USGS Aquatic Species and Habitat Assessment Protocol Rivers, Streams, and Creeks-Paper

Survey Protocol-

Prepared by the U.S. Department of the Interior, U.S. Geological Survey

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By United States Geological Survey

Introduction

This document details a standard protocol for conducting daytime inventory and monitoring surveys for aquatic species in river, stream, and creek systems in the south coast ecoregion of the United States (within the U.S. this extends from Monterey, California to the Mexican border and from the sea to the tops of the mountains). The protocol was developed primarily for amphibian larvae; however, it is also effective for documenting the presence of many aquatic amphibian life stages, turtles, snakes, fish, and other freshwater aquatic taxa.

The protocol is designed to standardize survey methods and to specifically determine locality, extent, and status of amphibian species that are threatened, endangered, and of special concern in an effort to provide baseline information applicable to amphibian declines in the south coast ecoregion. It will also contribute information on general habitat components and disturbances found at each location so that hypotheses can be formulated and tested as to why a species occurs or does not occur in a particular area.

The protocol describes surveys that are to be conducted in 125 m segments of rivers, streams, and creeks. Repeat visits to these segments within each survey area will provide a reasonable means of recording data that is representative of the entire site and will allow detection probability to be calculated. Surveys should be conducted during the day and at appropriate times of year for the target amphibian's breeding season in order to document eggs and/or larvae (tadpoles). The precise timing will depend on the goals of the study and the biology of the target species.

In southern California, there are several amphibian species that may be encountered while conducting a daytime stream survey. Some of the species are mainly nocturnal, however their larvae are detectable during the day, often with greater probabilities of detection than adults (Brehme et al., 2003). Therefore, we have modeled this survey protocol to detect amphibian life stages during the daytime. Egg, larval, and adults life stages are likely to be encountered for the following species native anurans and caudates: California treefrog adults, larvae, and eggs (*Pseudacris cadaverina*), Pacific treefrog adults, larvae, and eggs (*P. regilla*), western toad adults, larvae, and eggs (*Anaxyrus boreas*), red-spotted toad adults, larvae, and eggs (*A. punctatus*), arroyo toad larvae and eggs (*A. californicus*), spadefoot larvae and eggs (*Spea hammondii*), red-legged frog adults, larvae, and eggs (*Rana draytonii*), mountain yellow- legged frog (*Rana muscosa*) adults, larvae, and eggs, California newt or coast range newt adults, larvae, and eggs (*Taricha torosa*); and non-natives: bullfrog adults, larvae, and eggs (*Lithobates catesbeiana*), African clawed frog adults, larvae, and eggs (*Xenopus laevis*). In this protocol we assume that prior to conducting a survey, surveyors have familiarized themselves with background information and the biology of the target species in order to form a good search

image and know where to look for that species. For information on the key characteristics, natural history, and biology of your target species we suggest referring to Stebbins, 2003.

Purpose

Currently, aquatic inventory and monitoring surveys are conducted regularly across the ecoregion by many biologists from federal and state agencies, educational institutions, and non-governmental organizations throughout Los Angeles, San Bernardino, Riverside, Orange, and San Diego Counties. Survey methods and data collection differ greatly among biologists and across sites. Because of this, we are often unable to establish detection probabilities requiring standard survey techniques, to analyze what factors influence probabilities of detection for various species, or to build predictive or explanatory species models in an area or region. The purpose of this protocol is to provide a standard means of taking measurements and recording data so that changes reflected in these data are the result of natural phenomena and not because of changes in the way different individuals collect and record these data (Oakley et al., 2003). Standardizing data collection methods will also allow for data comparisons to be made across all parties and agencies using these methods (Oakley et al., 2003). The specific data collection methods described herein are intended for the purpose of quantifying information on the location and biology of amphibian species throughout the south coast ecoregion and on the habitat components at these survey locations. We attempted to include a full suite of standard measures that may be used to adequately describe and predict suitable habitat for variety of native and non-native amphibian and other aquatic species. Our goal is to then use these measures as covariates in statistical analyses to predict species presence and probability of detection (MacKenzie et al., 2002, 2003).

Protocol Organization Overview

This protocol is arranged in chronological order using a step-by-step procedure of what to do before, during, and after a survey. We begin with pre-survey preparation, including making a survey map, preparing a survey field kit, and navigating to a site. We then describe which data are to be collected and the techniques used to collect them. We follow with post-survey procedures such as disinfecting and storing equipment and correcting and storing data.

Appendices have been added at the end of this document to provide more detailed information on data definitions (Appendix 1), south coast ecoregion vegetative communities (Appendix 2), paper data form (Appendix 3), and additional references and resources (Appendix 4).

As procedures, equipment, and survey techniques improve, this protocol may be revised periodically to ensure that the most effective means of surveying and data collection are utilized.

Pre-survey Procedures

Preparing a Survey Map

It is recommended to create a map of the survey segments that shows the entire survey site. If applicable, also include any access points and any relevant property boundaries. For

repeated surveys, you will use the same segments for data collection. This will make it possible to standardize how the data are being collected and analyzed.

Preparing a General Survey Field Kit

Before going out to the survey site, make sure the survey field kit includes everything necessary to complete the survey including spare batteries, writing utensils, survey forms, and a safety kit. Prepare or inspect the survey field kit. Check additional protocols for any special equipment needed.

The general survey field kit lists the basic equipment needed for the surveys in this document. Permits are required for accessing sites and for handling animals. Note: Refer to the site permits for site specific restrictions and to see if you need to notify the property owner/manager that you will be accessing the site. Refer to your scientific collecting permit for permitted activities and what species you are allowed to handle. Some species have special handing restrictions. Familiarize yourself with the GPS unit. Make sure coordinate system and datum are set appropriately. USGS recommends using the datum WGS84 (NAD83 is also acceptable). The coordinates should be recorded in decimal degrees or hddd.ddddd°. Digital cameras are beneficial for documenting habitat and species present. We recommend using a waterproof, GPS enabled digital camera for these surveys. A waterproof camera is not only good to prevent accidental water damage, but it also allows the researcher to take underwater photos of fish and amphibian larvae. The GPS feature provides an additional cross-reference for location data. Alcohol-proof permanent pens are used to label collection vials to ensure that the labels are not erased when they come in contact with the preserving alcohol. VWR® markers work well. Note: these are only alcohol-proof when the ink has completely dried. Polarized sunglasses are particularly important for daytime stream surveys because the polarized lenses allow the researcher to see through surface glare.

Survey Field Kit:

1. Permits (eg Site, Scientific Collecting)
2. Copy of protocol
3. Map with survey segments
4. GPS unit with accompanying list of coordinates
5. Paper data forms and writing utensil
6. Clipboard
7. USGS field key for aquatic species and/or Stebbins 2003 field guide
8. Digital camera
9. Thermometer (for measuring air and water temperatures)
10. Metric ruler
11. Range finder or measuring tape (for stream and channel width measurements)
12. Hand lens (USGS recommends magnification of at least 10X)
13. Net
14. Calibrated conductivity (EC) meter

15. Calibrated pH meter
16. Extra batteries (AA, AAA, D) depending on equipment
17. Bleach and extra water for disinfecting equipment that has come in contact with animals or water, (Appendix 5)
18. Waders/water shoes
19. Polarized sunglasses
20. Flagging tape (optional)
21. Safety and first-aid kit
22. Cell phone or other communication device

Navigating to a Site and to Each Segment

Use your GPS unit to navigate the vehicle(s) closest to the beginning of the segment being surveyed by selecting the "GO TO" button for the beginning coordinates for the segment. On foot, navigate to the start point of the segment. Since the coordinates are typically defined using a topographical mapping program you can expect there to be some positioning error and you may need to adjust your position accordingly to place yourself in or adjacent the stream channel. Whenever possible, start downstream and work your way upstream. This prevents stirred up debris from traveling ahead of you which may alert the animals to your presence before you approach and decrease your visibility within the creek making it difficult to detect animals. At the beginning of each survey segment press the "GO TO" button and select the end point of that 125 m segment (also the start point of the next 125 m segment) and keep track of the distance remaining to the end coordinates, so you do not overshoot that end point.

Habitat and water data will be recorded at the beginning and the end of each 125 m segment while animals encountered will be recorded throughout the survey segment.

Survey Protocol

Initial Site Visit Information

Navigate to the start coordinates for the first segment being surveyed for the day. At the start of each stream segment data needs to be collected before surveying for animals and habitat characteristics. Initial survey data include; site name (drainage name), segment name, weather, segment photo (habitat photos), and water measurements. Fill out the Survey Event Information.

1. Date: Record the date.
2. Block (Site Name): Record the name of the site being surveyed. This is a grouping of segments. The block may refer to an entire stream, a specific preserve, or a group of distinct pools and ponds.
3. Segment Name: Record the segment name of the section being surveyed. This is the standardized name of the specific survey location.
4. Start Time: Record the time at which survey efforts began.
5. Site Photo: Take start photos at the beginning of each selected segment. First take a

photo facing upstream and then one facing downstream. Indicate whether or not a photo was taken of the study segment (Yes/No). Note: you will be taking photos of representative habitat and specific habitat features (i.e. fish barriers, basking areas, disturbances) throughout the survey.

6. Number of Photos: write in the number of photos taken (this field can remain blank if you record the photo identification numbers designated by the camera).
7. Observer: Record the names of all personnel conducting the survey.
8. Coordinates: Record the coordinates of the location where you are starting the survey. Manually record the latitude / longitude (or UTM, Easting/Northing), elevation, and datum. You may also want to take a photo of the waypoint on your GPS as secondary record of location data.

Weather Data

Record the weather condition, air temperature and any weather notes.

1. Weather Conditions: Select the general sky conditions. The options are: clear or few clouds, partly cloudy or variable, cloudy or overcast, fog, mist or drizzle, showers or light rain, heavy rain, sleet or hail, snow, and no data.
2. Air Temperature (°C): Measure air temperature (in degrees Celsius). Record temperature 1 m off the ground in the shade.
3. Weather Notes: Record any additional relevant weather information here (i.e., if there were any changes in the weather patterns such as rain during the middle of the survey).

Water Quality and Stream Measurements

The first-time water is encountered, often at the start of the survey segment, you will measure and record a number of water quality and stream measurements. Before taking measurements, look for any aquatic or riparian species within or next to the water. Document the species before recording water quality and stream measurements (see Animal Records Section). If an animal species is recorded and the water is affected by the search (i.e. increased turbulence, substrate disturbed in water, etc.), take water quality and stream measurements in an unaffected area upstream, if possible.

1. Water Present: Yes/No, is water present along the survey segment? If you encounter water, report the water quality measurements and stream measurements.

2. Coordinates: Record the Lat/Long field location, elevation and datum for where you are recording water quality data.

3. Water Temperature: Place your thermometer 10 cm below the surface of the water (if possible) in an area that is representative of the creek, (i.e., not in a backwater pool or side channel where temperatures would be expected to be warmer). Leave the thermometer under water for a minute or so and record the temperature once the thermometer reading has stabilized.

4. pH: Immerse the electrode of the pH meter below the surface of the water in an area

that is representative of the creek, (i.e., not in a backwater pool or side channel). Leave the meter under water for a minute or so and record the pH once the reading has stabilized.

5. Conductivity (µS): Immerse the electrode of the conductivity meter below the surface of the water in an area that is representative of the creek, (i.e., not in a backwater pool or side channel). Leave the meter under water for a minute or so and record the conductivity once the reading has stabilized. Specific conductance should be recorded in microsiemens (µS).

6. Channel Water Depth (cm): Measure water depth in centimeters at the thalweg (deepest/high flow portion of the main channel; see Appendix 1 for definition). It may be convenient to immerse a stick (or your leg) in the water and then measure the wetted length of the stick with a measuring tape. If water is not wadeable, estimate depth at mid-channel to the best of your ability to the nearest meter. See Figure 1.

7. Wetted Channel Width (m): Measure stream width in meters (wetted portion only) by using measuring tape or a rangefinder. (Note: if channel is braiding, add width of wetted braids to figure total stream width).

8. Number of Wetted Braids: Record the number of wetted braids or separate streams of water flow. A single moving water channel equals 1 (see Appendix 1 for definition).

9. Channel Surface Water Velocity (m/s): Surface water velocity is recorded in meters per second. Put a small stick/branch in water at mid-channel. Time for 2 to10 seconds, depending upon the speed of the water (slow water = 10 seconds/fast moving water = 2 seconds) and mark the distance moved. If the stick moves a short distance, measure with tape. If stick moves a longer distance, can use rangefinder to determine the distance traveled. It is easy to have the second observer walk and mark the spot traveled (1 cm = 0.01 m). Do this 3 times and record the average of the 3 measurements. Examples: if the stick moved 5 m in 10 seconds, water velocity equals 0.5 m/s (5/10). If it moved 5 cm (0.05 m) in 10 seconds, the velocity equals 0.005 m/s (0.05/10).

10. Transparency: Do a visual estimate of water transparency of the water at mid-channel (if possible) and choose the proper category. An easy method is to set a penny in the bottom of the pool. Choose one of the following options: “Clear” = can see the year on penny clearly in bottom of pool, “Moderate/Translucent” = cannot see year, but can see outline of penny, or “Opaque” = cannot see year or outline of penny.

Record any relevant or unusual notes pertaining to water, equipment readings or conditions.

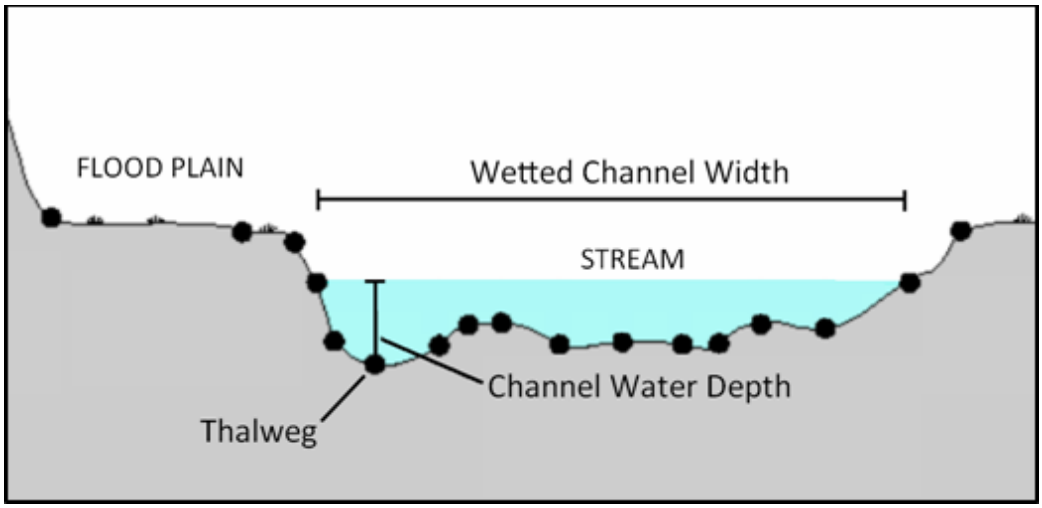

Figure 1. Channel Water Depth Example. Showing where to take the wetted channel width and channel depth measurements. Adapted from Fitzpatrick et al., 1998.

Search Methods and Survey Techniques

Slowly start walking up the stream channel, either in the water or immediately adjacent to the water. In addition to looking for your target species you need to make sure to document any other native or non-native aquatic species observed. For example, include all life stages of other amphibians and/or larvae, turtles, snakes, newts, fish, crayfish, Asian clams, beavers, and beaver sign. Use the following techniques to search for aquatic species.

1. Visual encounter: Carefully search the water, especially in pools, along shoreline, and near aquatic refugia for eggs, tadpoles, fish, and adult amphibians. Floating material can be gently moved back with a finger or stick to look underneath. Look ahead often to spot basking turtles and frogs that may leap into water when they hear or see you coming.

