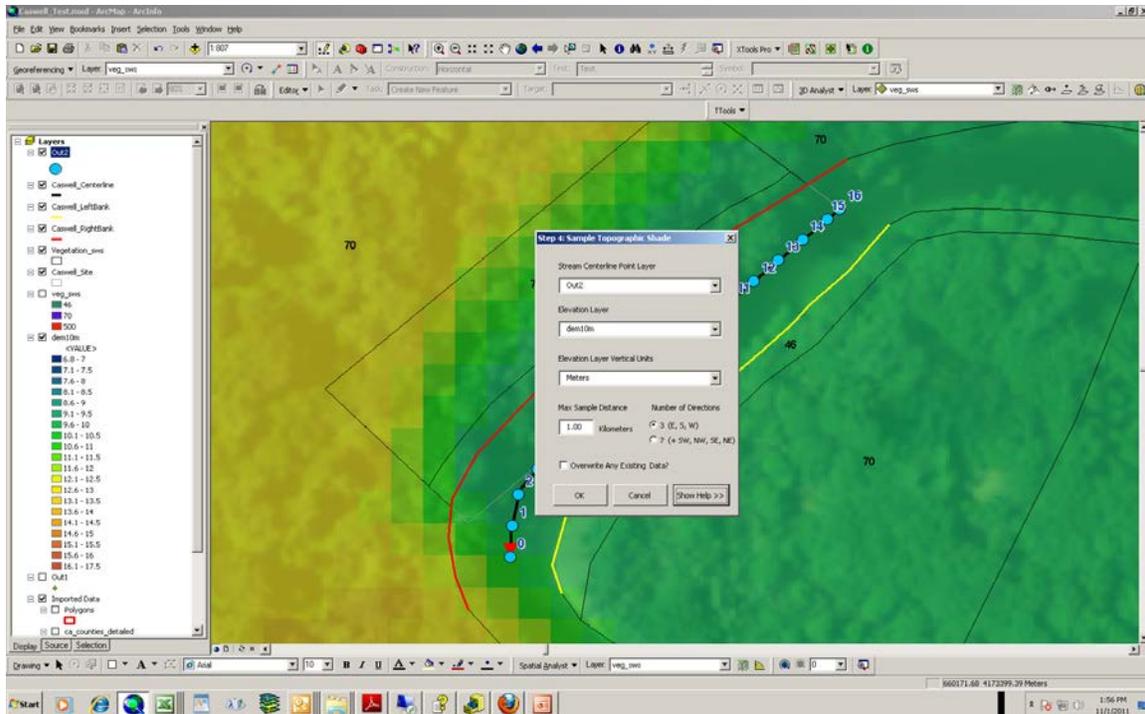


Figure 7-10. The fourth step in TTools is to define the topographic shade sampling criteria to be used by the Shade-A-Lator.

### 7.3.1.5 Obtain vegetation codes

The fifth step in using TTools to prepare data for the Shade-A-Lator involves obtaining vegetation codes and setting up sampling method rules for measuring riparian shade (Figure 7-11a).

- Vegetation sampling method: You can select either the star method or cross-sections perpendicular (which in this case is the same as ‘orthogonal’) to the stream. Select orthogonal to streamflow for the Shade-a-Lator.
- Stream centerline point layer: Select the same output file you have used for the first four TTools queries.
- Vegetation raster layer: Use the drop down arrow to select the vegetation raster files created in preparation for using TTools.
- Elevation layer: Use the drop down arrow to select the elevation layer for the project.
- Elevation layer vertical units: Again, identify the units used in the elevation layer (meters or feet)
- Number of vegetation samples (don’t include stream): In combination with the following question on distance between samples, define the cross-section width and sampling density for riparian shade along that cross-section. For example, if the Map Unit is 150 ft, (46 m) across, and you want vegetation shade effects sampled every 25 ft (7.6 m), then input ‘6’ for number of vegetation samples. Input values as meters, not feet.
- Distance between samples (meters): Here you input the desired distance between sample points along the cross-section. Depending upon the vegetation type, sampling distances should be set in order to capture changes in vegetation along the riparian cross-section. For

example, the crown width for many native riparian shrubs is roughly 15 to 25 ft (4.6 to 7.6 m). If you have a diverse set of vegetation, selecting a 30 ft (10 m) sampling interval would help to capture important variation in vegetation shade effects (Figure 7-11.b). The distance between samples needs to be set along with the number of vegetation samples to be sure that you are sampling across the desired Map Unit width (e.g., if you set the number at 10, and the distance between at 10 ft [3.5 m], then the sampled cross-sections will only be 100 ft [30.5 m] wide).

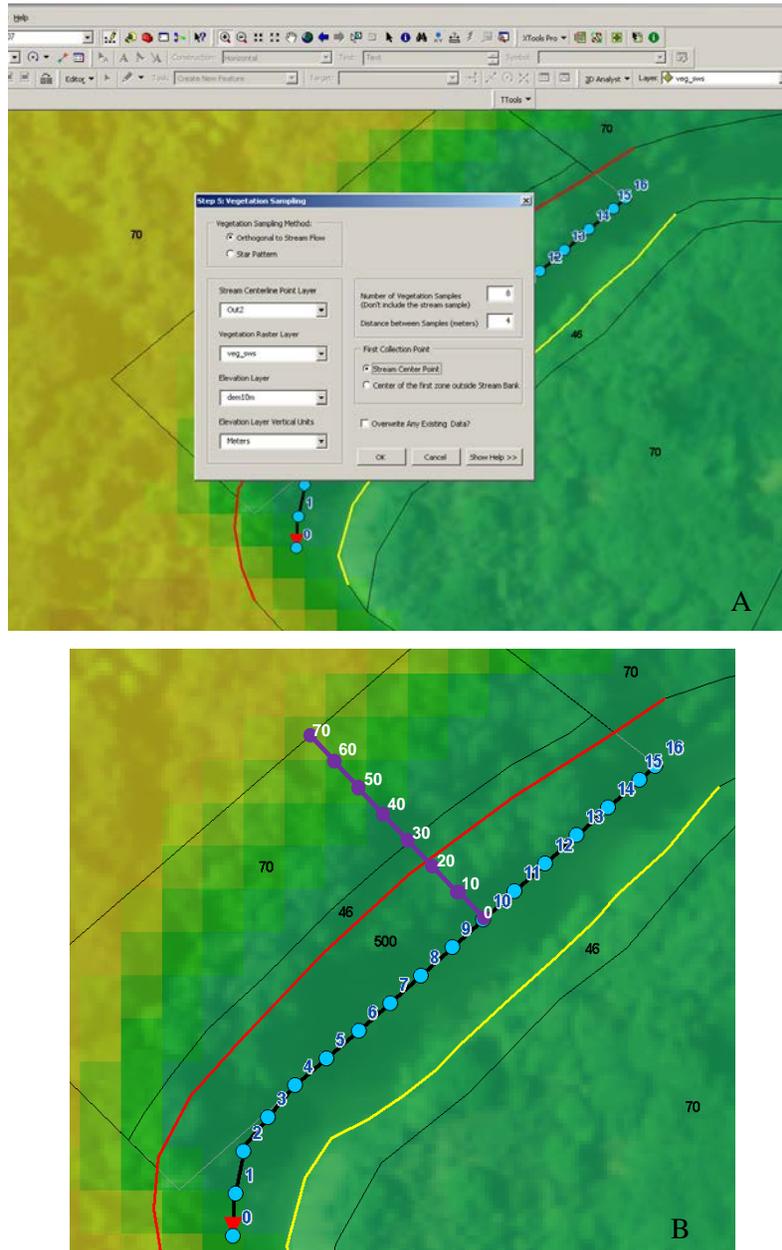


Figure 7-11. The fifth and final set of questions to address in TTools involves setting up the vegetation shade cross-section sampling requirements.

#### 7.3.1.6 Review output from TTools

To see the data generated by TTools, examine the attribute table of the output shapefile created, referred to in TTools as the 'Stream Centerline Point Layer'. The segments are number from the downstream most point to the upstream most point in the stream centerline layer. As you scroll to the right in the attribute table, you will see topographic shade values for west, south, and east for each segment cross-section, as well as aspect, channel width, elevation and channel gradient. Vegetation type codes for types encountered along each cross-section point are also listed in each row.

Export the data generated by TTools in the Stream Centerline Point Layer attribute table by right-clicking on the shapefile layer, and selecting 'export'. The attribute table will then be exported as a \*.dbf file which can be opened in and saved as an Excel file. Once this is completed, save and close out of the ArcGIS mxd. These data will be cut and pasted into the Shade-A-Lator spreadsheet, as detailed below.

### 7.3.2 Running riparian shade quantification tool

The Shade-A-Lator is a set of macros developed by the Oregon Department of Environmental Quality to generate estimates of solar energy input with and without topographic and vegetation shade. This model is subsumed in the Riparian Shade Quantification Tool and is the means by which effects of vegetation change on effective shade are estimated. The worksheet named 'Main Menu spreadsheet of the Riparian Shade Quantification Tool' There are a few pieces of information you need to add directly to the Shade-A-Lator spreadsheet about the Project Area. Fill in the following cells in the upper left corner of the Main Menu spreadsheet of the Riparian Shade Quantification Tool. and stream length. These can be obtained from the GIS data or from the field, but

#### 7.3.2.1 Transferring data from TTools to the Shade-A-Lator

All data input to the Shade-A-Lator goes into the worksheet named the 'Main Menu'. Open the newly created data file exported from ArcGIS as well as the Riparian Shade Quantification Tool excel file. Go to the Shade-A-Lator worksheet named 'main menu'. It is easiest to have both the ArcGIS generated data excel file open next to the Shade-A-Lator main menu worksheet—with both visible on your screen (Figure 7-12).

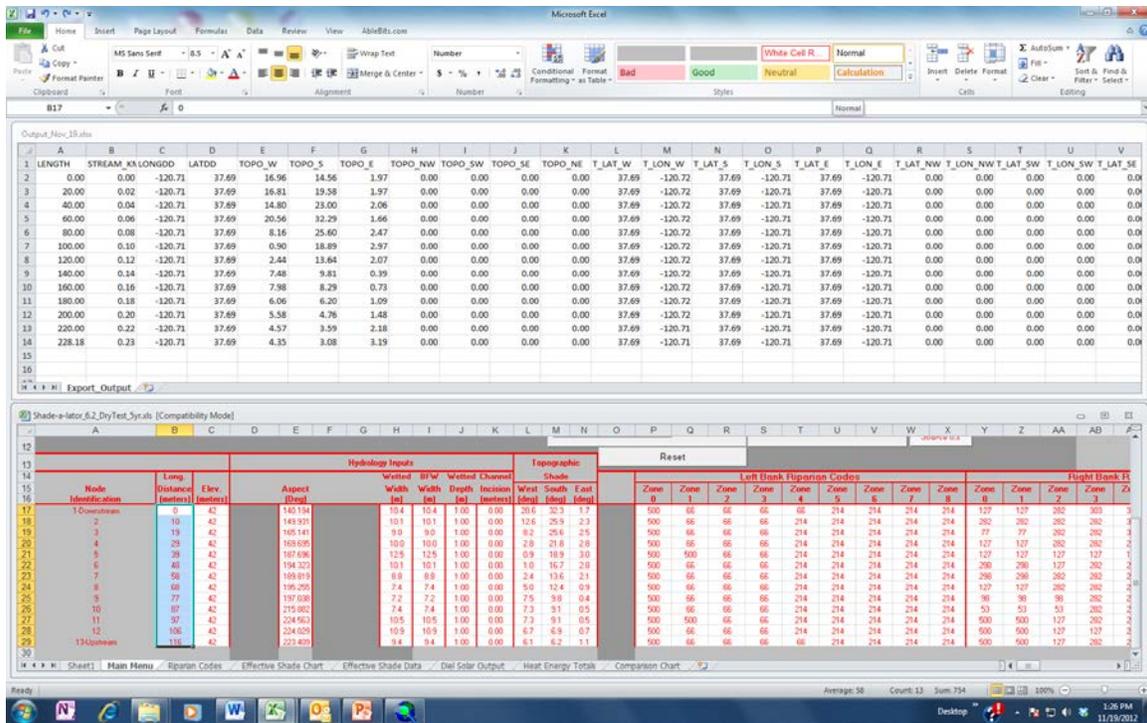


Figure 7-12. Both the Excel spreadsheet with the Output attribute table data and the Excel spreadsheets are open and visible on the screen so that data can be most easily copied and pasted from the attribute table spreadsheet to the Quantification Tool spreadsheet.

Table 7-1 summarizes the data columns that need to be copied from the Output file to corresponding columns in the Shade-A-Lator main menu worksheet. Simply copy and paste these data as indicated. Be careful NOT to copy, paste, delete, or otherwise alter any of the gray cells in the Main Menu worksheet. Doing this could break important links among the worksheets that are required for running the Shade-A-Lator. To be safe, save a ‘clean’ back up version of the Riparian Shade Quantification Tool file, which includes the Shade-A-Lator so that you can use this if problems arise.

**Table 7-1.** Data source and destination columns for transferring data from the TTools output file to the Shade-A-Lator Main Menu worksheet.

Streampoint output file column		Shade-A-Lator Main Menu	
Column letter	Column name	Column letter	Column name
A	LENGTH	B	Long. Distance
AD	Elevation	C	Elve.
Z	Aspect	E	Aspect
AA	Chan_Wid	H	Wetted width
AA	Chan_Wid	I	BFW (1)
n/a	n/a	J	Wetted Depth (2)
n/a	n/a	K	Channel Incision (3)
E	TOPO_W	L	West
F	TOPO_S	M	South
G	TOPO_E	N	East
AO	VEG0_LT	P	Zone 0 (left)
AP	VEG1_LT	Q	Zone 1 (left)
AW	VEG8_LT	.... To X	Zone 8 (left)
AF	VEG0_RT	Y	Zone 0 (right)
AG	VEG1_RT	Z	Zone 1 (right)
AN	VEG8_RT	... To AG	Zone 8 (right)
<p>(1) BFW means bank full width. If you collected this information in the field, you can enter it here, for the appropriate cross-section areas along the channel. Otherwise use wetted width.</p>			
<p>(2) Channel depth is used to estimate changes in temperature with water depth and is not used in generating effective shade estimates.</p>			
<p>(3) Channel incision can be measured in the field and entered for the appropriate cross-section areas along the channel here.</p>			

Once all of these data are satisfactorily transferred and the other general project information has been entered into worksheet cells D2 through D12 and H2 through H9, you are ready to run the Shade-A-Lator software.

### 7.3.2.2 Running the Shade-A-Lator

Running the Shade-A-Lator is fast and easy once all of the data has been correctly entered. There are three steps:

- Push the ‘reset’ button, then
- Push the ‘Run Vegematic’ button, then
- Push the Start Simulation button.

After the Simulation routine has completed its calculations, solar flux (Iy) and effective shade (percent of potential) values will be fed into the ‘Effective Shade Data’ worksheet. These data are then automatically obtained and averaged by the ‘ScoreSheet’ worksheet and used to generate overall Site Capacity scores. More detailed information on differences in percent effective shade

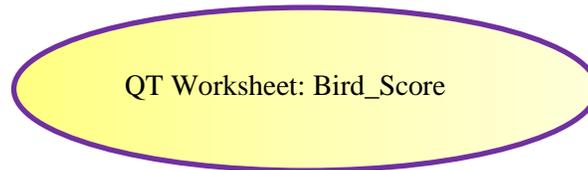
along the channel length, provided by topography and riparian vegetation, is provided in worksheets titled 'Effective Shade Chart' and 'Comparison Chart'. Modeled estimates of variation in solar heat energy entering the stream throughout the day are provided in the 'Diel Solar Output' worksheet. Data presented in the final worksheet, 'Heat Energy Totals' are not included in this model application.

## 8 READING AND UNDERSTANDING HABITAT SCORES

An explanation for scoring each riparian benefit is provided in the sections below. At the end of this Chapter, we also describe how the four riparian benefit scores are combined into a single riparian benefit score.

### 8.1 Riparian Bird Habitat Scores

Once all of the data and information have been entered into the excel spreadsheets and checked for accuracy, scores will automatically be generated in the 'Bird\_Score' worksheet of the Quantification Tool and final scores will be automatically transferred to the Summary\_Scores worksheet.



#### 8.1.1 Riparian bird habitat landscape priority score

The ability of the landscape to supply and support a riparian bird population is assessed using 5 attributes. These attributes, the percent of the landscape priority score they comprise, explanation and rationale for using these attributes are summarized in Table 8-1.

Table 8-1. Attributes used to develop landscape priority score for riparian bird habitat along the Lower Mokelumne River.

Variable number	Indicator	Weight	Explanation and rationale	Citations
1	Percent of area within 1.5-mile buffer around Project Area with a CADC Habitat Suitability Index of 40% or higher for riparian focal species.	27%	If highly suitable habitat for any single or several of the nine bird species of special concern associated with riparian areas in the Central Valley is within a short distance of the Project Area, then creating additional suitable habitat for this/these species in this area could be very valuable since the likelihood of occupation would be high. The CADC Habitat suitability index is based on both reported sightings in the area, and environmental parameters known to support each of the nine bird species of special concern associated with riparian areas in the Central Valley. The threshold was set at >40% suitability because this category (40-60%) includes the greater than 50% likelihood. Project Areas with high HSI in 25% or more of the buffer area for 1 indicator species are assigned 0.5 score for this variable, those with 2 indicator species are assigned 0.75 score, those with 3 indicator species, a 0.85 score and those with four or more are assigned a 1.0 score for this variable. With such high amounts of high quality habitat in the area, use and occupation by the indicator species is very likely. Having one or two would be good, three, four or more would be excellent. Maximum score is 1.0.	Guepel et al. 2007; California Avian Data Center website ( <a href="https://dataa.prbo.org/cadc2/">https://dataa.prbo.org/cadc2/</a> ), hosted by the PRBO to access an existing model on predicted riparian bird species distribution (go to directly at <a href="http://data.prbo.org/cadc2/index.php?page=predicted-bird-species-in-central-valley">http://data.prbo.org/cadc2/index.php?page=predicted-bird-species-in-central-valley</a> ).
2	Presence of intact riparian areas that are > 25 acres (10 ha) that overlap with 1.5-mile buffer around Project Area. "0" is "not present" and "1" is "present".	36%	Presence of nearby large intact riparian area represents a higher proximity to source populations and increases the opportunity for ongoing genetic exchange among (sub) populations. This increases robustness. Areas less than this size (25 ac) can act as sinks rather than sources in landscape. Areas that do not have this special feature are given an "NA" and the score weighting is adjusted so that there is not an inflated bias against them. If present, this variable is given a weight of 4.	RHJV 2004, Kus 1998, Tewksbury et al. 2002, Gardali and Holmes 2011

Variable number	Indicator	Weight	Explanation and rationale	Citations
3	Estimated percent of land within 0.5-mile buffer around Project Area that supports intact riparian vegetation (excluding Project Area itself).	18%	For 7 riparian bird species on the Sacramento River, 3 species responded to percent riparian in 0.3 mi (0.5 km) of a point, and 4 responded to percent riparian in 1.24 mi (2 km) of a point (Gardali and Holmes 2011). On Vandenberg Air Force Base, support was found for using percent riparian vegetation in 0.3 mi (0.5 km) vs. 0.03-mi (50-m) buffer for 3 of 8 species as indicators of better habitat (N. Seavy, pers. comm., October 2011). In contrast to these other findings in north and central California, in southern California O’neal and Rotenberry (2009) found little evidence for percent riparian measured at 0.6 mi (1 km) around points. Based on these findings, we are using the smaller 0.5 vs. larger 1.5-mile radius. Since this can include many small intact riparian areas, that are not as valuable as contiguous ones, the variable has a slightly lower weight than the 25 ac intact riparian area within 1.5 miles (Gardali and Holmes 2011). Data sources used for their analysis did not distinguish between native and non-native riparian vegetation, so we do not here. Giradali and Holmes (2010) found that most species responded to the presences of 0 to 75 acres of riparian habitat in their surrounding landscapes with greatest responses in the 0 to 10 acres within a 0.3-mile radius and 15 to 75 acres within a 1.2 mile radius. The tool assigns scores based on a direct linear relationship for areas of 10 or less acres within the 1.5-mile radius (up to 8% cover). All estimates above 8% are given the maximum score of 8.	Gardali and Holmes 2011; O’neal and Rotenberry (2009)
4	Percent of Project Area that is adjacent to (within 150 feet of) native or undeveloped lands (including non-intensively managed uplands, wetlands, riparian habitat, and annual grasslands), that are at least 100 feet wide.	9%	Written and scored as a stepped relationship, reaching maximum score above 75%. Native uplands and annual grasslands provide alternative nesting area during high flows and foraging area at all times; disturbance from adjacent developed lands can negatively affect breeding and survival.	Desrochers and Hannon 1997

Variable number	Indicator	Weight	Explanation and rationale	Citations
5	Percent of land within 0.5-mile buffer around Project Area that DOES NOT support non-native nest predator and parasite populations (e.g., housecats, rats, corvids, cowbirds).	9%	Intensive development brings in house cats (predator) and intensive agriculture (grain sources) brings in cowbirds (parasite). Domestic cats, jays, skunks, raccoons, ravens, and crows and other predatory species populations are larger with increased proximity to urbanized areas. The scores based on inverse of the data entered where data entered in data sheet for percent of surrounding area that supports pests is recorded here as percent of area that does NOT support pests. Scored as a linear response to percent area in land uses that do NOT support pests.	

### 8.1.2 Riparian bird habitat project area capacity score

The ability of the Project Area to support riparian bird populations is assessed using two fundamental indicators:

- The percent of Project Area that currently supports native riparian vegetation, and
- The acreage of native riparian vegetation in Project Area.

Thus, the extent of riparian vegetation (acres) and the degree of consolidation of this vegetation (estimated by the percent of the total Project Area) is used to assess the Project Area capacity. This score alone is not used but rather is combined with information on site characteristics gathered for each Map Unit. The Project Area Capacity score does represent 60% of the overall combined capacity score for the Project Area and the Map Units, as detailed below. The Project Area score can be found in cell J17 of the Bird\_Score worksheet in the Quantification Tool.

### 8.1.3 Combined capacity score for project area and map units

The capacity of each Map Unit to provide riparian bird habitat is assessed in up to ten 28-row blocks, which begin in a green colored row and end in an orange-colored row. The Map Unit capacity scores, combined with the overall Project Area capacity score, is tallied up at the bottom of each Map Unit block, based on the Map Unit scores presented in above blocks.

As detailed in Table 8-2, weighting in the Map Unit Capacity score is distributed between four types of site characteristics.

Table 8-2. Summary of score weighting used to assign capacity scores to each Map Unit.

Indicator group	Number of indicators	Weight
Map unit size, width	2	15
Riparian vegetation characteristics	7	15.5
Special habitat features	8	15
Resources management	3	8
Total	20	53.5

The scores Map Units, which must be entered in sequence, are combined using the area-weighted average of the Map Units:

$$\text{Weighted Average} = \frac{(MU1ac * MU1score + MU2ac * MU2score + MU3ac * MU3score)}{\text{MU Capacity Score} \quad (\text{sum MU1, MU2 and MU3 ac})}$$

The Project Area capacity score is then combined with the weighted average Map Unit capacity score using a 60/40 ratio:

$$\text{Combined Capacity Score} = \text{PA Capacity Score} * 0.6 + \text{Weighted Avg MU Capacity Score} * 0.4$$

Explanations and relevant literature for each of these 20 variables used to develop the Map Unit capacity score are detailed in Table 8-3 below.

Table 8-3. Explanations and rationales for indicators used to develop Map Unit Capacity scores for Riparian Bird Habitat.

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Map Unit Size, Width	1	Percent of Map Unit supporting native riparian vegetation (percent calculated based on acreage).	The actual percent of area within the Map Unit that supports riparian vegetation determines the degree to which the riparian vegetation characteristics affect the riparian habitat quality, so is given nearly equal weight to the sum of the riparian vegetation characteristic indicators.	Seavy et al. 2009, RHJV 2004
	2	Acres of riparian vegetation within map unit	Riparian focal species require sufficient habitat area to support nesting and other life stages and corridors of sufficient width to occur. Several riparian focal species, including Swainson's thrush, warbling vireos, and common yellowthroat were found in wider riparian areas more than very narrow ones (Holmes et al. 1999 study in Marin County, CA). Since no such studies have looked directly at riparian corridor width for these species in the Central Valley, a conservative approach to scoring assigns scores of based on a maximum of 5 acres, so that MUs that are 5.74 acres will receive 5 points, the same as an MU that is 5.0 acres; otherwise it is linear.	Holmes et al. 1999, Gardali et al. 2006, Heath and Ballard 2003 (this 3rd for Sierras)
		Map Unit Size, Width Score	The Map Unit size and width score is 34% of the total Map Unit score.	

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Riparian Vegetation Characterization	3	Canopy Closure: What percent of Map Unit is covered by woody vegetation, from a bird's eye view?	Individual bird species responsiveness to key riparian tree species and to canopy closure indicates that the more cover the better up to roughly 50% cover in the upper canopy. Overall, increased levels of deciduous vegetation adjacent to channel meanders provides important shade and organic material for the aquatic food web, which in turn produces higher amounts of emergent insects, a key part of the diet for many riparian bird species (Iwata et al. 2003).	RHJV 2004, Nur et al. 2008, Iwata et al. 2003
	4	Upper Canopy Diversity: number of different species over 15 feet tall within the Mapping Unit	Increased bird species diversity with increased tree diversity; individual bird species responsiveness to key riparian tree species and to canopy closure. Mid and upper canopy and cavity nesters such as tree swallow (large stem diameter), warbling vireo (deciduous trees), and Swainson's hawk (tall trees) depend on the presence of a variety of tree types in the riparian area for nesting.	RHJV 2004, Nur et al. 2008, White et al. 2005, Gardali et al. 2006
	5	Upper Canopy Density: total percent canopy density (over 15 feet)	Individual bird species responsiveness to key riparian tree species and to canopy closure indicates that the more cover the better up to roughly 50% cover in the upper canopy.	RHJV 2004, Nur et al. 2008
	6	Mid Canopy: number of different species (2 to 15 feet)	Increased bird species diversity with increased tree diversity; individual bird species responsiveness to key riparian tree species and to canopy closure. Up to 5 different species recognized; beyond 5 species, all considered the same.	RHJV 2004, Nur et al. 2008
	7	Mid Canopy Density: total percent canopy density (2 to 15 ft)	Individual bird species responsiveness to key riparian tree and shrub mid-canopy closure indicates that the more cover the better up to roughly 50% cover in the mid-canopy. Roughly one-third of the 17 CV riparian focal bird species depend upon healthy mid to upper canopy conditions for nesting (RHJV 2004)	RHJV 2004, Nur et al. 2008
	8	Percent cover of mugwort, hedgenettle, Santa Barbara Sedge, California blackberry	Mugwort, hedgenettle, and Santa Barbara sedge are known important food sources for many riparian bird species. Percent cover scores are rank-scored: 1–5% =1; 5–15% =2, >15% =3.	RHJV 2004, Nur et al. 2008
	9	Ground cover: total percent cover 00 to 2 feet	Ground nesting birds use the 0 to two foot vegetation—and don't use vegetation that is over 2 feet above ground (e.g., Wilson's warbler and the blue grosbeak use riparian forbs and grasses for nesting); accounting for this habitat increases the diversity by hosting ground-nesters. This is a direct linear function up to maximum credit at 80% and above.	RHJV 2004
		Sum of Riparian Vegetation Characteristics Weights and Scores	The final score for the riparian vegetation characteristics is the sum of the Scores over the sum of the weights and is 37% of the total capacity score for each Map Unit.	

