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Central Coast Watershed Studies

CCoWS

Central Coast Region South District Basin Planning & Habitat Mapping Project

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Preface

This is a report to the California Department of Fish and Game. Between 2003 and 2008, the Foundation of CSUMB produced fish habitat maps and GIS layers for CDFG based on CDFG field data. This report describes the data entry, mapping, and website construction procedures associated with the project. Included are the maps that have been constructed. This report marks the completion of the Central Coast region South District Basin Planning and Habitat Mapping Project.

Acknowledgements

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Table of Contents

PREFACE .... **III**

ACKNOWLEDGEMENTS .... **III**

TABLE OF CONTENTS .... **V**

1. OVERVIEW **1**

2. STUDY AREA **3**

2.1. Central Coast South District **3**

2.2. Figure 2. Map of Central Coast South district **3**

2.3. Watersheds **4**

3. CENTRAL COAST SALMONIDS **6**

4. HABITAT INVENTORY & DATABASE **8**

4.1. Habitat Inventory Data **8**

4.2. CDFG *Stream Habitat* Database **9**

4.3. Stream Habitat Database Input **10**

***4.4. Stream Habitat* Database Output** **11**

5. TECHNICAL NOTES ON MAPPING PROCEDURES **12**

5.1. Calibration of Hydrography **12**

5.2. Dynamic Segmentation **14**

5.3. Data Layers **15**

5.4. Maps **19**

6. WEBSITE **20**

7. LITERATURE CITED **21**

8. APPENDIX A – MAPS...22

1. Overview

In 2004, California Department of Fish and Game (CDFG) and the Central Coast Watershed Studies (CCoWS) team from The Watershed Institute at CSU Monterey Bay began collaboration on using GIS technology to graphically present CDFG field data on stream habitat typing (Figure 1). These field data have been collected by CDFG since 1995 as part of the stream habitat restoration program (Flosi et al., 1998). The goal of the project described in this report was to develop maps depicting the distribution of fish habitat parameters and important features, for use by CDFG for stream analysis and planning.

Various data processing steps have been employed since 1995 to facilitate data entry and summary. (1) Initially, field data were entered by CDFG staff into a CDFG database system known as *HABITAT 8*. (2) In the early stages of this CCoWS project, an in-house CCoWS MS Access database system was developed for creating summary data from the raw field data. (3) Most recently, a separate MS Access-based database system known as *Stream Habitat* was developed by Zeb Young (University of California Hopland Research & Extension Center) for performing similar data summary and export functions. The final products of the present project were produced using *Stream Habitat* in conjunction with *ESRI ArcMap*.

CCoWS received data in several forms, including raw field data sheets (hardcopies), old *HABITAT 8 dbf* files, and newer *Stream Habitat mdb* files. Field data were entered directly into *Stream Habitat*, with appropriate quality control procedures. *HABITAT 8* data were converted to *Stream Habitat* format.

To create maps, *Stream Habitat mdb* files were exported in *dbf* files which were then joined to ESSRI Shapefile (*shp*) files using ESRI Dynamic Segmentation software to create a final set of linked GIS files (*shp*, *shx*, *dbf*, etc) representing the spatial distribution of all stream habitat parameters. Printable quality maps were created directly from these files, which were also posted on the project web site. The mapped parameters included: canopy density, temperature, substrate embeddedness, percent pools, land cover, barriers, spawning substrate, geology, restoration, slope, vegetation cover, passage, population growth, habitat type, and bank erosion.

The information depicted in these maps is useful in planning, evaluating, and monitoring processes associated with these watershed and stream improvement programs. In order to further distribute information a website was also created. This ensured that the data and supporting documentation (this report) will be widely and more permanently available. To facilitate rapid interpretation of the data within their broader geographic context, Google Earth overlays were also created.