2. Dip Netting: Some fish, tadpoles, and other animals can be found at the edge or in the bottom mud of pooled water, in aquatic vegetation and under ledges along the perimeter of pools. When encountering deep pools and aquatic refugia, first visually check for any aquatic animals or egg masses. If no eggs are seen, you may take long sweeps with the dip net through these areas. Gently sweep the net along the bottom and sides of the pool or refugia, then check the net for aquatic species by carefully sifting through any mud and debris brought up from the bottom. We recommend using two sizes of nets, a large fish net with a long handle for sweeping deep pools and a small aquarium size net for small fish and tadpoles. Do not disturb any egg masses with dip nets. Capturing tadpoles and fish with a dip net is also a useful method to observe animals more carefully, take voucher photos, and make positive identifications. Special state and federal permits may be required for capturing and handling any listed species.

3. Call Surveys: Although many amphibians are most often heard calling at night, some can be heard during the day. Always be listening for calls (Davidson, 1995) and for the sound of animals jumping into the water.

As you search for animals, pay attention to the substrate and riparian vegetative and upland communities. Also note any non-native vegetation in the water or along the watercourse. Some common non-native plants include arundo (*Arundo donax*), tamarisk (*Tamarix sp.*), watercress (*Rorripa nasturtium aquaticum*), mustard (*Brassica nigra*), and floating primrose (*Ludwigia sp.).* Please bring and refer to a plant field guide if you are unfamiliar with the common native and non-native plants in southern California. As you conduct the visual survey, point out non-native plants and abrupt habitat changes to other members of the survey, this will help with documenting the vegetation at the end of the survey. Also look around every so often (~ 30 m) and make a mental note about the dominant substrate on the banks and in the water, riparian vegetation types, vegetative cover in the channel and on the banks, and amount of potential basking areas and aquatic refugia (see Appendices 1 & 2 for definitions). This information will be recorded at the end of the segment, so you want to obtain a representative mental picture of the proportions of these habitat components as you walk through them. It may take some practice to make a good estimate of all of the habitat components and their proportions within each designated segment so you may want to conduct a few mock-surveys to get accustomed to these methods. It is best if each member of the survey team makes their own individual mental notes and estimations and compares these to the estimates of other team members at the end of each segment.

As you are making your way through the segment, take photos of the habitat, fish barriers, artificial structures, and any disturbances along the way. Record the photo numbers in the appropriate place.

Animal Records

For this protocol it is not required that every single animal encountered be entered in the animal records, but that you enter an animal record the first time you encounter any species or life stage of that species within the segment. If you have specific questions pertaining to a particular species, you may want to record it more than once per segment depending on your research goals (i.e. record all juveniles and adults of target and/or listed species). If no species were encountered within the survey segment, record "None" in the Animals form. This will create negative data, showing that you were surveying for species, but none were found.

The first time you encounter any life stage of any species within the segment record the species and its age class in the animal form as follows:

4. Coordinates: Record the coordinates at the first observation of the target species within the segment.

5. Species: Record each life stage of each species the first time it is encountered within the 125 m segment by selecting that species from the drop-down list.

6. Age: Record the age category of the animals detected. Each age category should be recorded as a separate record. The options are Adult, Juvenile, Metamorph, Tadpole, 2nd Year Tadpole, Hatchling, Egg Mass, and Unknown.

7. Sex: Record the sex of the animals if known.

8. Count: Record the total count for the species documented.

9. Tissue: Collect tissue if permitted and required for the project. Record if tissue was

collected.

10. Photo: Take a voucher photo of the animal. Take more photos if necessary. If you have a scientific collecting permit and capture the animal take dorsal and ventral photos as well as photos of the front and side of the animal. For captured turtles, also take photos of both the left and right sides and the rear of the turtle.
    a. Select yes (Y) if you took a photo of your animal or no (N) if you did not.
    b. # of photos: Record the number of photos taken in the notes.

11. Deformities: Record if the animal had any deformities.

12. Notes: Record any pertinent information that does not fit into one of the other data fields.

Arroyo Toad Records/Pool Characterization

Additional pool data will be collected the first time you encounter arroyo toad tadpole(s). You will characterize the pool using the pool water and vegetation fields and enter the animal data within the animal form section on the datasheet. If no arroyo toads were found within a segment, collect data at a pool that may be suitable for arroyo toad tadpoles.

Water and Habitat Within Pool

1. Coordinates: Record the Lat/Long field location, for where you are recording water quality data in the pool.
2. Measure the depth of the water right next to the tadpoles. If there are lots of tadpoles, measure the depth next to the point of greatest tadpole density.
3. Measure surface water velocity in meters per second. Put small stick/branch in pool, time for 10 seconds, mark the distance moved, and measure with ruler or measuring tape. Do this 3 times and record the average of the 3 measurements. (1cm=.01m, if stick moves 8 cm in 10 seconds- the speed would be 0.08 m/s).
4. Record the dominant substrate of the bottom of the pool; Clay/silt, sand, gravel, pebble/cobble, boulder/bedrock.
5. Record the pool type: Natural- within main channel, Natural- outside main channel, Road rut, Dirt Road crossing, or Arizona (paved) Road crossing.
6. Transparency: Do a visual estimate of water transparency of the water at mid-channel (if possible) and choose the proper category. An easy method is to set a penny in the bottom of the pool. Choose one of the following options: “Clear” = can see the year on penny clearly in bottom of pool, “Moderate/Translucent” = cannot see year, but can see outline of penny, or “Opaque” = cannot see year or outline of penny.
7. Estimate the percent of sand cover in the bottom of the pool. The options are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.
8. Estimate the percent vegetative cover of aquatic plants (floating/submerged) in the pool.
9. Estimate the percent vegetative cover of aquatic emergent plants in the pool.

10. Estimate the percent vegetative cover of floating algae mat in the pool.

Animals Within Pool

1 Record the species of each animal in the pool. This is even if you have already recorded the same species along the channel.

2 Record Y/N to indicate if the species was documented within the pool.

3 Record the age of each species located in the pool.

   a. For arroyo toad metamorphs, also record and photograph any abnormalities or deformities.

Ending a 125 m Segment

Documenting Additional Arroyo Toad Data

1. For the wetted portion of the segment record the following arroyo toad characteristics.

   a. Count of tadpoles: Estimate and record count of arroyo toad tadpoles. The options are 0, 1 - 10, 11 - 25, 26 - 50, 51 - 100, 101 – 250, 251 – 500, 501 – 1000, > 1000.

   b. % of reach with tadpoles: Estimate and record % of arroyo toad tadpoles. The options for percentage are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%. Note the percent of tadpoles cannot be greater than the % wet within the segment. For example, if 50% of the segment is wet than % tadpoles should be 26-50% or less.

   c. % early tadpoles: Estimate and record % of early (black with small white spot) arroyo toad tadpoles. The options for percentage are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.

   d. % mid tadpoles: Estimate and record % of mid (tan or black with more white spotting) arroyo toad tadpoles. The options for percentage are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.

   e. % late tadpoles: Estimate and record % of late (tan with legs) arroyo toad tadpoles. The options for percentage are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.

   f. Notes: Add any relevant information on tadpole properties that have not yet been recorded.

Documenting Landscape and Vegetation Components

Once a visual survey is complete, riparian and upland vegetation communities in the water and along the watercourse need to be recorded. Dominant substrate on the banks and in the water, riparian vegetation types, vegetative cover in the channel and on the banks, and amount aquatic refugia (see Appendix 2 for definitions) will be recorded in this section and will be assessed based off observations and mental notes made while walking the segment. If there are drastic differences in the estimations from each team member it is best to take an average of the

two estimates or to re-estimate the proportion of the habitat components in that segment if you plan on passing through again on your way back to the vehicle.

In the Landscape and Vegetation sections, you will need to record both measured and non-measured habitat components of the segment. Measurable habitat components (those that you use a range finder for) should be measured at the end of each segment regardless of how representative the point location is to the rest of the segment. Estimated (non-measured) habitat components should be recorded upon completion of the segment and should be representative of the entire segment (using what you have mentally noted or taken notes on along the way). See Appendix 1 for definitions of landscape variables.

At the end of the segment, record the information on the non-native plants, landscape, vegetation, cover, stream characteristics, and water properties as follows:

1. In the "Exotic Plants" section, record any **non-native** plants observed. Some common non-native plants include arundo (*Arundo donax*), tamarisk (*Tamarix sp.*), watercress (*Rorripa nasturtium aquaticum*), mustard (*Brassica nigra*), and floating primrose (*Ludwigia sp.).*

    a. Plant Species: Document the species of plant detected. Remember, this field is to record non-native plants only. See plant field guides for identification and lists of invasive non-native plant species.

    b. Size Class: For each species report the abundance class of that species across the segment. The options are few plants, scattered small patches, or large contiguous stands.

    c. Notes: Record any other information that is pertinent to non-native plants in this field.

2. In the Landscape/Vegetation section, you will need to record both measured and non-measured habitat components of the segment. Measurable habitat components (those that you use a range finder for) should be measured at the end of each 125 m segment regardless of how representative the point location is to the rest of the segment. Estimated (non-measured) habitat components should be recorded upon completion of the 125 m segment and should be representative of the entire 125 m segment (using what you have mentally noted or taken notes on along the way). Note sections 2a-f can be omitted when conducting a repeat visit within the same year.

    a. Channel Width/Bankfull (m): Measure and record the channel width using a measuring tape or rangefinder. (Figure 2, See Appendix 1 for definitions of landscape variables).

    b. Flood Prone Width: Measure and record the flood prone width using a measuring tape or rangefinder. (Figure 2, See Appendix 1 for definitions of landscape variables). Entrenchment Ratio: divide the flood plain width by the channel/bankfull width to determine the entrenchment ratio. (See Appendix 1 for definition).

    c. Percent Overhead Canopy: Estimate the percent of canopy cover over the channel in the 125 m segment. Estimate the proportion of the creek and immediate riparian area that is open to the sky and estimate a percentage for this field. This would be cover

from trees and tall shrubs growing in the channel and on the bank, shading the channel. The options are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.

d. Riparian Community: Record the dominant riparian community along the 125 m segment. This is typically the habitat adjacent to the channel on the bank and in the floodplain. (See Appendix 1 for definition and Appendix 2 for a list of vegetative communities).

e. Dominant Riparian Plants: Record the top three dominant riparian plant species seen along the 125 m segment. Each plant should represent at least 10% of the riparian community or it should not be included. For example, if the segment is largely a monotypic stand of willow, with no other co-dominants ≥ 10%, record willow only.

f. Notes: Add any relevant information on landscape and vegetation that have not yet been recorded.

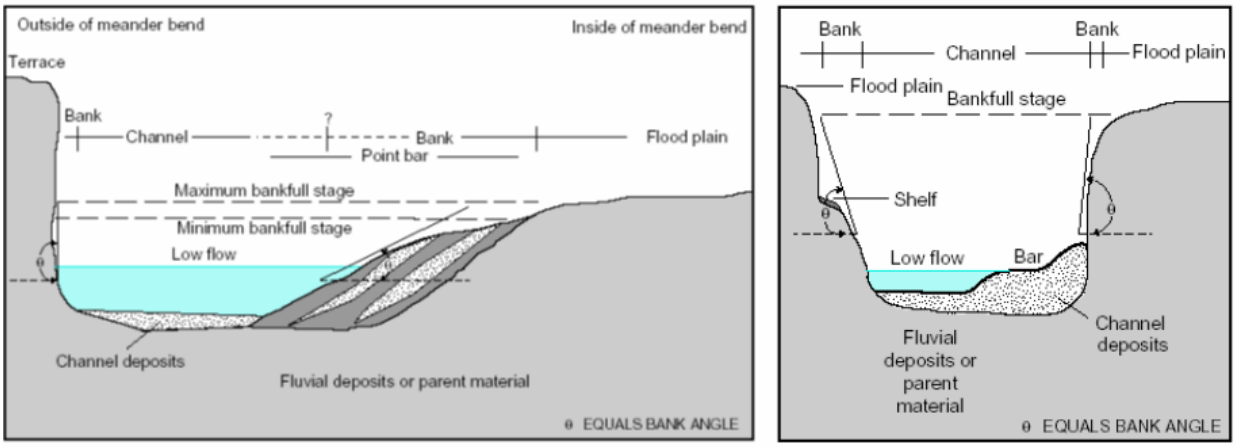

Figure 2. Bankfull and Flood Prone Width Examples.

Documenting Water and Habitat Characteristics

3. At the end of the segment estimate and record characteristics of the wetted portion of the segment.
   a. End Time: Enter the time that you finished surveying the segment.
   b. Percent Wet Length of Survey: Record the percentage of the length of the 125 m segment that contained water.
   c. Percent Reach with Shallow Pooling Water: Estimate the percentage of the segment containing shallow pooling water (water less than 10 cm deep with little or no water movement). Include side pools, pooling water along the side of the channel, within main channel, and isolated pools when making this estimate. Options are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.
   d. Percent Reach with Medium Pooling Water: Estimate the percentage of the segment containing medium pooling water, (water depth greater than 10 cm and less than 1 m). Include side pools, pooling water along the side of the channel, within main channel, and isolated pools when making this estimate. Options are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.

e. Percent Reach with Deep Pooling Water: Estimate the percentage of the segment containing deep pooling water, (water depth greater than 1 m deep). Include side pools, pooling water along the side of the channel, within main channel, and isolated pools when making this estimate. Options are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.

Note % reach with shallow/medium/deep pools cannot be greater than the % Wet Length of survey. For example if 50% of the reach is wet, the % of each type should add up to 50.

f. Plunge Pools Present: Record whether or not plunge pools were present. (See Appendix 1 for definition). Record Yes (Y), No (N), The options are 1 - 5, 6 - 10, 11 - 20, 21 - 30, 31 - 50, and 51 - 100).
g. Estimate the percent vegetative cover of aquatic plants (floating/submerged) in the segment.
h. Estimate the percent vegetative cover of aquatic emergent plants in the segment.
i. Estimate the percent vegetative cover of floating algae mat in the segment.
j. Aquatic Substrate: Estimate and record the top three dominant substrate types within the main channel and the relative percentage of each along the 125 m segment. The choices for substrate are clay, silt, sand, pebbles, cobble, boulders / bedrock, leaf-litter, and fallen logs / trees. The options for percentage are 0%, 1 - 10%, 11 - 25%, 26 - 50%, 51 - 75%, 76 - 100%.

Documenting Disturbance and Impacts to the Site

i. Disturbance Type: Document any disturbance seen and record the nature of the disturbance that was at the survey segment. Record all that apply (e.g., heavy foot traffic, trash, road/vehicle crossings, fire, etc.)

    - Intensity of Disturbance: Estimate the level of the disturbance across the 125 m segment as a whole. The options are light, moderate, and heavy.

j. Notes: Add any relevant information on the stream properties that have not yet been recorded.

End of Survey Attributes

1. End Coordinates: Record the coordinates of the location where you are ending the survey. Record the latitude, longitude, elevation, estimated positioning error (EPE), and datum.
2. End Photo: Take end photos at the end of each segment. First take a photo facing upstream and then one facing downstream. Record the photo numbers. In the appropriate fields indicate that it is an end photo, the first and last photo numbers, and any necessary photo notes.
3. End Weather: Record the following weather characteristics.
    a. Weather Conditions: Select the general sky conditions. The options are: clear or few clouds, partly cloudy or variable, cloudy or overcast, fog, mist or drizzle, showers or light rain, heavy rain, sleet or hail, snow, and no data.
    b. Air Temperature (ºC): Measure air temperature (in degrees Celsius). Record temperature 1 m off the ground in the shade.

c. Weather Notes: Record any additional relevant weather information here (i.e., if there were any changes in the weather patterns such as rain during the middle of the survey).

4. Notes: Enter any other relevant information to the survey that you have not yet recorded.

The visual survey for this segment is complete. Repeat for all segments in the survey.

Post-Survey Procedures

When you are finished with your field survey there are several post survey procedures that must be completed to 1) to ensure that your data are correct and can be read by anyone requesting it, and 2) prevent the spread of biological pathogens (Appendix 5).

1. Immediately after returning from the field, or before heading to another site all equipment coming in contact with water or mud (i.e., boots, dip nets, seine nets, plastic specimen containers) must be thoroughly disinfected in a 10:1 water / bleach mixture to prevent moving pathogens between study sites.

2. Conduct a quality assurance/quality control (QA/QC) check by reviewing your survey data. Correct any mistakes.

3. Label photographs and send to project lead.

4. Get positive species identifications from experts if needed.

5. Send data to USGS: Denise R. Clark (drclark@usgs.gov, 619-988-3631)

6. Make sure pH, and conductivity, are calibrated and properly stored according to directions included with the model you have.