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Special Habitat Features	10	Within the Map Unit, what percent of the banks have NOT been artificially altered? e.g., hardened, riprapped, revetment, channelization, etc.	Diverse riparian habitats are created and maintained in areas where the channel can access, flood and even rearrange it's floodplain. This diversity supports a greater number of native riparian dependent bird species. Intact natural hydrology supports early successional riparian habitat through natural flooding and scour regime. Eleven out of 14 Central Valley riparian focal bird species depend upon early successional riparian habitat such as dense willow/alder understory, and several other species are supported by the presence of lentic or slow-water wetlands, such as backchannels and small oxbow lakes, created by lateral channel migration (RHJV 2004).	Naiman et al. 2005, RHJV 2004
	11	Is the floodplain in the Map Unit disconnected from the channel by levees, other structures, or by incision? (0 denotes disconnected; 1 denotes connected.)		Naiman et al. 2005, RHJV 2004
	12	Eroding banks present (at least 3 ft tall and 20 ft long)?	Complex topography created through active meanders supports diverse vegetation and physical structures (e.g., Eroding banks for bank swallows; open gravel bars for spotted sandpiper). Credit is applied if this feature exists, otherwise it has no weight in the scoring process.	California Partners in Flight 2011
	13	Off-channel oxbows present?	Several bird species (4/14 focal species) demonstrated to prefer habitats with access to open standing water and or emergent vegetation; increases insect abundance benefits all bird species that depend on insects for some/part of their diet. Credit is applied if this feature exists; otherwise it has no weight in the scoring process.	RHJV 2004; N. Seavy, PRBO, pers. comm., June 2012.
	14	Fresh gravel/cobble bars (unvegetated or sparsely vegetated) present? (0 denotes 'no', 1 denotes 'yes'.)	Complex topography created through active meanders supports diverse vegetation and physical structures (e.g., Eroding banks for bank swallows; open gravel bars for spotted sandpiper). Credit is applied if this feature exists; otherwise it has no weight in the scoring process.	California Partners in Flight 2011
	15	Emergent herbaceous wetlands present? (0 denotes 'no', 1 denotes 'yes'.)	Several bird species (4/14 focal species) demonstrated to prefer habitats with access to open standing water and or emergent vegetation; increases insect abundance benefits all bird species that depend on insects for some/part of their diet. Credit is applied if this feature exists, otherwise it has no weight in the scoring process.	RHJV 2004; N. Seavy, PRBO, pers. comm., June 2012.
	16	Large trees (over 30 feet tall) present? (0 denotes 'no', 1 denotes 'yes'.)	Increased bird species diversity with increased tree size for cavity and upper canopy nesters. Credit is applied if this feature exists; otherwise it has no weight in the scoring process.	Nur et al. 2008, Seavy et al. 2009
	17	Number snags with DBH > 12 inches? (0 denotes 'no', 1 denotes 'yes'.)	Provides habitat for cavity nesters as well more food sources for insect foraging species; Thresholds now if 0 = 1; if 0 to 1 = 2; if 2 to 10 = 3; if >10 = 4. Credit is applied if this feature exists; otherwise it has no weight in the scoring process.	RHJV 2004, California Birds in Flight 2011
			Sum of Special Habitat Features Weights and Scores	The final score for the Special Habitat Features is the sum of the scores over the sum of the weights and ranges from 9 to 13% of the total capacity score for each Map Unit, depending on how many and which of the special features are present. If present, they are counted and given weight, thereby increasing the overall weight of the Special Habitat Feature category in the Map Unit Site Capacity Score.

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Management	18	Are there ground disturbance activities during breeding season (April through August) in Map Unit? (0 = yes; 1 = no)	Ground disturbance activities during breeding season reduces breeding success— maintenance of continuous herbaceous and dense shrub and understory cover provides good nesting habitat for several bird species.	California Partners in Flight 2011
	19	Is there application of ground insecticides within Map Unit? (0 = yes; 1 = no)	Herbicides and pesticides have been demonstrated to reduce reproductive success in many bird species.	RHJV 2004, Blus et al. 1997, Beedy and Hamilton 1999, Carson 1962
	20	What percent of the Map Unit is NOT currently grazed in a manner that has visibly and persistently altered the vegetation structure and/or composition (i.e., incomplete recovery between years)?	Intensive grazing can affect understory and ground cover, impact hydrologic conditions, and coincide with increased corvid pest bird species.	Mathews and Goguen 1997, Hochachka et al. 1999, Dobkin et al. 1998
		Sum of Management Effects Weights and Scores	The final score for Management is the sum of the scores over the sum of the weights and is 16% of the total capacity score for each Map Unit.	

## 8.2 Fish and Aquatic Habitat Scores

Once all of the data and information have been entered into the excel spreadsheets and checked for accuracy, scores will automatically be generated in the ‘Fish\_Score’ worksheet of the Quantification Tool and final scores will be automatically transferred to the Summary\_Scores worksheet.

### 8.2.1 Fish and aquatic habitat landscape priority score

The ability of the landscape to supply and support populations of fish and other aquatic species is assessed using just two attributes. These attributes, the percent of the landscape priority score they comprise, explanation and rationale for using these attributes are summarized in Table 8-4.

Table 8-4. Landscape priority indicators for aquatic and fish habitat quality in the Lower Mokelumne River.

Variable number	Indicator	Weight	Explanation and rationale
1	Presence of salmonid species and/or listed or candidate native fish species, or federally listed aquatic Species of Special Concern (e.g., Central Valley fall Chinook salmon and Central Valley steelhead).	66%	At the scale of the Mokelumne River watershed, all potential projects that are in a river or creek reach that supports targeted fish species (i.e., Chinook salmon and steelhead) have opportunity and value for improving riparian and in-stream habitat quantity and quality.
2	Occurrence of all BMPs within "zone of influence" defined as any area within 1,000 ft of project boundary as the same side of the river.	33%	Project areas can be negatively impacted or positively impacted by neighboring landowners. This does not penalize for negative impacts of neighboring land owners actions but provide incentive for Project area owners to work with neighbors to achieve BMPs within zone of influence (1,000 ft.).

### 8.2.2 Fish and aquatic habitat project area capacity score

The ability of the Project Area to support populations of fish and other aquatic species is assessed using two fundamental indicators:

- The percent of Project Area that currently supports native riparian vegetation, and
- The acreage of native riparian vegetation in Project Area.

### 8.2.3 Fish and aquatic habitat map unit scores

The capacity of each Map Unit to populations of fish and other aquatic species is assessed in up to ten 28-row blocks, which begin in a green colored row and end in an orange-colored row. The Map Unit capacity scores, combined with the overall Project Area capacity score, is tallied up at the bottom of each Map Unit block, based on the Map Unit scores presented in above blocks.

As detailed in Table 8-5., weighting in the Map Unit Capacity score is distributed between four types of site characteristics.

Table 8-5. Summary of score weighting used to assign capacity scores to each Map Unit.

<b>Indicator group</b>	<b>Number of indicators</b>	<b>Percent Weight</b>
Riparian and Floodplain	2	3
Riparian vegetation characteristics	7	43
Floodplain Dynamics	4	40
Best Management Practices	5	10
Total	18	100

The scores Map Units, which must be entered in sequence, are combined using the area-weighted average of the Map Units:

$$\text{Weighted Average} = \frac{(MU1ac * MU1score + MU2ac * MU2score + MU3ac * MU3score)}{MU \text{ Capacity Score}} \quad (\text{sum } MU1, MU2 \text{ and } MU3 \text{ ac})$$

The Project Area capacity score is then combined with the weighted average Map Unit capacity score using a 60/40 ratio:

$$\text{Combined Capacity Score} = PA \text{ Capacity Score} * 0.6 + \text{Weighted Avg } MU \text{ Capacity Score} * 0.4$$

Explanations and citations for each these 18 variables used to develop the Map Unit capacity score are detailed in Table 8-6 below.

Table 1-1. Explanations and rationales for indicators used to develop Map Unit Capacity scores for Aquatic Fish Habitat.

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Riparian and Floodplain	1	Percent of Map Unit supporting riparian vegetation.	The actual percent of area within the Map Unit that supports riparian vegetation influences the degree to which the riparian vegetation characteristics affect the aquatic habitat quality, so is given approximately equal weight to the sum of the riparian vegetation characteristic indicators.	Ahern et al. 2006
	2	Percent of Map Unit supporting active floodplain.	The actual percent of area within the Map Unit that supports active floodplain influences the degree to which floodplain dynamics affect aquatic habitat quality, so is given approximately equal weight to the sum of the floodplain characteristic indicators. The amount of the Project area that is active floodplain and regularly inundated during the wet season determines the amount of contribution to highly valuable and limited rearing habitat for salmonids, especially fall Chinook salmon juveniles. It also enriches the mainstem river with food and contributes to thermal diversity and high quality, diverse, and complex riparian habitats. Using the 3-year reoccurrence interval (~2,600 cfs post-dams) strikes the best balance between frequency of inundation and extent of inundation as anything less frequent is problematic but anything less in flow becomes increasingly non-significant for contributing to the extent of inundated floodplain habitat given the channel geometry in the Project area.	McDade et al. 1990, Fetherston et al. 1995, Schuett-Hames et al. 1999, Roni and Quinn 2001, Merz 2001

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Riparian Vegetation Characterization	3	Riparian forest: What percent of the map unit is covered by riparian woody vegetation (trees), from a bird's eye view?	Riparian forests contribute LWD, detritus, and terrestrial insects to the aquatic ecosystem, which enhances habitat quality and adds up cumulatively over a given river reach.	Ahern et al. 2006
	4	Within the area of the Map Unit, is there diversity in the vegetation types?	Diversity, patches, and edge effects create the most productive riparian and floodplain habitats for salmonids. Riparian grassland/herbaceous open areas contribute detritus and terrestrial insects to the aquatic ecosystem but also provide higher primary production during periods of inundation than forested areas, which enriches aquatic habitats. Diversity in vegetation types is defined as a minimum of 25% of the area having patches of grassland vegetation types (excluding invasive exotic species, see #13 and 18) with patches large enough to let sunlight reach the ground and support persistent grassy/herbaceous open areas.	McDade et al. 1990, Fetherston et al. 1995, Schuett-Hames et al. 1999, Roni and Quinn 2001, Merz 2001
	5	Evidence of succession and recruitment: presence of seedlings and/or saplings.	Evidence of succession and recruitment shows a dynamic riparian forest that is self-regenerating, which is important for the long-term health and sustainability of the riparian area.	McDade et al. 1990, Fetherston et al. 1995, Schuett-Hames et al. 1999, Roni and Quinn 2001, Merz 2001
	6	Percentage of channel margin with overhanging vegetation.	Overhanging riparian vegetation and forests contributes a greater amount of detritus and terrestrial insects to the aquatic food chain than non-overhanging vegetation, except during periods of floodplain inundation.	McDade et al. 1990, Fetherston et al. 1995, Schuett-Hames et al. 1999, Roni and Quinn 2001, Merz 2001
	7	What percent of the channel margin, if the map unit has any, is covered by riparian woody vegetation (trees) within ~60 ft of the channel?	Riparian trees, including dead snags, have a greater ability to contribute LWD to the channel and create beneficial fish habitat when they are adjacent to the river bank than trees farther away. Must be at least 4 inches dbh to qualify as LWD.	McDade et al. 1990, Fetherston et al. 1995, Schuett-Hames et al. 1999, Roni and Quinn 2001, Merz 2001
	8	Of the trees within ~60 ft of the channel, what percentage has a DBH $\geq$ 20-24 in?	Large trees, including dead snags, have a greater ability to create beneficial fish habitat when they are recruited to the river channel than small trees. Large trees that are adjacent to the river bank are more likely to be recruited than trees farther away (20 inches dbh has been used to classify large trees in riparian surveys). /recruitment of large trees is cumulative at the scale of a river reach and wood loading requires a lot of large wood pieces.	Ahern et al. 2006, Greenfield et al. 2006, Merz et al. 2008, Bisson et al. 2009
	9	Invasive vs. noninvasive species composition: total percent area occupied by non-invasive (tree and herbaceous plant) species within the Map Unit.	Invasive species create a suite of problems, and in riparian areas, can cause excessive shading of open grassy areas during periods of inundation thereby reducing primary production and food resources for rearing salmonids.	Merz 2001, Florsheim and Mount 2003, Ahern et al. 2006, Jeffres et al. 2008

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Floodplain Dynamics	10	Within the Map Unit, what percent of the banks have NOT been artificially altered (e.g., hardened, riprapped, revetment, channelization, etc, within ~60 ft of channel edge)?	Alteration and hardening river banks prevents channel migration, reduces connectivity to the floodplain, and degrades both floodplain and channel margin habitat, which is preferred by rearing salmonids over mid-channel and open water habitats.	Merz 2001, Florsheim and Mount 2003, Ahern et al. 2006, Jeffres et al. 2008
	11	What percent of the bank channel length is NOT leveed or what percent of the map unit area is NOT protected by a levee?	Leveeing river banks prevent channel migration, disconnect the floodplain, and degrade both floodplain and channel margin habitat, which is preferred by rearing salmonids over mid-channel and open water habitats.	Merz 2001, Florsheim and Mount 2003, Ahern et al. 2006, Jeffres et al. 2008
	12	Within the area of the Map Unit that is inundated at least every 3 years, is there diversity in the vegetation types (forested vs. open grassy and herbaceous patches)?	A diverse, patchy mix of riparian forests and grasslands creates complex and productive habitat if seasonally inundated, decreases inputs of over-land sediments, and native species contributes detritus and terrestrial insects to the stream food-web.	Merz 2001, Florsheim and Mount 2003, Ahern et al. 2006, Jeffres et al. 2008
	13	Within the area of the Map Unit that is inundated at least every 3 years, is there diversity in the topography (dips and rises with elevation variations of at least 3 ft over at least 50% of the total area)?	Complex topography created through active floodplains with lateral scour supports diverse aquatic habitat and high value features for salmonids along with seasonal habitat during floodplain inundation. This can be created by allowing natural processes to work or by active restoration via set-back levees, levee-breaching or removal, and conversion of old gravel mining areas into functioning floodplains. A diverse, patchy mix of riparian forests and grasslands create complex and productive habitat if seasonally inundated, decreases inputs of over-land sediments, and native species contributes detritus and terrestrial insects to the stream food-web.	Sholz et al. 2000, Moore and Waring 2001, Greenfield et al. 2006, Merz et al. 2008, Baldwin et al. 2009, Bisson et al. 2009

Indicator group	Variable number	Indicator	Explanation and rationale	Citations
Best Management Practices	14	Are priority invasive plant species manually removed annually without	Frequent, manual removal of invasive plant species is highly effective if done persistently over multiple seasons. Even at low concentrations, herbicides and pesticides have been demonstrated to reduce reproductive success and cause non-lethal stress in many aquatic species, especially salmonids. In order to qualify as an area implementing best management practices for aquatic species, pesticides and herbicides should not be used in riparian project areas.	Sholz et al. 2000, Moore and Waring 2001, Baldwin et al. 2009
	15	Is there application of pesticides within the Map Unit since the last evaluation, or if not, then within the last two years?	Even at low concentrations, pesticides have been demonstrated to reduce reproductive success and cause non-lethal stress in many aquatic species, especially salmonids. In order to qualify as an area implementing best management practices for aquatic species, pesticides should not be used in the riparian project areas. Fish are sensitive (non-lethal to lethal effects) to a wide range of synthetic pesticides, especially organophosphates, organochlorines, pyrethroids, and copper based pesticides (e.g., diazinon, chlorpyrifos, atrazine, chlordane, dieldrin, etc).	Sholz et al. 2000, Moore and Waring 2001, Baldwin et al. 2009
	16	What percent of the map unit is vegetated as opposed to bare soil?	Bare soil and improperly maintained local drainage can lead to gullyng, headcutting, and excessive sediment and soil-born contaminant inputs, which can reduce the health of riparian systems.	Brodie et al. 2002
	17	Are any stockpiles of fertilizers, manure, pesticides, or petrochemicals and fuels stored under secured roofs to prevent run-off?	Protect water quality from common pollutants (e.g., toxic chemicals, sediments, and nutrients) and altered run-off patterns. Nutrient laden run-off and groundwater seepage can contribute to nuisance algal blooms and associated dissolved oxygen sags at night and toxic by-products. Small amounts of hydrocarbon fuels and products can pollute large amounts of water and are toxic to fish.	Brodie et al. 2002
	18	Are there any septic tanks and fields with the Map Unit? If so, are they pumped and maintained regularly and in proper working order?	Septic tanks, especially poorly maintained ones, contribute nutrients and hormone disrupting chemicals (i.e., estrogen-like substances) that contributed to aquatic pollution and feminization of fish.	

### 8.3 Potential for Flood Attenuation

Once all of the data and information have been entered into the excel spreadsheets and checked for accuracy, scores will automatically be generated in the ‘Flood\_Score’ worksheet of the Quantification Tool and final scores will be automatically transferred to the Summary\_Scores worksheet.

#### 8.3.1 Potential for flood attenuation landscape priority score

The ability of a reach to attenuate downstream flooding, and the importance of such attenuation to downstream areas is assessed using six indicators. These attributes, the percent of the landscape priority score they comprise, explanation and rationale for using these attributes are summarized in Table 8-7.

Table 8-7. Landscape priority indicators for the potential of a site to provide for flood attenuation in the Lower Mokelumne River.

Variable number	Indicator	Weight	Explanation and rationale
1	Are there urban lands within 5 miles downstream of site and 0.5 miles of the river that are outside of the 100 yr FEMA flood area?	50%	If there are urban areas within a short distance downstream, even if behind a federal levee, the value of the area for reducing flood risk by reducing stress to that levee is high. The five mile distance cut off is meant to focus on areas that are relatively close to urban areas and could therefore have a more pronounced effect on potentially reducing flood risk.
2	100-year flood inundation area downstream of Project Area (acres)	8%	The maximum area in the 100-yr FEMA flood area along either the Mokelumne mainstem, or Dry Creek, is entered as the maximum value and the Project Area is scored based on what fraction of this potential maximum is downstream of the Project Area, based on the assumption that flood attenuation value increases with the increasing downstream area vulnerable to flooding. (100-yr FEMA flood area for the Mokelumne mainstem below the dam is 23,239 ac; the 100-yr FEMA flood area for Dry Creek is 28,331 ac.)
3	Value effect of reducing flood inundation in downstream reaches: Based on areas occupied by different land uses in 100yr flood zone	8%	Maximum value assumes all of the downstream 100-yr FEMA flood area has value that is moderately sensitive to flooding (total acreage multiplied by 0.5). The 100-yr FEMA flood zone is used because it indicates the area covered by the National Flood Insurance Program (administered by FEMA) and levees in this area must meet Federal requirements. FEMA treats accredited levees (levees that meet the requirements of the Code of Federal Regulation, 44 C.F.R. Section 65.10) as providing protection against a 1-percent-annual-chance (or 100-year) flood event.
4	Proximity of nearest downstream area with expected Medium Value Impact with flooding (acres and feet).	8%	Within FEMA 100-yr flood zone and based on National Land Cover Database 2006 (NLCD2006). Floodplains 500 or more acres get maximum score and anything less than 20 acres gets the minimum score, according to formula: +IF(F19>500, 4, IF(F19>100, 3, IF(F19>20, 2, 1))).

Variable number	Indicator	Weight	Explanation and rationale
5	Proximity of nearest downstream area with expected High Value Impact with flooding (acres and feet).	12%	
6	Proximity of this Project Area to other areas that are likely to provide flood attenuation at 2600, 5000, and 100 yr FEMA flows, in feet	15%	Proximities (ft) ranked for each flow level (closer gets higher score): If distance is <100 ft, then '1', otherwise score is (1/distance)*100) so that the score decreases quickly with distance 5,000 cfs weighted more than other two b/c it actually happens (highest since dam is ~6,000 in 1986).

### 8.3.2 Potential for flood attenuation Project Area capacity score

The potential of the Project Area to attenuate downstream flooding is assessed using eighteen indicators, divided into four groups, as outlined in Table 8-8.

Table 8-8. Summary of score weighting used to assign Project Area capacity scores for potential flood attenuation.

Indicator group	Number of indicators	Percent weight
Flood Zones in Project Area	4	17
Active Floodplain and Bank Confinement	4	21
Existing Floodplain with Direct Access to River Flow	5	62
Existing Floodplain with Impeded Access to River Flow	5	0
Total	18	100

Explanations and citations for each these 18 indicators are detailed in Table 8-9 below.

Table 8-9. Explanations and rationales for indicators used to assess Project Area potential to attenuate downstream flooding.

Indicator group	Variable number	Indicator	Explanation and rationale
Flood Zones in Project Area	1	100-year flood inundation in Project area	Max value $\geq$ 20 ac, Otherwise direct linear increase in score with size (acres) below 20 acres.
	2	5,000 cfs inundation within Project Area.	Max value $\geq$ 20 ac, Otherwise direct linear increase in score with size (acres) below 20 acres. The score weight is based on the assumption that the 5,000 cfs flows occur most frequently and have greatest effect.
	3	2,600 cfs inundation within Project Area.	Max value $\geq$ 20 ac, Otherwise direct linear increase in score with size (acres) below 20 acres. The scoring weight is based on the assumption that the 2,600 flood is frequent, effects are minimal, and that the 100 yr hasn't happened at all since the dam
	4	Has river access to the floodplain(s) within the Project Area changed for the long term since 2006? ("Y" is entered as a 1, and "N" is entered as a 0.)	If the river access to Project Area floodplains has changed since 2006, then these floodable area values are far less important than those estimated in other categories of the Quantification Tool. If it has not changed, then these empirical values are important.
		Sum of Existing Flood Zones Area Weights and Scores	These are important as empirical evidence of what flooded to what extent in 2006. They do not indicate what could flood if there were changes in the river-accessibility of floodplains since that time. Therefore, if changes were made since 2006, this category doesn't count. If no changes were made, it does. Therefore, when no changes have been made, the tool will weigh photo-based extents equally with field measurements. With changes, the tool places greater weight on the field measurements.

Indicator group	Variable number	Indicator	Explanation and rationale
Active Floodplain and Bank Confinement	5	Bankfull slope in Project Area (stream length weighted average, shown as percent)	Anything at or below 3% gets 'full credit'. Anything above gets '0 credit'.
	6	Average bank confinement	The confinement is the ratio of floodplain (plus channel) extent to channel width. The higher the ratio, the less confined the channel and the greater the capacity of the floodplain in relation to the channel capacity. Here we have set a ratio of 10 as the maximum score, such that areas with an even wider floodplain do not get additional credit. This is somewhat arbitrary but based on realistic range of opportunities in the Lower Mokelumne.
	7	Percentage of channel length in Project Area unconfined by a channel margin levee (where channel margin levees are < 30 feet from low flow channel).	The greater the percentage of unconfined channel length, the higher the floodplain connectivity and greater the flood attenuation potential. Channel margin levees weighted higher b/c less levee length directly adjacent to channel offers more FP area than lack of set-back levees
	8	Percentage of channel length in Project Area unconfined by a setback levee (levee >30 feet from low flow channel).	
			Sum of Active Floodplain and Bank Confinement Weights and Scores

Indicator group	Variable number	Indicator	Explanation and rationale
Existing Floodplain with Direct Access to River Flow	9	Size of floodplain that receives unimpeded flow from the river (acres).	Maximum value for anything 100 ac or more. Otherwise direct linear decrease in score with size (acres) below 100 acres. Assumption here is that 100 acres is the maximum practical amount people might give up. Idea of changing this to a percent of the downstream 5,000 cfs flooded area (April 2006 map) seems reasonable and could be included in a subsequent version of this tool.
	10	Elevation of floodplain that receives unimpeded flow from the river; entered as average elevation above bankfull flow.	Inverse of ht above bankfull, so that the closer to bankfull, the higher the score. If the height above bankfull is less than 3 ft, you get maximum score.
	11	Slope of floodplain that receives unimpeded flow from the river within Project Area (percent)	Anything under 3% is considered viable for a floodplain; over 3% slope is too steep to retain flood waters.
	12	Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas? (acre-feet)	Maximum score assumes whole floodplain floods 3 feet deep.
	13	Percent of floodplain that receives unimpeded flow from the river that is occupied by vegetation	Assumes that the maximum roughness occurs by 90 vegetation cover. Linear with percent vegetation up to 90%, then you get 'full credit'
			Sum of Existing Accessible Floodplain Weights and Scores

Indicator group	Variable number	Indicator	Explanation and rationale
Existing Floodplain with Impeded Access to River Flow	14	Size of floodplain at that or similar elevation on the land side of the levee (or other structure) within the Project Area (acres).	Same as set above—anything 100 acres or more gets maximum score; otherwise acres/100 is the score.
	15	Average elevation above bankfull flow (ft)	Inverse of ht above bankfull, so that the closer to bankfull, the higher the score. If the height above bankfull is less than 3 ft, you get maximum score.
	16	Slope of levee-impeded floodplain (percent).	Anything under 3% is considered viable for a floodplain; over 3% slope is too steep to retain flood waters.
	17	Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas? (acre-feet)	
	18	Percent of levee-impeded floodplain that is occupied by vegetation	Assume maximum effect occurs at 90% so scores 'top out' at 90%.
		Sum of Impeded Floodplain Weights and Scores	This is not included as a variable that increases likelihood of flood attenuation since there is no connection to river. It is shown to encourage the field data collection and then demonstrate what it could be if made accessible through the topic category score. The category scoring weight is "0".

## 8.4 Channel Shade

Once all of the data and information have been entered and the Shade-A-Lator run for the Project Area, the landscape priority and site capacity scores will automatically be carried over into the ‘ScoreSheet’ worksheet of the ShadeQT\_Shade\_A\_Lator and final scores will be automatically be generated in this worksheet.