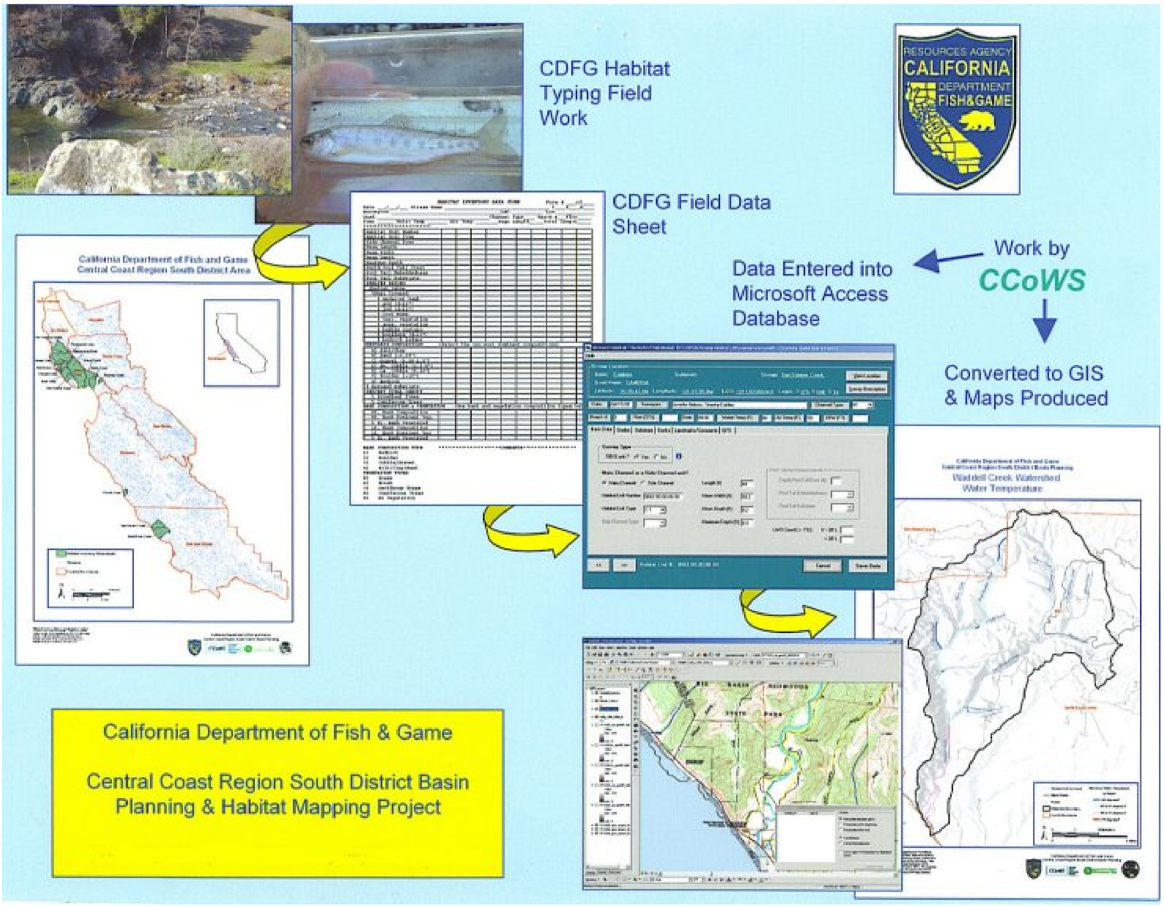
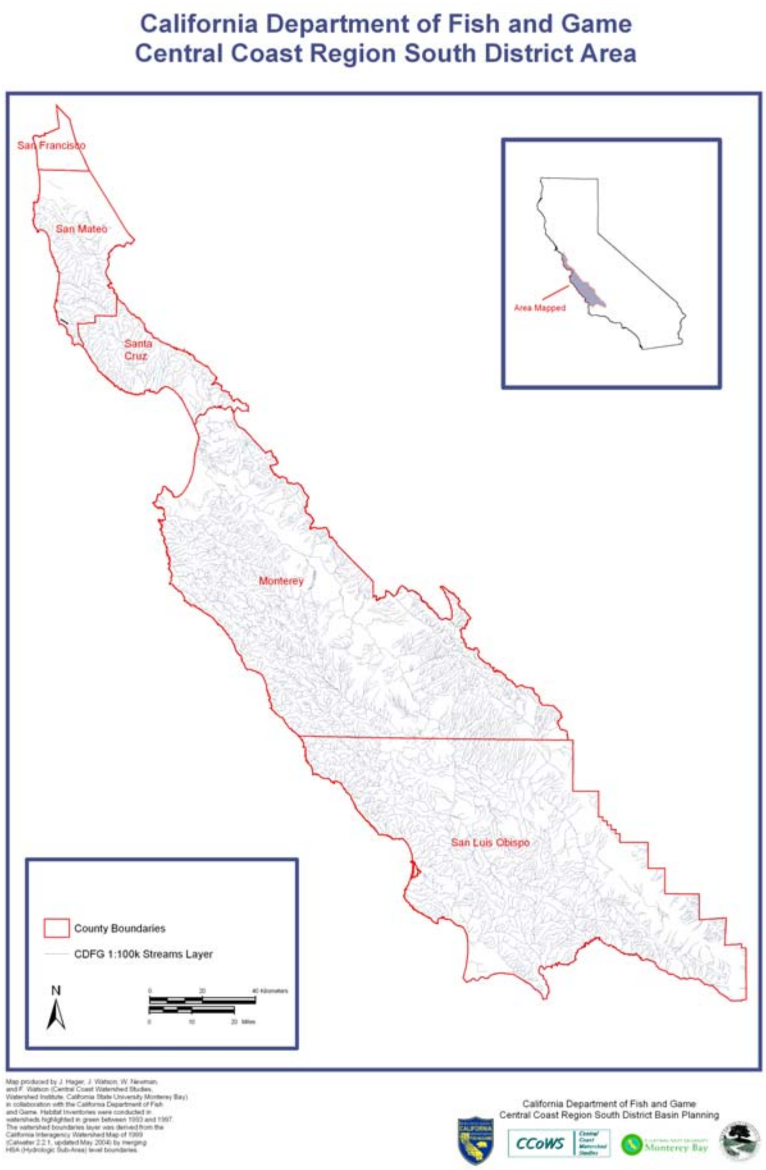