Second Site Visit

When conducting a repeat visit to a site/segment follow all steps outlined in the "Pre-Survey Procedures" and "Survey Protocol" sections. In the "Ending a 125 m Segment" section, omit section 2a-f in the "Documenting Landscape and Vegetation Components" section. The rest can be completed as outlined.

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Appendix 1. Landscape and water chemistry definitions. (Most material in this section is directly taken or adapted from Fitzpatrick et al., 1998).

Aquatic Refugia: Any material within the water or on the surface that provides shelter, cover, or hiding place, (i.e., rocks, downfall in the form of logs, branches, woody debris, and artificial materials, undercuts of banks, tree roots, rock crevices, aquatic submerged vegetation, emergent vegetation, and other floating material).

Bank: The sloping ground that borders a stream and confines the water in the natural channel when the water level, or flow, is normal. It is bordered by the flood plain and channel.

Bankfull Width: The width of the channel between the top of the natural banks. Bankfull level is the point at the top of the channel where, under yearly high flow conditions, the water level would be even with the top of the banks, or in a floodplain river, at the point just before water would spill over onto the floodplain. Signs of bankfull depth include vegetation changes, changes in the bank/channel substrate, and presence of drifted material "nests".

Basking Area: Area above the surface of the water where sunny space is available for animals to rest and sun themselves (i.e., rocks, sunny banks).

Channel: The channel includes the thalweg and streambed. Bars formed by the movement of streambed are included as part of the channel.

Conductance: Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. (https://www.fondriest.com/environmental-measurements/parameters/water-quality/conductivity-salinity-tds/)

Disconnected Pools: Any pool that is completely disconnected from the main channel.

Dissolved Oxygen: The concentration of oxygen dissolved in water, expressed in mg / l or as percent saturation, where saturation is the maximum amount of oxygen that can theoretically be dissolved in water at a given altitude and temperature. (www.biology-online.org)

Disturbance: Any natural or artificial destruction and/or alteration of the habitat (e.g., flood, fire, beaver dams, vehicle, trail, trash, etc.).

Downfall: Any forest material that has fallen (downfall in the form of logs, branches).

Drainage: The area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel.

Entrenchment Ratio: The ratio of the width of the flood-prone area to the bankfull surface width of the channel.

Expected Species: Species that are known to be in the area and whose presence can be reasonably expected based on the presence of basic habitat (e.g., water) and the time of the year.

Flood Plain: The relatively level area of land bordering a stream channel and inundated during moderate to severe floods. The level of the flood plain is generally about the stage of the 1 to 3 year flood.

Flood Prone Width: The width measured at an elevation which is determined at twice the maximum bankfull depth (1 to 50 year flood; Rosgen, 1994).

Overhead Canopy: The area of the stream covered by the topmost vegetative cover. Can be calculated by estimating the average percent of the sky visible between 45 degree upward angles of the bank.

Overstory: The area of the stream (wetted portion only) covered by low growth vegetation, not including the overhead canopy cover.

pH: An expression of the intensity of the basic or acid condition of a liquid; may range from 0 to 14, where 0 is the most acid and 7 is neutral. Natural waters usually have a pH between 6.5 and 8.5.

Plunge Pool: When cascading water forms a pool (generally in higher gradient streams).

Pool (Pooling water): A part of the reach with little velocity, commonly with water deeper than surrounding areas, however, can also be areas of shallow slow moving water alongside moving channel.

Riffle: A shallow part of the stream where water flows swiftly over completely or partially submerged obstructions to produce surface agitation.

Riparian: Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands

Run: A part of a stream with moderate velocity and little or no surface turbulence. Usually with similar depths along length.

Side Pool: Any still water area that adjoins or is part of the main area channel.

Slope: A measure of the angle of the ground with respect to the plane of the horizon. Also called “inclination.” Measured by dividing the “rise” (difference in elevation between point A and point B) by the “run” (the length of the distance between point A and point B).

Splash Zone: Where water splashes against the substrate (i.e., a rock wetted by cascading water).

Substrate: The surface composition of the ground. (Aquatic substrate = the ground composition under the water, usually cobble, gravel, silt, etc.; Terrestrial substrate = the ground composition on the banks and upland, usually boulder, cobble, leaf litter, etc.)

Terrace: An abandoned flood-plain surface. A terrace is a long, narrow, level or slightly inclined surface that is contained in a valley and bounded by steeper ascending or descending slopes, and it is always higher than the flood plain. A terrace may be inundated by floods larger than the 1 to 3 year flood.

Thalweg: The line formed by connecting points of minimum streambed elevation; deepest part of the channel (Leopold et al., 1964).

Transparency: For this protocol, a measure of how clear or silted the water is.

Undercuts: Any overhanging bank which provides cover along the perimeter of the pool.

Upland: The area or habitat outside of the riparian corridor.

Wadeable: Sections of a stream where an investigator can wade from one end of the reach to the other, even though the reach may contain some pools that cannot be waded.

Wet Braids: When the water flows in a braided pattern around islands and bars, dividing and reuniting as it flows downstream.

Appendix 2. Vegetation communities commonly found in southern California (Holland, 1986; Sawyer and Keeler-Wolfe, 2003; SANDAG, 2006).

Vegetative Community	Abbreviated List	Description	Name that Populates Database	Element Code
Chaparral				
	Mixed Chaparral	general chap	chaparral	37000
	Chamise Chaparral	chamise dominate	chamise chaparral	37200
	Scrub Oak Chaparral	scrub oak dominate	scrub oak chaparral	37900
	Manzanita Chaparral	manzanita dominate	upper sonoran manzanita chaparral	37B00
Desert				
	Creosote Bush Scrub	creosote dominate	mojave creosote bush scrub	34100
	Wash Scrub	sandy canyon bottom with shrubs	mojave wash scrub	34250
	Blackbush Scrub	blackbush dominate	blackbush scrub	34300
	Tamarisk Scrub	tamarisk dominate	tamarisk scrub	63810
	Sonoran Cottonwood-Willow Riparian	desert	sonoran cottonwood-willow riparian forest	61810
	Fan Palm Oasis	fan palm dominate	desert fan palm oasis woodland	62300
	Mojave Riparian Forest	cottonwood and willow	mojave riparian forest	61700
	Joshua Tree Woodland	Joshua tree dominate	Joshua tree woodland	73000
	Desert Mountain White Fir	desert - white fir dominate	desert mountain white fir	85330
Forest				
	Knobcone Pine	1000-5000 ft	knobcone pine forest	83210
	Coulter Pine	4000-5000 ft	coulter pine forest	84140
	Bigcone Spruce-Canon Oak	douglas fir and live oak dominate	bigcone spruce-canon oak forest	84150
	Westside Ponderosa Pine	2000-5000 ft	westside ponderosa pine porest	84210
	Jeffrey Pine	5500-8000 ft	Jeffrey pine forest	85100
	Jeffrey Pine-Fir	6000-8000 ft	Jeffrey pine-fir forest	85210
	White Fir	7500-9500 ft	southern California white fir forest	85320
	Lodgepole Pine	9000-11000 ft	lodgepole pine forest	86100
	Subalpine	9500-11200 ft	southern California subalpine forest	86500
	Cypress	cypress dominated	southern interior cypress forest	83230
Grassland				
	Non-Native	non-native grasses	non-native grassland	42200
	Native	bunchgrass dominate	native grassland	42100
Meadows/Marshes				
	Coastal Salt Marsh	salt tolerant plants	southern coastal salt marsh	52120
	Brackish Marsh	salt marshes with freshwater input	coastal brackish marsh	
	Montane Freshwater Marsh	permanently flooded by fresh water	montane freshwater marsh	52430
	Montane Meadow	herb grass dominated opening in	montane meadow	45100
	Pavement Plain	Jeffrey pine forest	pavement plain	47000
Riparian				
	Cottonwood Willow	non-desert	southern cottonwood willow riparian forest	61330
	Coast Live Oak	live oak dominate	southern coast live oak riparian forest	61310
	Alder	alder dominate	white alder riparian forest	61510
	Sycamore-Alder	sycamore, alder dominate	southern sycamore-alder riparian woodland	62400
	Mule Fat Scrub	mule fat dominate	mule fat scrub	63310
	Willow Scrub	willow dominate	southern willow scrub	63320
	Tamarisk Scrub	tamarisk dominate	tamarisk scrub	63810
	Arundo	arundo dominate	arundo	RNF01
Scrub				
	Sage Scrub	low soft-woody subshrubs (to 1 m high)	coastal scrub	32000
Urban/Invasive				
	Arundo Scrub/Forest	arundo dominate	arundo scrub / forest	RNF01
	Tamarisk Scrub	tamarisk dominate	tamarisk scrub	63810
	Eucalyptus Woodland	eucalyptus dominate	eucalyptus woodland	11100
	Other Non-Native Community		other non-native community	11000
	Urban/Developed		urban / developed	12000
	Agriculture		general agriculture	18000
	Field/Pasture		field / pasture	18310
	Unvegetated	no vegetation present	unvegetated habitat	13000
Woodland				
	Oak	oak dominate	oak woodland	71100
	CA Walnut	CA walnut dominate	California walnut woodland	71210
	Pinon/Juniper	pinon / juniper dominate	pinon and juniper woodland	72000

Appendix 2a. Vegetation communities commonly found in southern California (Holland, 1986; Sawyer and Keeler-Wolfe, 2003; SANDAG, 2006)

SCRUB

SAGE SCRUB

Element Code: 32000

Combined several sage scrub vegetation communities – description from the Diegan Coastal Sage Scrub community, element code – 32500.

Description: Low, soft-woody subshrubs (1 m tall) that is most active in winter and early spring. Many taxa are facultatively drought deciduous. Dominated by CA sagescrub (*Artemisia californica*) and CA buckwheat (*Eriogonum fasciculatum*) together with laurel sumac (*Malosma laurina*) and white sage (*Salvia apiana*). Stem and leaf succulents, while present, are not nearly as conspicuous as in Maritime Succulent scrub (32400).

Site Factors: Typically, on low moisture-availability sites: steep, xeric slopes or clay-rich soils that are slow to release stored water. Intergrades at higher elevation s with several chaparrals (37000) or, in drier more inland areas with Riversidean Sage Scrub (32700).

Characteristic Species: CA sagebrush (*Artemisia californica*), CA buckwheat (*Eriogonum fasciculatum*), bush-snapdragon (*Galvesia speciosa*), isocoma (*Haplopappus venetus*), CA tree mallow (*Lavatera assurgentiflora*), CA broom (*Lotus scoparius*), chaparral mallow (*Malacothamnus fasciculatus*), laurel sumac (*Malosma laurina*), lemonadeberry (*Rhus integrifolia*), white sage (*Salvia apiana*), foothill stipa (*Stipa lepida*).

Distribution: This is a wide-spread coastal sage scrub in coastal southern CA from LA into Baja CA.

DESERT

CREOSOTE BUSH SCRUB

Element Code: (34100)

Description: Shrubs, 0.5 - 3 m tall, widely spaced, usually with bare ground between. Growth occurs during spring (or rarely in summer or fall) if rainfall is sufficient. Growth is prevented by cold in winter and limited by drought at other seasons. Many species of ephemeral herbs may flower in late March and April if the winter rains are sufficient. Other, less numerous species of annuals appear following summer thundershowers. This is the basic creosote scrub of the Mojave Desert, dominated by creosote bush (*Larrea tridentate*) and white bur-sage (*Ambrosia dumosa*).

Site Factors:
Well-drained secondary soils with very low available water holding capacity on slopes, fans, and valleys rather than upland sites with thin residual soils or sites with high soil salinity. Winter

temperatures often below freezing. Intergrades at higher elevations with Shadscale Scrub (36140), or Joshua Tree Woodland (73000), at lower elevations or more osmotic sites with Desert Chenopod Scrub (36100).

Characteristic Species: white bur-sage (*Ambrosia dumosa*), desert senna (*Cassia armata*), Mormon tea (*Ephedra nevadensis*), burrobush (*Hymenoclea salsola*), creosote bush (*Larrea tridentata*), box thorn (*Lycium* spp.).

Distribution: Extensive from the Death Valley region southward across the Mojave Desert to the little San Bernardino Mountains, eastward to northwestern Arizona and southern Nevada. The dominate plant community below 3,000 or 4,000 feet (910 - 1210 m) in this region.

WASH SCRUB

Element Code: (34250)

Description: A low, open community with a scattered to locally dense overstory of microphyllous trees.

Site Factors: Sandy bottoms of wide canyons, incised arroyos of upper bajadas, and sandy, braided, shallow washes of the lower bajadas, usually below about 5,000 feet.

Characteristic Species: catclaw (*Acacia greggii*), alkali saltbush (*Atriplex polycarpa*), desert willow (*Chilopsis linearis*), rabbitbrush (*Chrysothamnus paniculatus*), smoke tree (*Dalea spinosa*), cheesebush (*Hymenoclea salsola*), desert fir (*Peucephyllum schottii*), honey mesquite (*Prosopis glandulosa torreyana*), screwbean mesquite (*P. pubescens*), Desert Almond (*Prunus fasciculata*), Skunk bush (*Rhus trilobata anisophylla*).

Distribution: Washes, arroyos, and canyons of intermittent streams throughout the Mojave Desert region.

BLACKBUSH SCRUB

Element Code: (34300)

Description: Low, often intricately branched shrubs, 0.5 - 1 m tall, with crowns usually not touching and with bare ground between plants. Most growth and flowering occurs in late spring. Dormant in winter (from cold) and probably in summer and fall (from drought).

Site Factors: On dry, well-drained slopes and flats with shallow often calcareous soils of very low water holding capacity, often intergrading with Great Basin Sagebrush Scrub (35210), Joshua Tree Woodland (73000), or Pinyon Juniper Woodlands (72000), but typically at somewhat lower elevations, warmer, and drier.

Characteristic Species: Utah agave (*Agave utahensis*), shadescale (*Artemisia spinescens*), rabbitbrush (*Atriplex confertifolia*), rubberbush (*Chrysothamnus teretifolius*), blackbush (*Coleogyne ramosissima*), Mormon tea (*Ephedra nevadensis*), CA buckwheat (*Eriogonum fasciculatum polifolium*), winterfat (*Eurotia lanata*), big galleta (*Hilaria rigida*), hop-sage

(*Grayia spinosa*), spiny desert olive (*Menodora spinescens),* Mexican bladder sage (*Salazaria mexicana*), Dorr's sage (*Salvia dorrii*), squirreltail (*Sitanion longifolium*), desert globmallow (*Spheralcea ambigua*), turpentine-broom (*Thamnosma Montana*), Joshua tree (*Yucca baccata*).

Distribution: From the Owens Valley region (Inyo and southern Mono Counties to the Mojave Desert (Kern and San Bernardino Counties). Typically between 4000 and 7000 feet.

TAMARISK SCRUB

Element Code: (63810)

Description: A weedy, virtual monoculture of any of several tamarisk (*Tamarix*) species, usually supplanting native vegetation following major disturbance.

Site Factors: Sandy or gravelly braided washes or intermittent streams, often in areas where high evaporation increases the streams saltiness. Tamarisk is a strong phreatophyte and a prolific seeder, attributes which predispose the species to be aggressive competitors in disturbed riparian corridors.

Characteristic Species: big saltbush (*Atriplex lentiformis*), Palmer's coldenia (*Coldenia palmeri*), salt grass (*Distichlis spicata*), arrow-weed (*Pleuchea sericea*), sandbar willow (*Salix exiqua*), tamarix (*Tamarix chinensis*), (*T. ramosissima*).

Distribution: Widely scattered and increasing its range, throughout the drier parts of CA from the rain shadow east of the Inner North Coast Ranges south through the Great Valley to southern CA and across the deserts to Nevada, Arizona and beyond.

SONORAN COTTONWOOD-WILLOW RIPARIAN

Element Code: (61810)

Description: Winter-deciduous, broad-leafed streamside forests to about 60 feet tall, dominated by cottonwood (*Populus fremontii macdougallii*) with dense understories of several *Salix* species. There appear to be virtually no compositional data available for this type.