### 8.4.1 Potential for channel shade landscape priority score

The overall importance of reducing stream water solar heating with vegetation shade is assessed under the OfficeForm of the ShadeQT\_Shade\_A\_Lator spreadsheet with two to six indicators. These attributes, the percent of the landscape priority score they comprise, explanation and rationale for using these attributes are summarized in Table 8-10.

Table 8-10. Landscape priority indicators for channel shade in the Lower Mokelumne River.

Variable number	Indicator	Weight	Explanation and rationale	Source (citation)
1	Does the Basin Water Quality Control Plan identify COLD freshwater habitat as a beneficial use for the project reach (or for the reach to which it is a significant tributary)?		Elevated temperatures can cause stress and lethality in cold water fish (including Coho and Steelhead). In lower reaches, limits based on Adult Migration plus Non-Core Juvenile Rearing chronic temperature thresholds	Ligon et al. 1999, RWQCB 2011
2	Is reach listed or being considered for listing in EPA Section 303(d) for temperature?		If Project Reach is considered impaired for temperature, it means that documentation exists on excessive temperature and actions to maintain low temperatures can be valuable.	EPA 2010
3	Is there a current, or in the reasonably foreseeable future, state or federally listed as threatened or endangered cold freshwater species that uses this reach or adjacent reaches as part of its habitat at some stage in its life?		If cold water dependent aquatic species occur in the Project Reach (or could occur there), then maintaining cold water is important for biodiversity.	CDFW 2014 (CNDDDB)
4	Do current/recent water temperature measurements exist for the project reach or nearby reach during mid to late summer?		If data exists then it is possible to ascertain whether or not elevated temperatures could be occurring during late summer.	DWR CDEC website
5	If so, does the current weekly average temperature during the warmest part of the year (late August to late September) significantly exceed historical levels ( $p < 0.10$ )?		Elevated temperatures can cause stress and lethality in cold water fish (including Coho and Steelhead) In lower reaches, limits based on Adult Migration plus Non-Core Juvenile Rearing chronic temperature thresholds	Ligon et al. 1999, RWQCB 2000, EPA 2003, DWR CDEC website

Variable number	Indicator	Weight	Explanation and rationale	Source (citation)
6	6. Are stream flows during the growing season of an average water year lower than under historical (pre-1930) conditions?		Elevated temperatures can cause stress and lethality in cold water fish (including Coho and Steelhead). In lower reaches, limits based on Adult Migration plus Non-Core Juvenile Rearing chronic temperature thresholds	DWR CDEC website

#### 8.4.2 Potential for flood attenuation Project Area capacity score

The ability of the Project Area to provide shade is assessed using the Shade-A-Lator and includes both topographic and vegetative shade. This is calculated using a 60 to 40 weighting of Potential Site Capacity to Realized Site Capacity scores. The rationale for this weighting is to place emphasis on the importance of selecting areas for riparian revegetation and restoration where the greatest shade benefit will occur; namely not in areas where topographic shade is already doing most of the work. This score is presented as a percentage (see Figure 8-1).

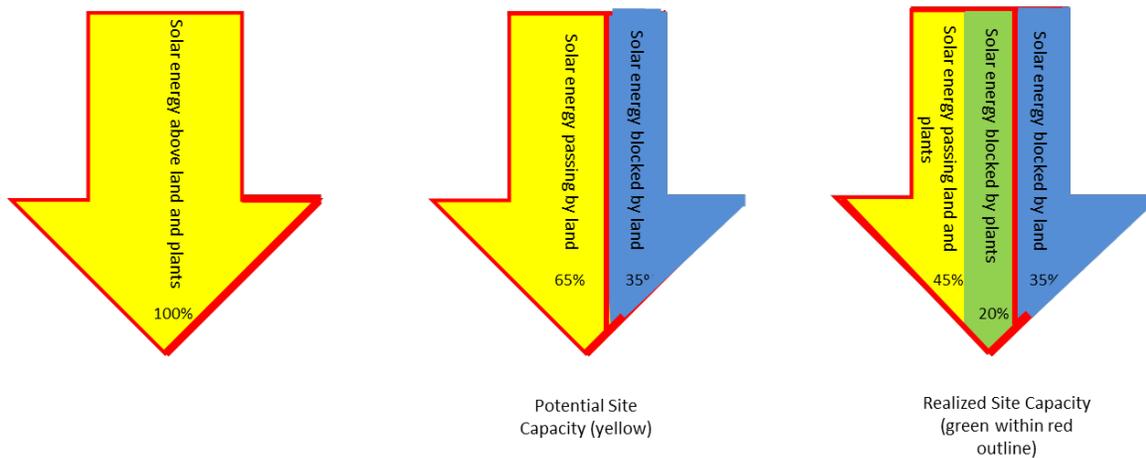


Figure 8-1. Graphic explanation of potential vs. realized site capacity for riparian channel shade.

Site capacity is a measure of the extent to which existing attributes of the site enable it to provide ecosystem services. For riparian channel shade this is calculated as a combination of both the capacity of the site to provide important shade with riparian vegetation, and that actual vegetation shade provided. As described in Section 3. Model Structure, this format is designed to place greater value on riparian shade provided in stream reaches that have smaller amounts of natural topographic shade. For example, stream reaches that run along the northern edge of a tall bluff already have a large portion of the channel shaded by the bluff and what small exposed areas remain could be shaded by vegetation. However, a reach downstream that runs through a topographically flat area has no topographic shade, so that increasing vegetation shade in this reach could block more sunlight that would otherwise reach and warm the channel. Thus, Site Capacity Score is calculated with a 60:40 weighting of the Potential Site Capacity vs. the Realized Site Capacity scores, according to the following mathematical relationships:

$$\text{Potential Site Capacity} = \frac{\text{Solar flux below topographic shade}}{\text{Solar flux above topographic shade}}$$

$$\text{Realized Site Capacity} = \frac{\text{Solar flux below topographic shade} - \text{Solar flux below topographic \& riparian shade}}{\text{Solar flux above topographic shade}}$$

Table 8-11. Site Capacity indicators for riparian shade effects on stream water temperature.

Target characteristic	Indicator	Metrics	Rational for characteristic
Riparian vegetation COULD provide a large portion of effective shade for channel	Channel exposure after only topographic shade	Percent of Project Area reach that is exposed to solar heating with no riparian vegetation	Reaches that are not primarily shaded by topographic features have a higher potential for riparian shading than those that are.
Riparian vegetation DOES provide a large portion of effective shade for channel	Difference in channel exposure with vs. without riparian shade	Percent of Project Area reach that is exposed to solar heating with riparian vegetation	The percent of channel shade provided by riparian vegetation is a direct measure of effective riparian shade.

## 8.5 Combining Benefits Scores

The final shade scores must be ‘manually’ entered into the Summary\_Scores worksheet of the Riparian Benefits Quantification Tool. The other landscape priority and site capacity scores are automatically entered into the Summary\_Scores worksheet.

Landscape priority and Site capacity scores for each riparian benefit are combined, with the following weighting.

Table 8-12. Weighting for landscape priority and site capacity differs for the four riparian benefits.

Benefit	Landscape priority weight	Site capacity weight
Bird habitat	30%	70%
Fish and aquatic habitat	50%	50%
Potential flood attenuation	50%	50%
Channel shading	70%	30%

Once all of these scores are entered, the relative weighting of the four riparian benefits are calculated, automatically, in the Summary\_Scores spreadsheet. These are calculated based on the benefit landscape priority scores by summing all of the landscape priority scores (as percentages), and then calculating the portion of the total occupied by each benefit type, as illustrated in Figure 8-2.

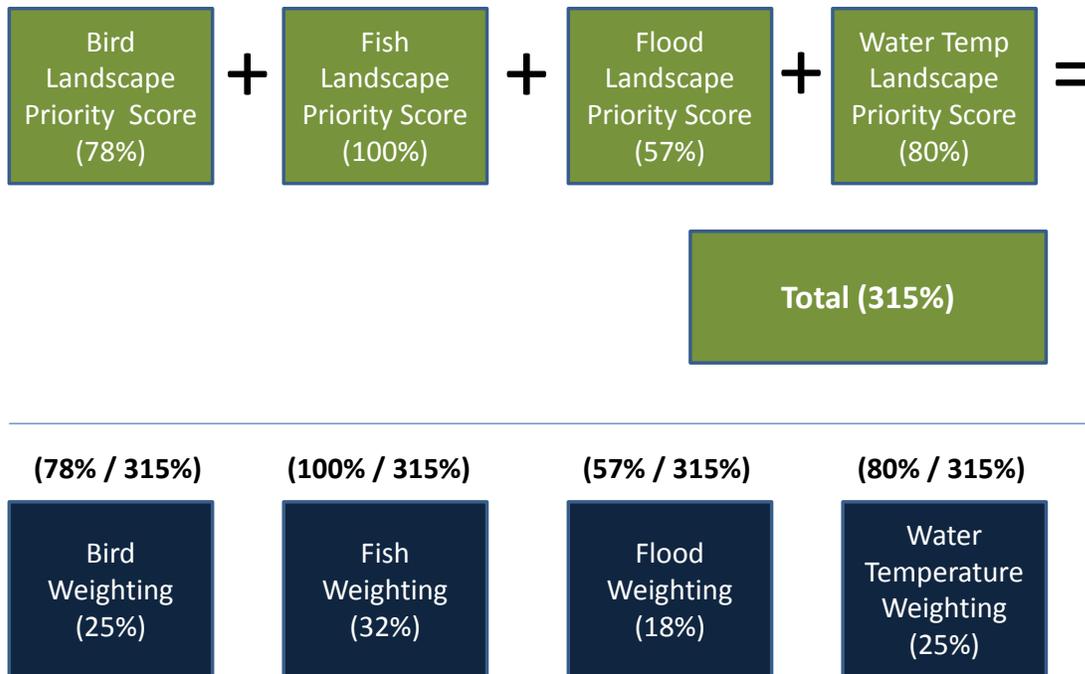


Figure 8-2. Illustration of how riparian benefit weights are calculated based on their landscape priority scores.

These weights (which add up to 100% for all four of the benefits), are then each multiplied by the Project Area score for each benefit and summed for the final combined riparian benefit score. The score is then multiplied by the number of acres to calculate the combined riparian benefit acres of the Project Area (Table 8-13).

Table 8-13. Site scores are multiplied by the benefit weights, and summed to generate the final combined riparian benefit score, as a percentage. The percentage is then multiplied by the site acreage to generate the number of functional acres credited to a site.

Riparian benefit	Site score x	Benefit weight =	Product
Bird habitat	81	25	20
Fish habitat	32	32	10
Flood attenuation	35	18	06
Channel shade	44	25	11
Combined Score		<i>SUM</i>	48
<b>Functional Acres</b>	<b>22.3 acres x</b>	<b>48%</b>	<b>10.6 functional acres</b>

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## Appendices

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**Appendix A**  
**Advisory Committee Members**

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**Colleague & project partners who will participate with the Review Committee:**

- Trish Hickson, Associate, Environmental Incentives, LLC
- Theresa Becchetti, Livestock & Natural Resources, UC Cooperative Extension, San Joaquin & Stanislaus Counties
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- Rene Henry, PhD, California Science Director, Trout Unlimited
- Jeanette Howard, PhD, Associate Science Director for Freshwater Habitat, TNC California
- James Jones, Wildlife Biologist, East Bay Municipal Utility District
- Keiller Kyle, Conservation Project Director, Audubon California
- Stefan Lorenzato, Riparian Habitat Joint Venture, Department of Water Resources
- Anitra Pawley, PhD, Floodsafe Environmental Stewardship and Statewide Resources Office, North Delta Restoration Program, Department of Water Resources
- Donnie Ratcliff, USFWS Anadromous Fish Restoration Program & Region 8 Fish Passage Programs
- Nat Seavy, PhD, Research Director, Pacific Coast and Central Valley Group, PRBO Conservation Science
- Josh Viers, PhD, Assistant Research Ecologist, UC Davis and CEO & Managing Partner, Pacific Agroecology, LLC
- John Wooster, Hydrologist/Geomorphologist, NOAA—Fisheries

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- Jay Stallman, Senior geomorphologist, Stillwater Sciences

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## Appendix B

### Blank Office and Field Data Sheets

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## Office Data Sheet: Ecosystem Services Riparian Bird Habitat

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes: \_\_\_\_\_

Area set out for implementation targeting riparian bird habitat (Project Area), determined by client/design plans (acres): \_\_\_\_\_

Variable	Measurement	Value	Notes
1. Percent of area within <b>1.5-mile buffer</b> around Project Area with a PRBO Habitat Suitability Index of 40% or higher for riparian focal species (blue).	Black-headed grosbeak		a. Go to California Avian Data Center website hosted by the PRBO to access an existing model on predicted riparian bird species distribution. ( <a href="http://data.prbo.org/cadc2/index.php?page=predicted-bird-species-in-central-valley">http://data.prbo.org/cadc2/index.php?page=predicted-bird-species-in-central-valley</a> ). b. Navigate to the project location. c. Mark out a 1.5-mile buffer from the boundaries of the Project Area (single click creates a point; double click removes it from interactive map). d. Select one riparian bird species at a time and record the percent cover of blue area within the 1.5 mile circle for that species (enter appropriate range: 0–5%, 6–15%, 15–24%, 25–50%, 50–100%). e. Blue indicate where the Habitat Suitability Index is estimated at 60% or greater.
	Blue grosbeak		
	Common yellowthroat		
	Song sparrow		
	Spotted towhee		
	Swainson's hawk		
	Tri-colored blackbird		
	Yellow-breasted chat		
	Yellow warbler		
2. Presence of intact riparian areas that are > 25 acres (10 ha) that overlap with <b>1.5-mile buffer</b> around Project Area.	Presence vs. absence		a. This is most easily done in Google Earth, and uses same buffer area created for question 1. b. Draw a buffer around the project area boundaries that is 1.5 miles in width. c. Create a 'reference square' on Google Earth that is 25 acres in size (about 1,000 x 1,000 feet). d. Look within the 1.5-mile buffer area for intact riparian areas that are roughly equal to or larger than your reference square. e. Record a '1' for 'Yes' or a '0' for No.
3. Estimated percent of area within 0.5-mile buffer around Project Area that supports intact riparian vegetation (excluding Project Area itself). Estimate areas from 0 to 10% carefully.	Percent of area		a. This is most easily done in Google Earth. b. Draw 0.5 mile wide buffer around Project Area. c. Include non-native as well as native riparian vegetation. Riparian vegetation is any shrub, tree, wetland, grass and/or forb vegetation that is not farmed, gardened or otherwise managed, or grazed and occurs within the apparent floodplain or within 2 channel widths of the channel. d. Bird species are sensitive to differences at the low end of the scale (1 to 2 acres) so try to be precise by entering the appropriate range: (0–2%, 2–4%, 5–10%, 10–20%, 20–50%, 50–100%)

## Office Data Sheet: Ecosystem Services Riparian Bird Habitat

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Variable	Measurement	Value	Notes
<p>4. Percent of Project Area that is adjacent to (within 150 feet of) native or undeveloped lands (including non-intensively managed uplands, wetlands, riparian habitat, and annual grasslands), that are at least 100 feet wide.</p>	<p>Percent of Project Area boundary length that borders undeveloped lands that are at least 100 feet wide and no more than 150 feet from the project boundary. Enter percent as 0 to 100 value</p>		<p>a. Estimate and record percent of Project Area border length that is within 150 feet of 'natural lands' that are <math>\geq</math> 100 feet wide.                      b. Where "natural lands" include shrub land, forest, native prairies, vegetated wetlands, untilled fields, lightly grazed pastures, and timber harvest areas.                      c. As used here, it does not include grain fields, golf courses, recreational fields, tilled cropland, pavement, bare soil, gravel pits, or dirt roads.                      d. Natural land cover is not the same as native vegetation. It may include areas of Himalayan blackberry or salt-cedar, for example.                      e. Enter the appropriate range (0–5%, 5–15%, 15–25%, 25–50%, 50–100%)</p>
<p>5. Percent of area within <b>0.5-mile buffer</b> around Project Area that supports non-native nest predator and parasite populations (e.g., housecats, rats, corvids, cowbirds)</p>	<p>Percent of buffer area in listed land uses</p> <p>_____ Moderate to large feedlots or other livestock operations (<math>\geq</math> 20 head)</p> <p>_____ Rural homes/ranchettes</p> <p>_____ Manicured park /picnic area</p> <p>_____ Urban/suburban development</p> <p>Total</p>		<p>a. Record the percent of buffer area per land use in the spaces provided.                      b. The total percent of all the different categories will be automatically calculated once this information is entered into the Riparian Bird Habitat spreadsheet.</p>

## Field Data Sheet: Ecosystem Services Riparian Bird Habitat

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_  
 Notes: \_\_\_\_\_

**Project Overview Information (fill out A–D)**

There are 2 Project Area Overview questions and 8 questions for each Map Unit. Record the answers for the Project Area Overview on this datasheet.

Information for each map unit will be recorded on the Map Unit Bird Field Sheet (5 map units per page). Use the Map Unit Bird Reference sheet for explanations and definitions in order to answer question in the field.

Variable	Value	Explanation
Number of Map Units (MUs)		Identify Map Units (channel reaches). Divide channel within the Project Area into 500-foot lengths that are, on average, equal to or less than 500 feet wide, as measured by a perpendicular line from the channel edge. Label on Riparian Birds Map sheet (the 8.5x11" print out).
Assessment year		Pre-restoration year = 0, one year post-restoration = 1, two years post-restoration = 2, etc.; mature reference site = 60

**Riparian Birds Map**

**Using 8.5x11" hard copy aerial photograph (Google Earth or NAIP image)**, draw locations of the following characteristics. Mark map with the letter for locations of the following and check when completed:

- \_\_\_ Project Area boundary for riparian bird habitat restoration (*label with red line and 'PA'*)
- \_\_\_ Map Unit boundaries labels (label numerically starting with '1')
- \_\_\_ Outline vegetated areas in Project Area supporting the same plant species or groups of species that are > 100 ft<sup>2</sup> in size (e.g., grasses, willows, alders).
- \_\_\_ Give each vegetated area ('polygon') a unique number and record associated information on **Vegetation Data sheets** at end of this packet.
- \_\_\_ Existing riparian vegetation (lateral extent of predominantly native riparian vegetation) (*label with green line and 'RV'*)
- \_\_\_ Lateral extent of most common water level (*label with straight blue line*)
- \_\_\_ Lateral extent of high water marks (*label with wavy blue line*)
- \_\_\_ Emergent herbaceous wetlands (*label with a 'W'*)

## Field Data Sheet: Ecosystem Services Riparian Bird Habitat

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes: \_\_\_\_\_

	#	Variable	Map Unit Number				
Special Habitat Features in Map Unit	1	Within the Map Unit, what percent of the banks have NOT been artificially altered (e.g., hardened, riprapped, revetment, channelization, within ~60 ft of channel)?					
	2	Are eroding banks present (at least 3 ft tall and 20 ft long) in the Map Unit?					
	3	Are off-channel oxbows present in Map Unit?					
	4	Are fresh gravel/cobble bars (unvegetated or sparsely vegetated) that are at least 100 square feet present in Map Unit?					
	5	Are there snags w/DBH > 12 inches in the Map Unit?					
Appropriate management practices	6	Are there ground disturbance activities during breeding season (April through August) in Map Unit?					
	7	Is there application of ground insecticides within Map Unit? If yes, how many times a year?					
	8	What percent of the Map Unit is currently grazed in a manner that has visibly and persistently altered the vegetation structure and/or composition (i.e., incomplete recovery between years)?					

## Field Data Sheet: Ecosystem Services Riparian Bird Habitat

	#	Variable	Explanations and Definitions
Special Habitat Features in Map Unit	1	Within the Map Unit, what percent of the banks have NOT been artificially altered (e.g., hardened, riprapped, revetment, channelization, etc, within ~60 ft of channel edge)?	Record the percent of the bank length within the Map Unit that has NOT been artificially altered into column C (0–5% [enter 2.5], 6–15% [enter 10], 15–24% [enter 20], 25–50% [enter 37], 50–100% [enter 75]).
	2	Are eroding banks present (at least 3 ft tall and 20 ft long) in the Map Unit?	Record '1' for Yes or a '0' for No.
	3	Are off-channel oxbows present in Map Unit?	Record '1' for Yes or a '0' for No.
	4	Are fresh gravel/cobble bars (unvegetated or sparsely vegetated) that are at least 100 square feet present in Map Unit?	Record '1' for Yes or a '0' for No.
	5	Are there snags w/DBH > 12 inches in the Map Unit?	Record '1' for Yes and '0' for No for whether or not there is one or more snags with DBH > 12 inches in the riparian area. DBH is diameter of tree trunk at 4.5 feet above the ground.
Appropriate management practices	6	Are there ground disturbance activities during breeding season (April through August) in Map Unit?	Record '1' for Yes or a '0' for No. Examples of ground disturbing activities include mowing hay, tilling, herbicide applications for weed control, and grazing during nesting period.
	7	Is there application of ground insecticides within Map Unit? If yes, how many times a year?	Record '1' for Yes or a '0' for No. Enter the number of times a year insecticides are applied to the Project Area.
	8	What percent of the Map Unit is currently grazed in a manner that has visibly and persistently altered the vegetation structure and/or composition (i.e., incomplete recovery between years)?	Record percent of Map Unit that applies (0–5% [enter 2.5], 6–15% [enter 10], 15–24% [enter 20], 25–50% [enter 37], 50–100% [enter 75]).

## VEGETATION DATA SHEET

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes: \_\_\_\_\_

### Project Overview Information (fill out A–D)

There are 3 general questions and 18 for each Map Unit. Record the answers for the General Questions on this datasheet. Information for each map unit will be recorded on a separate Map Unit Vegetation Field Sheet. For each Map Unit, either use GIS or a manual method to calculate the area of each vegetation type polygon that occurs in the Map Unit. Vegetation types are described with associated codes in the Field Data Sheets. Enter the size of each polygon in square feet; meters will be automatically calculated. Two vegetation types are allowed in order to reflect a matrix or different vegetation layers. For each type also enter the average age of the dominant plants. If you are matching a time-series with for Riparian Shade Model, only use years 1, 2, 3, 4, 5, 10, 15, 20, 30, and 50. If you are not interested in matching a time sequence with the Riparian Shade model, you do not have constraints on what years are used. You may enter as many as 25 different polygons, two vegetation types each, for each Map Unit.

Variable	Value
1. Are you running a time series? Enter '1' for yes, and '0' for no.	
2. If yes to (1), enter year of time series since restoration here (this will be added to age of each species entered in tables below).	
3. Are you targeting a period of high (H), medium (M), or low (L) precipitation or irrigation since last measured?	

### Riparian Vegetation Notes



### Aquatic Habitat: Landscape Priority Data Sheet

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes: \_\_\_\_\_

Area set out for implementation targeting aquatic fish habitat (Project Area), determined by client/design plans (acres): \_\_\_\_\_

Variable	Measurement	Value	Notes
1. Presence of salmonid species and/or listed or candidate native fish species (Central Valley fall Chinook salmon and Central Valley steelhead).	Documented presence vs. absence (list of species, life stages, and periodicity of occurrence).		<ol style="list-style-type: none"> <li>1. Refer to literature, published agency reports, or expert communication.</li> <li>2. Create list of species, life-stages, and periodicity of occurrence.</li> <li>3. Record '1' for Yes or a '0' for No.</li> </ol>
2. Implementation of all BMPs within "zone of influence" defined as any area within 1,000 ft of project boundary on the same side of the river.	Implementation of all BMPs within the area of influence.		<ol style="list-style-type: none"> <li>1. BMPs fish field form include (1) annual invasive plant species removal without herbicide application; (2) no pesticide application within past 2 yrs; (3) minimizing surface erosion from bare soil; (4) stockpiling any fertilizers, manure, pesticides, petrochemicals or fuels under secure roofs to prevent runoff; and (5) regular pumping and proper maintenance of any local septic tanks.</li> <li>2. Record '1' for Yes or a '0' for No.</li> </ol>

## Field Data Sheet: Ecosystem Services Aquatic Fish Habitat

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes: \_\_\_\_\_

	#	Variables (1-8)	Map Unit				
<b>Size of riparian and floodplain</b>	1	Reach length of Map Unit (feet).					
	2	Percent of Map Unit supporting active floodplain (enter as percent, e.g. 50 for 50%).					
<b>Riparian vegetation</b>	3	Within the area of the Map Unit, is there diversity in the vegetation types (forested vs. open grassy and herbaceous patches)?					
	4	Percentage of channel margin with overhanging vegetation.					
	5	What percent of the map unit, if any, is covered by riparian woody vegetation (trees) within ~60 ft of the channel?					
	6	Of the trees within ~60 ft of the channel, what percentage have a DBH $\geq$ 20–24 in?					
	7	Noninvasive vs. Invasive species composition: total percent area occupied by non-invasive (woody and herbaceous plant) species within the Map Unit.					

## Field Data Sheet: Ecosystem Services Aquatic Fish Habitat

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes:

	#	Variables (9-17)	Map Unit				
Floodplain dynamics	8	Within the Map Unit, what percent of the banks have NOT been artificially altered (e.g., hardened, riprapped, revetment, channelization, etc, within ~60 ft of channel edge)?.					
	9	What percent of the bank channel length is NOT leveed or what percent of the map unit area is NOT protected by a levee?					
	10	Within the area of the Map Unit that is inundated at least every 3 years, is there diversity in the vegetation types (forested vs. open grassy and herbaceous patches)?					
	11	Within the area of the Map Unit that is inundated at least every 3 years, is there diversity in the topography (dips and rises with elevation variations of at least 3 ft over at least 50% of the total area)?					
Best management practices	12	Are priority invasive plant species manually removed annually without herbicides?					
	13	Is there application of pesticides within the Map Unit since the last evaluation, or if not, then within the last two years?					
	14	What percent of the map unit is vegetated as opposed to bare soil?					
	15	Are any stockpiles of fertilizers, manure, pesticides, or petrochemicals and fuels stored under secured roofs to prevent run-off?					
	16	Are there any septic tanks and fields with the Map Unit? If so, are they pumped and maintained regularly and in proper working order?					