Figure 1. Illustration of data processing steps involved in this project.

2. Study Area

2.1. Central Coast South District

The Central Coast South District contains San Mateo, Santa Cruz, Monterey, and San Luis Obispo counties (Figure 2). A total of twenty-three streams were analyzed in this study not including the tributaries that are part of these watersheds. The salmonid species present in this area include the Central California Coast and South-Central California Coast distinct population segments of steelhead trout and the Central California Coho salmon population units.



2.2. Figure 2. Map of Central Coast South district.

2.3. Watersheds

Watersheds were selected based on logistical criteria, landowner access, and land use. The watersheds that are contained in the south district can be found in the four counties of San Mateo, Santa Cruz, Monterey, and San Luis Obispo (Table 1 and (Figure 2).

County	Watershed	Year Surveyed
San Mateo	San Gregorio Creek	1995/1996, 2006
	Pescadero Creek	1995
	Ano Nuevo Creek	1995
	Gazos Creek	1993
	Tunitas Creek	2006
	Lobitos Creek	2006
	Whitehouse Creek	2006
Santa Cruz	Waddell Creek	1997
	Scott Creek	1997
	San Vicente Creek	1996
	Soquel Creek	1996
	Aptos Creek	1997
	San Lorenzo River	1995, 1996 & 1997
	Ramsey Gulch Creek (sp)	2002
	San Jose Creek	2006
Monterey	Prewitt Creek	1995
	Salmon Creek	2005
San Luis Obispo	San Luis Obispo Creek	1996
	Toro Creek	2000
	Chorro Creek	2001
	Pismo Creek	2005
	Santa Rosa Creek	2005
	San Simeon Creek	2005