Site Factors: Deep well-watered, loamy alluvial soils along the near-channel floodplains of perennial desert rivers. This forest intergraded on sites slightly higher above and farther away from the river channels with Mesquite Bosques (61820) before these were cut down for fence posts and fuel.

Characteristic Species: arundo (*Arundo donax*), devil-weed (*Aster spinosus*), big saltbush (*Atriplex lentiformis*), sticky baccharis (*Baccharis glutinosa*), (*B. glutinosa*), (*B. sarothroides)*, common reed (*Phragmites australis*), arrow-weed (*Pleuchea sericea*), cottonwood (*Populus fremontii macdougallii*), willow species *(Salix exiqua*), (*Salix gooddingii gooddingii*), (*Sesbania macrocarpa*), tamarix (*Tamarix* spp).

Distribution: Formerly extensive along the lower Colorado River buy now virtually eliminated by flood control projects, agriculture, or by tamarisk invasion.

FAN PALM OASIS

Element Code: (62300)

Description: Open to dense groves dominated by fan palms (*Washingtonia filifera*) to 75 - 100 feet tall. The understory is sparse in dense groves (where the ground is mulched by fallen fronds) or in more alkaline areas. More open or favorable sites may have a dense understory reminiscent of Mojave or Colorado Riparian Forests (61700, 61800) or Riparian Scrubs (62700, 62800).

Site Factors: Restricted to sites with high water tables in regions with high summer temperatures, mild winters, and little rain. The largest groves are in steep-sided canyons with permanent streams, or adjacent to large springs. Smaller groves occur in canyon bottoms with intermittent surface water, moist canyon sides, or seeps. Oases often have alkaline soils due to high evaporation. Intergrades (often abruptly) with Mojave Riparian Forest (61700), Mojave Mixed Scrub (32400), Desert Dry Wash Woodland (62200), or Sonoran Creosote Bush Scrub (33100).

Characteristic Species: southern maidenhair fern (*Adiantum capillus-veneris*), desert columbine (*Aquilegia shockleyi*), squaw waterweed (*Baccharis sergiloides*), netleaf hackberry (*Celtis reticulata*), thistle sp. (*Cirsium nidulum*), stream orchid (*Epipactis gigantean*), smooth horsetail (*Equisetum laevigatum*), velvet ash *(Fraxinus velutina*), alkali goldenbush (*Haplopappus acradenius*), common reed (*Phragmites australis*), CA sycamore (*Platanus racemosa*), arrowweed (*Pleuchea sericea*), western cottonwood (*Populus fremontii*), mesquite (*Prosopis gladulosa*), canyon live oak (*Quercus chrysolepis*), willow Sp. (*Salix exiqua*), (*S. gooddingii*), (*S. lasiolepis*), blue elderberry (*Sambucus mexicana*), alkali dropseed (*Sporobolis airoides*), tamarisk (*Tamarix* spp.), cat-tail (*Typha domingensis*), and nettle (*Urtica dioica*).

Distribution: Scattered in the canyons of the western edge of the Colorado Desert from near Twenty-nine Palms south into Baja CA, usually below 3000 feet.

MOJAVE RIPARIAN FOREST

Element Code: (61700)

Description: A relatively open, broad-leafed, winter-deciduous streamside forest dominated by western cottonwood (*Populus fremontii*), willow (*Salix gooddingii*), and (*S. laevigata*). The open canopy allows a dense shrubby understory of Torrey's saltbush (*Atriplex torreyi*), rabbitbrush (*Chrysothamnus nauseosus*), Woods' rose (*Rosa woodsii*), and sandbar willow (*Salix exiqua*) to prosper. Similar to and intergrading in the lower elevations of Inyo County with Modoc-Great Basin Cottonwood-Willow Riparian Forest (61610).

Site Factors: Flat, fine-grained, subirrigated alluvium along perennial desert rivers.

Characteristic Species: shadescale (*Atriplex confertifolia*), (*A. parryi*), (*A. torreyi*), rabbitbrush (*Chrysothamnus nauseosus*), Russian olive (*Eleagnus angustifoli*a), desert olive (*Forestiera neomexicana*), western cottonwood (*Populus fremontii*) (and var. *macdougallii*), Woods' rose

(*Rosa woodsii*) willow (*Salix exiqua*), (*S. gooddingii*), (*S. Laevigata*), greasewood (*Sarcobatus vermiculatus*), and tamarix (*Tamarix* spp.).

Distribution: Along the larger desert rivers (Owens, Mojave, Colorado) where the vegetation has not been cleared for irrigated agriculture or been dewatered by upstream diversions. Generally below about 4000 feet.

JOSHUA TREE WOODLAND

Element Code: (73000)

Description: An open woodland with Joshua trees (*Yucca brevifolia*) usually as the only arborescent species (to 12 m high) and numerous shrub species between 1 and 4 m tall. Little or no herbaceous understory during most of the year. The dominate species display a diversity of life forms: sclerophyllous evergreen trees and shrubs Yucca (*Yucca* spp.), microphyllous evergreen shrubs juniper (*Juniperus* spp.), semideciduous shrubs buckwheat, horsebrush (*Eriogonum, Tetradymia*), semi-succulents box thorn (*Lycium* spp.), and succulents prickly pear (*Opuntia* spp.). The main growing season is spring, with most growth limited by cold in winter and brought in summer and fall. Many species of ephemeral herbs may germinate following sufficient late fall or winter rains and flower in mid-spring.

Site Factors: Typically on sandy, loamy, or gravelly, well-drained gentle alluvial slopes. Transitional climatologically and biologically between low and high elevation desert regions. Intergrades at lower elevations with Mojave Creosote Bush Scrub (34100) (poorer soil drainage, colder winters from cold air drainage). At higher elevations, intergrades with Mojavean Pinyon-Juniper Woodland (72200) (cooler and moister, but better drained).

Characteristic Species: buckwheat (*Eriogonum fasciculatum*), (spp. *polifolium*), juniper sp. (*Juniperus californica*), (*J. osteosperma*), box thorn (*Lycium* spp.), prickly pear (*Opuntia* spp*.),* longspine horsebrush (*Tetradymia axillaris*), Joshua tree (*Yucca brevifolia*), Mojave yucca (*Y. schidigera*), banana yucca (*Y. baccata*), Great Basin sagebrush (*Artemisia tridentata*), (*Coreogyme ramossissina*), spiny hopsage (*Grayia spinosa*), juniper (*Juniperus californica*), creosote bush (*Larrea divaricata*), Anderson box thorn (*Lycium andersonii*), stipa (*Stipa speciosa*), Mormon tea (*Ephedra nevadensis*), big galleta (*Hilaria ridida*), spiny menodora (*Menodora spinescens*), branched pencil cholla (*Opuntia ramosissima*), and bladder sage (*Salazaria mexicana*).

Distribution: Desert slopes of the Southern Sierra Nevada, Tehachapi, and Transverse Ranges of Inyo, Kern, LA, San Bernardino, and northern Riverside Counties. Eastward across the Mojave Desert to southwestern Utah, mostly on the slopes of mountains and mesas. Extensive stands in the vicinity of Halloran Summit and Mountain Pass in northeastern San Bernardino County. One extensive stand west of the Sierran Crest on the watershed of the South fork of Kern River. Elevation from 2500 – 5000 feet (760 – 1520 m). Many of the characteristics species (but not Joshua trees (*Yucca brevifolia*) occur southward into San Diego County and northern Baja CA, on the Desert slopes of the Peninsular Ranges.

DESERT MOUNTAIN WHITE FIR

Element Code: (85330)

Description: Fairly low (to 50 feet) open forests dominated by the Rocky Mountain race of white fir (*Abies concolor*) and single leaf pinyon pine (*Pinus monophylla*). Understories are fairly open, shorter than 8 - 10 feet, characterized by several shrubs with affinities to the southern Rocky Mountains.

Site Factors: Steep, mesic, north-facing canons and slopes near mountain ridges and summits, mostly between 6200 and 7500 feet. Occurs on both granite and limestone parent materials.

Characteristic Species: Rocky Mountain maple (*Acer glabrum diffusum*), Coville's service-berry (*Amelanchier utahensis covillei*), sedge (*Carex brevipes*), rabbitbrush (*Chrysothamnus viscodiflorus*), Mormon tea (*Ephedra utridis*), Utah fendlerbush (*Fendlerella utahensis*), Utah fendlerella (*Franxinus anomala*), goldenbush (*Haplopappus cuneatus*), Mojave halimolobos (*Halimolobos diffusa jaegeri*), pink alumroot (*Heuchera rubescens pachypoda*), (*Holodiscus microphyllous*), juniper (*Juniperus osteosperma*), matted prickly-phlox (*Leptodactylon pungens hallii*), canyonlands biscuitroot (*Lomatium parryi*), (*Oryzopsis micrantha*), (*Philadelphus microphyllous stramineus*), singleleaf pinyon (*Pinus monophylla*), current (*Ribes cereum*), (*R. velutinum*), and desert snowberry (*Symphoricarpos longiflorus*).

Distribution: Limited to the higher ranges of the eastern Mojave Desert: Kingston, Clark, and New York Mountains.

CHAPARRAL

MIXED CHAPARRAL

Element Code: (37000)

Combined several chaparral vegetation communities – description from the Southern Mixed Chaparral community (37120)

Description: Similar to Northern Mixed Chaparral (37110) but typically not quite so tall (1.5 – 3 m) or dense. Occasionally with patches of bare soil or forming a mosaic with Venturan Coastal Sage Scrub (32300) or Riversidean Sage Scrub (32700). Divisible into Granitic (37121) and Mafic (37122) subtypes based on substrate, but floristic distinctions between these two subtypes remain unknown.

Site Factors: Similar to Northern Mixed Chaparral (37110) but somewhat lower precipitation and more moderate temperatures. Often adjacent to and on moister sites than Chamise Chaparral (37200). Transitional from the chaparral habitats of California to the coastal semi-desert of Baja CA Norte.

Characteristic Species: chamise (*Adenostoma fasciculatum*), manzanita sp. (*Arctostaphylos gladulosa*), (*A. pennisularis*), Mariposa lily (*Calochortus albus*), ceanothus (*Ceanothus tomentosus olivaceus*), (*C. verrucosus*), mountain mahogany (*Cercocarpus minutiflorus*),

bushrue (*Cneoridium dumosum*), chocolate lily (*Fritillaria biflora*), toyon (*Heteromeles arbutifolia*), honeysuckle (*Lonicera subspicata*), scrub oak (*Quercus dumosa*), laurel sumac (*Malosma laurina*), spiny redberry (*Rhamnus crocea*), lemonadeberry (*Rhus ovata*), gooseberry (*Ribes indecorum*), mission manzanita (*Xylcoccus bicolor*), Mojave yucca (*Yucca schidigera*), and our lord's candle (*Y. whipplei*).

Distribution: Coastal foothills of San Diego County and Northern Baja CA, usually below 3000 feet (910 m).

CHAMISE CHAPARRAL

Element Code: (37200)

Description: A 1 - 3 m tall chaparral overwhelmingly dominated by chamise. Associated species contribute little to cover. Adapted to repeated fires by stump sprouting. Mature stands are densely interwoven with very little herbaceous understory or litter.

Site Factors: Similar to Upper Sonoran Mixed Chaparrals (37100), but on shallower, drier soils or at somewhat lower elevations. Often on xeric slopes and ridges, with adjacent more mesic sites mantled by Upper Sonoran Mixed Chaparrals.

Characteristic Species: chamise (*Adenostoma fasciculatum*), manzanita sp. (*Arctostaphylos glauca*), (*A. tomentosa*), *(A. viscida*), mariposa lily (*Ceanothus cuneatus*), (*C. papillosus*), birch-leaf mountain mahogany (*Cercocarpus betuloides*), hairgrass (*Dendromecon rigida*), CA buckwheat (*Eriogonum fasciculatum*), yerba santa (*Eriodictyon californicum*), deerweed (*Lotus scoparius*), holly-leaf cherry (*Prunus ilicifolia*), scrub oak (*Quercus dumosa*), sugar bush (*Rhus ovata*), lemonadeberry (*R. laurina*), white sage (*Salvia apiana*), black sage (*S. mellifera*), ashy spike-moss (*Selaginella cinerascens*), Mojave yucca (*Yucca schidigera*), and our lord's candle (*Y. Whipplei*).

Distribution: General distribution similar to Northern Mixed Chaparral (37110) but relatively infrequent in the north compared to its abundance in the south. The predominate chaparral type in Ventura, LA, San Bernardino, Riverside, and San Diego Counties.

SCRUB OAK CHAPARRAL

Element Code: (37900)

Description: A dense, evergreen chaparral to 20 feet tall, dominated by scrub oak (*Quercus dumosa*) with considerable birch-leaf mountain mahogany (*Cercocarpus betuloides*).

Site Factors: Somewhat more mesic than many chaparrals, and often occurring at slightly higher elevations (to 5000 feet). These more favorable sites recover from fire more quickly than other chaparrals. Substantial leaf litter accumulates.

Characteristic Species: Del Mar manzanita (*Arctostaphylos glandulosa*), deerbrush (*Ceanothus integerrimus*), CA whitethorn (*C. leucodermis*), blueblossom (*C. thrysiflorus*), birch-leaf mountain mahogany (*Cercocarpus betuloides*), CA ash (*Fraxinus dipetala*), narrow-leaved

bedstraw (*Galium angustifolium*), canyon silktassel (*Garrya veatchii*), toyon (*Heteromeles arbutifolia*),honeysuckle (*Lonicera* spp.), chaparral pea (*Pickeringia montana*), holly-leaved cherry (*Prunus ilicifolia*), scrub oak (*Quercus dumosa*), live oak (*Q. wislizenii frutescens*), spiny redberry (*Rhamnus californica*), holly-leaved redberry (*R. ilicifolia*), poison oak (*Toxicodendron diversilobum*).

Distribution: Western Sierran foothills and North Coast ranges from Tehama County south through the southern California mountains to Baja California.

MANZANITA CHAPARRAL

Element Code: (37B00)

Description: A dense chaparral to 15 feet in which dominance is shared by chamise and various species of Manzanita.

Site Factors: Most stands appear to be disturbance followers, establishing after fire, logging, hydraulic mining, or other disruptions. Young conifers (especially white fir (*Abies concolor*) or ponderosa pine (*Pinus ponderosa*) often can be found beneath the shrub canopy in these seral stands.

Characteristic Species: chamise (*Adenostoma fasciculatum*), Del Mar manzanita (*Arctostaphylos gladulosa*), manzanita (*A. glauca*), big berry manzanita (*A. mariposa*), Indian manzanita (*A. mewukka*), pinemat manzanita (*A. nevadensis*), greenleaf manzanita (*A. patula*), sticky white-leaf manzanita (*A. viscida*), and whitethorn chaparral (*Ceanothus leucodermis*).

Distribution: Widespread in the Sierran foothills and Coast Ranges, usually at elevations higher than Chamise Chaparral (37200), but lower than Montane Chaparral (37500). Somewhat more patchily distributed along the coastal side of the Transverse and Peninsular Ranges, typically between 2500 and 5000 feet.

GRASSLAND

NON-NATIVE

Element Code: (42200)

Description: A dense to sparse cover of annual grasses with flowering culms 0.2 - 0.5 (1.0) m high. Often associated with numerous species of showy-flowered, native annual forbs (“wildflowers”), especially in years of favorable rainfall. Germination occurs with the onset of the late fall rains; growth, flowering, and seed-set occur from winter through spring. With a few exceptions, the plants are dead through the summer-fall dry season, persisting as seeds.

Site Factors: On fine-textured, usually clay soils, moist or even waterlogged during the winter rainy season and very dry during the summer and fall. Oak Woodland (71100) is often adjacent on moister, better drained.
Characteristic Species: slender wild oats (*Avena barbata*), wild oats (A. fatua), Brome sp. (*Bromus mollis*), (*B. rigidus*), red brome (*B. rubens*), Fillaree (*Erodium botrys*) red stem fillaree

(*E. cicutarium*), CA poppy (*Eschscholtzia californica*), gilia sp. (*Gilia spp*.), tarweed (*Hemizonia spp.*), goldfields (*Lasthenia spp*.), tidytips (*Layia spp*.), Italian ryegrass (*Lolium multiflorum*), lupine sp. (*Lupinus spp*.), pepperweed (*Lepidium dictyotum*), CA burclover (*medicago hispida*), (*Namophila manziesii*), owl's clover (*Orthocarpus spp*.), Phacelia (*Phacelia spp*.), Mediterranean schismus grass (*Schismus arabicua*), fescue sp. (*Vulpia megalura*), and (*V. microstachys*).