	#	Variable (1–8)	Explanations and Definitions
Size of riparian and	1	Reach length of Map Unit (feet).	Record reach length in feet. Record notes on how this was determined.
	2	Percent of Map Unit supporting active floodplain.	Record the percent of the Map Unit that is inundated at least every 3 years (photo documentation or elevation verification at ~2,600 cfs). If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten). Record notes on how this was determined.
Riparian vegetation	3	Within the area of the Map Unit, is there diversity in the vegetation types (forested vs. open grassy and herbaceous patches)?	Record '1' for Yes or a '0' for No. Island/herbaceous open areas contribute detritus and terrestrial insects to the aquatic ecosystem but also provide higher primary production during periods of inundation than forested areas, which enriches aquatic habitats. Diversity in vegetation types is defined as a minimum of 25% of the area having patches of grassland vegetation types (excluding invasive exotic species, see #13 and 18) with patches large enough to let sunlight reach the ground and support persistent grassy/herbaceous open areas.
	4	Percentage of channel margin with overhanging vegetation.	Record the total percent of channel margin with overhanging vegetation within the Map Unit observed by viewer looking through the canopy as if 2 to 15 feet above, but parallel to the channel margin. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten).
	5	What percent of the channel margin, if the map unit has any, is covered by riparian woody vegetation (trees) within ~60 ft of the channel?	Record the percent of map unit that includes trees and shrubs along the channel margin (within ~60 ft of the channel edge) such that the channel margin is covered by riparian woody vegetation from a bird's eye view during the summer peak growing season. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten). If the map unit does not include area within 60 ft of the channel margin, enter '0'.
	6	Of the trees within ~60 ft of the channel, what percentage have a DBH $\geq$ 20–24 in?	Record the percent of the riparian forest, including dead snags, with a DBH $\geq$ 20–24 in within ~60 ft of the channel edge. DBH is diameter of tree trunk at 4.5 ft above the ground (i.e., diameter breast height). If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten).
	7	Noninvasive vs. Invasive species composition: total percent area occupied by non-invasive (woody and herbaceous plant) species within the Map Unit.	Record total percent area NOT occupied by priority invasive plant species observed in the Map Unit (i.e., percent area of non-invasive plant species). If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten). Refer to the Invasive Species List for relevant species.

	#	Variable	Explanations and Definitions
Floodplain dynamics	8	Within the Map Unit, what percent of the banks have NOT been artificially altered (e.g., hardened, riprapped, revetment, channelization, etc, within ~60 ft of channel edge)?	Record the percent of the bank length within the Map Unit that has NOT been artificially altered within ~60 ft of the channel edge. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten).
	9	What percent of the bank channel length is NOT leveed or what percent of the map unit area is NOT protected by a levee?	Record the percent of the channel length that is NOT leveed or the percent of the map unit area that is NOT behind a levee, if it is not leveed then record 0. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten). Should use levee GIS layer and/or first hand observation. Record notes on how this was determined.
	10	Within the area of the Map Unit that is inundated at least every 3 years, is there diversity in the vegetation types (forested vs. open grassy and herbaceous patches)?	Record '1' for Yes or a '0' for No. Again, the area that is inundated at least every 3 years is based on photo documentation or elevation verification at ~2,600 cfs. Record notes on how this was determined.
	11	Within the area of the Map Unit that is inundated at least every 3 years, is there diversity in the topography (dips and rises with elevation variations of at least 3 ft over at least 50% of the total area)?	Record '1' for Yes or a '0' for No. Again, the area that is inundated at least every 3 years is based on photo documentation or elevation verification at ~2,600 cfs. Record notes on how this was determined.
Best management practices	12	Are priority invasive plant species manually removed annually without herbicides?	Record '1' for Yes or a '0' for No. Refer to the tab with the Invasive Species List.
	13	Is there application of pesticides within the Map Unit since the last evaluation, or if not, then within the last two years?	Record '0' for Yes or a '1' for No. A value of 1 means no pesticide use within the last 2 years.
	14	What percent of the map unit is vegetated as opposed to bare soil?	Record the percent of the Map Unit that is vegetated as opposed to bare, erodible, disturbed soil.. If you are not sure of specific value, estimate to the nearest 10% (0 to 100, increments of ten).
	15	Are any stockpiles of fertilizers, manure, pesticides, or petrochemicals and fuels stored under secured roofs to prevent run-off?	Record '0' for Yes or a '1' for No.
	16	Are there any septic tanks and fields with the Map Unit? If so, are they pumped and maintained regularly and in proper working order?	Record '2' for no septic systems, "1" for a septic system in proper order, or a '0' for a septic system not in proper order. Proper order can be defined using the Mokelumne Owner's Manual questionnaires starting on pg. 18 (Brodie et al. 2002).

### Explanation: Landscape Priority Data Sheet Ecosystem Services Flood Attenuation

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes: \_\_\_\_\_

Group	#	Indicator	Measurement	Value	
<b>Downstream Flooding</b>	1	Is Project Area within the Dry Creek or mainstem Mokelumne River contributing area?	See map showing confluence area (shared flooding area) above Bear Slough and about 2 miles east of highway 5. If in Mokelumne mainstem (including below the confluence with Dry Creek) contributing area, enter '1'; if in Dry Creek contributing area, enter '2'.		
	2	Are there urban lands within 5 miles downstream of site and 0.5 miles of the river that are outside of the 100 yr FEMA flood area?	Indicate yes with a 'y' and no with an 'n'. You may use Google Earth to answer this question.		
	3	What is the river mile at the lower end of the Project Area?	See KMZ file titled "Flood Analysis Layers" that accompanies the Mokelumne Benefits Quantification Tool. Record three-digit slice ID is downstream end of the Project Area; these range from 001 to 499 within the Lower Mokelumne Benefits Program Area.		
	4	Proximity of this Project Area to other areas that are likely to provide flood attenuation	Stream length (feet) between either the up or downstream end of the Project Area and the closest end of other areas of at least <b>10 acres</b> in size that flood at the three listed flow levels.	Closest flooded area at 2,600 cfs level flow (distance in feet)	
	5		Closest flooded area at 5,000 cfs level flow (distance in feet)		
	6		Closest flooded area within FEMA 100 yr flood zone (distance in feet)		

Group	#	Indicator	Measurement	Value
Current and Potential Flooding on Site	7	100-year flood inundation in Project area	Extent (acres) of Project Area inundated by 100-year flood.	
	8	5,000 cfs inundation within Project Area.	Extent (acres) of Project Area inundated by approximately 5,000 cfs.	
	9	2,600 cfs inundation within Project Area.	Extent (acres) of Project Area inundated by approximately 2,600 cfs.	
Current and Potential Flooding on Site	10	Has river access to the floodplain(s) within the Project Area changed for the long term since 2006?	Indicate yes with a 'y' and no with an 'n'. Long-term permanent changes can include removal or movement of levees, notches in levees or similar changes affecting flood access to Project Area.	
	11	Man-made impediments to 100 yr floodplain inundation in Project Area	Probable extent (acres) of 100-year floodplain within Project Area if levees or other man-made impediments to flooding within the site were removed.	
	12	Man-made impediments to floodplain inundation in Project Area at 5,000 cfs.	Probable extent (acres) of flood within Project Area at 5,000 cfs if levees or other man-made impediments to flooding within the site were removed.	
	13	Man-made impediments to floodplain inundation in Project Area at 2,600 cfs.	Probable extent (acres) of flood within Project Area at 2,600 cfs if levees or other man-made impediments to flooding within the site were removed.	

## Field Data Sheet: Ecosystem Services Flood Attenuation

Project Area Name: \_\_\_\_\_ Observer: \_\_\_\_\_ Date: \_\_\_\_\_

Notes:

Group	Indicator Number	Indicator (No data collected for grey cells)	Measurement	Value
Flood observations	1	Has flooding from the river, or a tributary to the river, occurred in the Project Area?	Y for 'yes', and N for 'no'.	
	2	If flooding has been observed in the Project Area, record the lowest annual peak flow at which flooding occurred, the percent of the Project Area flooded at that time, and the average depth of flooding that occurred.	a. Lowest annual peak flow at which flooding occurred	
			b. Percent of Project Area flooded at that time.	
			c. Average depth of high water in flooded portion of the Project Area during lowest flooding (feet)?	
	3	If flooding has been observed in the Project Area, record the highest annual peak flow at which flooding occurred, the percent of the Project Area flooded at that time, and the average depth of flooding that occurred.	a. Highest annual peak flow at which flooding occurred	
			b. Percent of Project Area flooded at that time.	
			c. Average depth of high water in the flooded portion of the Project Area during highest flooding event (ft)?	
	4	What hydrologic processes have been observed at the project site during flooding (Mark Y or N in the column to the right).	a. Floodplain inundation directly from river channel flow	
			b. Floodplain inundation from flow entering Project Area from adjacent property	
			c. Flow overtopped levee	
			d. Seepage through levee	
			e. Flow through gaps or breaches in levee that were subsequently fixed.	
		f. Flow through gaps or breaches in levee that were left as is.		
		g. Summary		

## Field Data Sheet: Ecosystem Services Flood Attenuation

Group	Indicator Number	Indicator (No data collected for grey cells)	Measurement	Value
Channel width-to-depth ratio	5	Bankfull channel elevation at the upper, mid, and lower cross-sections in the Project Area (ft).	a. upstream cross section	
			b. mid cross section	
			c. lower cross section	
	6	Distance along channel between upstream and mid cross section (feet)		
	7	Distance along channel between mid and lower cross section (feet)		
	8	Bankfull slope in Project Area ( stream length weighted average, shown as percent) between upstream and lower cross sections		<b>ND</b>
	9	Elevation difference between low flow water surface and bankfull indicators at the upper, mid, and lower cross-section of the Project Area (feet).	a. upstream cross section	
			b. mid cross section	
			c. lower cross section	
	10	Bankfull width at the upper, mid, and lower cross-section of the Project Area (feet).	a. upstream cross section	
			b. mid cross section	
c. lower cross section				
11	Bankfull width-to-depth ratio.	average for project site	<b>ND</b>	

## Field Data Sheet: Ecosystem Services Flood Attenuation

Group	Indicator Number	Indicator (No data collected for grey cells)	Measurement	Value
Existing Floodplain with Direct Access to River Flow	12	Length of channel margin levee (where levee is < 30 feet from low flow channel) on project side of river.		
	13	Length of setback levee (where levee is >30 feet from low flow channel) on project side of river.		
	14	Is there a floodplain that inundates at 2,600 and/or 5,000 cfs that has unimpeded connection to the river? E.g., If a levee is present, this floodplain would be on the river-side of the levee. If no, skip to question 37	a. At 2,600 cfs	
			b. At 5,000 cfs	
	15	Floodplain area that receives unimpeded flow from the river (acres).		
	16	Elevation of floodplain that receives unimpeded flow from the river	a. upstream cross section	
			b. mid cross section	
			c. lower cross section	
			d. Average elevation above low flow and bankfull	ND
	17	Width of floodplain that receives unimpeded flow from the river, ft.	a. upstream cross section (river left)	
			b. mid cross section (river left)	
			c. lower cross section (river left)	
			a. upstream cross section (river right)	
			b. mid cross section (river right)	
			c. lower cross section (river right)	
			d. Average floodplain width	ND
			e. Average confinement	ND
	18	Distance 'as a crow flies' from upper to lower end cross sections across floodplain that receives unimpeded flow from the river (ft)		ND
	19	Slope of floodplain that receives unimpeded flow from the river within Project Area (percent)		ND
	20	Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas?	a. Elevational difference common to the floodplain area (ft)	
			b. Areal extent of swale or local depression (acres)	
21	Percent of floodplain that receives unimpeded flow from the river that is occupied by vegetation	a. Percent cover all vegetation from 0 to 2 ft height	ND	
		b. Percent cover woody vegetation 0 to 2 ft height	ND	
		c. Percent cover woody vegetation from 2 to 10 ft height	ND	

## Field Data Sheet: Ecosystem Services Flood Attenuation

Group	Indicator Number	Indicator (No data collected for grey cells)	Measurement	Value
Existing Floodplain with Impeded Access to River Flow	22	Is there a floodplain or relatively flat area from which river flow is regularly impeded by a levee, but that has a similar surface elevation to the areas flooded at 2,600 or 5,000 cfs on the river side of the levee? E.g., a floodplain on the land-side of a levee. Enter 'y' for yes and 'n' for no. If no, skip the following questions.		
	23	Size of floodplain or relatively flat area from which river flow is regularly impeded by a levee.		
	24	Difference in elevation between low flow water surface and top of levee at the upper, mid, and lower cross-section of the Project Area (ft) .	a. upstream cross section	
			b. mid cross section	
			c. lower cross section	
	25	Difference in elevation between top of levee and the levee-impeded floodplain at the upper, mid, and lower cross-section of the Project Area (ft) .	a. upstream cross section	
			b. mid cross section	
			c. lower cross section	
			d. Average height above bankfull elevation (ft)	ND
	26	Distance 'as a crow flies' from upper to lower end cross sections across levee-impeded floodplain (ft)		
	27	Slope of levee-impeded floodplain (percent).		ND
	28	Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas?	a. Elevational difference common to floodplain area (ft)	
			b. Areal extent of swale or local depression (acres)	
29	Percent of levee-impeded floodplain that is occupied by vegetation	a. Percent cover all vegetation from 0 to 2 ft height	ND	
		b. Percent cover woody vegetation 0 to 2 ft height	ND	
		c. Percent cover woody vegetation from 2 to 10 ft height	ND	

## Explanation: Flood Attenuation Data Sheets

Indicator Number	Indicator	Specific Instructions and Explanations
1	Has flooding from the river, or a tributary to the river, occurred in the Project Area?	No instructions
2	If flooding has been observed in the Project Area, record the lowest annual peak flow at which flooding occurred, the percent of the Project Area flooded at that time, and the average depth of flooding that occurred.	If no flooding has been observed in the Project Area, enter NA; if it has been observed, then record the lowest flood flow at which it was observed, as recorded at the USGS gage at the base of Camanche dam in cfs. Estimate or measure percent of Project Area flooded at that flow and the average depth of the flood waters in the flooded area. Cells in column F will automatically calculate the acre-feet of water based on area and depth.
3	If flooding has been observed in the Project Area, record the highest annual peak flow at which flooding occurred, the percent of the Project Area flooded at that time, and the average depth of flooding that occurred.	If no flooding has been observed in the Project Area, enter NA; if it has been observed, then record the highest flood flow at which it was observed, as recorded at the USGS gage at the base of Camanche dam in cfs. Estimate or measure percent of Project Area flooded at that flow and the average depth of the flood waters in the flooded area. Cells in column F will automatically calculate the acre-feet of water based on area and depth.
4	What hydrologic processes have been observed at the project site during flooding (Mark Y or N in the column to the right).	Use this information as a 'reality check' on the tool score.
5	Bankfull channel elevation at the upper, mid, and lower cross-sections in the Project Area (ft).	First estimate using 2007 LiDAR and/or 2 ft contour data developed by EBMUD, then survey in the field data (data sheet attached). Enter final surveyed elevation above MSL in space to the right.
6	Distance along channel between upstream and mid cross section (feet)	Value in column F is slope between upstream and mid cross sections
7	Distance along channel between mid and lower cross section (feet)	Value in column F is slope between mid and lower cross sections

## Explanation: Flood Attenuation Data Sheets

Indicator Number	Indicator	Specific Instructions and Explanations
8	Bankfull slope in Project Area ( stream length weighted average, shown as percent) between upstream and lower cross sections	No data collected
9	Elevation difference between low flow water surface and bankfull indicators at the upper, mid, and lower cross-section of the Project Area (feet) .	Measure only where channel banks are expressed well. Use survey data sheet to record field survey data and enter final. Values in column F are the calculated relative elevation of the low water surface.
10	Bankfull width at the upper, mid, and lower cross-section of the Project Area (feet).	Measure only where channel banks are expressed well. Use rangefinder to measure width at top of bank.
11	Bankfull width-to-depth ratio.	Automatic Calculation: Because low flow depth is infeasible to measure in the field, the width-to-depth calculation does not include the portion of the bankfull channel wetted during summer low flow.
12	Length of channel margin levee (where levee is < 30 feet from low flow channel) on project side of river.	Values in column F are percent of project length confined by channel margin levee.
13	Length of setback levee (where levee is >30 feet from low flow channel) on project side of river.	Values in column F are percent of project length confined by setback levee.
14	Is there a floodplain that inundates at 2,600 and/or 5,000 cfs that has unimpeded connection to the river? E.g., If a levee is present, this floodplain would be on the river-side of the levee. If no, skip to question 37	No instructions

## Explanation: Flood Attenuation Data Sheets

Indicator Number	Indicator	Specific Instructions and Explanations
15	Floodplain area that receives unimpeded flow from the river (acres).	No instructions
16	Elevation of floodplain that receives unimpeded flow from the river	Height above low water surface calculated in column F and height above bankfull calculated in column G. Use same cross sections as in 22-28
	Width of floodplain that receives unimpeded flow from the river, ft.	Use same cross sections as in 22-28
	Channel confinement [(floodplain + channel width)/channel width]	Automatic calculation: Floodplain width divided by bankfull width
18	Distance 'as a crow flies' from upper to lower end cross sections across floodplain that receives unimpeded flow from the river (ft)	No data collected
19	Slope of floodplain that receives unimpeded flow from the river within Project Area (percent)	No data collected
20	Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas?	Look for evidence of back channels, ponding, or wetlands.
21	Percent of floodplain that receives unimpeded flow from the river that is occupied by vegetation	Calculated using VEG_DATA Worksheet (Indirect flow)

## Explanation: Flood Attenuation Data Sheets

Indicator Number	Indicator	Specific Instructions and Explanations
22	Is there a floodplain or relatively flat area from which river flow is regularly impeded by a levee, but that has a similar surface elevation to the areas flooded at 2,600 or 5,000 cfs on the river side of the levee? E.g., a floodplain on the land-side of a levee. Enter 'y' for yes and 'n' for no. If no, skip the following questions.	No instructions
23	Size of floodplain or relatively flat area from which river flow is regularly impeded by a levee.	No instructions
24	Difference in elevation between low flow water surface and top of levee at the upper, mid, and lower cross-section of the Project Area (ft) .	First estimate using 2007 LiDAR and/or 2 ft contour data developed by EBMUD, then survey in the field data (data sheet attached). Enter final surveyed difference in elevation in space to the right. Top of levee elevation calculated in column F.
25	Difference in elevation between top of levee and the levee-impeded floodplain at the upper, mid, and lower cross-section of the Project Area (ft) .	First estimate using 2007 LiDAR and/or 2 ft contour data developed by EBMUD, then survey in the field data (data sheet attached). Enter final surveyed difference in elevation in space to the right. Elevation of impeded floodplain calculated in column F. Height of impeded floodplain above bankfull elevation calculated in column G.
		Reality Check
26	Distance 'as a crow flies' from upper to lower end cross sections across levee-impeded floodplain (ft)	No instructions
27	Slope of levee-impeded floodplain (percent).	No data collected
28	Is the ground surface behind the levee flat, or are there low areas or depressions that would hold or direct flood flows more than other areas?	No instructions
29	Percent of levee-impeded floodplain that is occupied by vegetation	Calculated using VEG_DATA Worksheet (Indirect flow)

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## Appendix C

### Estimating Percent Area

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One method for estimating percent cover is to delineate a circular plot and subdivide it into halves, quarters and eighths. One can then look at the vegetation in each eighth pie-section and estimate the percent of that pie piece that is covered in vegetation. Since one-eighth is 12.5%, then a pie piece that is one-quarter covered represents approximately 3% cover. If you add up the eight percentages of each pie piece, you should have the total percent cover of the circular plot (Figure C-1).

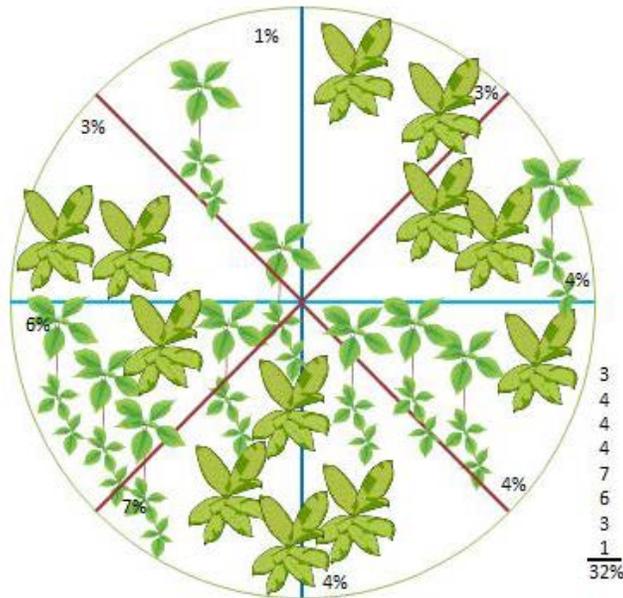


Figure C-1. Estimating percent cover one-eighth of the plot at a time and then summing.

If there is very low vegetation cover, another alternative is to imagine clustering all of the vegetation to one quarter of the circular plot and ‘visualizing’ how much of that quarter plot would be covered. In this example the percent cover is approximately 50%, which for the whole plot, would translate to approximately 12.5%.

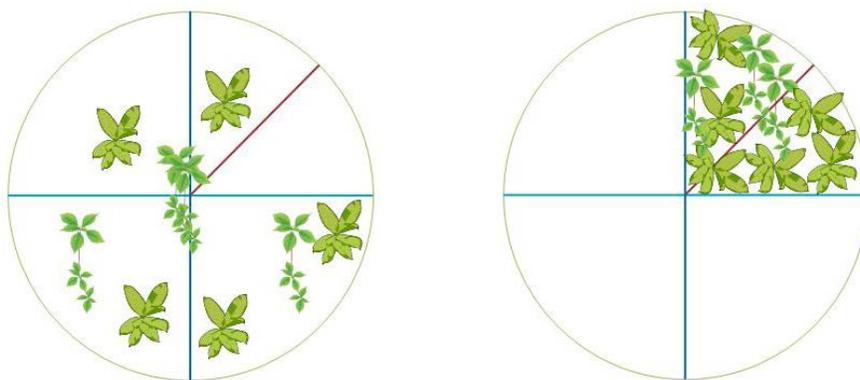


Figure C-2. Estimating percent cover in sparsely vegetated areas.

Percent cover estimates from the California Native Plant Society are presented below.

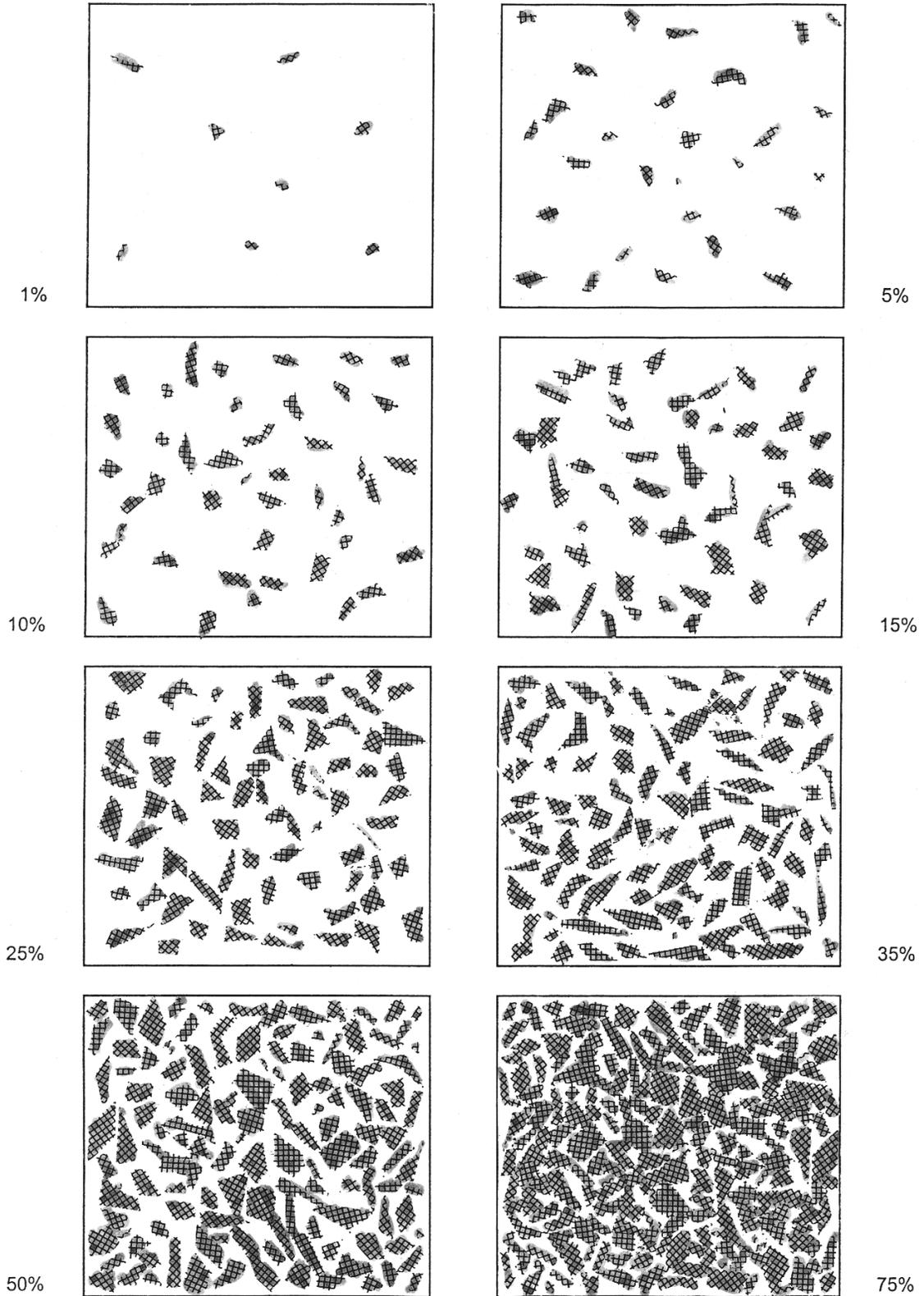


Figure C-3. CNPS cover diagrams.