Table 1: List of Watersheds and the year in which they were surveyed

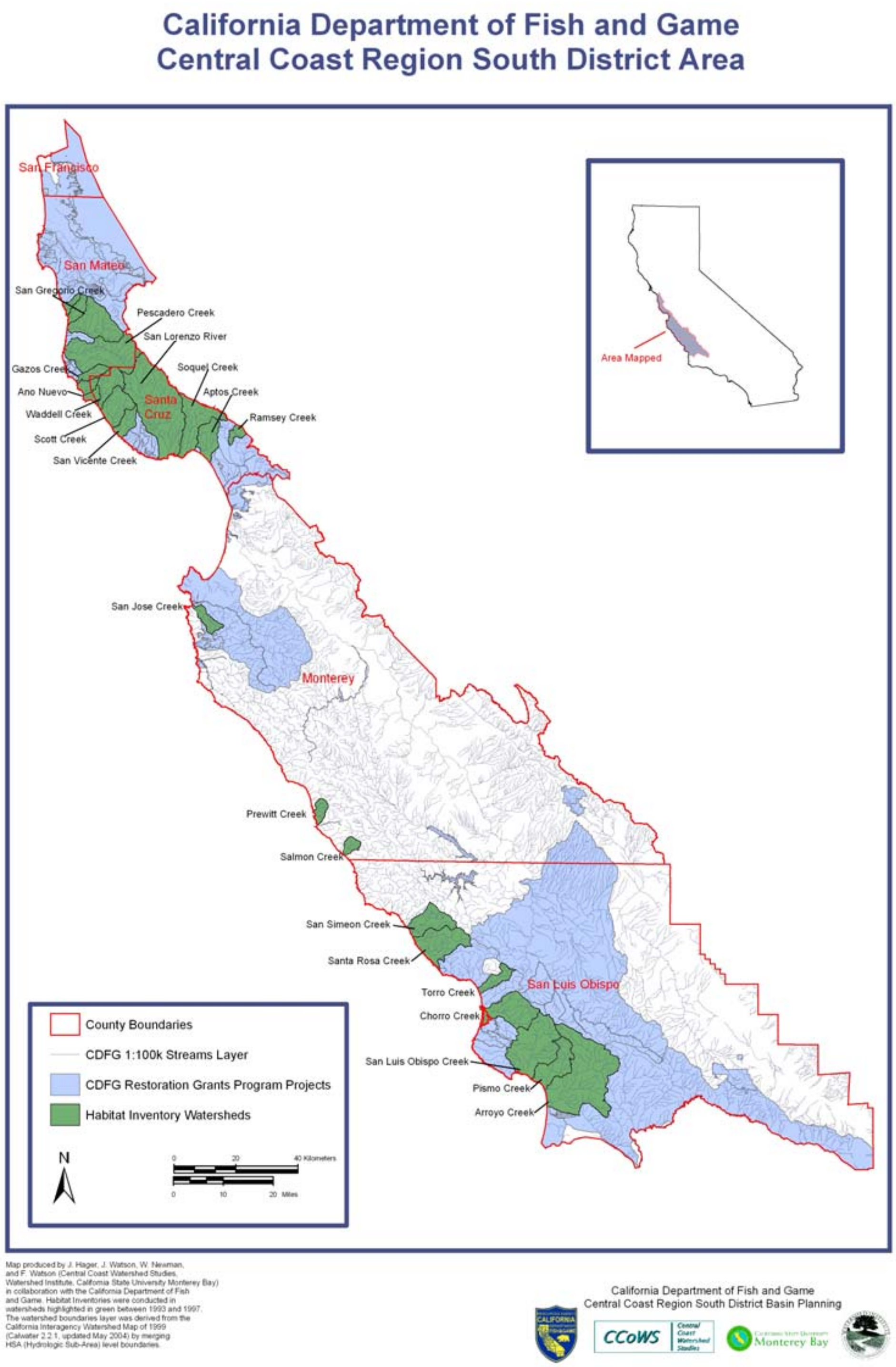


Figure 3. Map of South District inventory watersheds and restoration project watersheds.