Distribution: Valleys and foothills of most of California except for the north coastal and desert regions. Usually below 3000 feet, but reaching 4000 feet in the Tehachapi Mountains and interior San Diego County. Intergrades with Coastal Prairie (41000) along the central coast. Formerly occupied large portions of the Sacramento, San Joaquin, and Salinas Valleys as well as the LA basin, areas that are now agricultural or urban.

NATIVE

Element Code: (42100)

Combined several native vegetation communities – description is a combination of the Valley Needlegrass Grassland (42110) and the Serpentine Bunchgrass (42130) vegetation communities.

Description: Open grassland dominated by perennial bunchgrasses or a mid-height (to 2 feet) grassland dominated by perennial, tussock-forming Needlegrass (*Stipa pulchra*). Cover typically is low, but is markedly dominated by native species (usually much more so than Non-native Grasslands (42200) or Native and introduced annuals occur between the perennials, often actually exceeding the bunchgrasses in cover.

Site Factors: Serpentine Bunchgrass is restricted to serpentine sites. While Valley Needlegrass Grasslands usually on a fine-textured (often clay) soils, moist or even waterlogged during winter, but very dry in summer. Often interdigitates with Oak Woodlands (71100) on moister, better drained sites.

Characteristic Species: blow wives (*Achyrachaena mollis*), bentgrass (*Agoseris heterophylla*), wild oats (*Avena fatua*), goldenstar (*Bloomeria crocea*), brodiaea (*Brodiaea lutea*), ripgut brome (*Bromus diandrus*) brome sp. (*Bromus mollis*), red brome (*Bromus rubens*), serpentine reedgrass (*Calamagrostis ophitidis*), soap plant (*Chlorogalum pommeridianum*), farwell-to-spring (*Clarkia purpurea*), shooting star (*Dodecatheon jefferyi*), CA poppy (*Eschscholtzia californica*), fescue sp. (*Festuca grayii*), tarweed (*Hemizonia luzulaefolia*), trefoil (*Lotus subpinnatus*), oniongrass (*Melica californica*), (*M. imperfecta*), owl's clover (*Orthocarpus attenuatus*), plantain (*Plantago hookeriana californica*), bluegrass (*Poa scabrella*), stipa sp. (*Stipa cernua*), (*S. lepida*), (*S. pulchra*), fescue (*Vulpia microstachys*).

Distribution: Scattered widely through the Coast Ranges, less common in the Sierra Nevada and southern CA mountains.

RIPARIAN

COTTONWOOD WILLOW

Element Code: (61330)

Description: Tall, open, broad-leafed winter-deciduous riparian forests dominated by cottonwood sp. (*Populus fremontii*), (*P. trichocarpa*), and several tree willows. Similar to Central Coast Cottonwood-Sycamore Riparian Forest (61210), although apparently with less coast live oak (*Quercus agrifolia*) or white alder (*Alnus rhombifolia*) (this merits further study). Understories usually are shrubby willows.

Site Factors: Sub-irrigated and frequently overflowed lands along rivers and streams. The dominate species requires moist, bare mineral soil for germination and establishment. This is provided after flood waters recede, leading to uniform-aged stands in this seral type.

Characteristic Species: mugwort (*Artemisia douglasiana*), mule fat (*Baccharis viminea*), wild cucumber (*Marah macrocarpus*), western sycamore (*Platanus racemosa*), western cottonwood (*Populus fremontii*), cottonwood sp. (*P. trichocarpa*), willow sp. (*Salix gooddingii*), (*S. hindsiana*), (*S. lasiandra*), (*S. lasiolepis*), stinging nettle (*Urtica holosericea*).

Distribution: Along perennially wet steam reaches of the Transverse and Peninsular Ranges, from Santa Barbara County south to Baja California north and east to the edge of the deserts.

COAST LIVE OAK

Element Code: (61310)

Description: Open to locally dense evergreen sclerophyllous riparian woodlands dominated by coast live oak (*Quercus agrifolia*). This type appears to be richer in herbs and poorer in understory shrubs than other riparian communities. Similar to and questionably distinct from Central Coast Live Oak Riparian Forest (61220).

Site Factors: Bottomlands and outer floodplains along larger streams, on fin-grained, rich alluvium.

Characteristic Species: bigleaf maple (*Acer macrophyllum*), mugwort (*Artemisia douglasiana*), milkmaids (*Cardamine californica*), spotted hideseed (*Eucrypta chrysanthemifolia*), toyon (*Heteromeles arbutifolia*), keckiella (*Keckiella cordifolia*), honeysuckle (*Lonicera hispidula*), wild cucumber (*Marah macrocarpus*), fiesta flower (*Pholistoma auritum*), coast live oak (*Quercus agrifolia*), skunkbrush (*Rhus trilobata*), CA wild rose (*Rosa californica*), CA blackberry (*Rubus ursinus*), elderberry (*Sambucus Mexicana*), trip vine (*Symphoricarpos mollis*), poison oak (*Toxicodendron diversilobum*), CA laurel (*Umbellularia californica*).

Distribution: Canyons and valleys of coastal southern California, mostly south of Point Conception.

ALDER

Element Code: (61510)

Description: Medium-tall broad-leafed deciduous streamside forests dominated by (*Alnus rhombifolia*), with a shrubby, deciduous understory. Stands in the Coast Ranges have abundant (*Salix* spp.), (*Baccharis viminea*), (*Symphoricarpos* spp.), CA wild rose (*Rosa californica*), and poison oak (*Toxicodendron diversilobum*), while Sierran stands have understories rich in (*Cornus stolonifera*), (*Fraxinus latifolia*), and (*Rhododendron occidentale*). These two types probably should be separated. Riparian alder forests in southern CA need study – these too may be separable.

Site Factors: Best developed along rapidly flowing, well aerated perennial streams with coarse bedloads that reflect high stream power during spring runoff. These streams typically flow in bedrock-constrained, steep sided canyons, so the riparian corridor typically is rather narrow.

Characteristic Species: bigleaf maple (*Acer macrophyllum*), white alder (*Alnus rhombifolia*), mule fat (*Baccharis viminea*), blackfruit dogwood (*Cornus sessilis*), dogwood sp. (*C. stolonifera*), Oregon ash (*Fraxinus latifolia*), western azalea (*Rhododendron occidentale*), willow sp. (*Salix* spp.), and poison oak (*Toxicodendron diversilobum*).

Distribution: Perennial streams in incised canyons of the lower Sierra Nevada, Coast, Transverse, and Peninsular ranges, usually below about 6000 feet.

SYCAMORE-ALDER

Element Code: (62400)

Description: A tall, open, broad-leafed, winter-deciduous streamside woodland dominated by western sycamore (*Platanus racemosa*), (and often also white alder (*Alnus rhombifolia*)). These stands seldom form closed canopy forests, and even may appear as trees scattered in a shrubby thicket of sclerophyllous and deciduous species. Lianas include CA blackberry (*Rubus ursinus*) and poison oak (*Toxicodendron diversilobum*). Distinctions between this type and Sycamore Alluvial Woodland (62100) merit additional study.

Site Factors: Very rocky streambeds subject to seasonally high-intensity flooding. (*Alnus*) increases in abundance on more perennial streams, while (*Platanus*) favors more intermittent hydrographs.

Characteristic Species: bigleaf maple (*Acer macrophyllum*), white alder (*Alnus rhombifolia*), mugwort (*Artemisia douglasiana*), CA spikenard (*Aralia californica*), scouring rush (*Equisetum hyemale*), smilo grass (*Oryzopsis miliacea*), coast live oak (*Quercus agrifolia*), CA blackberry (*Rubus ursinus*), elderberry (*Sambucus Mexicana*), poison oak (*Toxicodendron diversilobum*), CA laurel (*Umbellularia californica*), and stinging nettle (*Urtica holsoericea*).

Distribution: Transverse and Peninsular ranges from Point Conception south into Baja California Norte

MULE FAT SCRUB

Element Code: (63310)

Description: A depauperate, tall herbaceous riparian scrub strongly dominated by mule fat (*Baccharis viminea*). This early seral community is maintained by frequent flooding. Absent this, most stands would succeed to cottonwood- or sycamore-dominated riparian forests or woodlands.

Site Factors: Intermittent stream channels with fairly coarse substrate and moderate depth to the water table. Frequently occurs as a patchy understory in light gaps in Sycamore Alluvial Woodlands (62100), especially under heavy grazing.

Characteristic Species: mule fat (*Baccharis viminea*), sedge sp. (*Carex barbarae*), willow sp. *(Salix exiqua*), (*S. hindsiana*), (*S. lasiolepis*), stinging nettle (*Urtica holosericea*).

Distribution: Widely scattered along intermittent streams and near larger rivers from about Tehama County south through the Coast Ranges and Sierra Nevada to San Diego and northwestern Baja California Norte, usually below about 2000 feet.

WILLOW SCRUB

Element Code: (63320)

Description: Dense, broad-leafed, winter-deciduous riparian thickets dominated by several willow sp. (*Salix*), with scattered emergent western cottonwood (*Populus fremontii*) and (*Plantanus racemosa*). Most stands are too dense to allow much understory development.

Site Factors: Loose, sandy or fine gravelly alluvium deposited near stream channels during flood flows. This early seral type requires repeated flooding to prevent succession to Southern Cottonwood-Sycamore Riparian Forest (61330).

Characteristic Species: arrowweed (*Pluchea sericea*), western cottonwood (*Populus fremontii*), willow sp. (*Salix gooddingii*), (*S. hindsiana*), (*S. laevigata arauipa*), (*S. lasiandra*), (*S. lasiolepis*), (*S. hindsiana*), (*S. leucodendroides*), others?

Distribution: Formerly extensive along the major rivers of coastal southern CA, but now much reduced by urban expansion, flood control, and channel “improvements”.

TAMARISK SCRUB

Element Code: (63810)

Description: A weedy, virtual monoculture of any of several *Tamarix* species, usually supplanting native vegetation following major disturbance.

Site Factors: Sandy or gravelly braided washes or intermittent streams, often in areas where high evaporation increases the streams saltiness. Tamarisk is a strong phreatophyte and a prolific

seeder, attributes which predispose the species to be aggressive competitors in disturbed riparian corridors.

Characteristic Species: big saltbush (*Atriplex lentiformis*), Palmer's coldenia (*Coldenia palmeri*), salt grass (*Distichlis spicata*), arrow-weed (*Pleuchea sericea*), sandbar willow (*Salix exigua*), tamarix (*Tamarix chinensis*), (*T. ramosissima*).

Distribution: Widely scattered and increasing its range, throughout the drier parts of CA from the rain shadow east of the Inner North Coast Ranges south through the Great Valley to southern CA and across the deserts to Nevada, Arizona and beyond.

ARUNDO SCRUB/FOREST

Element Code: (RNF01)

Description: A dense monoculture dominated by arundo also known as the giant reed (Arundo donax). This is a very invasive grass that was introduced to CA in the 1880's. This species persist in riparian areas, and reduces or replaces native species

WOODLAND

OAK

Element Code: (71100)

Combined several oak woodland vegetation communities – description from the Coast Live Oak Woodland community, element code – 71160

Description: Very similar to Oregon Oak Woodland (71110) within only one dominate tree, coast live oak (*Quercus agrifolia*), which is evergreen and reaches 10 - 25 m in height. The shrub layer is poorly developed, but may include toyon (*Heteromeles arbutifolia*), gooseberry (*Ribes* spp.), laurel sumac (*Rhus laurina*), or elderberry (*Sambucus mexicana*). The herb component is continuous and dominated by ripgut brome (*Bromus diandrus*) and several other introduced taxa.

Site Factors: Typically on north-facing slopes and shaded ravines in the south and more exposed sites in the north. Intergrades with Coastal Scrub (32000) and Upper Sonoran Mixed Chaparral (37100) on drier sites and with Coast Live Oak Forest (81310) or Mixed Evergreen Forest (81100) on moister sites.

Characteristic Species: CA buckeye (*Aesculus californica*), sanicle (*Sanicula laciniata*), toyon (*Heteromeles arbutifolia*), coast live oak (*Quercus agrifolia*), coffee berry (*Rhamnus californica*), elderberry (*Sambucus mexicana*), poison oak (*Toxicodendron diversilobum*), orange monkey flower (*Diplacus aurantiacus*), pacific pea (*Lathyrus vestitus*), CA sagebrush (*Artemisia californica*), pacific madrone (*Arbutus menziesii*), CA laurel (*Umbellularia californica*), gooseberry (*Ribes* spp.), ripgut brome (*Bromus diandurs*), chickweed (*Stellaria media*), bedstraw (*Galium apartine*), thistle (*Cirsium vulgare*), knotted hedgeparsley (*Torilis nodosa*).

Distribution: Outer south Coast Ranges, and coastal slopes of Transverse and Peninsular Ranges, usually below 4000 feet (1220 m). Intergrades with Blue Oak Woodland (71120) in inner South Coast Ranges and with Engelmann Oak Woodland (71180) in interior southern CA.

CA WALNUT

Element Code: (71210)

Description: Similar to and intergrading with Interior Live Oak Woodland (71150) or Coast Live Oak Woodland (71160), but with a more open tree canopy locally dominated by CA walnut (*Juglans californica*). The open tree canopy allows development of a grassy understory. In most sites, this understory is comprised of introduced winter-active annuals that complete most of their growth cycle before the deciduous walnut (*Juglans*) leafs out in spring.

Site Factors: On relatively moist, fine-textured soils of valley slopes and bottoms, as well as encircling rocky outcrops. These drier, rocky sites often support Venturan (32300) or Riversidean Sage Scrub (32700). Intergrades with Coast Live Oak Woodland (71160) or Coast Live Oak Forest (81310) on more mesic sites, especially in canyons.

Characteristic Species: CA walnut (*Juglans californica*), coast live oak (*Quercus agrifolia),* Engelmann oak (*Quercus engelmannii*), sugar bush (*Rhus ovata*), skunkbrush (*R. trilobata*), red brome (Bromus rubens), horehound (*Marrubium vulgare*).

Distribution: South side of San Gabriel Mountains to the Santa Ana Mountains, mostly between 500 and 3000 feet.

PINON/JUNIPER

Element Code: (72000)

Combined several Pinon and/or Juniper vegetation communities – description from the Great Basin Pinon-Juniper Woodland community, element code – 72121

Description: Very similar to Northern Juniper woodland (72110), but lacking the occasional taller trees and having Utah juniper (*Juniperus occidentalis*) and singleleaf pinyon pine (*Pinus monophylla*) as conspicuous canopy components. Shrub and herb species typically are those seen in adjacent non-forested stands of Great basin Scrub (35000 series).

Site Factors: Very similar to Northern Juniper Woodlands (72110) but receiving slightly more moisture. Intergrades at higher elevations with Jeffrey Pine Forest (85100) or Montane Chaparral (37500) in the Sierra Nevada; and with Bristlecone Pine Forest (86400) or Subalpine Sagebrush Scrub (35200) in the White, Inyo, and Panamint Ranges.

Characteristic Species: wheat grass (*Agropyron spicatum*), big sagebrush (*Artemisia tridentata*), curled-leafed mountain-mahogany (*Cercocarpus ledifolius),* Utah juniper (*Juniperus osteosperma*), singleleaf pinyon pine (*Pinus monophylla*), desert bitterbrush (*Purshia glandulosa*), and antelope bush (*P. tridentate*).

Distribution: Desert mountains from the first range east of the Sierra Nevada from Alpine County to Kern County, east through the Basin Ranges of Nevada. Abundant in the White Mountains, Inyo Mountain, and Panamint Range, from 6000 - 9000 feet (1830 - 2745 m). Intergrades in Kern County (on both sides of the Sierran crest) with Mojavean Pinon-Juniper Woodland (72210).