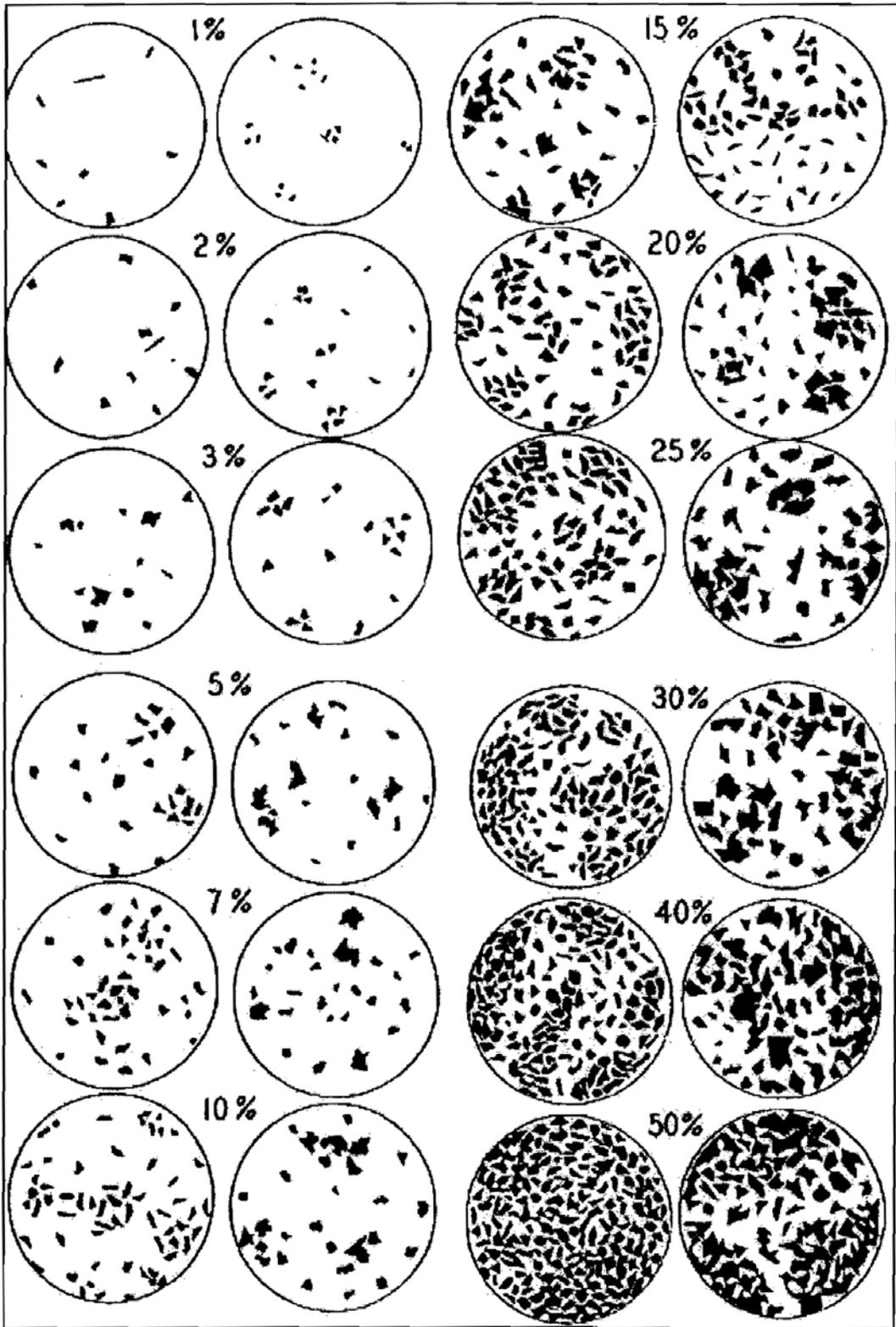


Figure C-4. Reference plots for cover estimation.

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## Appendix D

### Common Native Woody Riparian Plants of the Central Valley

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Table D-1. Common native woody riparian plants of the Central Valley.

<b>Common name</b>	<b>Latin name</b>	<b>Vegetation layer</b>
Box elder	<i>Acer negundo</i>	Small tree
White alder	<i>Alnus rhombifolia</i>	Large tree
Dutchman's pipe	<i>Aristolochia californica</i>	Vine
Mule fat	<i>Baccharis salicifolia</i>	Shrub
Buttonbush	<i>Cephalanthus occidentalis</i>	Shrub
Western virgin's bower	<i>Clematis ligusticifolia</i>	Vine
Brown dogwood	<i>Cornus glabrata</i>	Shrub
Oregon ash	<i>Fraxinus latifolia</i>	Large tree
California walnut	<i>Juglans hindsii</i>	Large tree
California man-root	<i>Marah fabaceus</i>	Vine
Western sycamore	<i>Platanus racemosa</i>	Large tree
Fremont cottonwood	<i>Populus fremontii</i>	Large tree
Live oak	<i>Quercus agrifolia</i>	Large tree
Canyon live oak	<i>Quercus wislizenii</i>	Large tree
Coffeeberry	<i>Rhamnus californica</i>	Small tree
California rose	<i>Rosa californica</i>	Shrub
California blackberry	<i>Rubus ursinus</i>	Shrub/vine
Narrow-leaved willow	<i>Salix exigua</i>	Shrub
Goodding's black willow	<i>Salix goodingii</i>	Large tree
Red willow	<i>Salix laevigata</i>	Large tree
Arroyo willow	<i>Salix lasiolepis</i>	Shrub, Small tree
Shining willow	<i>Salix lucida</i>	Shrub, Small tree
Mexican elderberry	<i>Sambucus mexicana</i>	Shrub
Common snowberry	<i>Symphoricarpus rivularis</i>	Shrub
Poison oak	<i>Toxicodendron diversilobum</i>	Vine
Valley oak	<i>Quercus lobata</i>	Large tree
California grape	<i>Vitis californica</i>	Vine

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## Appendix E

### Common Invasive Non-Native Plants of the Central Valley

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Table E-1. Common invasive non-native plants of the Central Valley.

<b>Common name</b>	<b>Latin name</b>	<b>Vegetation layer</b>
Tree of heaven	<i>Ailanthus altissima</i>	Large tree
Giant reed	<i>Arundo donax</i>	Herbaceous
Blue gum	<i>Eucalyptus spp.</i>	Large tree
Edible fig	<i>Ficus carica</i>	Small tree
Pepperweed	<i>Lepidium latifolium</i>	Herbaceous
Cherry plum	<i>Prunus cerasifera</i>	Small tree
Himalayan black berry	<i>Rubus discolor</i>	Shrub, vine
Scarlet wisteria	<i>Sesbania punicea</i>	Small tree
Salt cedar	<i>Tamerisk spp.</i>	Small tree, shrub

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**Appendix F**  
**Vegetation Type List**

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Table F-1. Vegetation type list.

<b>Code</b>	<b>Latin name</b>	<b>Common name or descriptions</b>
Code	Common name or Descriptions	Scientific Name
1000	Annual row crops	Annual row crops
1100	Apple	Malus spp.
1200	Bare ground (<5% cover)	Bare ground (<5% cover)
1300	Bare ground with <40% cover	Bare ground with <40% cover
1400	Blue oak (deciduous)	Quercus douglasii
1500	Boxelder	Acer negundo
1600	Broadleaved invasive exotic trees	Broadleaved invasive exotic trees
1700	Broadleaved non-invasive exotic Trees	Broadleaved non-invasive exotic trees
1800	Bunch grass/sedge	Bunch grass/sedge
1900	Button willow, button bush	Cephalanthus occidentalis
2000	California bay	Umbellularia californica
2100	California black oak	Quercus kelloggii
2200	California black walnut	Juglans hindsii
2300	California blackberry	Rubus californica
2400	California buckeye	Aesculus californica
2500	California coffeeberry	Frangula californica
2600	California grape	Vitis californica
2700	California redbud	Cercis orbiculata
2800	California sycamore	Platanus racemosa
2900	California wildrose	Rosa californica
3000	Conifers (native or non-native)	Conifers (native or non-native)
3100	Cottonwood	Populus fremontii
3200	Coyote brush	Baccharis pilularis
3300	Dogwood shrub	Cornus spp
3400	Elderberry	Sambucus nigra subsp. caerulea
3500	Emergent wetland plants <3' tall	Emergent wetland plants <3'
3600	Emergent wetland plants over 3' tall	Emergent wetland plants >3'
3700	English walnut	Juglans regia
3800	Exotic invasive shrubs	Exotic invasive shrubs
3900	Exotic non-invasive shrubs	Exotic non-invasive shrubs
4000	Fig	Ficus carica

<b>Code</b>	<b>Latin name</b>	<b>Common name or descriptions</b>
4100	Foothill or Ghost pine	Pinus sabiniana
4200	Giant reed	Arundo donax
4300	Grass: irrigated manicured lawn	Grass: irrigated manicured lawn
4400	Grasses and forbs: non-native annual grasses	Grasses and forbs: non-native annual grasses
4500	Grasses and forbs: Riparian native	Grasses and forbs: Riparian native
4600	Himalayan blackberry	Rubus armeniacus
4700	Incense cedar	Calocedrus decurrens
4800	Lewis' mock orange	Philadelphus lewisii
4900	Live oak (canyon or interior)	Quercus chrysolepis
5000	Mesic native shrub	Mesic native shrub
5100	Mountain mahogany	Cercocarpus betuloides
5200	Mugwort and/or Hedgenettle	Artemisia douglasiana or Stachys spp.
5300	Mule's fat	Baccharis salicifolia
5400	Native Riparian deciduous trees	Native Riparian deciduous trees
5500	Orchard: Peach/plum/almond/cherry	Orchard: Peach/plum/almond/cherry
5600	Oregon ash	Fraxinus latifolia
5700	Salt cedar	Tamarisk spp.
5800	Stone fruit trees: Peach/plum/almond/cherry	Prunus spp.
5900	Unknown Oak	Quercus spp.
6000	Upland annual grasses and forbs	Upland annual grasses and forbs
6100	Urban- developed	Urban- developed
6200	Valley oak	Quercus lobata
6300	Vineyard	Vineyard
6400	Water	WATER
6500	Weeds, herbaceous and highly invasive	Weeds, herbaceous and highly invasive
6600	Weeds, herbaceous and non-invasive	Weeds, herbaceous and non-invasive
6700	White alder	Alnus rhombifolia
6800	Willow shrub (other than sandbar willow)	Salix spp. (shrub)
6900	Willow tree (other)	Salix spp. (tree)
7000	Willow, Goodding's or Red	Salix goodingii, S. laevigata
7100	Willow, sandbar	Salix exigua

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## Appendix G

### Vegetation Parameters for the Veggiematic

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Table G-1. Vegetation parameters for the Veggiematic.

Code	Scientific name	Ht max m	Ht Rate	Canopy density max	Canopy density rate	Canopy width max	Canopy width rate	Coeff soil coarse	Coeff soil fine	Coeff low precip	Veg strata	CALIPC status
			m/y	max %	rate %/y	m	m/y				code	
1000	Annual row crops	1.50	1.50	0.45	0.45	0.50	0.50	0.50	0.50	0.20	H	Non-Native
1100	Malus spp.	12.00	1.50	0.85	0.60	12.00	0.60	1.00	0.50	0.20	T	Non-Native
1200	Bare ground (<5% cover)	0.20	0.20	0.05	0.05	0.05	0.05	#N/A	#N/A	#N/A	H	N/A
1300	Bare ground with <40% cover	0.20	0.20	0.40	0.40	0.10	0.10	#N/A	#N/A	#N/A	H	N/A
1400	Quercus douglasii	20.00	0.50	0.75	0.25	5.00	0.80	1.00	0.50	0.80	T	Native
1500	Acer negundo	16.50	1.00	0.80	0.35	6.00	0.65	1.00	1.00	0.80	T	Native
1600	Broadleaved invasive exotic trees	8.00	1.24	0.90	0.50	6.00	0.65	1.00	1.00	0.50	T	Highly invasive
1700	Broadleaved non-invasive exotic trees	10.00	0.50	0.85	0.50	6.00	0.60	0.50	1.00	0.50	T	Non-Native
1800	Bunch grass/sedge	1.09	1.09	0.80	0.80	1.00	1.00	0.50	1.00	0.80	H	Native
1900	Cephalanthus occidentalis	3.50	0.53	0.80	0.40	3.00	0.61	1.00	1.00	0.50	Sh	Native
2000	Umbellularia californica	25.00	1.20	0.90	0.40	15.00	2.00	1.00	1.00	0.20	T	Native
2100	Quercus kelloggii	25.00	0.50	0.75	0.30	10.00	1.00	1.00	0.50	0.50	T	Native
2200	Juglans hindsii	23.00	1.00	0.80	0.50	12.00	0.75	0.50	1.00	0.50	T	Native
2300	Rubus californica	1.00	1.50	0.75	0.30	2.00	1.50	1.00	1.00	0.50	Sh	Native
2400	Aesculus californica	7.60	0.80	0.75	0.25	6.00	0.65	1.00	0.50	0.80	T	Native
2500	Frangula californica	1.56	1.00	0.80	0.30	3.00	0.50	1.00	1.00	0.80	Sh	Native
2600	Vitis californica	3.00	2.00	0.25	0.10	2.00	0.50	1.00	1.00	FALSE	Sh	Native
2700	Cercis orbiculata	6.25	1.00	0.70	0.20	3.00	0.50	1.00	1.00	0.80	Sh	Native
2800	Platanus racemosa	24.00	1.00	0.70	0.30	10.00	1.00	1.00	0.50	0.50	T	Native

Code	Scientific name	Ht max m	Ht Rate	Canopy density max	Canopy density rate	Canopy width max	Canopy width rate	Coeff soil coarse	Coeff soil fine	Coeff low precip	Veg strata	CALIPC status
			m/y	max %	rate %/y	m	m/y				code	
2900	Rosa californica	1.50	1.00	0.75	0.30	2.00	0.50	1.00	1.00	0.50	Sh	Native
3000	Conifers (native or non-native)	35.00	0.65	0.85	0.50	12.00	0.80	1.00	0.50	0.20	T	Native or Non-Native
3100	Populus fremontii	24.00	2.00	0.80	0.50	10.00	1.00	1.00	1.00	0.50	T	Native
3200	Baccharis pilularis	2.00	0.34	0.65	0.45	2.00	0.39	1.00	0.50	0.80	Sh	Native
3300	Cornus spp	4.00	0.67	0.70	0.30	4.00	0.67	1.00	1.00	0.20	Sh	Native
3400	Sambucus nigra subsp. caerulea	5.00	0.50	0.65	0.70	3.50	0.38	1.00	0.50	0.80	Sh	Native
3500	Emergent wetland plants <3'	1.00	1.00	0.95	0.95	0.50	0.50	0.50	1.00	0.20	H	Native
3600	Emergent wetland plants >3'	2.00	2.00	0.95	0.95	0.50	0.50	1.00	1.00	FALSE	H	Native
3700	Juglans regia	30.00	1.00	0.80	0.50	12.00	0.75	0.50	1.00	0.50	T	Non-Native
3800	Exotic invasive shrubs	4.00	1.00	0.75	0.20	2.00	0.50	1.00	1.00	0.20	Sh	Highly invasive
3900	Exotic non-invasive shrubs	3.00	0.20	0.80	0.30	3.00	0.35	1.00	1.00	0.80	Sh	Non-Native
4000	Ficus carica	8.00	1.24	0.90	0.50	6.00	0.55	FALSE	FALSE	FALSE	T	Highly invasive
4100	Pinus sabiniana	35.00	0.50	0.30	0.10	5.00	0.80	1.00	0.50	0.80	T	Native
4200	Arundo donax	9.00	3.00	0.95	0.95	1.00	1.00	0.50	1.00	0.20	H	Highly invasive
4300	Grass: irrigated manicured lawn	0.20	0.20	0.95	0.95	0.10	0.10	0.50	1.00	0.20	H	Native
4400	Grasses and forbs: non-native annual grasses	0.80	0.80	0.95	0.95	0.10	0.10	1.00	1.00	0.50	H	Native

Code	Scientific name	Ht max m	Ht Rate	Canopy density max	Canopy density rate	Canopy width max	Canopy width rate	Coeff soil coarse	Coeff soil fine	Coeff low precip	Veg strata	CALIPC status
			m/y	max %	rate %/y	m	m/y				code	
4500	Grasses and forbs: Riparian native	0.80	0.80	0.95	0.95	0.10	0.10	1.00	1.00	0.20	H	Native
4600	Rubus armeniacus	1.50	1.00	0.95	0.50	3.00	2.00	1.00	1.00	0.20	Sh	Highly invasive
4700	Calocedrus decurrens	30.00	0.50	0.90	0.20	10.00	1.00	1.00	1.00	0.50	T	Native
4800	Philadelphus lewisii	3.00	0.20	0.80	0.30	3.00	0.30	1.00	0.50	0.50	Sh	Native
4900	Quercus chrysolepis	25.00	0.60	0.90	0.30	10.00	1.00	1.00	1.00	0.80	T	Native
5000	Mesic native shrub	4.00	0.67	0.70	0.30	4.00	0.67	1.00	1.00	0.50	Sh	Native
5100	Cercocarpus betuloides	5.00	0.30	0.50	0.10	3.00	0.50	1.00	0.50	0.80	Sh	Native
5200	Artemisia douglasiana or Stachys spp.	2.50	2.50	0.95	0.95	0.50	0.50	1.00	1.00	0.50	H	Native
5300	Baccharis salicifolia	4.00	0.57	0.70	0.30	2.50	0.55	1.00	1.00	0.20	Sh	Native
5400	Native Riparian deciduous trees	20.00	1.67	0.73	0.37	10.00	1.22	1.00	1.00	0.20	T	Native
5500	Orchard: Peach/plum/almond/c herry	10.00	0.50	0.85	0.50	6.00	0.60	1.00	1.00	0.20	T	Non-Native
5600	Fraxinus latifolia	22.00	1.00	0.90	0.50	10.00	1.50	1.00	1.00	0.20	T	Native
5700	Tamarisk spp.	8.00	2.00	80.0 0	30.00	3.00	1.00	1.00	1.00	0.80	Sh	Highly invasive
5800	Prunus spp.	10.00	0.50	0.85	0.50	6.00	0.60	1.00	1.00	0.20	T	Moderately invasive
5900	Quercus spp.	25.00	0.73	0.79	0.29	10.00	1.08	1.00	0.50	0.50	T	Native
6000	Upland annual grasses and forbs	1.50	1.50	0.90	0.90	0.10	0.10	1.00	1.00	0.50	H	Native
6100	Urban- developed	0.00	0.00	0.00	0.00	0.00	0.00	#N/A	#N/A	#N/A	URBAN	N/A

Code	Scientific name	Ht max m	Ht Rate	Canopy density max	Canopy density rate	Canopy width max	Canopy width rate	Coeff soil coarse	Coeff soil fine	Coeff low precip	Veg strata	CALIPC status
			m/y	max %	rate %/y	m	m/y				code	
6200	Quercus lobata	30.00	2.00	0.75	0.30	15.00	1.50	1.00	0.50	0.50	T	Native
6300	Vineyard	2.00	0.50	0.65	0.65	2.00	0.55	1.00	0.50	0.80	Sh	Non-Native
6400	WATER	0.00	0.00	0.00	0.00	0.00	0.00	#N/A	#N/A	#N/A	WATER	N/A
6500	Weeds, herbaceous and highly invasive	1.50	1.50	0.95	0.95	0.20	0.20	1.00	1.00	0.80	H	Highly invasive
6600	Weeds, herbaceous and non-invasive	1.00	1.00	0.95	0.95	0.20	0.20	1.00	1.00	FALSE	H	Non-Native
6700	Alnus rhombifolia	20.31	1.33	0.70	0.20	8.00	1.00	1.00	1.00	0.20	T	Native
6800	Salix spp. (shrub)	10.00	0.75	0.80	0.43	7.50	0.65	1.00	0.50	0.50	Sh	Native
6900	Salix spp. (tree)	12.00	2.00	0.80	0.30	10.00	0.75	1.00	0.50	0.50	T	Native
7000	Salix goodingii, S. laevigata	12.00	2.00	0.70	0.30	10.00	2.00	1.00	0.50	0.50	T	Native
7100	Salix exigua	3.50	0.73	0.70	0.30	2.50	0.55	1.00	0.50	0.50	Sh	Native

Table G-2. Vegetation parameters for the Veggiematic.

Code	Common name or descriptions	Scientific name	CALIPC status	Adapted to coarse textured soils	Adapted to fine textured soils	Drought tolerance	Coeff soil coarse (calc)	Coeff yne (calc)	Coeff yecip (calc)	Native Riparian? <sup>1</sup> (1=Native; 0 = invasive)
1000	Annual row crops	Annual row crops	Non-Native	No	No	Low	0.50	0.50	0.20	0.00
1100	Apple	<i>Malus spp.</i>	Non-Native	Yes	No	Low	1.00	0.50	0.20	0.00
1200	Bare ground (<5% cover)	Bare ground (<5% cover)	N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00
1300	Bare ground with <40% cover	Bare ground with <40% cover	N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00
1400	Blue oak (deciduous)	<i>Quercus douglasii</i>	Native	Yes	No	High	1.00	0.50	0.80	0.00
1500	Boxelder	<i>Acer negundo</i>	Native	Yes	Yes	High	1.00	1.00	0.80	1.00
1600	Broadleaved invasive exotic trees	Broadleaved invasive exotic trees	Highly Invasive	Yes	Yes	Medium	1.00	1.00	0.50	0.00
1700	Broadleaved non-invasive exotic Trees	Broadleaved non-invasive exotic trees	Non-Native	No	Yes	Medium	0.50	1.00	0.50	0.00
1800	Bunch grass/sedge	Bunch grass/sedge	Native	No	Yes	High	0.50	1.00	0.80	1.00
1900	Button willow, button bush	<i>Cephalanthus occidentalis</i>	Native	Yes	Yes	Medium	1.00	1.00	0.50	1.00
2000	California bay	<i>Umbellularia californica</i>	Native	Yes	Yes	Low	1.00	1.00	0.20	1.00
2100	California black oak	<i>Quercus kelloggii</i>	Native	Yes	No	Medium	1.00	0.50	0.50	0.00
2200	California black walnut	<i>Juglans hindsii</i>	Native	No	Yes	Medium	0.50	1.00	0.50	1.00
2300	California blackberry	<i>Rubus californica</i>	Native	Yes	Yes	Medium	1.00	1.00	0.50	1.00
2400	California buckeye	<i>Aesculus californica</i>	Native	Yes	No	High	1.00	0.50	0.80	1.00
2500	California coffeeberry	<i>Frangula californica</i>	Native	Yes	Yes	High	1.00	1.00	0.80	0.00
2600	California grape	<i>Vitis californica</i>	Native	Yes	Yes	Medium	1.00	1.00	FALSE	1.00
2700	California redbud	<i>Cercis orbiculata</i>	Native	Yes	Yes	High	1.00	1.00	0.80	1.00
2800	California sycamore	<i>Platanus racemosa</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00

Code	Common name or descriptions	Scientific name	CALIPC status	Adapted to coarse textured soils	Adapted to fine textured soils	Drought tolerance	Coeff soil coarse (calc)	Coeff yne (calc)	Coeff yecip (calc)	Native Riparian? <sup>1</sup> (1=Native; 0 = invasive)
2900	California wildrose	<i>Rosa californica</i>	Native	Yes	Yes	Medium	1.00	1.00	0.50	1.00
3000	Conifers (native or non-native)	Conifers (native or non-native)	Native or Non-Native	Yes	No	Low	1.00	0.50	0.20	0.00
3100	Cottonwood	<i>Populus fremontii</i>	Native	Yes	Yes	Medium	1.00	1.00	0.50	1.00
3200	Coyote brush	<i>Baccharis pilularis</i>	Native	Yes	No	High	1.00	0.50	0.80	1.00
3300	Dogwood shrub	<i>Cornus spp</i>	Native	Yes	Yes	Low	1.00	1.00	0.20	1.00
3400	Elderberry	<i>Sambucus nigra subsp. caerulea</i>	Native	Yes	No	High	1.00	0.50	0.80	1.00
3500	Emergent wetland plants <3' tall	Emergent wetland plants <3'	Native	No	Yes	Low	0.50	1.00	0.20	1.00
3600	Emergent wetland plants over 3' tall	Emergent wetland plants >3'	Native	Yes	Yes	None	1.00	1.00	FALSE	1.00
3700	English walnut	<i>Juglans regia</i>	Non-Native	No	Yes	Medium	0.50	1.00	0.50	0.00
3800	Exotic invasive shrubs	Exotic invasive shrubs	Highly Invasive	Yes	Yes	Low	1.00	1.00	0.20	0.00
3900	Exotic non-invasive shrubs	Exotic non-invasive shrubs	Non-Native	Yes	Yes	High	1.00	1.00	0.80	0.00
4000	Fig	<i>Ficus carica</i>	Highly Invasive	0.00	0.00	0.00	FALSE	FALSE	FALSE	0.00
4100	Foothill or Ghost pine	<i>Pinus sabiniana</i>	Native	Yes	No	High	1.00	0.50	0.80	0.00
4200	Giant reed	<i>Arundo donax</i>	Highly Invasive	No	Yes	Low	0.50	1.00	0.20	0.00
4300	Grass: irrigated manicured lawn	Grass: irrigated manicured lawn	Native	No	Yes	Low	0.50	1.00	0.20	0.00
4400	Grasses and forbs: non-native annual grasses	Grasses and forbs: non-native annual grasses	Native	Yes	Yes	Medium	1.00	1.00	0.50	1.00
4500	Grasses and forbs: Riparian native	Grasses and forbs: Riparian native	Native	Yes	Yes	Low	1.00	1.00	0.20	1.00

Code	Common name or descriptions	Scientific name	CALIPC status	Adapted to coarse textured soils	Adapted to fine textured soils	Drought tolerance	Coeff soil coarse (calc)	Coeff yne (calc)	Coeff yecip (calc)	Native Riparian? <sup>1</sup> (1=Native; 0 = invasive)
4600	Himalayan blackberry	<i>Rubus armeniacus</i>	Highly Invasive	Yes	Yes	Low	1.00	1.00	0.20	0.00
4700	Incense cedar	<i>Calocedrus decurrens</i>	Native	Yes	Yes	Medium	1.00	1.00	0.50	0.00
4800	Lewis' mock orange	<i>Philadelphus lewisii</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00
4900	Live oak (canyon or interior)	<i>Quercus chrysolepis</i>	Native	Yes	Yes	High	1.00	1.00	0.80	1.00
5000	Mesic native shrub	<i>Mesic native shrub</i>	Native	Yes	Yes	Medium	1.00	1.00	0.50	1.00
5100	Mountain mahogany	<i>Cercocarpus betuloides</i>	Native	Yes	No	High	1.00	0.50	0.80	1.00
5200	Mugwort and/or Hedgenettle	<i>Artemisia douglasiana</i> or <i>Stachys spp.</i>	Native	Yes	Yes	Medium	1.00	1.00	0.50	1.00
5300	Mule's fat	<i>Baccharis salicifolia</i>	Native	Yes	Yes	Low	1.00	1.00	0.20	1.00
5400	Native Riparian deciduous trees	Native Riparian deciduous trees	Native	Yes	Yes	Low	1.00	1.00	0.20	1.00
5500	Orchard: Peach/plum/almond/c herry	Orchard: Peach/plum/almond/c herry	Non-Native	Yes	Yes	Low	1.00	1.00	0.20	0.00
5600	Oregon ash	<i>Fraxinus latifolia</i>	Native	Yes	Yes	Low	1.00	1.00	0.20	1.00
5700	Salt cedar	<i>Tamarisk spp.</i>	Highly Invasive	Yes	Yes	High	1.00	1.00	0.80	0.00
5800	Stone fruit trees: Peach/plum/almond/c herry	<i>Prunus spp.</i>	Moderately invasive	Yes	Yes	Low	1.00	1.00	0.20	0.00
5900	Unknown Oak	<i>Quercus spp.</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00
6000	Upland annual grasses and forbs	Upland annual grasses and forbs	Native	Yes	Yes	Medium	1.00	1.00	0.50	0.00
6100	Urban- developed	Urban- developed	N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00
6200	Valley oak	<i>Quercus lobata</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00

Code	Common name or descriptions	Scientific name	CALIPC status	Adapted to coarse textured soils	Adapted to fine textured soils	Drought tolerance	Coeff soil coarse (calc)	Coeff yne (calc)	Coeff yecip (calc)	Native Riparian? <sup>1</sup> (1=Native; 0 = invasive)
6300	Vineyard	Vineyard	Non-Native	Yes	No	High	1.00	0.50	0.80	0.00
6400	Water	WATER	N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	0.00
6500	Weeds, herbaceous and highly invasive	Weeds, herbaceous and highly invasive	Highly Invasive	Yes	Yes	High	1.00	1.00	0.80	0.00
6600	Weeds, herbaceous and non-invasive	Weeds, herbaceous and non-invasive	Non-Native	Yes	Yes	None	1.00	1.00	FALSE	0.00
6700	White alder	<i>Alnus rhombifolia</i>	Native	Yes	Yes	Low	1.00	1.00	0.20	1.00
6800	Willow shrub (other than sandbar willow)	<i>Salix spp. (shrub)</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00
6900	Willow tree (other)	<i>Salix spp. (tree)</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00
7000	Willow, Goodding's or Red	<i>Salix goodingii, S. laevigata</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00
7100	Willow, sandbar	<i>Salix exigua</i>	Native	Yes	No	Medium	1.00	0.50	0.50	1.00

<sup>1</sup> Non-invasive grasses 'accepted' as native riparian due to their broad distribution.