3. Central Coast Salmonids

Two salmonid species occur in Central Coast watersheds, steelhead (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*). The coho range is limited to the northern portion of the Central Coast South District. A number of factors determine the successful reproduction, overwintering, growth, and survival of these salmonid species. Documenting and measuring habitat conditions within Central Coast watersheds is necessary in order to identify limiting factors and determine restoration priorities. There are several life history stages that collectively determine the health of an individual and thus the population: spawning, overwintering, spring/summer rearing (instream and lagoon), and ocean survival.

Habitat conditions that lead to spawning success include flows sufficient for access to spawning habitat that includes coarse substrate, hydraulics that allow for oxygenation of eggs (often located at the transition zone between riffles and head of pool habitats), timing, frequency and magnitude of subsequent winter storms and flow, and presence of nearby escape cover both for adults and emerging fry.

Overwintering habitat, such as pools formed by large woody debris and other backwater areas are important for refuge during high winter flows.

Spring and summer rearing habitat for adequate growth is also important. Ocean survival has recently been shown to be directly correlated with juvenile rearing and size attainment (Bond, 2006). Growth is related to key factors such as temperature, which regulates metabolic function, and food availability. Availability of food in streams is affected by turbidity, competition, and productivity, which is directly related to temperature, substrate, canopy closure (light), and organic matter. Rearing can occur in streams, lagoons, or in a combination of both. Utilization of stream or lagoon habitat for rearing is watershed-specific and is related to watershed size (i.e. distance from spawning streams to lagoon), stream geomorphology (i.e. drainage network type, slope, habitat formation), climate, canopy cover/vegetation type (i.e. deciduous versus non-deciduous), lagoon size and formation, and lagoon sandbar management.

In some Central Coast streams, especially in more inland and/or southern watersheds located long distances from lagoon habitat and dominated by more open, deciduous canopies, steelhead growth primarily occurs in warmer fast water habitats with an abundance of food. Steelhead have been documented to reach smolt size in one year under these conditions (Smith and Li 1983; Casagrande in prep). In more coastal/northern type watersheds (i.e. small, shady, conifer dominated), located in close proximity to lagoons, the steelhead primary growth occurs in productive lagoons where adequate sizes can be attained in one year. In other areas a combination of rearing strategies may be used and rearing may take two years.

The life history of coho is more rigid than that of steelhead (3-year life cycle). Coho primarily rear one year in stream and lagoon habitats and spend two years in the ocean prior to spawning (Shapovalov and Taft 1954). Whereas steelhead utilize a variety of instream habitats, including warmer fast water habitat, coho primarily utilize pool habitat, and are more sensitive to elevated temperatures (Smith 2003). When coho and steelhead occur in the same system, competition can affect habitat utilization (Smith 2003).

Life history, primary rearing location, and habitat utilization vary geographically, both large scale (i.e. north versus central coast) and small scale (between and within watersheds). Ideal habitat is often described as cool, well-oxygenated streams with cobble sized substrate, an abundance of pools, and high canopy cover. However, when examining the maps and habitat summaries presented in this report, it is important to realize that these salmonid species are adaptable and populations can persist in a variety of habitat that may not be considered “ideal”. Resource managers and scientists must examine populations on a watershed-by-watershed basis to identify what works and what is limiting.

4. Habitat Inventory & Database

4.1. Habitat Inventory Data

Habitat inventory data originate from data entry forms that are completed during the habitat assessment process in the field (Figure 4). These data sheets are then QA'd to check for discrepancies and entered into the *Stream Habitat* database (or previously, the *HABITAT 8* database).