FOREST

KNOBCONE PINE

Element Code: (83210)

Description: A fire-maintained, variable forest dominated by knobcone pine (*Pinus attenuate*) that may reach 25 - 30 m, though usually closer to 15 m tall. Stands usually are even-aged except on relatively "fire-proof", rocky sites. Understories usually are sparse scatters of chaparral shrubs whose composition varies greatly over the type's range.

Site Factors: Shallow, dry, stoney sites, often on serpentine or other magnesium-rich ultramafics that limit effective conifer competition. Adapted to frequent fires by means of very early and abundant production of seeds, which are retained in the closed cones until released by the heat of a fire. Similar to Bishop Pine Forest (83121), but in more interior, hotter and drier localities, where growth is probably more limited by drought in summer. Often associated with Serpentine Chaparral (37600), Chamise Chaparral (37200) or Californian Mixed Chaparral (37110). On better-developed or non-serpentine soils, may intergrade with Broadleaved Evergreen Montane Coniferous forest (84000).

Characteristic Species: chamise (*Adenostoma fasciculatum*), Saskatoon serviceberry (*Amelanchier alnifolia*), Del Mar manzanita (*Arctostaphylos gladulosa*), whitethorn ceanothus (*Ceanothus cordulatus*), wart-stemmed ceanothus (*C. velutinus*), cypress sp. (*Cupressus abramsiana*), bush poppy (*Dendromecon rigi*da), tarweed (*Holodiscus discolor*), knobcone pine (*Pinus attenuate*), Coulter pine (*P. coulteri*), Monterey pine (*P. radiata*), deer oak (*Quercus sadleriana*), huckleberry oak (*Q. vaccinifolia*), interior live oak (*Q. wislizenii*).

Distribution: Abundant in the Siskiyou, Klamath and North Coast Ranges away from the immediate coast, from southwestern Oregon to southern Sonoma and Napa Counties. On Mt. Diablo, Contra Costa County. Abundant in the Santa Cruz Mts. in Santa Cruz and Santa Clara Counties. In the Santa Lucia Mountains of Monterey County near San Luis Obispo. Eastward from the Klamath Mountains across the southern Cascade Range to Modoc County on the west slope of the Sierra Nevada. From Sierra to El Dorado Counties and Mariposa County. Also in the San Bernardino and Santa Ana Mountains in southern CA, and near Ensenada, Baja CA. Elevation usually between 1000 to 5000 feet (300 and 1500 m), occasionally to 6000 feet (1800 m).

COULTER PINE

Element Code: (84140)

Description: An open forest (or more accurately, woodland) of scattered Coulter pine (*Pinus coulteri*) and CA black oak (*Quercus kelloggii*) over shrubs typically associated with Upper Sonoran Mixed Chaparral (37100). Some stands are dense enough to suppress the shrubby layer. Most growth occurs in spring and early summer

Site Factors: Typical on dry, rocky soils of slopes and ridges. Most frequent on south-facing slopes, frequently intermixing there with Californian Mixed Chaparral (37110) or Lower Montane Chaparral (37510). Subject to fairly frequent fires on these sites. In the Coast Ranges intergrades with Coast Range Mixed Conifer Forest (84110), Coast Range Ponderosa Pine Forest (84130), or Mixed Evergreen Forest (81100) on moist sites; Blue Oak Woodland on low-elevation, dry sites; Knobcone Pine Forest (83210) on dry, sterile soils. In southern CA, frequently merges into Sierran Mixed Conifer Forest (84230) at its upper limits. Fire exclusion may be facilitating conversion of some oak woodlands to Coulter pine stands as in the Gabilan Range.

Characteristic Species: bristlecone fir (*Abies bracteata*), Zaca's manzanita (*Arctostaphylos glandulosa*), pringle manzanita (*A. pringlei drupacea*), pointleaf manzanita (*A. pungens*), deerbrush (*Ceanothus integerrimus*), mountain mahogany (*Cercocarpus betuloides*), Coulter pine (*Pinus coulteri*), ponderosa pine (*P. ponderosa*), CA foothill pine (*P. sabiniana*), bigcone Douglas-fir (*Pseudotsuga macrocarpa*), coast live oak (*Quercus agrifolia*), canyon live oak (*Q. chrysolepis*), and CA black oak (*Q. kelloggii*).

Distribution: Widely scattered, through fragmented, throughout the south Coast Ranges from Contra Costa County south into Baja CA. Elevations vary from 2500 - 5000 feet in the north, to 4000 - 6500 feet in the south. Best developed in San Gabriel, San Bernardino, and San Jacinto Mountains.

BIGCONE SPRUCE-CANON OAK

Element Code: (84150)

Description: An open (on steep slopes) to dense (on flats) forest dominated by (Pseudotsuga macrocarpa) 50 - 80 feet tall over a dense sub-canopy of (Quercus chrysolepis) and a very sparse herb layer. Most stands are fairly small within a chaparral matrix.

Site Factors: Largely on rocky sites with little soil development. Restricted to mesic exposures and canon sides at low elevations (1000 feet), but on mesic exposures and canyon sides at low elevations (1000 feet), but on warmer aspects at upper altitudinal limit (8000 feet). Fires appear to be frequent, though perhaps less intense than in surrounding chaparrals. Mature (Pseudotsuga) is capable of trunk-sprouting after fire. Intergrades in canyon bottoms Southern Riparian Forest (62130), with Upper Sonoran Mixed Chaparral (37000) on more xeric sites, and with Coulter Pine Forest (84140) or Sierran Mixed Conifer Forest (84200) at higher elevations.

Characteristic Species: bigleaf maple (Acer macrophyllum), incense cedar (*Calocedrus decurrens*), mountain mahogany (*Cercocarpus betuloides*), big cone Douglas fir (*Pseudotsuga macrocarpa*), coast live oak (*Quercus agrifolia*), canyon live oak (*Q. chrysolepis*), gooseberry (*Ribes californicum*), poison oak (*Toxicodendron diversilobum*), CA laurel (*Umbellularia californica*), wild grape (*Vitis girdiana*).

Distribution: Transverse and Peninsular Ranges from the Mt. Pinos region south to near Banner in San Diego County, mostly on coastal (rather than desert-facing) slopes.

WESTSIDE PONDEROSA PINE

Element Code: (84210)

Description: An open, park-like forest of coniferous evergreens to 70 m tall, dominated by ponderosa pine (*Pinus ponderosa*). The understory typically is sparse, consisting of scattered chaparral shrubs and young trees. There is often considerable accumulation of needle litter and pine cones on the ground. Growth occurs mostly from late spring to midsummer and is probably limited by summer and fall drought. Cones mature in the early autumn. All plants are essentially dormant in the winter.

Site Factors: Well-developed in areas with warm, dry summers and cool, moist winters with considerable snow accumulation at the higher elevations. Often on south-facing slopes, except near lower elevational margins. Usually on coarse, well-drained soils; often granite or basaltic, very rarely serpentine. Probably maintained by occasional ground fires. Crown fires may result in temporary replacement of the forest by dense Montane Chaparral (37500). At its lower limits, intergrades with Coast Range Ponderosa Pine Forest (84130) in the North Coast Ranges, with Blue Oak Woodland (71210) on non-rocky soils in the interior North Coast Ranges and Cascade-Sierra foothills, with Coulter Pine Forest (84140) in southern CA, with Knobcone Pine Forest (83210) on rocky, often serpentine soils; with Lower Montane Chaparral (37510) on dry, rocky soils in the Cascades and northern Sierra Nevada; with Californian Mixed Chaparral (37110) in the southern Sierra and extensively in southern CA. Within its elevational range, intergrades with Montane Chaparral (37500) or Mixed Conifer Forest (84230) on moist sites. At its upper limits, intergrades with Sierran Mixed Conifer Forest (85100) on dry slopes.

Characteristic Species: white fir (*Abies concolor*), manzanita sp. (*Arctostaphylos patula*), incense cedar (*Calocedrus decurrens*), deerbrush (*Ceanothus integerrimus*), whitethorn ceanothus (*C. cordulatus*), mountain misery (*Chamaebatia foliosa*), tanoak (*Lithocarpus densiflorus*), knobcone pine (*Pinus attenuata*), Coulter pine (*P. coulteri*), sugar pine (*P. lambertiana*), ponderosa pine (*P. ponderosa*), canyon live oak (*Quercus chrysolepis*), CA black oak (*Q. kelloggii*), coffee berry (*Rhamnus californica*).

Distribution: Higher elevations of the interior North Coast ranges and Siskiyou Mountains. From Lake County to Siskiyou County and northward into Oregon. Abundant on the west side of the Cascade Range and Sierra Nevada from the Siskiyou Mountains to northern Kern County. Also on the coastal side of the eastern San Gabriel Mountains, LA-San Bernardino Counties; the San Bernardino Mountains, San Bernardino County; and the San Jacinto Mountains, Riverside County. Sparingly presenting the San Rafael-San Emigdio Mountains, Santa Barbara-Ventura

Counties; Tehachapi Mountains, Kern County/ Palomar and Cuyamaca Ranges, San Diego County. Elevation from 2000 - 5000 feet (900 -1500 m) in the north and 4500 - 6500 feet (1300–2000 m) in the south. The lowest-occurring montane forest type over most of its range.

JEFFREY PINE

Element Code: (85100)

Description: A tall, open forest dominated by Jeffrey pines (*Pinus jeffreyi*), with sparse understories of species drawn from Montane Chaparral (37500) or Sagescrub Scrub (35200). Very similar in aspect to Ponderosa Pine Forest (84210, 84220). Pure stands are best developed on desert-facing slopes.

Site Factors: Dry, cold sites, especially on well-drained slopes, ridges, or cold air accumulation basins. West of the Sierran crest, it intergrades at its lower elevational limit (5000 - 65000 feet) with Montane Chaparral (37500), Coulter Pine Forest (84140) or Westside Ponderosa Pine Forest (84210). East of the Crest it passes to Pinon-Juniper Woodlands (72000), Great Basin Scrub (35000) or Eastside Ponderosa Pine Forest (84220). Passes in more mesic sites or higher elevations (7000 - 9000 feet), into Upper Montane Mixed Conifer Forest (85200) or Subalpine Forest (86000).

Characteristic Species: Great Basin sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysolepsis sempervirens*), Jeffrey pine (*Pinus jeffreyi*), antelope bitterbrush (*Purshia tridentata*), huckleberry oak (*Quercus vaccinifolia*), snowberry (*Symphoricarpus parishii*), prostrates ceanothus (*Ceanothus prostrates*), snowbush ceanothus (*C. velutinus*), whitethorn ceanothus (*C. cordulatus*), greenleaf manzanita (*Arctostaphylos patula*), curled-leaf mountain mahogany (*Cercocarpus ledifolius*), manzanita sp. (*Arctostaphylos nevadensis*).

Distribution: Similar to Sierran Mixed Conifer Forest (84230) but typically at higher elevations and more extensive toward the south and east. Scattered through the higher North Coast Ranges and Klamath Mountains. Abundant from Shasta and Lassen Counties southward through the Sierra Nevada to Kern County. Best developed on the east side of the central Sierra Nevada, especially south of Mono Lake. Relatively abundantly in the higher portions of the Transverse and Peninsular Ranges of southern CA and Baja California, including the Mt. Pinos region, the eastern San Gabriel Mountains, and the Sierra San Pedro Martir. Elevation usually 5500 - 7500 feet (1650 -2700 m) in the north and 6500 - 9000 feet (2000 - 2700 m) in the south. Stands at lower elevations probably are on ultramafic substrates.

JEFFREY PINE-FIR

Element Code: (85210)

Description: Very similar to Sierran Mixed Conifer Forest (84230), but not quite so tall (to 60 m). The understory is open, primarily of scattered Montane Chaparral (37500) and small trees, lacking the mesophytic components of the Sierran Mixed Conifer Forest. Growth is most active in early and midsummer, about the same as in Jeffrey Pine Forest (85100) and a little later than in Sierran Mixed Conifer Forest (84230).

Site Factors: Similar to and probably the high-elevation equivalent of Sierran Mixed Conifer Forest (84230). Similar to Jeffrey Pine Forest (85100) but moister. On well-drained slopes, usually avoiding the driest and moistest sites. Typically occurs above Sierran Mixed Conifer Forest and intergrades broadly with Jeffrey Pine Forest on dry slopes and ridges, with Upper Montane Fir Forest (85300) on moist, north-facing slopes and with Lodgepole Pine Forest (86100) in cold, wet sites and stream valleys. Replaced at its upper limit by Subalpine Coniferous Forest (86000), usually Lodgepole Pine Forest.

Characteristic Species: White fir (*Abies concolor*) mostly in southern CA, (*A. magnifica*) lacking in southern CA, whitethorn ceanothus (*Ceanothus cordulatus*), rabbitbrush (*Chrysolepis sempervirens*), Jeffery pine (*Pinus Jeffreyi*), (*P. monticola*) lacking in southern CA, (*P. murrayana*), huckleberry oak (*Quercus vaccinifolia*).

Distribution: Abundant from Mt. Lassen southward along the west side of the Sierra Nevada to Tulare County. More scattered on the east side of the Sierra Nevada from Lake Tahoe to the Mt. Whitney region and in the higher portions of the North Coast Ranges and Klamath Mountains. Occurs with fewer trees species in the southern Sierra Nevada in Kern County, and the higher portions of the Tehachapi Mountains, the Mt. Pinos region, the eastern San Gabriel Mountains, San Bernardino Mountains, and San Jacinto Mountains. Elevation usually 6000 - 8000 feet (1800 - 2420 m) in the north and 7000 - 9000 feet (2100 - 2700 m) in the south.

WHITE FIR

Element Code: (85320)

Description: Very similar to Sierran White Fire Forest (84240) and Red Fir Forest (85310) but not so tall or dense. Typically consists of nearly pure stands of white fir (*Abies concolor*) which grows to about 30 m tall. The southern CA stands of this species, especially the Mojave Desert disjuncts, show some affinity to the Rocky Mountain form. The understory is sparse, with moderate accumulation of needles litter and downed branches. Growth is most active from early to midsummer, probably limited by drought in late summer and by low temperature.

Site Factors: Similar to Sierran White Fir Forest (84240), but higher, colder and probably drier. Similar to Red Fir Forest (85310) and probably its southern equivalent, but drier. Usually confined to steep, north-facing slopes where snow lingers until late spring. The soil is usually rocky and well drained. Intergrades at its lower elevation limit or on drier sites with Jeffrey Pine-Fir Forest (85210). Replaced at its upper limit by Lodgepole Pine Forest (86100).

Characteristic Species: white fir (*Abies concolor*), rabbitbrush (*Chrysolepis sempervirens*), sugar pine (*Pinus lambertiana*), gooseberry (*Ribes* spp.), snowplant (*Sarcodes sanguinea*), snowberry (*Symphoricarpos* spp).

Distribution: Scattered in the southern Sierra Nevada and the highest parts of the Tehachapi Mountains, Kern County; on Mt. Pinos, Ventura-Kern County line; common in the higher portions of the eastern San Gabriel Mountains, LA and San Bernardino Counties; the San Bernardino Mountains, San Bernardino County and the San Jacinto -Santa Rosa Mountains, Riverside County. Elevation usually 7500 - 9500 feet (2300 -2880 m).

LODGEPOLE PINE

Element Code: (86100)

Description: Typically form dense forests of slender trees up to 40 m tall, often in nearly pure stands of (*Pinus murrayana*). More open stands up to 20 m tall occur on dry sites or near timberline. May form krummholz at timberline. The trees in the moister, denser stands are relatively short-lived, and if the stand has not burned for a long time, fallen trees, branches and needles cover the ground. The understory is normally spars in these dense stands, but low shrubs and perennial herbs occur abundantly in forest openings.
There is much less litter in the drier, more open stands; other tree species occur occasionally and understory plants are scattered throughout the stand. Flowering of most plants is concentrated in the early summer; growth of at least the smaller plants may be limited by drought in late summer. Most plants are dormant from fall through spring.