Table G-3. Information Sources for the Vegetation parameters for the Veggiematic.

Code	Common name or descriptions	Scientific name	Information sources
1000	Annual row crops	Annual row crops	USDA Plants National Database 2013 (Assume corn [ <i>Zea mays</i> L.]
1100	Apple	<i>Malus spp.</i>	Jepson interchange 2013, USDA Plants National Database 2013; used <i>Malus fusca</i> for soil, moisture needs as no data for <i>M. pumila</i>
1200	Bare ground (<5% cover)	Bare ground (<5% cover)	
1300	Bare ground with <40% cover	Bare ground with <40% cover	
1400	Blue oak (deciduous)	<i>Quercus douglasii</i>	Jepson interchange 2013, USDA Plants National Database 2013
1500	Boxelder	<i>Acer negundo</i>	Stillwater Sciences 2011 (Bradford), River Partners 2011 (data),
1600	Broadleaved invasive exotic trees	Broadleaved invasive exotic trees	Based on <i>Ailanthus altissima</i> , USDA Plants National Database 2013
1700	Broadleaved non-invasive exotic Trees	Broadleaved non-invasive exotic trees	Based on <i>Juglans regia</i> (English walnut); USDA Plants National Database 2013
1800	Bunch grass/sedge	Bunch grass/sedge	Jepson interchange 2013 for <i>Leymus tritichoides</i> and <i>Deschampsia ceaspitosa</i> . USDA Plants National Database 2013
1900	Button willow, button bush	<i>Cephalanthus occidentalis</i>	Stillwater Sciences 2011 (Bradford), River Partners 2011 (data), USDA Plants National Database 2013
2000	California bay	<i>Umbellularia californica</i>	Jepson interchange 2013, USDA Plants National Database 2013
2100	California black oak	<i>Quercus kelloggii</i>	Jepson interchange 2013, USDA Plants National Database 2013
2200	California black walnut	<i>Juglans hindsii</i>	Jepson interchange 2013; used <i>Juglans regia</i> for soil and moisture needs. USDA Plants National Database 2013
2300	California blackberry	<i>Rubus californica</i>	Stillwater Sciences 2011 (Bradford)]; USDA Plants National Database 2013
2400	California buckeye	<i>Aesculus californica</i>	Jepson interchange 2013, USDA Plants National Database 2013
2500	California coffeeberry	<i>Frangula californica</i>	Jepson interchange 2013, USDA Plants National Database 2013; Soil and climate information from <a href="http://grownatives.cnps.org/2010/09/28/california-coffeeberry/">http://grownatives.cnps.org/2010/09/28/california-coffeeberry/</a>
2600	California grape	<i>Vitis californica</i>	Plants for a Future 2013; used PFAF for soil and moisture needs <a href="http://www.pfaf.org/user/Plant.aspx?LatinName=Vitis+californica">http://www.pfaf.org/user/Plant.aspx?LatinName=Vitis+californica</a>

Code	Common name or descriptions	Scientific name	Information sources
2700	California redbud	<i>Cercis orbiculata</i>	Jepson interchange 2013, USDA Plants National Database 2013; for soil and moisture needs used <a href="http://www.theodorepayne.org/mediawiki/index.php?title=Cercis_occidentalis">http://www.theodorepayne.org/mediawiki/index.php?title=Cercis_occidentalis</a>
2800	California sycamore	<i>Platanus racemosa</i>	River Partners 2011 (data); USDA Plants National Database 2013
2900	California wildrose	<i>Rosa californica</i>	Stillwater Sciences 2011 (Bradford)]
3000	Conifers (native or non-native)	Conifers (native or non-native)	USDA Plants National Database 2013 ( <i>Pseudotsuga menziesii</i> , Douglas fir)
3100	Cottonwood	<i>Populus fremontii</i>	Stillwater Sciences 2011 (Bradford), River Partners 2011 (data), USDA Plants National Database 2013
3200	Coyote brush	<i>Baccharis pilularis</i>	Stillwater Sciences 2011 (Bradford)]; USDA Plants National Database 2013
3300	Dogwood shrub	<i>Cornus spp</i>	Jepson interchange 2013, USDA Plants National Database 2013, for <i>Cornus sericea</i>
3400	Elderberry	<i>Sambucus nigra subsp. caerulea</i>	River Partners 2011 (data); USDA Plants National Database 2013
3500	Emergent wetland plants <3' tall	Emergent wetland plants <3'	Self-defined size USDA Plants National Database 2013 for <i>Juncus mexicanus</i>
3600	Emergent wetland plants over 3' tall	Emergent wetland plants >3'	Self-defined size USDA Plants National Database 2013 for <i>Typha latifolia</i>
3700	English walnut	<i>Juglans regia</i>	Jepson interchange 2013, USDA Plants National Database 2013
3800	Exotic invasive shrubs	Exotic invasive shrubs	CAL IPC online database 2013 (based on scarlet wisteria [ <i>Sesbiana punicea</i> ]); Wikipedia
3900	Exotic non-invasive shrubs	Exotic non-invasive shrubs	Based on <i>Caragana arborescens</i> [siberian peashrub]; USDA Plants National Database 2013
4000	Fig	<i>Ficus carica</i>	Jepson interchange 2013, USDA Plants National Database 2013, CAL IPC online database 2013
4100	Foothill or Ghost pine	<i>Pinus sabiniana</i>	Jepson interchange 2013, USDA Plants National Database 2013
4200	Giant reed	<i>Arundo donax</i>	CAL IPC online database 2013; USDA Plants National Database 2013
4300	Grass: irrigated manicured lawn	Grass: irrigated manicured lawn	Assuming frequent mowing; <i>Poa pratensis</i> in USDA Plants National Database 2013
4400	Grasses and forbs: non-native annual grasses	Grasses and forbs: non-native annual grasses	USDA Plants National Database 2013 ( <i>Bromus mollis</i> and <i>Avena fatua</i> averaged with shorter stature forbs)

Code	Common name or descriptions	Scientific name	Information sources
4500	Grasses and forbs: Riparian native	Grasses and forbs: Riparian native	USDA Plants National Database 2013 ( <i>Leymus triticoides</i> and <i>Conyza canadensis</i> averaged with shorter stature forbs)
4600	Himalayan blackberry	<i>Rubus armeniacus</i>	Caplan and Yeakley 2006, DiTomaso et al. 2010 . USDA Plants National Database 2013; Cal-IPC website RUAR for soil and moisture needs <a href="http://www.cal-ipc.org/ip/management/ipcw/pages/detailreport.cfm@usernumber=71&amp;surveynumber=182.php">http://www.cal-ipc.org/ip/management/ipcw/pages/detailreport.cfm@usernumber=71&amp;surveynumber=182.php</a>
4700	Incense cedar	<i>Calocedrus decurrens</i>	Jepson interchange 2013, USDA Plants National Database 2013
4800	Lewis' mock orange	<i>Philadelphus lewisii</i>	Jepson interchange 2013, USDA Plants National Database 2013
4900	Live oak (canyon or interior)	<i>Quercus chrysolepis</i>	Jepson interchange 2013, USDA Plants National Database 2013
5000	Mesic native shrub	Mesic native shrub	Based on dogwood ( <i>Cornus sericea</i> ); USDA Plants National Database 2013
5100	Mountain mahogany	<i>Cercocarpus betuloides</i>	Jepson interchange 2013, USDA Plants National Database 2013; for soil and moisture needs used PFAF with <i>Cercocarpus montanus</i> ; <a href="http://www.pfaf.org/user/Plant.aspx?LatinName=Cercocarpus+montanus">http://www.pfaf.org/user/Plant.aspx?LatinName=Cercocarpus+montanus</a>
5200	Mugwort and/or Hedgenettle	<i>Artemisia douglasiana</i> or <i>Stachys spp.</i>	Jepson interchange 2013; for soil and moisture needs used <a href="http://www.theodorepayne.org/mediawiki/index.php?title=Artemisia_douglasiana">http://www.theodorepayne.org/mediawiki/index.php?title=Artemisia_douglasiana</a>
5300	Mule's fat	<i>Baccharis salicifolia</i>	Stillwater Sciences 2011 (Bradford); USDA Plants National Database 2013
5400	Native Riparian deciduous trees	Native Riparian deciduous trees	Average of <i>Salix gooddingii</i> , <i>Quercus lobata</i> , <i>Platanus racemosa</i> , and <i>Populus fremontii</i> ); USDA Plants National Database 2013, <i>Fraxinus latifolia</i>
5500	Orchard: Peach/plum/almond/cherry	Orchard: Peach/plum/almond/cherry	Jepson interchange 2013, USDA Plants National Database 2013; for soils and moisture needs used <i>Prunus persica</i> PFAF <a href="http://www.pfaf.org/user/Plant.aspx?LatinName=Prunus+persica">http://www.pfaf.org/user/Plant.aspx?LatinName=Prunus+persica</a>
5600	Oregon ash	<i>Fraxinus latifolia</i>	River Partners 2011 (data); USDA Plants National Database 2013
5700	Salt cedar	<i>Tamarisk spp.</i>	CAL IPC online database 2013 for <i>Tamarisk ramosissima</i> ; for soil and moisture needs, used PFAF database <a href="http://www.pfaf.org/user/Plant.aspx?LatinName=Tamarix+parviflora">http://www.pfaf.org/user/Plant.aspx?LatinName=Tamarix+parviflora</a>

Code	Common name or descriptions	Scientific name	Information sources
5800	Stone fruit trees: Peach/plum/almond/cherry	<i>Prunus spp.</i>	<i>Prunus cerasifera</i> or cherry plum is listed by CA IPC as 'limited' concern; for soil and moisture needs, used PFAF <a href="http://www.pfaf.org/user/plant.aspx?LatinName=Prunus+cerasifera">http://www.pfaf.org/user/plant.aspx?LatinName=Prunus+cerasifera</a>
5900	Unknown Oak	<i>Quercus spp.</i>	Based on average of <i>Q. lobata</i> , <i>Q. kelloggii</i> , <i>Q. douglasii</i> and <i>Q. chrysolepis</i> values; USDA Plants National Database 2013
6000	Upland annual grasses and forbs	Upland annual grasses and forbs	USDA Plants National Database 2013 ( <i>Bromus diandrus</i> , <i>Foeniculum vulgare</i> , <i>Avena fatua</i> )
6100	Urban- developed	Urban- developed	
6200	Valley oak	<i>Quercus lobata</i>	Stillwater Sciences 2011 (Bradford), River Partners 2011 (data); USDA Plants National Database 2013
6300	Vineyard	Vineyard	<i>Vitis aestivalis</i>
6400	Water	WATER	
6500	Weeds, herbaceous and highly invasive	Weeds, herbaceous and highly invasive	CAL IPC online database 2013, based on fennel [ <i>Foeniculum vulgare</i> ]; for soil and moisture needs, used PFAF DB <a href="http://www.pfaf.org/user/Plant.aspx?LatinName=Foeniculum+vulgare">http://www.pfaf.org/user/Plant.aspx?LatinName=Foeniculum+vulgare</a>
6600	Weeds, herbaceous and non-invasive	Weeds, herbaceous and non-invasive	USDA Plants National Database 2013 (based on field mustard [ <i>Brassica rapa</i> ] and <i>Panicum dichotomiflorum</i> )
6700	White alder	<i>Alnus rhombifolia</i>	Jepson interchange 2013, USDA Plants National Database 2013
6800	Willow shrub (other than sandbar willow)	<i>Salix spp.</i> (shrub)	Growth max and rates based on <i>Salix lasiolepis</i> : Stillwater Sciences 2011 (Bradford), River Partners 2011 (data); Soils and climate based on <i>Salix exigua</i> : USDA Plants National Database 2013
6900	Willow tree (other)	<i>Salix spp.</i> (tree)	Based on Goodding's or Red Willow; USDA Plants National Database 2013
7000	Willow, Goodding's or Red	<i>Salix goodingii</i> , <i>S. laevigata</i>	Stillwater Sciences 2011 (Bradford), River Partners 2011 (data); USDA Plants National Database 2013 in formation based on <i>Salix goodingii</i> only
7100	Willow, sandbar	<i>Salix exigua</i>	River Partners 2011 (data); USDA Plants National Database 2013

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**Appendix H**  
**Vegetation Codes for Shade-A-Lator**

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Code	Ecoreg	Description	Height	Density	Oh
			(m)	(%)	(m) 0.333* width
1001	CV-FH	Annual row cropsYr 1	0.95	28%	0.1
1002	CV-FH	Annual row cropsYr 2	1.30	39%	0.1
1003	CV-FH	Annual row cropsYr 3	1.43	43%	0.2
1004	CV-FH	Annual row cropsYr 4	1.47	44%	0.2
1005	CV-FH	Annual row cropsYr 5	1.49	45%	0.2
1010	CV-FH	Annual row cropsYr 10	1.50	45%	0.2
1015	CV-FH	Annual row cropsYr 15	1.50	45%	0.2
1020	CV-FH	Annual row cropsYr 20	1.50	45%	0.2
1030	CV-FH	Annual row cropsYr 30	1.50	45%	0.2
1050	CV-FH	Annual row cropsYr 50	1.50	45%	0.2
1101	CV-FH	AppleYr 1	1.41	43%	0.2
1102	CV-FH	AppleYr 2	2.65	64%	0.4
1103	CV-FH	AppleYr 3	3.75	75%	0.6
1104	CV-FH	AppleYr 4	4.72	80%	0.7
1105	CV-FH	AppleYr 5	5.58	83%	0.9
1110	CV-FH	AppleYr 10	8.56	85%	1.6
1115	CV-FH	AppleYr 15	10.16	85%	2.1
1120	CV-FH	AppleYr 20	11.01	85%	2.5
1130	CV-FH	AppleYr 30	11.72	85%	3.1
1150	CV-FH	AppleYr 50	11.98	85%	3.7
1201	CV-FH	Bare ground (<5% cover)Yr 1	0.13	3%	0.0
1202	CV-FH	Bare ground (<5% cover)Yr 2	0.17	4%	0.0
1203	CV-FH	Bare ground (<5% cover)Yr 3	0.19	5%	0.0
1204	CV-FH	Bare ground (<5% cover)Yr 4	0.20	5%	0.0
1205	CV-FH	Bare ground (<5% cover)Yr 5	0.20	5%	0.0
1210	CV-FH	Bare ground (<5% cover)Yr 10	0.20	5%	0.0
1215	CV-FH	Bare ground (<5% cover)Yr 15	0.20	5%	0.0
1220	CV-FH	Bare ground (<5% cover)Yr 20	0.20	5%	0.0
1230	CV-FH	Bare ground (<5% cover)Yr 30	0.20	5%	0.0
1250	CV-FH	Bare ground (<5% cover)Yr 50	0.20	5%	0.0
1301	CV-FH	Bare ground with <40% coverYr 1	0.13	25%	0.0
1302	CV-FH	Bare ground with <40% coverYr 2	0.17	35%	0.0
1303	CV-FH	Bare ground with <40% coverYr 3	0.19	38%	0.0
1304	CV-FH	Bare ground with <40% coverYr 4	0.20	39%	0.0
1305	CV-FH	Bare ground with <40% coverYr 5	0.20	40%	0.0
1310	CV-FH	Bare ground with <40% coverYr 10	0.20	40%	0.0
1315	CV-FH	Bare ground with <40% coverYr 15	0.20	40%	0.0
1320	CV-FH	Bare ground with <40% coverYr 20	0.20	40%	0.0
1330	CV-FH	Bare ground with <40% coverYr 30	0.20	40%	0.0
1350	CV-FH	Bare ground with <40% coverYr 50	0.20	40%	0.0
1401	CV-FH	Blue oak (deciduous)Yr 1	0.49	21%	0.2

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
1402	CV-FH	Blue oak (deciduous)Yr 2	0.98	36%	0.5
1403	CV-FH	Blue oak (deciduous)Yr 3	1.45	47%	0.6
1404	CV-FH	Blue oak (deciduous)Yr 4	1.90	55%	0.8
1405	CV-FH	Blue oak (deciduous)Yr 5	2.35	61%	0.9
1410	CV-FH	Blue oak (deciduous)Yr 10	4.42	72%	1.3
1415	CV-FH	Blue oak (deciduous)Yr 15	6.25	74%	1.5
1420	CV-FH	Blue oak (deciduous)Yr 20	7.87	75%	1.6
1430	CV-FH	Blue oak (deciduous)Yr 30	10.55	75%	1.7
1450	CV-FH	Blue oak (deciduous)Yr 50	14.27	75%	1.7
1501	CV-FH	BoxelderYr 1	0.97	28%	0.2
1502	CV-FH	BoxelderYr 2	1.88	47%	0.4
1503	CV-FH	BoxelderYr 3	2.74	58%	0.6
1504	CV-FH	BoxelderYr 4	3.55	66%	0.7
1505	CV-FH	BoxelderYr 5	4.31	71%	0.8
1510	CV-FH	BoxelderYr 10	7.50	79%	1.3
1515	CV-FH	BoxelderYr 15	9.85	80%	1.6
1520	CV-FH	BoxelderYr 20	11.59	80%	1.8
1530	CV-FH	BoxelderYr 30	13.82	80%	1.9
1550	CV-FH	BoxelderYr 50	15.70	80%	2.0
1601	CV-FH	Broadleaved invasive exotic treesYr 1	1.15	38%	0.2
1602	CV-FH	Broadleaved invasive exotic treesYr 2	2.13	60%	0.4
1603	CV-FH	Broadleaved invasive exotic treesYr 3	2.97	73%	0.6
1604	CV-FH	Broadleaved invasive exotic treesYr 4	3.70	80%	0.7
1605	CV-FH	Broadleaved invasive exotic treesYr 5	4.31	84%	0.8
1610	CV-FH	Broadleaved invasive exotic treesYr 10	6.30	90%	1.3
1615	CV-FH	Broadleaved invasive exotic treesYr 15	7.22	90%	1.6
1620	CV-FH	Broadleaved invasive exotic treesYr 20	7.64	90%	1.8
1630	CV-FH	Broadleaved invasive exotic treesYr 30	7.92	90%	1.9
1650	CV-FH	Broadleaved invasive exotic treesYr 50	8.00	90%	2.0
1701	CV-FH	Broadleaved non-invasive exotic TreesYr 1	0.49	38%	0.2
1702	CV-FH	Broadleaved non-invasive exotic TreesYr 2	0.95	59%	0.4
1703	CV-FH	Broadleaved non-invasive exotic TreesYr 3	1.39	70%	0.5
1704	CV-FH	Broadleaved non-invasive exotic TreesYr 4	1.81	77%	0.7
1705	CV-FH	Broadleaved non-invasive exotic TreesYr 5	2.21	81%	0.8
1710	CV-FH	Broadleaved non-invasive exotic TreesYr 10	3.93	85%	1.3

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
1715	CV-FH	Broadleaved non-invasive exotic Trees Yr 15	5.28	85%	1.6
1720	CV-FH	Broadleaved non-invasive exotic Trees Yr 20	6.32	85%	1.7
1730	CV-FH	Broadleaved non-invasive exotic Trees Yr 30	7.77	85%	1.9
1750	CV-FH	Broadleaved non-invasive exotic Trees Yr 50	9.18	85%	2.0
1801	CV-FH	Bunch grass/sedge Yr 1	0.69	51%	0.2
1802	CV-FH	Bunch grass/sedge Yr 2	0.94	69%	0.3
1803	CV-FH	Bunch grass/sedge Yr 3	1.03	76%	0.3
1804	CV-FH	Bunch grass/sedge Yr 4	1.07	79%	0.3
1805	CV-FH	Bunch grass/sedge Yr 5	1.08	79%	0.3
1810	CV-FH	Bunch grass/sedge Yr 10	1.09	80%	0.3
1815	CV-FH	Bunch grass/sedge Yr 15	1.09	80%	0.3
1820	CV-FH	Bunch grass/sedge Yr 20	1.09	80%	0.3
1830	CV-FH	Bunch grass/sedge Yr 30	1.09	80%	0.3
1850	CV-FH	Bunch grass/sedge Yr 50	1.09	80%	0.3
1901	CV-FH	Button willow, button bush Yr 1	0.49	31%	0.2
1902	CV-FH	Button willow, button bush Yr 2	0.91	51%	0.3
1903	CV-FH	Button willow, button bush Yr 3	1.28	62%	0.5
1904	CV-FH	Button willow, button bush Yr 4	1.59	69%	0.6
1905	CV-FH	Button willow, button bush Yr 5	1.86	73%	0.6
1910	CV-FH	Button willow, button bush Yr 10	2.73	79%	0.9
1915	CV-FH	Button willow, button bush Yr 15	3.14	80%	1.0
1920	CV-FH	Button willow, button bush Yr 20	3.33	80%	1.0
1930	CV-FH	Button willow, button bush Yr 30	3.46	80%	1.0
1950	CV-FH	Button willow, button bush Yr 50	3.50	80%	1.0
2001	CV-FH	California bay Yr 1	1.17	32%	0.6
2002	CV-FH	California bay Yr 2	2.29	53%	1.2
2003	CV-FH	California bay Yr 3	3.35	66%	1.6
2004	CV-FH	California bay Yr 4	4.37	75%	2.1
2005	CV-FH	California bay Yr 5	5.33	80%	2.4
2010	CV-FH	California bay Yr 10	9.53	89%	3.7
2015	CV-FH	California bay Yr 15	12.83	90%	4.3
2020	CV-FH	California bay Yr 20	15.43	90%	4.6
2030	CV-FH	California bay Yr 30	19.08	90%	4.9
2050	CV-FH	California bay Yr 50	22.73	90%	5.0
2101	CV-FH	California black oak Yr 1	0.50	25%	0.3
2102	CV-FH	California black oak Yr 2	0.98	41%	0.6
2103	CV-FH	California black oak Yr 3	1.46	52%	0.9
2104	CV-FH	California black oak Yr 4	1.92	60%	1.1
2105	CV-FH	California black oak Yr 5	2.38	65%	1.3
2110	CV-FH	California black oak Yr 10	4.53	74%	2.1
2115	CV-FH	California black oak Yr 15	6.48	75%	2.6
2120	CV-FH	California black oak Yr 20	8.24	75%	2.9
2130	CV-FH	California black oak Yr 30	11.28	75%	3.2
2150	CV-FH	California black oak Yr 50	15.80	75%	3.3
2201	CV-FH	California black walnut Yr 1	0.98	37%	0.2
2202	CV-FH	California black walnut Yr 2	1.92	57%	0.5
2203	CV-FH	California black walnut Yr 3	2.81	68%	0.7

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
2204	CV-FH	California black walnutYr 4	3.67	73%	0.9
2205	CV-FH	California black walnutYr 5	4.49	76%	1.1
2210	CV-FH	California black walnutYr 10	8.11	80%	1.9
2215	CV-FH	California black walnutYr 15	11.02	80%	2.4
2220	CV-FH	California black walnutYr 20	13.36	80%	2.9
2230	CV-FH	California black walnutYr 30	16.76	80%	3.4
2250	CV-FH	California black walnutYr 50	20.38	80%	3.8
2301	CV-FH	California blackberryYr 1	0.78	25%	0.4
2302	CV-FH	California blackberryYr 2	0.95	41%	0.5
2303	CV-FH	California blackberryYr 3	0.99	52%	0.6
2304	CV-FH	California blackberryYr 4	1.00	60%	0.6
2305	CV-FH	California blackberryYr 5	1.00	65%	0.7
2310	CV-FH	California blackberryYr 10	1.00	74%	0.7
2315	CV-FH	California blackberryYr 15	1.00	75%	0.7
2320	CV-FH	California blackberryYr 20	1.00	75%	0.7
2330	CV-FH	California blackberryYr 30	1.00	75%	0.7
2350	CV-FH	California blackberryYr 50	1.00	75%	0.7
2401	CV-FH	California buckeyeYr 1	0.76	21%	0.2
2402	CV-FH	California buckeyeYr 2	1.44	36%	0.4
2403	CV-FH	California buckeyeYr 3	2.06	47%	0.6
2404	CV-FH	California buckeyeYr 4	2.61	55%	0.7
2405	CV-FH	California buckeyeYr 5	3.11	61%	0.8
2410	CV-FH	California buckeyeYr 10	4.95	72%	1.3
2415	CV-FH	California buckeyeYr 15	6.03	74%	1.6
2420	CV-FH	California buckeyeYr 20	6.67	75%	1.8
2430	CV-FH	California buckeyeYr 30	7.28	75%	1.9
2450	CV-FH	California buckeyeYr 50	7.56	75%	2.0
2501	CV-FH	California coffeeberryYr 1	0.74	25%	0.2
2502	CV-FH	California coffeeberryYr 2	1.13	42%	0.3
2503	CV-FH	California coffeeberryYr 3	1.33	54%	0.4
2504	CV-FH	California coffeeberryYr 4	1.44	62%	0.5
2505	CV-FH	California coffeeberryYr 5	1.50	68%	0.6
2510	CV-FH	California coffeeberryYr 10	1.56	78%	0.8
2515	CV-FH	California coffeeberryYr 15	1.56	80%	0.9
2520	CV-FH	California coffeeberryYr 20	1.56	80%	1.0
2530	CV-FH	California coffeeberryYr 30	1.56	80%	1.0
2550	CV-FH	California coffeeberryYr 50	1.56	80%	1.0
2601	CV-FH	California grapeYr 1	1.46	8%	0.1
2602	CV-FH	California grapeYr 2	2.21	14%	0.3
2603	CV-FH	California grapeYr 3	2.59	17%	0.4
2604	CV-FH	California grapeYr 4	2.79	20%	0.4
2605	CV-FH	California grapeYr 5	2.89	22%	0.5
2610	CV-FH	California grapeYr 10	3.00	25%	0.6
2615	CV-FH	California grapeYr 15	3.00	25%	0.7
2620	CV-FH	California grapeYr 20	3.00	25%	0.7
2630	CV-FH	California grapeYr 30	3.00	25%	0.7
2650	CV-FH	California grapeYr 50	3.00	25%	0.7
2701	CV-FH	California redbudYr 1	0.92	17%	0.2
2702	CV-FH	California redbudYr 2	1.71	30%	0.3
2703	CV-FH	California redbudYr 3	2.38	40%	0.4
2704	CV-FH	California redbudYr 4	2.95	48%	0.5