HABITAT INVENTORY DATA FORM Form # ___of___
Date ___/___/___ Stream Name ______ T___R___S___
Surveyors ______ Lat.______ Lon.______
Quad.______ Channel Type____ Reach #___Flow_____
Time _____ Water Temp _______ Air Temp ________ Page Length_______ Total Length_________
****
Habitat Unit Number....
Habitat Unit Type......
Side Channel Type......
Mean Length............
Mean Width.............
Mean Depth.............
Maximum Depth..........
Depth Pool Tail Crest..
Pool Tail Embeddedness.
Pool Tail Substrate....
SHELTER RATING
Shelter Value........
% Unit Covered.......
% undercut bank....
% swd (d<12")......
% lwd (d>12")......
% root mass........
% terr. vegetation.
% aqua. vegetation.
% bubble curtain...
% boulders (d>10").
% bedrock ledges...
SUBSTRATE COMPOSITION (Select two most dominant compositions)
A) Silt/Clay.........
B) Sand (<0.08")..
C) Gravel (0.08-2.5")
D) Sm Cobble (2.5-5")
E) Lg Cobble(5-10")..
F) Boulder (>10")..
G) Bedrock...........
% Exposed Substrate....
PERCENT TOTAL CANOPY...
% Broadleaf Trees......
% Evergreen Trees......
BANK COMPOSITION & VEGETATION (See bank and vegetation types below)
Rt Bk Composition. ....
Rt Bk Dominant Veg.....
% Rt Bk Vegetated......
Lft Bk Composition.....
Lft Bk Dominant Veg ...
% Lft Bk Vegetated.....
*********************COMMENTS***********************
BANK COMPOSITION TYPE
1) Bedrock
2) Boulder
3) Cobble/Gravel
4) Silt/Clay/Sand
VEGETATION TYPES
5) Grass
6) Brush
7) Deciduous Trees
8) Coniferous Trees
9) No Vegetation

Figure 4: Habitat Inventory Data Sheet

4.2. CDFG *Stream Habitat* Database

The Stream Habitat database is used by CDFG to store and summarize stream habitat survey information. A screen-shot illustrating the user interface is shown in Figure 5.