Site Factors: Typically occurs at elevations with long, snowy winters and cool, dry summers; colder in winter and usually drier than Red Fir Forest (85310). Often best developed in the transitional elevations between the Upper Montane Coniferous Forest (85000) and the true Subalpine Coniferous Forest (86000). At its lower limit it occupies cold, moist sites within the Upper Montane Coniferous Forest; at its upper limits it occupies dry, exposed sites at timberline, especially in the southern Sierra Nevada and in southern CA. Apparently tolerates large variations in soil and moisture factors, but most commonly occurs on rocky, well drained soils. Where is forms dense forests, it is subject to devastation by fire or epidemic outbreaks of Lodgepole Pine Needle Miner (*Coleothechnites milleri*). Reseeding is relatively rapid following fires, and Lodgepole Pine Forest is often successional in areas that are eventually dominated by other species. However, this fire succession is more universal in the moister forests of the Cascades and northern Rockies.

Characteristic Species: purple mountainheath (*Phyllodoce breweri*), Sierra lodgepole pine (*Pinus contorta murrayana*), quaking aspen (*Populus tremuloides*), cinquefoil (*Potentilla breweri*), wintergreen (*Pyrola* spp.), mountain hemlock (*Tsuga martensiana* from Yosemite North), blueberry (*Vaccinium* spp).

Distribution: Scattered and poorly developed in the Klamath Mountains. More extensive stands occur east of Mt. Shasta on the Modoc Plateau of eastern Siskiyou and Shasta Counties. Scattered in the higher parts of the Warmer Mountains in eastern Modoc County. Abundant in the vicinity of Mt. Lassen. Scattered in the northern most part of the Sierra Nevada, then very abundant from Sierra County to southern Tulare County. Scattered in the highest portions of the San Gabriel Mountains, LA-San Bernardino Counties; abundant on the upper slopes of the San Bernardino Mountains, San Bernardino County; locally abundant near the summit of Mt. San Jacinto, Riverside County; the southern limit is on the summit plateau of the Sierra San Pedro Martir, Baja CA. Extensively developed on the east side of the Cascade Range in Oregon and in the northern Rockies. Elevation 6000 - 8000 feet (1800 - 2420 m) in the north, 9000 - 11000 feet (2700 - 3330 m) in the south. Common as much as 2000 feet (610 m) lower in cold, moist sites such as stream valleys and meadow margins.

SUBALPINE

Element Code: (86500)

Description: Very similar to Whitebark Pine-Lodgepole Forest (86220) and to Foxtail Pine Forest (86300) but dominated by (*Pinus flexilis*) and (*P. murrayana*). The former species is most important on exposed high slopes and ridges, where it may form small pure stands. The trees are rarely over 10 m high even in the lower portions of the forest and form very scattered, low krummholz at timberline. The understory is typically very spars. Growth is concentrated in early summer, probably limited by drought in late summer and by low temperature the rest of the year.

Site Factors: Similar to Whitebark Pine-Lodgepole Pine Forest (86220), but drier and probably not quite so cold. Very similar to Foxtail Pine Forest (86300), but possibly with more variable precipitation and / or faster runoff. Usually occurs on dry, rocky slopes and ridges subject to very strong winds in winter. These winds, rather than other factors associated with high altitude, may determine the upper timberline of this forest. At its lower limit may intergrade with Jeffrey Pine Forest (85100) on south-facing slopes, Southern CA White Fire Forest (84320) on north- facing slopes, or Lodgepole Pine Forest (86100) in various situations. Lodgepole Pine Forest may also occur to timberline. Replaced above timberline by Southern California Alpine Fell- Fields (91130).

Characteristic Species: whitethorn ceanothus (*Ceanothus cordulatus*), rabbitbrush (*Chrysoleris sempervirens*), manzanita (*Arctostaphylos patula platyphylla*), limber pine (*Pinus flexilis*), Sierra lodgepole pine (*P. contorta murrayana*), western juniper (*Juniperus occidentalis australis*), curl-leaf mountain mahogany (*Cercocarpus ledifolius*), white fir (*Abies concolor*), Kern buckwheat (*eriogonum kennedyi alpigenum*).

Distribution: Confined to the highest peaks in southern CA: the upper slopes of Mt. Baden-Powell and San Antonio Mountain in the San Gabriel Mountains; Mt. San Jacinto in the San Jacinto Mountains; most abundant in the vicinity of Mt. San Gorgonio in the San Bernardino Mountains. Outliers of (*Pinus flexilis*) occur on Mt. Pinos, southwestern Kern County and on Toro Peak, Riverside County. Elevation usually 9500 - 11200 feet (2880 - 3390 m) but occasionally as low as 8500 feet (2580 m).

CYPRESS

Element Code: (83230)

Description: A fairly dense, fire-maintained, low forest dominated by either (*Cupressus nevadensis*), (*C. forbesii*), or (*C. stephensonii*). This forest often occurs as isolated groves within a matrix of Chaparral or Pinon Juniper Woodland. Many stands are even-aged due to fire density, and spacing within the stands vary in relation to site factors and fire history.

Site Factors: Similar to but in a drier climate than Northern Interior Cypress Forests (83220), but not usually associated with ultramafic substrates. Most often found on northern exposures. Characteristic Species: (*Adenostoma fasciculatum*), (*Arctostaphylos gladulosa*), (*Cercocarpus betuloides*), (*Cupressus forbesii*), (*C. nevadensis*), (*C. stephensonii*), (*Eriogonum fasciculatum*), (*Heteromeles arbutifolia*), (*Juniperus californica*), (*Pinus coulteri*), (*P. monophylla*).

Distribution: Southern Sierra Nevada (Kern River watershed, *C. nevadensis*) and Peninsular Ranges south into Baja CA. Elevations vary with species: 1000 - 4500 feet for (*C. forbesii*), 5500 feet for (*C. stephensonii*), and 4000 - 6000 feet for (*C. nevadensis*).

MEADOWS/MARSHES

COASTAL SALT MARSH

Element Code: (52120)

Description: Similar to Northern Coastal Salt Marsh (52110) but with longer growing season and a greater abundance of suffrutescent species in the higher, drier sites. Southern "specialties" include (*Atriplex watsonii*), (*Batis maritima*), (*Lucium californicum*), (*Monanthochloe littoralis*), (*Sueda californica*), and (*Salicornia subterminalis*).

Site Factors: Very similar to Northern Coastal Salt Marsh but with warmer water and air temperatures. (*Frankenia*), (*Suaeda*), and/or (*Salicrnia subterminalis*) often occur along the upper, landward edges of the marshes; (*Salicornia bigelovii*), (*S. virginica*), and (*Batis maritima*) at middle elevations; and (*Spartina*) closest to open water.

Characteristic Species: dwarf coastweed (*Amblyopappus pussilus),* Watson's saltbush (Atri*plex watsonii*), turtleweed (*Batis maritima*), spreading alkaliweed (*Cressa truxillensis*), saltmarsh dodder (*Cuscuta salina*), saltgrass (*Distichlis spicata*), buckthorn (*Frankenia grandifolia*), salt heliotrope (*Heliotropium curassavicum*), marsh jaumea (*Jaumea carnosa*), spiny rush (*Juncus acutus sphaerocarpus*), heliotrope (*Heliotropium limonium californicum*), fig (*Carpobrotus aequilateralis*), icepant (*Mesembryanthemum crystalinum*), slenderleaf iceplant (*M. nodiflorum*), shoregrass (*Monanthochloe littoralis*), dwarf saltwort (*Salicornia bigelovii*), saltwort (*Salicornia* spp.), CA cordgrass (*Spartina foliosa*), wooly seablite (*Suaeda californica*).

Distribution: Bays, lagoons, and estuaries along the coast from about Point Conception to the Mexican border. Intergrades broadly with Northern Coastal Salt Marsh (52110) along the south central coast. Nowhere as extensive as the larger northern marshes, and now considerably reduced by land development activities. Good to fair examples occur at Goleta Slough and near Carpentaria, Santa Barbara Counties; Point Mugu, Ventura County; Upper Newport Bay, Orange County; and several small areas in San Diego County.

BRACKISH MARSH

Element Code: (52200)

Description: Dominated by perennial, emergent, herbaceous monocots to 2 m tall. Cover is often complete and dense. Similar to Salt Marshes (52100) and to Freshwater Marshes (52400) with some plants characteristics of each.
Site Factors: Similar to Coastal Salt Marshes, but brackish from freshwater input. Salinity may vary considerably, and may increase at high tide or during seasons of low freshwater runoff or

both. Usually intergrades with Coastal Salt Marshes toward the ocean and occasionally with freshwater Marshes (52400) at the mouths of rivers, especially in the Sacramento-San Joaquin River Delta.

Characteristic Species: Harford's sedge (*Carex harfordii*), slough sedge (*Carex obnupta*), sedge spp. (*Carex* spp), saltgrass (*Distichlis spicata*), rush (*Juncus* spp.), saltwort (*Salicornia* spp.) bogrush (*Scirpus* spp.), cattail (*Typha latifolia*).

Distribution: Usually at the interior edges of coastal bays and estuaries or in coastal lagoons. Adjacent to several Salt Marshes (52110 and 52120). Most extensively developed around Suisun Bay at the mouth of the Sacramento-San Joaquin Delta.

MONTANE FRESHWATER MARSH

Element Code: (52430)

Description: Similar to Coastal and Valley Freshwater Marsh (52430) and to Bogs and Fens (51000), with which many species are shared.

Site Factors: Similar to Coastal and Valley Freshwater Marsh but with a shorter growing season due to cold winters. Less acidic and nutrient-rich than Bogs or Fens.

Characteristic Species: slenderbeak sedge (*Carex athrostachya*), Nebraska sedge (*C. nebracensis*), cottongrass (*Eriophorum*), bogrush (*Scirpus acutus*), (*S. americanus*), others?

Distribution: Widely scattered throughout Montane CA, though less frequent in the Transverse and Peninsular ranges.

MONTANE MEADOW

Element Code: (45100)

Description: Dense growth of sedges and other perennial herbs, usually from 0.5 – 1 m high, but with some taller herbs to 2 m. Main growth period from late spring through summer (summer only at higher elevations); flowering mostly in summer; dormant in winter (from fall through spring at higher elevations). Montane Meadows are subdivided into Wet (45110) and Dry (45120) subtypes. Wet Montane Meadows have soils that remain saturated throughout the year.

Site Factors: On fine-textured, more or less permanently moist or wet soils. May be associated with Bogs (51100), Fens (51200) or Freshwater Swamps (52600) in more extremely waterlogged soils. Adjacent forest or scrub are on coarser, better drained soil, and characterized by young trees encroaching from the margins. On seasonally driers, but still fine-textured Valley and foothill Grasslands (42000) in the North Coast Ranges, Great Basin Grassland (43100) or Great Basin Sagebrush (35200) in northeastern CA. Both Wet and Dry types may occur in a given meadow.
Characteristic Species: small camas (*Camassia guamash*), sedge (*Carex bolanderi*), (*C. rostrata*), (*C. vesicaria*), Sierra shootingstar (*Dodecatheon jeffreyi*), mannagrass (*Glyceria*

elata), needle spikerush (*Eleocharis acicularis bella*), cowparsnip (*Heracleum sphondylium* spp. *montanum*), Sierra rush (*Juncus nevadensis*), bigleaf lupine (*Lupinus polyphyllus* ssp. *superbus*), pullup muhly (*Muhlenbergia filiformis*), western brackenfern (*Pteridium aguilinum*), scirpus (*Scrirpus congdonii*), (*S. Criniger*), CA false hellebore (*Veratrum californicum*), (*V. fimbriatum*, in North Coast Ranges).

Distribution: Scattered within the North Coast Coniferous forests (8200), Lower Montane Forests (84000), and Upper Montane Forest (85000) of the North coast ranges, Klamath Ranges, Cascade Ranges, Sierra Nevada, Transverse and Peninsular Ranges. Elevation from 1000 - 7000 feet (300 - 2130 m) in the north to 5000 – 9000 feet (1520 -2740 m) in the south.

PAVEMENT PLAIN

Element Code: (47000)

Description: Herb and grass-dominated openings in Jeffrey Pine Forests (85100) or Pinyon-Juniper Woodland (72300). Total cover usually is low (CA 35%), composed of scattered, short, cushion-forming plants, and dominated by several taxa endemic to the San Bernardino Mountains.

Site Factors: Dense, clay soils armored by a lagg-gravel of quartzite pebbles. Frost action, and wind and water action, prevent large, woody vegetation from establishing.

Characteristic Species: low pussytoes (*Antennaria dimorpha*), Bear Valley sandwort (*Arenaria ursine*), black sagebrush (*Artemisia nova*), Kern buckwheat (*eriogonum kennedyi*), silverhair mousetail (*Ivesia argyrocoma*), (*Poa incurva*).

Distribution: Restricted to about 30 pavements in the area around Big Bear Lake and Holcomb Valley in San Bernardino County. Elevation about 6500 - 7000 feet.

URBAN/INVASIVE

ARUNDO SCRUB/FOREST

Element Code: (RNF01)

Description: A dense monoculter dominated by arundo also known as the giant reed (Arundo donax). This is a very invasive grass that was introduced to CA in the 1880’s. This species persist in riparian areas, and reduces or replaces native species.

TAMARISK SCRUB

Element Code: (63810)

Description: A weedy, virtual monoculture of any of several Tamarix species, usually supplanting native vegetation following major disturbance.

Site Factors: Sandy or gravelly braided washes or intermittent streams, often in areas where high evaporation increases the streams saltiness. Tamarisk is a strong phreatophyte and a prolific

seeder, attributes which predispose the species to be aggressive competitors in disturbed riparian corridors.

Characteristic Species: big saltbush (*Atriplex lentiformis*), Palmer's coldenia (*Coldenia palmeri*), salt grass (*Distichlis spicata*), arrow-weed (*Pleuchea sericea*), sandbar willow (*Salix exigua*), tamarix (*Tamarix chinensis*), (*T. ramosissima*).

Distribution: Widely scattered and increasing its range, throughout the drier parts of CA from the rain shadow east of the Inner North Coast Ranges south through the Great Valley to southern CA and across the deserts to Nevada, Arizona and beyond.

EUCALYPTUS WOODLAND

Element Code: (11100)

Description: eucalyptus is the sole or dominate tree in the canopy; few other species present. Trees are greater than 50 m tall creating a continuous canopy. Shrubs are infrequent and ground layer is sparse.

OTHER NON-NATIVE COMMUNITY

Element Code: (11000)

Description: A dense monoculture dominated by an invasive species other than arundo, tamarix, or eucalyptus.