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
2705	CV-FH	California redbudYr 5	3.44	53%	0.6
2710	CV-FH	California redbudYr 10	4.99	66%	0.8
2715	CV-FH	California redbudYr 15	5.68	69%	0.9
2720	CV-FH	California redbudYr 20	6.00	70%	1.0
2730	CV-FH	California redbudYr 30	6.20	70%	1.0
2750	CV-FH	California redbudYr 50	6.25	70%	1.0
2801	CV-FH	California sycamoreYr 1	0.98	24%	0.3
2802	CV-FH	California sycamoreYr 2	1.92	40%	0.6
2803	CV-FH	California sycamoreYr 3	2.82	51%	0.9
2804	CV-FH	California sycamoreYr 4	3.68	57%	1.1
2805	CV-FH	California sycamoreYr 5	4.51	62%	1.3
2810	CV-FH	California sycamoreYr 10	8.18	69%	2.1
2815	CV-FH	California sycamoreYr 15	11.15	70%	2.6
2820	CV-FH	California sycamoreYr 20	13.57	70%	2.9
2830	CV-FH	California sycamoreYr 30	17.12	70%	3.2
2850	CV-FH	California sycamoreYr 50	21.01	70%	3.3
2901	CV-FH	California wildroseYr 1	0.73	25%	0.1
2902	CV-FH	California wildroseYr 2	1.10	41%	0.3
2903	CV-FH	California wildroseYr 3	1.30	52%	0.4
2904	CV-FH	California wildroseYr 4	1.40	60%	0.4
2905	CV-FH	California wildroseYr 5	1.45	65%	0.5
2910	CV-FH	California wildroseYr 10	1.50	74%	0.6
2915	CV-FH	California wildroseYr 15	1.50	75%	0.7
2920	CV-FH	California wildroseYr 20	1.50	75%	0.7
2930	CV-FH	California wildroseYr 30	1.50	75%	0.7
2950	CV-FH	California wildroseYr 50	1.50	75%	0.7
3001	CV-FH	Conifers (native or non-native)Yr 1	0.64	38%	0.3
3002	CV-FH	Conifers (native or non-native)Yr 2	1.28	59%	0.5
3003	CV-FH	Conifers (native or non-native)Yr 3	1.90	70%	0.7
3004	CV-FH	Conifers (native or non-native)Yr 4	2.51	77%	0.9
3005	CV-FH	Conifers (native or non-native)Yr 5	3.10	81%	1.1
3010	CV-FH	Conifers (native or non-native)Yr 10	5.93	85%	1.9
3015	CV-FH	Conifers (native or non-native)Yr 15	8.51	85%	2.5
3020	CV-FH	Conifers (native or non-native)Yr 20	10.86	85%	2.9
3030	CV-FH	Conifers (native or non-native)Yr 30	14.95	85%	3.5
3050	CV-FH	Conifers (native or non-native)Yr 50	21.17	85%	3.9
3101	CV-FH	CottonwoodYr 1	1.92	37%	0.3
3102	CV-FH	CottonwoodYr 2	3.68	57%	0.6
3103	CV-FH	CottonwoodYr 3	5.31	68%	0.9
3104	CV-FH	CottonwoodYr 4	6.80	73%	1.1
3105	CV-FH	CottonwoodYr 5	8.18	76%	1.3
3110	CV-FH	CottonwoodYr 10	13.57	80%	2.1

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
3115	CV-FH	CottonwoodYr 15	17.12	80%	2.6
3120	CV-FH	CottonwoodYr 20	19.47	80%	2.9
3130	CV-FH	CottonwoodYr 30	22.03	80%	3.2
3150	CV-FH	CottonwoodYr 50	23.63	80%	3.3
3201	CV-FH	Coyote brushYr 1	0.31	32%	0.1
3202	CV-FH	Coyote brushYr 2	0.58	49%	0.2
3203	CV-FH	Coyote brushYr 3	0.80	57%	0.3
3204	CV-FH	Coyote brushYr 4	0.99	61%	0.4
3205	CV-FH	Coyote brushYr 5	1.15	63%	0.4
3210	CV-FH	Coyote brushYr 10	1.63	65%	0.6
3215	CV-FH	Coyote brushYr 15	1.84	65%	0.6
3220	CV-FH	Coyote brushYr 20	1.93	65%	0.7
3230	CV-FH	Coyote brushYr 30	1.99	65%	0.7
3250	CV-FH	Coyote brushYr 50	2.00	65%	0.7
3301	CV-FH	Dogwood shrubYr 1	0.61	24%	0.2
3302	CV-FH	Dogwood shrubYr 2	1.13	40%	0.4
3303	CV-FH	Dogwood shrubYr 3	1.57	51%	0.5
3304	CV-FH	Dogwood shrubYr 4	1.95	57%	0.6
3305	CV-FH	Dogwood shrubYr 5	2.26	62%	0.8
3310	CV-FH	Dogwood shrubYr 10	3.24	69%	1.1
3315	CV-FH	Dogwood shrubYr 15	3.67	70%	1.2
3320	CV-FH	Dogwood shrubYr 20	3.86	70%	1.3
3330	CV-FH	Dogwood shrubYr 30	3.97	70%	1.3
3350	CV-FH	Dogwood shrubYr 50	4.00	70%	1.3
3401	CV-FH	ElderberryYr 1	0.48	43%	0.1
3402	CV-FH	ElderberryYr 2	0.91	57%	0.2
3403	CV-FH	ElderberryYr 3	1.30	62%	0.3
3404	CV-FH	ElderberryYr 4	1.65	64%	0.4
3405	CV-FH	ElderberryYr 5	1.97	65%	0.5
3410	CV-FH	ElderberryYr 10	3.16	65%	0.8
3415	CV-FH	ElderberryYr 15	3.88	65%	0.9
3420	CV-FH	ElderberryYr 20	4.32	65%	1.0
3430	CV-FH	ElderberryYr 30	4.75	65%	1.1
3450	CV-FH	ElderberryYr 50	4.97	65%	1.2
3501	CV-FH	Emergent wetland plants <3' tallYr 1	0.63	60%	0.1
3502	CV-FH	Emergent wetland plants <3' tallYr 2	0.86	82%	0.1
3503	CV-FH	Emergent wetland plants <3' tallYr 3	0.95	90%	0.2
3504	CV-FH	Emergent wetland plants <3' tallYr 4	0.98	93%	0.2
3505	CV-FH	Emergent wetland plants <3' tallYr 5	0.99	94%	0.2
3510	CV-FH	Emergent wetland plants <3' tallYr 10	1.00	95%	0.2
3515	CV-FH	Emergent wetland plants <3' tallYr 15	1.00	95%	0.2
3520	CV-FH	Emergent wetland plants <3' tallYr 20	1.00	95%	0.2
3530	CV-FH	Emergent wetland plants <3' tallYr 30	1.00	95%	0.2

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
3550	CV-FH	Emergent wetland plants <3' tallYr 50	1.00	95%	0.2
3601	CV-FH	Emergent wetland plants over 3' tallYr 1	1.26	60%	0.1
3602	CV-FH	Emergent wetland plants over 3' tallYr 2	1.73	82%	0.1
3603	CV-FH	Emergent wetland plants over 3' tallYr 3	1.90	90%	0.2
3604	CV-FH	Emergent wetland plants over 3' tallYr 4	1.96	93%	0.2
3605	CV-FH	Emergent wetland plants over 3' tallYr 5	1.99	94%	0.2
3610	CV-FH	Emergent wetland plants over 3' tallYr 10	2.00	95%	0.2
3615	CV-FH	Emergent wetland plants over 3' tallYr 15	2.00	95%	0.2
3620	CV-FH	Emergent wetland plants over 3' tallYr 20	2.00	95%	0.2
3630	CV-FH	Emergent wetland plants over 3' tallYr 30	2.00	95%	0.2
3650	CV-FH	Emergent wetland plants over 3' tallYr 50	2.00	95%	0.2
3701	CV-FH	English walnutYr 1	0.98	37%	0.2
3702	CV-FH	English walnutYr 2	1.93	57%	0.5
3703	CV-FH	English walnutYr 3	2.85	68%	0.7
3704	CV-FH	English walnutYr 4	3.74	73%	0.9
3705	CV-FH	English walnutYr 5	4.61	76%	1.1
3710	CV-FH	English walnutYr 10	8.50	80%	1.9
3715	CV-FH	English walnutYr 15	11.80	80%	2.4
3720	CV-FH	English walnutYr 20	14.60	80%	2.9
3730	CV-FH	English walnutYr 30	18.96	80%	3.4
3750	CV-FH	English walnutYr 50	24.33	80%	3.8
3801	CV-FH	Exotic invasive shrubsYr 1	0.88	18%	0.1
3802	CV-FH	Exotic invasive shrubsYr 2	1.57	31%	0.3
3803	CV-FH	Exotic invasive shrubsYr 3	2.11	41%	0.4
3804	CV-FH	Exotic invasive shrubsYr 4	2.53	49%	0.4
3805	CV-FH	Exotic invasive shrubsYr 5	2.85	55%	0.5
3810	CV-FH	Exotic invasive shrubsYr 10	3.67	70%	0.6
3815	CV-FH	Exotic invasive shrubsYr 15	3.91	74%	0.7
3820	CV-FH	Exotic invasive shrubsYr 20	3.97	75%	0.7
3830	CV-FH	Exotic invasive shrubsYr 30	4.00	75%	0.7
3850	CV-FH	Exotic invasive shrubsYr 50	4.00	75%	0.7
3901	CV-FH	Exotic non-invasive shrubsYr 1	0.19	25%	0.1
3902	CV-FH	Exotic non-invasive shrubsYr 2	0.37	42%	0.2
3903	CV-FH	Exotic non-invasive shrubsYr 3	0.54	54%	0.3
3904	CV-FH	Exotic non-invasive shrubsYr 4	0.70	62%	0.4
3905	CV-FH	Exotic non-invasive shrubsYr 5	0.85	68%	0.4
3910	CV-FH	Exotic non-invasive shrubsYr 10	1.46	78%	0.7
3915	CV-FH	Exotic non-invasive shrubsYr 15	1.90	80%	0.8
3920	CV-FH	Exotic non-invasive shrubsYr 20	2.21	80%	0.9
3930	CV-FH	Exotic non-invasive shrubsYr 30	2.59	80%	1.0
3950	CV-FH	Exotic non-invasive shrubsYr 50	2.89	80%	1.0

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
4001	CV-FH	FigYr 1	1.15	38%	0.2
4002	CV-FH	FigYr 2	2.13	60%	0.3
4003	CV-FH	FigYr 3	2.97	73%	0.5
4004	CV-FH	FigYr 4	3.70	80%	0.6
4005	CV-FH	FigYr 5	4.31	84%	0.7
4010	CV-FH	FigYr 10	6.30	90%	1.2
4015	CV-FH	FigYr 15	7.22	90%	1.5
4020	CV-FH	FigYr 20	7.64	90%	1.7
4030	CV-FH	FigYr 30	7.92	90%	1.9
4050	CV-FH	FigYr 50	8.00	90%	2.0
4101	CV-FH	Foothill or Ghost pineYr 1	0.50	9%	0.2
4102	CV-FH	Foothill or Ghost pineYr 2	0.99	15%	0.5
4103	CV-FH	Foothill or Ghost pineYr 3	1.47	19%	0.6
4104	CV-FH	Foothill or Ghost pineYr 4	1.94	22%	0.8
4105	CV-FH	Foothill or Ghost pineYr 5	2.41	24%	0.9
4110	CV-FH	Foothill or Ghost pineYr 10	4.66	29%	1.3
4115	CV-FH	Foothill or Ghost pineYr 15	6.75	30%	1.5
4120	CV-FH	Foothill or Ghost pineYr 20	8.70	30%	1.6
4130	CV-FH	Foothill or Ghost pineYr 30	12.20	30%	1.7
4150	CV-FH	Foothill or Ghost pineYr 50	17.87	30%	1.7
4201	CV-FH	Giant reedYr 1	2.55	60%	0.2
4202	CV-FH	Giant reedYr 2	4.38	82%	0.3
4203	CV-FH	Giant reedYr 3	5.69	90%	0.3
4204	CV-FH	Giant reedYr 4	6.63	93%	0.3
4205	CV-FH	Giant reedYr 5	7.30	94%	0.3
4210	CV-FH	Giant reedYr 10	8.68	95%	0.3
4215	CV-FH	Giant reedYr 15	8.94	95%	0.3
4220	CV-FH	Giant reedYr 20	8.99	95%	0.3
4230	CV-FH	Giant reedYr 30	9.00	95%	0.3
4250	CV-FH	Giant reedYr 50	9.00	95%	0.3
4301	CV-FH	Grass: irrigated manicured lawnYr 1	0.13	60%	0.0
4302	CV-FH	Grass: irrigated manicured lawnYr 2	0.17	82%	0.0
4303	CV-FH	Grass: irrigated manicured lawnYr 3	0.19	90%	0.0
4304	CV-FH	Grass: irrigated manicured lawnYr 4	0.20	93%	0.0
4305	CV-FH	Grass: irrigated manicured lawnYr 5	0.20	94%	0.0
4310	CV-FH	Grass: irrigated manicured lawnYr 10	0.20	95%	0.0
4315	CV-FH	Grass: irrigated manicured lawnYr 15	0.20	95%	0.0
4320	CV-FH	Grass: irrigated manicured lawnYr 20	0.20	95%	0.0
4330	CV-FH	Grass: irrigated manicured lawnYr 30	0.20	95%	0.0
4350	CV-FH	Grass: irrigated manicured lawnYr 50	0.20	95%	0.0
4401	CV-FH	Grasses and forbs: non-native annual grassesYr 1	0.51	60%	0.0

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
4402	CV-FH	Grasses and forbs: non-native annual grassesYr 2	0.69	82%	0.0
4403	CV-FH	Grasses and forbs: non-native annual grassesYr 3	0.76	90%	0.0
4404	CV-FH	Grasses and forbs: non-native annual grassesYr 4	0.79	93%	0.0
4405	CV-FH	Grasses and forbs: non-native annual grassesYr 5	0.79	94%	0.0
4410	CV-FH	Grasses and forbs: non-native annual grassesYr 10	0.80	95%	0.0
4415	CV-FH	Grasses and forbs: non-native annual grassesYr 15	0.80	95%	0.0
4420	CV-FH	Grasses and forbs: non-native annual grassesYr 20	0.80	95%	0.0
4430	CV-FH	Grasses and forbs: non-native annual grassesYr 30	0.80	95%	0.0
4450	CV-FH	Grasses and forbs: non-native annual grassesYr 50	0.80	95%	0.0
4501	CV-FH	Grasses and forbs: Riparian nativeYr 1	0.51	60%	0.0
4502	CV-FH	Grasses and forbs: Riparian nativeYr 2	0.69	82%	0.0
4503	CV-FH	Grasses and forbs: Riparian nativeYr 3	0.76	90%	0.0
4504	CV-FH	Grasses and forbs: Riparian nativeYr 4	0.79	93%	0.0
4505	CV-FH	Grasses and forbs: Riparian nativeYr 5	0.79	94%	0.0
4510	CV-FH	Grasses and forbs: Riparian nativeYr 10	0.80	95%	0.0
4515	CV-FH	Grasses and forbs: Riparian nativeYr 15	0.80	95%	0.0
4520	CV-FH	Grasses and forbs: Riparian nativeYr 20	0.80	95%	0.0
4530	CV-FH	Grasses and forbs: Riparian nativeYr 30	0.80	95%	0.0
4550	CV-FH	Grasses and forbs: Riparian nativeYr 50	0.80	95%	0.0
4601	CV-FH	Himalayan blackberryYr 1	0.73	39%	0.5
4602	CV-FH	Himalayan blackberryYr 2	1.10	62%	0.7
4603	CV-FH	Himalayan blackberryYr 3	1.30	75%	0.9
4604	CV-FH	Himalayan blackberryYr 4	1.40	83%	0.9
4605	CV-FH	Himalayan blackberryYr 5	1.45	88%	1.0
4610	CV-FH	Himalayan blackberryYr 10	1.50	95%	1.0
4615	CV-FH	Himalayan blackberryYr 15	1.50	95%	1.0
4620	CV-FH	Himalayan blackberryYr 20	1.50	95%	1.0
4630	CV-FH	Himalayan blackberryYr 30	1.50	95%	1.0
4650	CV-FH	Himalayan blackberryYr 50	1.50	95%	1.0
4701	CV-FH	Incense cedarYr 1	0.50	18%	0.3
4702	CV-FH	Incense cedarYr 2	0.98	32%	0.6
4703	CV-FH	Incense cedarYr 3	1.46	44%	0.9
4704	CV-FH	Incense cedarYr 4	1.93	53%	1.1

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
4705	CV-FH	Incense cedarYr 5	2.40	60%	1.3
4710	CV-FH	Incense cedarYr 10	4.61	80%	2.1
4715	CV-FH	Incense cedarYr 15	6.64	87%	2.6
4720	CV-FH	Incense cedarYr 20	8.50	89%	2.9
4730	CV-FH	Incense cedarYr 30	11.80	90%	3.2
4750	CV-FH	Incense cedarYr 50	16.96	90%	3.3
4801	CV-FH	Lewis' mock orangeYr 1	0.19	25%	0.1
4802	CV-FH	Lewis' mock orangeYr 2	0.37	42%	0.2
4803	CV-FH	Lewis' mock orangeYr 3	0.54	54%	0.3
4804	CV-FH	Lewis' mock orangeYr 4	0.70	62%	0.3
4805	CV-FH	Lewis' mock orangeYr 5	0.85	68%	0.4
4810	CV-FH	Lewis' mock orangeYr 10	1.46	78%	0.6
4815	CV-FH	Lewis' mock orangeYr 15	1.90	80%	0.8
4820	CV-FH	Lewis' mock orangeYr 20	2.21	80%	0.9
4830	CV-FH	Lewis' mock orangeYr 30	2.59	80%	0.9
4850	CV-FH	Lewis' mock orangeYr 50	2.89	80%	1.0
4901	CV-FH	Live oak (canyon or interior)Yr 1	0.59	26%	0.3
4902	CV-FH	Live oak (canyon or interior)Yr 2	1.17	44%	0.6
4903	CV-FH	Live oak (canyon or interior)Yr 3	1.74	57%	0.9
4904	CV-FH	Live oak (canyon or interior)Yr 4	2.29	66%	1.1
4905	CV-FH	Live oak (canyon or interior)Yr 5	2.83	73%	1.3
4910	CV-FH	Live oak (canyon or interior)Yr 10	5.33	87%	2.1
4915	CV-FH	Live oak (canyon or interior)Yr 15	7.56	89%	2.6
4920	CV-FH	Live oak (canyon or interior)Yr 20	9.53	90%	2.9
4930	CV-FH	Live oak (canyon or interior)Yr 30	12.83	90%	3.2
4950	CV-FH	Live oak (canyon or interior)Yr 50	17.47	90%	3.3
5001	CV-FH	Mesic native shrubYr 1	0.61	24%	0.2
5002	CV-FH	Mesic native shrubYr 2	1.13	40%	0.4
5003	CV-FH	Mesic native shrubYr 3	1.57	51%	0.5
5004	CV-FH	Mesic native shrubYr 4	1.95	57%	0.6
5005	CV-FH	Mesic native shrubYr 5	2.26	62%	0.8
5010	CV-FH	Mesic native shrubYr 10	3.24	69%	1.1
5015	CV-FH	Mesic native shrubYr 15	3.67	70%	1.2
5020	CV-FH	Mesic native shrubYr 20	3.86	70%	1.3
5030	CV-FH	Mesic native shrubYr 30	3.97	70%	1.3
5050	CV-FH	Mesic native shrubYr 50	4.00	70%	1.3
5101	CV-FH	Mountain mahoganyYr 1	0.29	9%	0.2
5102	CV-FH	Mountain mahoganyYr 2	0.57	16%	0.3
5103	CV-FH	Mountain mahoganyYr 3	0.82	23%	0.4
5104	CV-FH	Mountain mahoganyYr 4	1.07	28%	0.5
5105	CV-FH	Mountain mahoganyYr 5	1.30	32%	0.6
5110	CV-FH	Mountain mahoganyYr 10	2.26	43%	0.8
5115	CV-FH	Mountain mahoganyYr 15	2.97	48%	0.9
5120	CV-FH	Mountain mahoganyYr 20	3.49	49%	1.0
5130	CV-FH	Mountain mahoganyYr 30	4.17	50%	1.0
5150	CV-FH	Mountain mahoganyYr 50	4.75	50%	1.0

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
5201	CV-FH	Mugwort and/or HedgenettleYr 1	1.58	60%	0.1
5202	CV-FH	Mugwort and/or HedgenettleYr 2	2.16	82%	0.1
5203	CV-FH	Mugwort and/or HedgenettleYr 3	2.38	90%	0.2
5204	CV-FH	Mugwort and/or HedgenettleYr 4	2.45	93%	0.2
5205	CV-FH	Mugwort and/or HedgenettleYr 5	2.48	94%	0.2
5210	CV-FH	Mugwort and/or HedgenettleYr 10	2.50	95%	0.2
5215	CV-FH	Mugwort and/or HedgenettleYr 15	2.50	95%	0.2
5220	CV-FH	Mugwort and/or HedgenettleYr 20	2.50	95%	0.2
5230	CV-FH	Mugwort and/or HedgenettleYr 30	2.50	95%	0.2
5250	CV-FH	Mugwort and/or HedgenettleYr 50	2.50	95%	0.2
5301	CV-FH	Mule's fatYr 1	0.53	24%	0.2
5302	CV-FH	Mule's fatYr 2	0.99	40%	0.3
5303	CV-FH	Mule's fatYr 3	1.39	51%	0.4
5304	CV-FH	Mule's fatYr 4	1.74	57%	0.5
5305	CV-FH	Mule's fatYr 5	2.04	62%	0.6
5310	CV-FH	Mule's fatYr 10	3.04	69%	0.7
5315	CV-FH	Mule's fatYr 15	3.53	70%	0.8
5320	CV-FH	Mule's fatYr 20	3.77	70%	0.8
5330	CV-FH	Mule's fatYr 30	3.94	70%	0.8
5350	CV-FH	Mule's fatYr 50	4.00	70%	0.8
5401	CV-FH	Native Riparian deciduous treesYr 1	1.60	29%	0.4
5402	CV-FH	Native Riparian deciduous treesYr 2	3.07	46%	0.7
5403	CV-FH	Native Riparian deciduous treesYr 3	4.42	57%	1.0
5404	CV-FH	Native Riparian deciduous treesYr 4	5.67	63%	1.3
5405	CV-FH	Native Riparian deciduous treesYr 5	6.82	67%	1.5
5410	CV-FH	Native Riparian deciduous treesYr 10	11.31	73%	2.3
5415	CV-FH	Native Riparian deciduous treesYr 15	14.27	73%	2.8
5420	CV-FH	Native Riparian deciduous treesYr 20	16.22	73%	3.0
5430	CV-FH	Native Riparian deciduous treesYr 30	18.36	73%	3.2
5450	CV-FH	Native Riparian deciduous treesYr 50	19.69	73%	3.3
5501	CV-FH	Orchard: Peach/plum/almond/cherryYr 1	0.49	38%	0.2
5502	CV-FH	Orchard: Peach/plum/almond/cherryYr 2	0.95	59%	0.4
5503	CV-FH	Orchard: Peach/plum/almond/cherryYr 3	1.39	70%	0.5

Code	Ecoreg	Description	Height	Density	Oh
5504	CV-FH	Orchard: Peach/plum/almond/cherryYr 4	1.81	77%	0.7
5505	CV-FH	Orchard: Peach/plum/almond/cherryYr 5	2.21	81%	0.8
5510	CV-FH	Orchard: Peach/plum/almond/cherryYr 10	3.93	85%	1.3
5515	CV-FH	Orchard: Peach/plum/almond/cherryYr 15	5.28	85%	1.6
5520	CV-FH	Orchard: Peach/plum/almond/cherryYr 20	6.32	85%	1.7
5530	CV-FH	Orchard: Peach/plum/almond/cherryYr 30	7.77	85%	1.9
5550	CV-FH	Orchard: Peach/plum/almond/cherryYr 50	9.18	85%	2.0
5601	CV-FH	Oregon ashYr 1	0.98	38%	0.5
5602	CV-FH	Oregon ashYr 2	1.91	60%	0.9
5603	CV-FH	Oregon ashYr 3	2.80	73%	1.2
5604	CV-FH	Oregon ashYr 4	3.66	80%	1.5
5605	CV-FH	Oregon ashYr 5	4.47	84%	1.8
5610	CV-FH	Oregon ashYr 10	8.04	90%	2.6
5615	CV-FH	Oregon ashYr 15	10.87	90%	3.0
5620	CV-FH	Oregon ashYr 20	13.14	90%	3.2
5630	CV-FH	Oregon ashYr 30	16.37	90%	3.3
5650	CV-FH	Oregon ashYr 50	19.73	90%	3.3
5701	CV-FH	Salt cedarYr 1	1.77	2502%	0.3
5702	CV-FH	Salt cedarYr 2	3.15	4221%	0.5
5703	CV-FH	Salt cedarYr 3	4.22	5403%	0.6
5704	CV-FH	Salt cedarYr 4	5.06	6215%	0.7
5705	CV-FH	Salt cedarYr 5	5.71	6773%	0.8
5710	CV-FH	Salt cedarYr 10	7.34	7812%	1.0
5715	CV-FH	Salt cedarYr 15	7.81	7971%	1.0
5720	CV-FH	Salt cedarYr 20	7.95	7996%	1.0
5730	CV-FH	Salt cedarYr 30	8.00	8000%	1.0
5750	CV-FH	Salt cedarYr 50	8.00	8000%	1.0
5801	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 1	0.49	38%	0.2
5802	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 2	0.95	59%	0.4
5803	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 3	1.39	70%	0.5
5804	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 4	1.81	77%	0.7
5805	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 5	2.21	81%	0.8
5810	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 10	3.93	85%	1.3
5815	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 15	5.28	85%	1.6
5820	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 20	6.3	85%	1.7
5830	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 30	7.8	85%	1.9