URBAN/DEVELOPMENT

Element Code: (12000)

AGRICULTURE

Element Code: (18000)

FIELD/PASTURE

Element Code: (18310)

UNVEGETATED

Element Code: (13000)

Appendix 3. Paper Data Forms

Arroyo Toad Stream Survey Form-1st Visit

Date: _____ **Observer1** _____
Block/Site Name: _____ **Start Time:** _____ **Segment Photo:** Y / N **Observer2** _____
Segment Name: _____ **End Time:** _____ **# Photos:** _____ **Observer3** _____
Photo Numbers:

Start Lat		End Lat		Slope	
Start Long		End Long			
Start Elev		End Elev		Site Length	
Datum		Drainage			

Start Weather:

Temperature (˚C): _____
Condition: clear or few clouds, partly cloudy or variable, cloudy or overcast, fog, mist or drizzle, showers or light rain, heavy rain, sleet or hail, snow
Notes:

End Weather:

Temperature (˚C): _____
Condition: clear or few clouds, partly cloudy or variable, cloudy or overcast, fog, mist or drizzle, showers or light rain, heavy rain, sleet or hail, snow
Notes:

Start Water Fields:

Water Present: Y / N
Lat: _____ **Elev**
Long: _____ **Datum**
Water Temperature (˚C): _____
pH: _____
Conductivity: _____
Channel Water Depth (m): _____
Wetted Channel Width (m): _____
 # braids: _____
Channel Surface Water Velocity (m/s): _____
Transparency: Clear, Moderate/Translucent, Opaque

Arroyo Toad Pool Data

Pool Water Fields: (enter at first occurrence of ARTO tadpole)

Lat: _____ **Elev**
Long: _____ **Datum**
Pool Depth (m): _____
Pool Velocity m/s: _____
Bottom: Silt, Sand, Gravel, Cobble, Bedrock
Pool Type natural within main channel, road rut, dirt road x-ing, AZ road x-ing, natural outside main channel, artificial/man-made
Transparency: Clear, Moderate/Translucent, Opaque
Notes:

Pool Veg Fields:(enter at first occuance of ARTO tadpole)

Sand Cover: 0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% Cover- Aquatic Floating/submerged vegetation
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% Cover- Aquatic Emergent vegetation
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% Cover- Aquatic Floating Algae Mat
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

Recent Disturbance:

Disturbance Type (circle all that apply):
None, Cows, Hiking, Fishing, Trash
ORV use, Wading/bathing, Construction,
Roads, Fire, Debris Flow
Other: _____
Intensity of Disturbance: Light, Moderate, Heavy

End Habitat Form:

Channel width/bankfull (m): _____
Flood prone width (m): _____
Entrenchment Ratio (flood plain wdth / bankfull width): _____
% overhead canopy: 0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

Riparian Community: Chapparral, Desert, Forest, Meadow/Marsh, Riparian, Scrub, Urban/Invasive, Woodland

Top 3 Dominant Riparian Plants
Species 1: _____
Species 2: _____
Species 3:

End Water Fields:

% wet lgth of survey: 0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% reach w shallow pooling H2O: 0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% reach w medium pooling H2O: 0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% reach w deep pooling H2O: 0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
Plunge pools present: Y / N
# of plunge pool: 1 - 5, 6 - 10, 11 - 20, 21 - 30, 31 - 50, 51 - 100

% Cover- Aquatic Floating/submerged veg
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% Cover- Aquatic Emergent veg
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% Cover- Aquatic Floating Algae Mat
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

Aquatic Substrate (Record Top 3):

clay	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	leaf litter	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
silt	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	fallen logs	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
sand (<2 mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
gravel (2-32mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
pebbles (33-64mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
cobble (65-256mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
boulder/bedrock (>256mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		

Arroyo Toad Stream Survey Form-1st Visit

Exotic Plants:

Plant Species		Size Class	Plant Species	Size Class
		few plants, scattered small patches, large contiguous stands		few plants, scattered small patches, large contiguous stands
		few plants, scattered small patches, large contiguous stands		few plants, scattered small patches, large contiguous stands
		few plants, scattered small patches, large contiguous stands		few plants, scattered small patches, large contiguous stands

Animal Form:

	Lat./Long	Species	Age (A / J / MM / Tadpole / U / Eggs)	Sex	Pool Y/N	Count	Tissue Y/N	swab ID	Photo Y/N	Deformities
1				M / F / U						
	Notes:									
2				M / F / U						
	Notes:									
3				M / F / U						
	Notes:									
4				M / F / U						
	Notes:									
5				M / F / U						
	Notes:									
6				M / F / U						
	Notes:									
7				M / F / U						
	Notes:									
8				M / F / U						
	Notes:									
9				M / F / U						
	Notes:									
10				M / F / U						
	Notes:									
11				M / F / U						
	Notes:									
12				M / F / U						
	Notes:									
13				M / F / U						
	Notes:									
14				M / F / U						
	Notes:									
15				M / F / U						
	Notes:									
16				M / F / U						
	Notes:									
17				M / F / U						
	Notes:									
18				M / F / U						
	Notes:									
19				M / F / U						
	Notes:									
20				M / F / U						
	Notes:									

Arroyo Toad Tadpole Information

Count of Tadpoles:	0,	1-10,	11-25,	26-50,	51-100,	101-250,	251-500, 501-1000, >1000
% reach with arroyo toad tadpoles:	0%,	1-10%,	11-25%,	26-50%,	51-75%,	76-100%	
% reach early (black w spot) tadpoles:	0%,	1-10%,	11-25%,	26-50%,	51-75%,	76-100%	
% reach mid (tan) tadpoles:	0%,	1-10%,	11-25%,	26-50%,	51-75%,	76-100%	
% reach late (legs) tadpoles:	0%,	1-10%,	11-25%,	26-50%,	51-75%,	76-100%	
Notes:							

Additional Site Notes:

Arroyo Toad Stream Survey Form-2nd Visit

Date: _____ **Observer1** _____

Block/Site Name: _____ **Start Time:** _____ **Segment Photo:** Y / N **Observer2** _____

Segment Name: _____ **End Time:** _____ **# Photos:** _____ **Observer3** _____

Photo Numbers:

Start Lat		End Lat		Slope	
Start Long		End Long			
Start Elev		End Elev		Site Length	
Datum		Drainage			

Start Weather:

Temperature (˚C): _____

Condition: clear or few clouds, partly cloudy or variable, cloudy or overcast, fog, mist or drizzle, showers or light rain, heavy rain, sleet or hail, snow

Notes:

End Weather:

Temperature (˚C): _____

Condition: clear or few clouds, partly cloudy or variable, cloudy or overcast, fog, mist or drizzle, showers or light rain, heavy rain, sleet or hail, snow

Notes:

Start Water Fields:

Water Present: Y / N

Lat: _____ **Elev**

Long: **Datum**

Water Temperature (˚C): _____

pH: _____

Conductivity: _____

Channel Water Depth (m): _____

Wetted Channel Width (m): _____

 # braids: _____

Channel Surface Water Velocity (m/s): _____

Transparency: Clear, Moderate/Translucent, Opaque

Arroyo Toad Pool Data

Pool Water Fields: (enter at first occurrence of ARTO tadpole)

Lat: _____ **Elev**

Long: **Datum**

Pool Depth (m): _____

Pool Velocity m/s: _____

Bottom: Silt, Sand, Gravel, Cobble, Bedrock

Pool Type natural within main channel, road rut, dirt road x-ing, AZ road x-ing, natural outside main channel, artificial/man-made

Transparency: Clear, Moderate/Translucent, Opaque

Notes:

Pool Veg Fields:(enter at first occuance of ARTO tadpole)

Sand Cover: 0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

% Cover- Aquatic Floating/submerged vegetation
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

% Cover- Aquatic Emergent vegetation
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

% Cover- Aquatic Floating Algae Mat
0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

Recent Disturbance:

Disturbance Type (circle all that apply):
None, Cows, Hiking, Fishing, Trash
ORV use, Wading/bathing, Construction,
Roads, Fire, Debris Flow
Other: _____

Intensity of Disturbance: Light, Moderate, Heavy

End Water Fields:

% wet lgth of survey:	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	**% Cover- Aquatic Floating/submerged veg**
% reach w shallow pooling H2O:	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% reach w medium pooling H2O:	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	**% Cover- Aquatic Emergent veg**
% reach w deep pooling H2O:	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
Plunge pools present:	Y / N	**% Cover- Aquatic Floating Algae Mat**
# of plunge pool:	1 - 5, 6 - 10, 11 - 20, 21 - 30, 31 - 50, 51 - 100	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%

Aquatic Substrate (Record Top 3):

clay	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	leaf litter	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
silt	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%	fallen logs	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
sand (<2 mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
gravel (2-32mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
pebbles (33-64mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
cobble (65-256mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		
boulder/bedrock (>256mm)	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%		

Arroyo Toad Stream Survey Form-2nd Visit

Exotic Plants:

Plant Species		Size Class		Plant Species	Size Class
		few plants, scattered small patches, large contiguous stands			few plants, scattered small patches, large contiguous stands
		few plants, scattered small patches, large contiguous stands			few plants, scattered small patches, large contiguous stands
		few plants, scattered small patches, large contiguous stands			few plants, scattered small patches, large contiguous stands

Animal Form:

	Lat./Long	Species	Age (A / J / MM / Tadpole / U / Eggs)	Sex	Pool Y/N	Count	Tissue Y/N	swab ID	Photo Y/N	Deformities
1				M / F / U						
	Notes:									
2				M / F / U						
	Notes:									
3				M / F / U						
	Notes:									
4				M / F / U						
	Notes:									
5				M / F / U						
	Notes:									
6				M / F / U						
	Notes:									
7				M / F / U						
	Notes:									
8				M / F / U						
	Notes:									
9				M / F / U						
	Notes:									
10				M / F / U						
	Notes:									
11				M / F / U						
	Notes:									
12				M / F / U						
	Notes:									
13				M / F / U						
	Notes:									
14				M / F / U						
	Notes:									
15				M / F / U						
	Notes:									
16				M / F / U						
	Notes:									
17				M / F / U						
	Notes:									
18				M / F / U						
	Notes:									
19				M / F / U						
	Notes:									
20				M / F / U						
	Notes:									

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% reach early (black w spot) tadpoles:	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% reach mid (tan) tadpoles:	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
% reach late (legs) tadpoles:	0%, 1-10%, 11-25%, 26-50%, 51-75%, 76-100%
Notes:	

Additional Site Notes:

Appendix 4. Additional References and Resources

Additional Reference Material:

Lannoo, M., Ed. 2005. Amphibian declines: The conservation status of the United States species. Berkeley, CA, University of California Press. 1094 pp.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Boston, Massachusetts, Houghton Mifflin Company. 533 pp.

Wright, A.H. and Wright, A.A. 1995. Handbook of frogs and toads of the United States and Canada. Ithaca, New York, Comstock Publishing. 640 pp.

Brown, C.W., C.J. Hitchcock, C.S. Brehme, A,R. Backlin, D. Wood, and Fisher, R.N. 2006. A key to breeding amphibians of coastal southern California. 25 pp.

Appendix 5. Bio-control/Disinfecting

Background:

Amphibians are declining rapidly throughout the world. One of the key hypotheses for global amphibian declines is emerging infectious diseases. Specifically, *Bactrachochytrium dendrobatidis,* more commonly called B. D. or chytrid fungus has been implicated in die-offs of entire amphibian assemblages (Berger et al., 1998; Bosch et al., 2001). This pathogen is commonly found in the environment and degrades chitin, cellulose, and keratin, but has only recently been shown to parasitize vertebrates (Berger et al., 1998). In anurans, seemingly healthy tadpoles can carry the pathogen, but they generally die before metamorphosis. Indications of tadpoles carrying the disease include missing or broken tooth rows, and loss of pigmentation in the tooth rows (Berger et al., 1998; Daszak et al., 1999; Vredenburg and Summers, 2001). Often this is the only way to diagnose B. D. in tadpoles in the field however it is not infallible. When post-metamorphic frogs are infected, the disease is highly deadly and causes the frogs skin to slough off, erupt in ulcerations, or break out in lesions (Daszak et al., 1999). One of the means of spreading B. D. zoospores from site to site is on biologist's nets, boots, waders and any equipment that has been in contact with the water or mud. Therefore, extra precautions must be taken to eliminate the possibility of spreading this pathogen. The following procedures should be followed when using the same equipment from site to site, even if B. D. has not been previously detected at a site.

Supplies:

1. 10:1 water /commercial bleach solution (6% sodium hypochlorite-NaC1O)
2. Ethanol
3. Rags
4. Disposable powderless vinyl exam gloves
5. Sealable plastic bags
6. Coarse brush (to remove mud)

Procedure (adapted from Speare et al., 2004):

A. If possible, use separate equipment for each watershed you visit.
B. Prior to going in the field, disinfect all equipment using a 10:1 water / commercial bleach solution.
C. Always work from the "cleanest" site (sites that have tested negative for chytrid) to the "dirtiest" site (sites of unknown status and sites known to have the pathogen) and disinfect in between water bodies.
D. Use disposable powderless vinyl exam gloves (new pair per animal) when handling animals. Keep a bag handy to dispose of gloves, turning gloves inside-out as they are removed. Be sure to moisten gloves prior to touching delicate amphibian skin.
E. Use a new bag to process each animal and discard bag when done.
F. When handling (eg. measuring, PIT-tagging or toe-clipping) animals use sterile instruments. Sterilize equipment with ethanol between animals.
G. Do not allow disinfectants to contact amphibians.
H. Disinfect all equipment before leaving any site. This means wash first to remove all clumps of dirt etc., then disinfect with a 10:1 water / commercial bleach solution. After

cleaning your equipment of debris, soak all surfaces in the bleach solution and allow to air-dry. That will give the bleach enough time to disinfect. If you are concerned about damaging your equipment rinse, soak for at least 5 minutes and immediately rinse with clean water. If ranavirus mortality has been confirmed or suspected at a site, consider using the strongest recommended concentration of bleach, soaking for longer, or using another disinfectant (Table A). *Remember: the product label is the law! It is the responsibility of the users of this protocol to read and follow the product label and MSDS for use and disposal.*

I. If wet shoes have been in the vehicle, scrub floor and pedals with disinfectant and do not drive through water at another watershed unless you disinfect wheels with the bleach solution.
J. Wash your field clothes after each visit.

Table A: Bleach % and dilutions based on commercial bleach assuming ~6% sodium hypochlorite (NaClO). Adjust accordingly if the bleach you buy has a different sodium hypochlorite concentration.

	Approx. % bleach	Dilution, x:10parts water	Liquids cups per gallon	Approx. % NaClO target for disinfection	
Recommended	10%	1	1.5	0.5%	Most effective in least amount of soaking time. Rinse well after disinfecting, toxic to amphibians
Minimally recommended	3%	0.3	0.5	0.2%	Should inactivate ranavirus and chytrids. Be sure to soak long enough. Rinse well after disinfection

See text and link below for concentrations and soak times if you require lower concentrations of bleach

"Common disinfectants used are chlorhexidine and sodium hypochlorite (bleach). Bleach is often preferred because it is cost effective, easily obtained, and effective against most bacteria and many viruses. The US Fish and Wildlife Service and American Fisheries Society – Fish Health Section (USFWS and AFS-FHS) (2005) recommend 10 min of exposure of a 0.05% bleach solution (i.e. 28.4 g of 6.15% sodium hypochlorite in 3.8 L of clean water) for disinfection of field equipment and surfaces for B. dendrobatidis, and, although not conclusive, a 0.5% solution (i.e. 312 g of 6.15% sodium hypochlorite per 3.8 L of water) is recommended to destroy myxosporeans. However, bleach is not very effective at inactivating Ranavirus, and requires at least a 3% concentration (Bryan et al. 2009). It should be noted that this concentration can be toxic to amphibians. In contrast, chlorhexidine used at a dosage that is safe for amphibians (0.75% for a 1 min exposure) has been shown to inactivate Ranavirus (Bryan et al. 2009). Further, it is important to keep in mind that the shelf-life of bleach solutions is influenced by exposure to light, air, and organic material, and solutions should be discarded after 5–7 days. After disinfection, equipment may be allowed to air dry or rinsed with fresh, clean water. Alternatively, if carrying large quantities of water is not possible because multiple fields sites are to be visited, surface water from the subsequent site (i.e. where the equipment will be used next) can serve as the rinse water. If mountain systems with stream watersheds are sampled, we

recommend that researchers begin sampling at higher elevations and work towards lower sites. If a disease agent is present at higher elevations, it is likely to be at lower elevations due to downstream transmission. Hence, if accidental transmission occurs during travel on fomites, it is less likely to be a novel introduction" (Green et al. 2009).

Literature Cited:

Berger, L., R. Speare, P. Daszak, D.E. Green, A.A. Cunningham, C.L. Goggin, R. Slocombe, M.A. Ragan, A.D. Hyatt, K.R. McDonald, H.B. Hines, K.R. Lips, G. Marantelli, and Parkes, H.. 1998. Chitridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. Proceedings of the National Academy of Science 95:9031-9036.

Bosch, J., I. Martinez-Solano, and Garcia-Paris, M. 2001. Evidence of a chytrid fungus infection involved in the decline of the common midwife toad (Alytes obstetricans) in protected areas of central Spain. Biological Conservation 97:331-337.

Daszak, P., L. Berger, A.A. Cunningham, A.D. Hyatt, D.E. Green, and Speare, R. 1999. Emerging infectious diseases and amphibian population declines. Emerging Infectious Diseases 5:735-748.

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Speare, R., L. Berger, L.F. Skerratt, R. Alford, D. Mendez, S. Cashins, N. Kenyon, K. Hauselberger, and Rowley, J. 2004. Hygiene protocol for handling amphibians in field studies. Amphibian Diseases Group, James Cook University, Townsville 4811, Australia.

Vredenburg, V.T., and Summers, A.P. 2001. Field identification of chytridiomycosis in Rana muscosa (Camp 1915). Herpetological Review 32:151-152.