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
5850	CV-FH	Stone fruit trees: Peach/plum/almond/cherryYr 50	9.2	85%	2.0
5901	CV-FH	Unknown OakYr 1	0.7	24%	0.3
5902	CV-FH	Unknown OakYr 2	1.4	41%	0.6
5903	CV-FH	Unknown OakYr 3	2.1	52%	0.9
5904	CV-FH	Unknown OakYr 4	2.7	60%	1.2
5905	CV-FH	Unknown OakYr 5	3.4	66%	1.4
5910	CV-FH	Unknown OakYr 10	6.3	77%	2.2
5915	CV-FH	Unknown OakYr 15	8.8	78%	2.7
5920	CV-FH	Unknown OakYr 20	11.0	79%	2.9
5930	CV-FH	Unknown OakYr 30	14.5	79%	3.2
5950	CV-FH	Unknown OakYr 50	19.1	79%	3.3
6001	CV-FH	Upland annual grasses and forbsYr 1	0.9	57%	0.0
6002	CV-FH	Upland annual grasses and forbsYr 2	1.3	78%	0.0
6003	CV-FH	Upland annual grasses and forbsYr 3	1.4	86%	0.0
6004	CV-FH	Upland annual grasses and forbsYr 4	1.5	88%	0.0
6005	CV-FH	Upland annual grasses and forbsYr 5	1.5	89%	0.0
6010	CV-FH	Upland annual grasses and forbsYr 10	1.5	90%	0.0
6015	CV-FH	Upland annual grasses and forbsYr 15	1.5	90%	0.0
6020	CV-FH	Upland annual grasses and forbsYr 20	1.5	90%	0.0
6030	CV-FH	Upland annual grasses and forbsYr 30	1.5	90%	0.0
6050	CV-FH	Upland annual grasses and forbsYr 50	1.5	90%	0.0
6101	CV-FH	Urban-developedYr 1	0.0	0%	0.0
6102	CV-FH	Urban-developedYr 2	0.0	0%	0.0
6103	CV-FH	Urban-developedYr 3	0.0	0%	0.0
6104	CV-FH	Urban-developedYr 4	0.0	0%	0.0
6105	CV-FH	Urban-developedYr 5	0.0	0%	0.0
6110	CV-FH	Urban-developedYr 10	0.0	0%	0.0
6115	CV-FH	Urban-developedYr 15	0.0	0%	0.0
6120	CV-FH	Urban-developedYr 20	0.0	0%	0.0
6130	CV-FH	Urban-developedYr 30	0.0	0%	0.0
6150	CV-FH	Urban-developedYr 50	0.0	0%	0.0
6201	CV-FH	Valley oakYr 1	1.9	25%	0.5
6202	CV-FH	Valley oakYr 2	3.7	41%	0.9
6203	CV-FH	Valley oakYr 3	5.4	52%	1.3
6204	CV-FH	Valley oakYr 4	7.0	60%	1.6
6205	CV-FH	Valley oakYr 5	8.5	65%	2.0
6210	CV-FH	Valley oakYr 10	14.6	74%	3.2
6215	CV-FH	Valley oakYr 15	19.0	75%	3.9
6220	CV-FH	Valley oakYr 20	22.1	75%	4.3
6230	CV-FH	Valley oakYr 30	25.9	75%	4.7
6250	CV-FH	Valley oakYr 50	28.9	75%	5.0

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
6301	CV-FH	VineyardYr 1	0.4	41%	0.2
6302	CV-FH	VineyardYr 2	0.8	56%	0.3
6303	CV-FH	VineyardYr 3	1.1	62%	0.4
6304	CV-FH	VineyardYr 4	1.3	64%	0.4
6305	CV-FH	VineyardYr 5	1.4	65%	0.5
6310	CV-FH	VineyardYr 10	1.8	65%	0.6
6315	CV-FH	VineyardYr 15	2.0	65%	0.7
6320	CV-FH	VineyardYr 20	2.0	65%	0.7
6330	CV-FH	VineyardYr 30	2.0	65%	0.7
6350	CV-FH	VineyardYr 50	2.0	65%	0.7
6401	CV-FH	WaterYr 1	0.0	0%	0.0
6402	CV-FH	WaterYr 2	0.0	0%	0.0
6403	CV-FH	WaterYr 3	0.0	0%	0.0
6404	CV-FH	WaterYr 4	0.0	0%	0.0
6405	CV-FH	WaterYr 5	0.0	0%	0.0
6410	CV-FH	WaterYr 10	0.0	0%	0.0
6415	CV-FH	WaterYr 15	0.0	0%	0.0
6420	CV-FH	WaterYr 20	0.0	0%	0.0
6430	CV-FH	WaterYr 30	0.0	0%	0.0
6450	CV-FH	WaterYr 50	0.0	0%	0.0
6501	CV-FH	Weeds, herbaceous and highly invasive Yr 1	0.9	60%	0.0
6502	CV-FH	Weeds, herbaceous and highly invasive Yr 2	1.3	82%	0.1
6503	CV-FH	Weeds, herbaceous and highly invasive Yr 3	1.4	90%	0.1
6504	CV-FH	Weeds, herbaceous and highly invasive Yr 4	1.5	93%	0.1
6505	CV-FH	Weeds, herbaceous and highly invasive Yr 5	1.5	94%	0.1
6510	CV-FH	Weeds, herbaceous and highly invasive Yr 10	1.5	95%	0.1
6515	CV-FH	Weeds, herbaceous and highly invasive Yr 15	1.5	95%	0.1
6520	CV-FH	Weeds, herbaceous and highly invasive Yr 20	1.5	95%	0.1
6530	CV-FH	Weeds, herbaceous and highly invasive Yr 30	1.5	95%	0.1
6550	CV-FH	Weeds, herbaceous and highly invasive Yr 50	1.5	95%	0.1
6601	CV-FH	Weeds, herbaceous and non-invasive Yr 1	0.6	60%	0.0
6602	CV-FH	Weeds, herbaceous and non-invasive Yr 2	0.9	82%	0.1
6603	CV-FH	Weeds, herbaceous and non-invasive Yr 3	1.0	90%	0.1
6604	CV-FH	Weeds, herbaceous and non-invasive Yr 4	1.0	93%	0.1
6605	CV-FH	Weeds, herbaceous and non-invasive Yr 5	1.0	94%	0.1
6610	CV-FH	Weeds, herbaceous and non-invasive Yr 10	1.0	95%	0.1

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
6615	CV-FH	Weeds,herbaceous and non-invasive Yr 15	1.0	95%	0.1
6620	CV-FH	Weeds,herbaceous and non-invasive Yr 20	1.0	95%	0.1
6630	CV-FH	Weeds,herbaceous and non-invasive Yr 30	1.0	95%	0.1
6650	CV-FH	Weeds,herbaceous and non-invasive Yr 50	1.0	95%	0.1
6701	CV-FH	White alderYr 1	1.3	17%	0.3
6702	CV-FH	White alderYr 2	2.5	30%	0.6
6703	CV-FH	White alderYr 3	3.6	40%	0.8
6704	CV-FH	White alderYr 4	4.7	48%	1.0
6705	CV-FH	White alderYr 5	5.7	53%	1.2
6710	CV-FH	White alderYr 10	9.8	66%	1.9
6715	CV-FH	White alderYr 15	12.7	69%	2.3
6720	CV-FH	White alderYr 20	14.8	70%	2.4
6730	CV-FH	White alderYr 30	17.5	70%	2.6
6750	CV-FH	White alderYr 50	19.5	70%	2.7
6801	CV-FH	Willow shrub (other than sandbar willow)Yr 1	0.7	33%	0.2
6802	CV-FH	Willow shrub (other than sandbar willow)Yr 2	1.4	53%	0.4
6803	CV-FH	Willow shrub (other than sandbar willow)Yr 3	2.0	64%	0.6
6804	CV-FH	Willow shrub (other than sandbar willow)Yr 4	2.6	71%	0.7
6805	CV-FH	Willow shrub (other than sandbar willow)Yr 5	3.1	75%	0.9
6810	CV-FH	Willow shrub (other than sandbar willow)Yr 10	5.3	80%	1.4
6815	CV-FH	Willow shrub (other than sandbar willow)Yr 15	6.8	80%	1.8
6820	CV-FH	Willow shrub (other than sandbar willow)Yr 20	7.8	80%	2.1
6830	CV-FH	Willow shrub (other than sandbar willow)Yr 30	8.9	80%	2.3
6850	CV-FH	Willow shrub (other than sandbar willow)Yr 50	9.8	80%	2.5
6901	CV-FH	Willow tree (other)Yr 1	1.8	25%	0.2
6902	CV-FH	Willow tree (other)Yr 2	3.4	42%	0.5
6903	CV-FH	Willow tree (other)Yr 3	4.7	54%	0.7
6904	CV-FH	Willow tree (other)Yr 4	5.8	62%	0.9
6905	CV-FH	Willow tree (other)Yr 5	6.8	68%	1.0
6910	CV-FH	Willow tree (other)Yr 10	9.7	78%	1.8
6915	CV-FH	Willow tree (other)Yr 15	11.0	80%	2.2
6920	CV-FH	Willow tree (other)Yr 20	11.6	80%	2.6
6930	CV-FH	Willow tree (other)Yr 30	11.9	80%	3.0
6950	CV-FH	Willow tree (other)Yr 50	12.0	80%	3.3
7001	CV-FH	Willow, Goodding's or RedYr 1	1.8	24%	0.6
7002	CV-FH	Willow, Goodding's or RedYr 2	3.4	40%	1.1
7003	CV-FH	Willow, Goodding's or RedYr 3	4.7	51%	1.5
7004	CV-FH	Willow, Goodding's or RedYr 4	5.8	57%	1.8

<b>Code</b>	<b>Ecoreg</b>	<b>Description</b>	<b>Height</b>	<b>Density</b>	<b>Oh</b>
7005	CV-FH	Willow, Goodding's or RedYr 5	6.8	62%	2.1
7010	CV-FH	Willow, Goodding's or RedYr 10	9.7	69%	2.9
7015	CV-FH	Willow, Goodding's or RedYr 15	11.0	70%	3.2
7020	CV-FH	Willow, Goodding's or RedYr 20	11.6	70%	3.3
7030	CV-FH	Willow, Goodding's or RedYr 30	11.9	70%	3.3
7050	CV-FH	Willow, Goodding's or RedYr 50	12.0	70%	3.3
7101	CV-FH	Willow, sandbarYr 1	0.7	24%	0.2
7102	CV-FH	Willow, sandbarYr 2	1.2	40%	0.3
7103	CV-FH	Willow, sandbarYr 3	1.6	51%	0.4
7104	CV-FH	Willow, sandbarYr 4	2.0	57%	0.5
7105	CV-FH	Willow, sandbarYr 5	2.3	62%	0.6
7110	CV-FH	Willow, sandbarYr 10	3.1	69%	0.7
7115	CV-FH	Willow, sandbarYr 15	3.3	70%	0.8
7120	CV-FH	Willow, sandbarYr 20	3.4	70%	0.8
7130	CV-FH	Willow, sandbarYr 30	3.5	70%	0.8
7150	CV-FH	Willow, sandbarYr 50	3.5	70%	0.8

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## Appendix I

### Examples of Delineated Vegetation Polygons

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The following examples were randomly selected from Google Earth imagery and do not reflect any land owner or manager agreements on management changes. Locations of these areas are intentionally unidentified, although both examples are from the Central Valley.

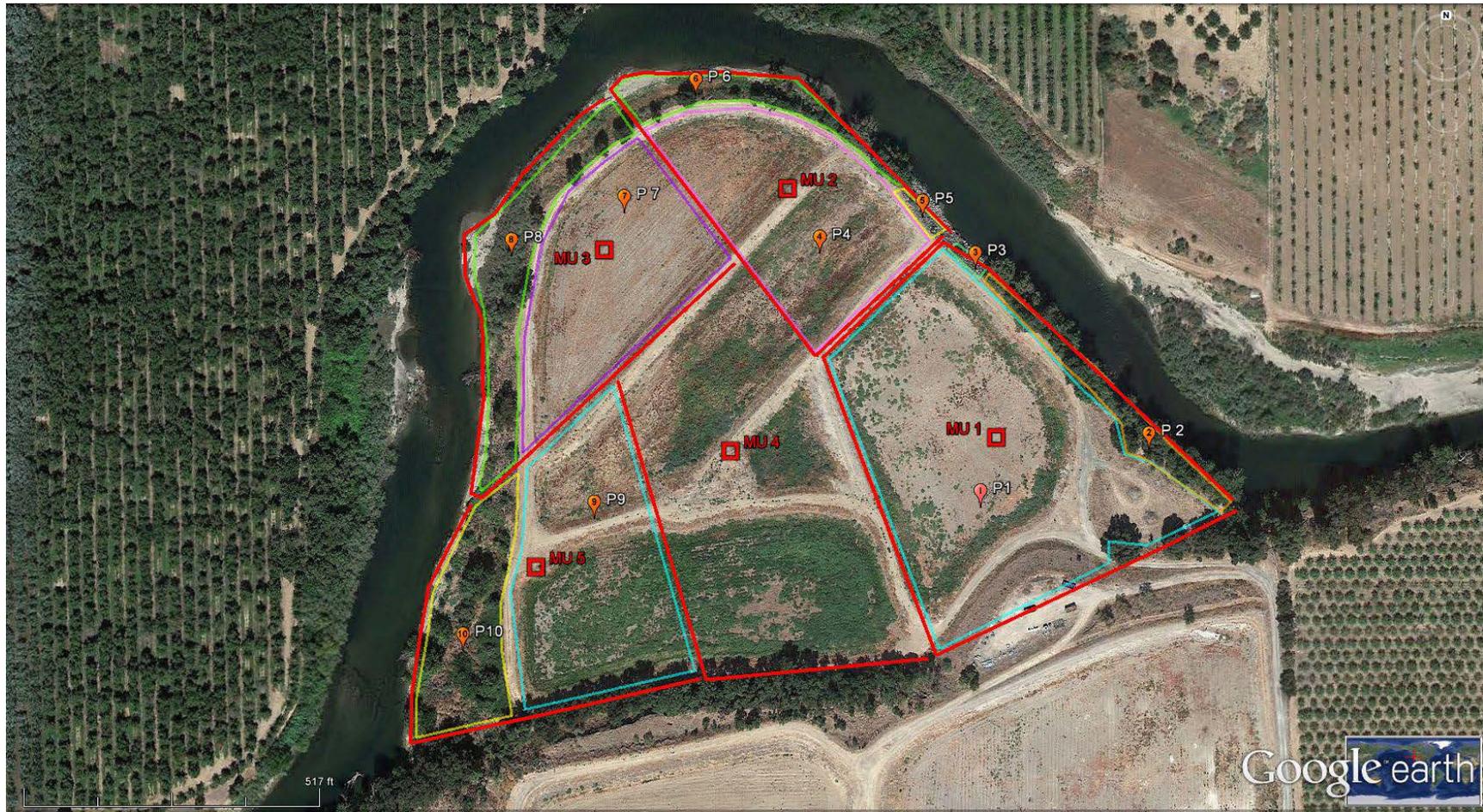


Figure I-1. One project area with 5 Map Units delineated as < 500' long and wide areas within the Project Area. Polygons supporting consistent vegetation are outlined and labeled P1-P11. Delineations done using Google Earth's 'polygon' tool and

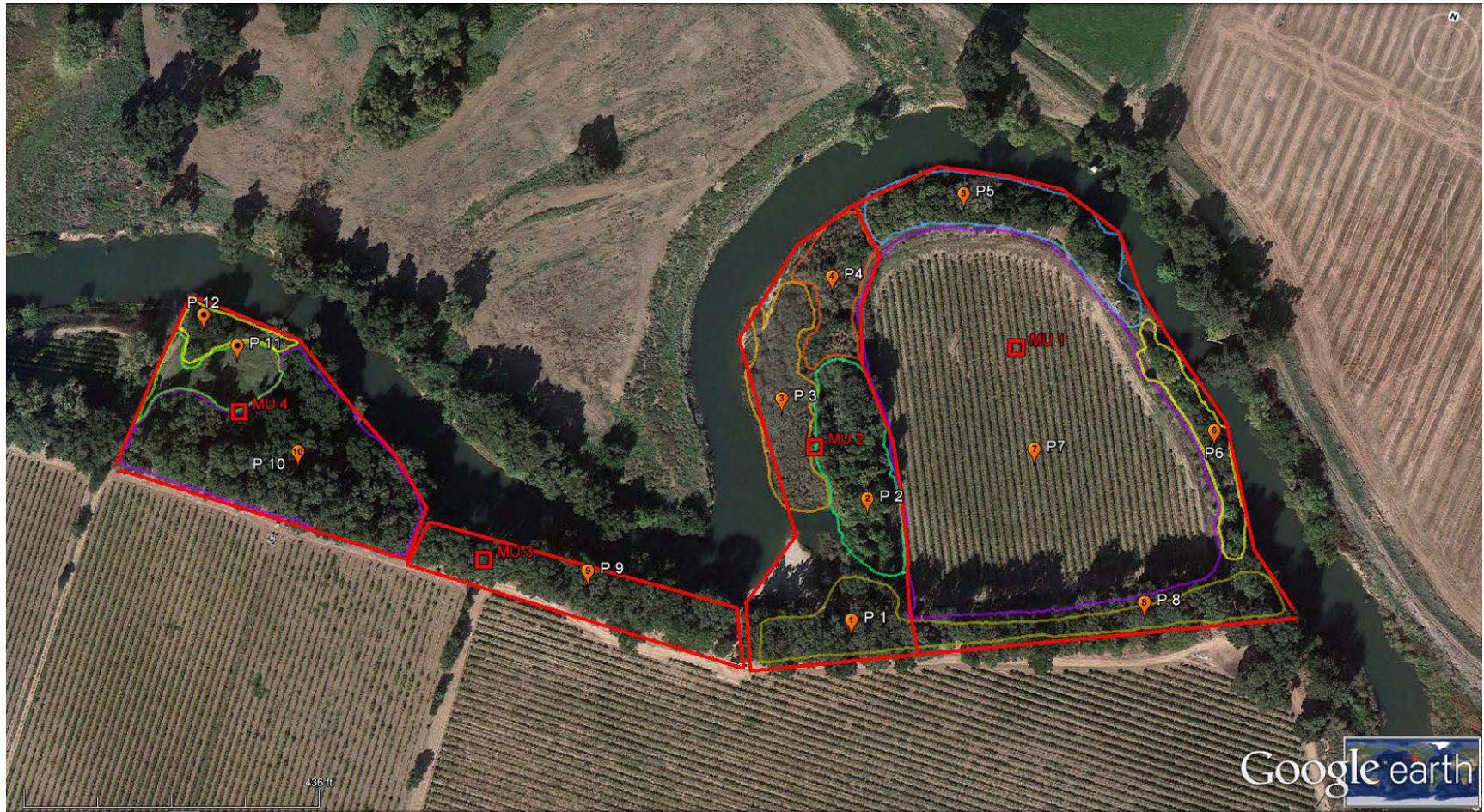


Figure I-2. Hypothetical Project Area in Central Valley with four Map Units, labeled in red as MU 1-4. Within each Map Unit, are twelve polygons supporting consistent vegetation types, labeled P1 through P 12.

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**Appendix J**  
**Identifying Bankfull**

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# BANKFULL: WHAT IT IS AND HOW TO LOCATE IT

## WHY BANKFULL?

Several procedures in this manual require you to locate what is known as the “bankfull channel edge,” or more simply as “bankfull.” This is an important concept in understanding the workings of a stream.

## HOW DOES A “BANKFULL” GET CREATED?

Most lower portions of streams in our area are alluvial, meaning that they create their own channels by moving sediment from the surrounding hillslopes and from the stream channel itself. Major episodes of such movement occur during floods and are called “channel-forming events.” These events determine the size of the channel needed to convey the water. In a period of relatively stable climate and land-cover, a stream system will develop an equilibrium between its flows and the size of the channel, whereby the channel is large enough to contain the stream under most flow conditions. When flows are greater than this capacity, the stream overflows its banks and flooding occurs.

In such streams, the channel is usually big enough to contain a high-flow event that recurs on an average of every 1.5 years (which we call the “1.5-year flood”). Such a frequency of inundation is frequent enough that perennial vegetation can’t grow there, either because its roots are too wet or its seedlings get swept away. So usually, what you’ll see if you look at the cross-section of a stream channel is a sort of “bowl” that contains the stream most of the time, inside which no perennial vegetation grows, and a place over the top of this bowl where the water can flow during a high-water event greater than a 1.5-year flood. This “floodplain” may be on one or both banks, depending on the site.

## WHAT ARE INDICATORS OF BANKFULL?

Most stream systems are in a continual cycle of change, and every site is unique; thus, no single indicator of bankfull can always get you the “right answer.” There are several indicators

which can help to identify the bankfull channel edge, and you should consider all that are present at a given site:

- A. **Bank slope:** In stream channels with natural (undiked) riparian areas and a low, flat floodplain, the bankfull edge is located at the edge of this plain. Often the floodplain will slope down very gradually and then more abruptly. This abrupt slope-break is usually a good indicator. However, you may find such a slope-break on only one bank, or none at all, for instance if the channel has cut down into the streambed. Or the slope-break may be impossible to find on a bank that is slumping or undercut.
- B. **Vegetation:** The bankfull edge is often indicated by a demarcation line between lower areas that are either bare or have aquatic and annual vegetation, and higher areas with perennial vegetation such as ferns, shrubs, and trees. (Keep in mind, though, that the vegetation line is always in transition, retreating during wetter periods and advancing during dryer ones. So except for ferns, you should rely most heavily on perennial vegetation which is more than 6 feet high.) One particular confusion arises from willow or alder trees growing within the bankfull channel, because the channel has migrated into them, or they fell into the stream and managed to reestablish themselves. Therefore, when you look at vegetation, you should also look at soils...
- C. **Soils:** Look for a transition as you move up the bank, from cobble/gravel to sand/silt to soil. Above bankfull level, you should find old leaf litter forming into soil with organic matter. (Beware: this may be covered by flood deposits, so you may have to dig down.)
- D. **Point bars and bank undercuts:** Often on the inside of meander bends, the stream will build up a bar of sediment from the eddy current created by the bend; the top of such a bar is the minimum height of

## BANKFULL

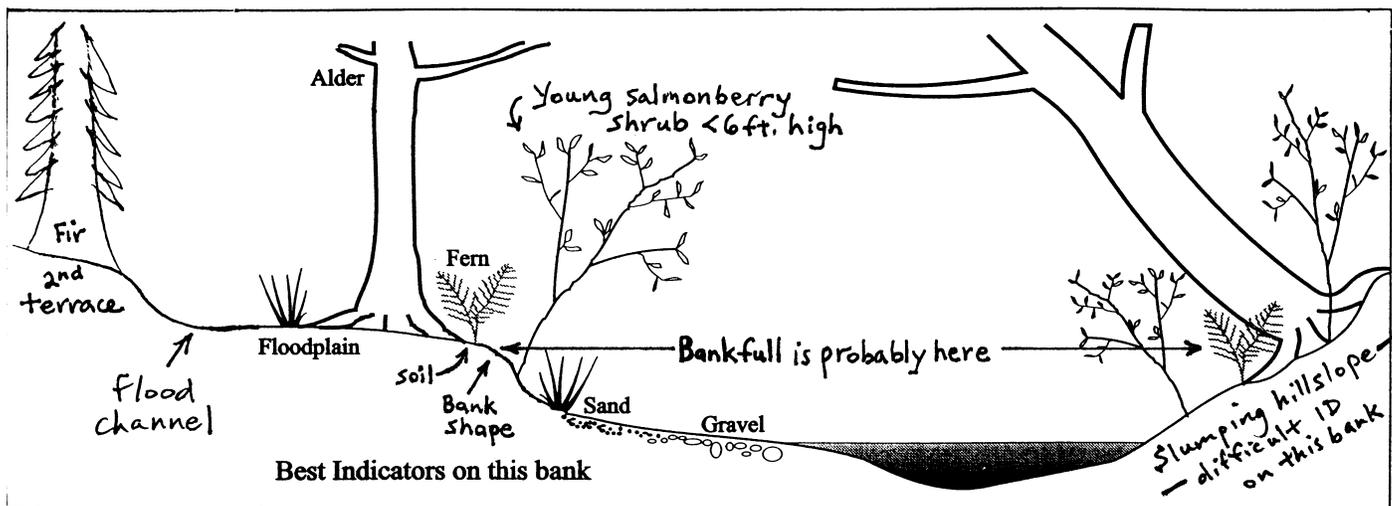
bankfull. Similarly, on the outside of such bends, the stream will often undercut the bank and expose root mats. If you reach up beneath this mat, you can estimate the upper extent of the undercut. This would also be the minimum height of bankfull.

- E. Lines on boulders/bedrock:** If you're in a steep channel with no clear floodplain, look for the highest mineral-stain line or the lowest line of lichen or moss on stable rock.
- F. Adjacent indicators:** If the indicators are unclear where you're looking, try looking up- or downstream to see if there is a clear bankfull line from which you can extrapolate.

## HOW SHOULD I LOCATE BANKFULL?

The following method was found by the TFW program to maximize data precision and minimize bias toward over- or under-estimation of bankfull elevation:

1. Start on the bank with the best bankfull indicators.
  - a. Move up the bank from the channel, observing the indicators listed above.
2. Now follow the same procedure on the other bank. If it is not possible to accurately identify the bankfull level on that bank (which often happens on the outside bank of a meander bend), locate it using a level line from the bankfull point on the first bank.



Typical bankfull ID situation, adapted from Pleus and Schuett-Hames, 1998.

(Also referenced for this section: Harrelson et al., 1994.)