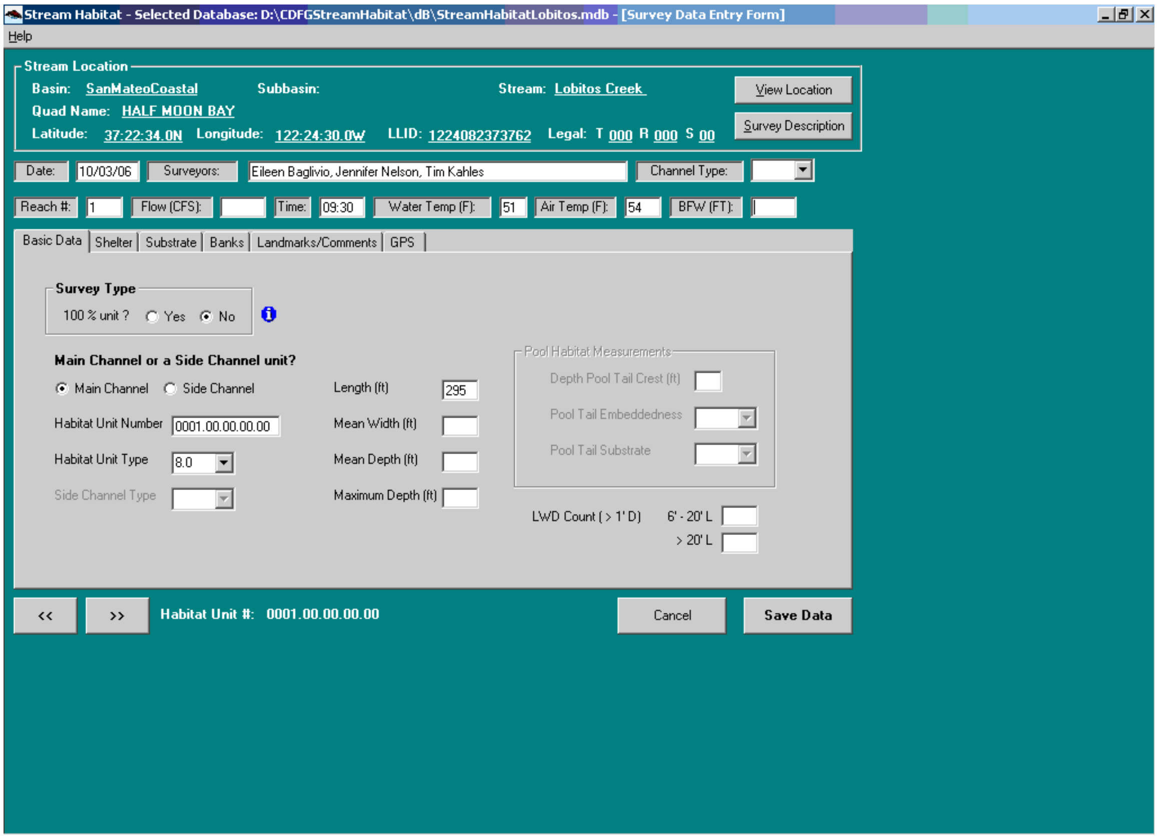


Figure 5 Screen shot of data entry form from MS Access *Stream Habitat* database created by Zeb Young (UC).

4.3. Stream Habitat Database Input

Stream habitat data were received and processed by CCoWS staff in three ways, as summarized in Table 2. Initially, old *Hab 8 dbf* files for several streams were imported into the new *Stream Habitat* program. Several other streams had no *Hab 8 dbf* information and therefore original data sheets were entered by the CCoWS staff manually into the *Stream Habitat* database. Lastly newer *Stream Habitat mdb* files were received directly by CCoWS for certain streams (Table 2).

County	Watershed	When Received	.dbf Process
San Mateo	San Gregorio Creek	2004	old Hab 8 .dbf
	Pescadero Creek	2006	no .dbf data entered by hand
	Ano Nuevo Creek	2005	no .dbf data entered by hand
	Gazos Creek	2005	no .dbf data entered by hand
	Tunitas Creek	2007	.mdb files sent
	Lobitos Creek	2007	.mdb files sent
	Whitehouse Creek	2007	.mdb files sent
Santa Cruz	Waddell Creek	2004	old Hab 8 .dbf
	Scott Creek	2004	old Hab 8 .dbf
	San Vicente Creek	2004	old Hab 8 .dbf
	Soquel Creek	2004	old Hab 8 .dbf
	Aptos Creek	2004	old Hab 8 .dbf
	San Lorenzo River	2006	.mdb files sent
	Ramsey Gulch Creek	2006	no .dbf data entered by hand
	San Jose Creek	2007	.mdb files sent
Monterey	Prewitt Creek	2005	no .dbf data entered by hand
	Salmon Creek	2006	.mdb files sent
San Luis Obispo	San Luis Obispo Creek	2006	no .dbf data entered by hand
	Toro Creek	2006	.mdb files sent
	Chorro Creek	2006	no .dbf data entered by hand
	Pismo Creek	2006	.mdb files sent
	Santa Rosa Creek	2006	.mdb files sent
	San Simeon Creek	2006	.mdb files sent

Table 2: Stream Habitat Database file process information

4.4. *Stream Habitat* Database Output

GIS summaries were required at two spatial scales: a coarse 'reach-level' scale and a finer 'habitat-level' scale. Once all data were entered and collated within the *Stream Habitat* database, export of GIS-ready files for reach-level and habitat-level summaries was performed. Each record complied in the database consisted of in-stream *Habitat Unit* attributes summarized at the reach level and the habitat level for the stream habitat surveys (Figure 6). These data were then outputted into *dbf* files that could be used to create appropriately attributed Shapefiles in ArcGIS to visually display these attributes for analytical analysis.

A certain degree of spatial error is to be expected primarily within the habitat-level data. This is because the original field surveys record the location of habitat units in terms of the along-stream distance (feet) of each habitat unit from known locations such as confluences and bridges. When these distances are translated into GIS (see Section 5.1), the habitat units may be slightly mislocated because of differences between the mapped stream vector and the actual stream location, and because of error in field measurement of along-stream distance. These errors are typical and unavoidable in this kind of GIS process. Uncertainty of habitat unit placement on the map is presumed to increase with distance upstream from starting point. Note that for consistency across all watersheds, we used what are known as '1:100,000' stream vector GIS files instead of the more recent '1:24,000' files. Whenever the length of the stream as measured in the surveys to exceed the apparent stream length mapped in the GIS files, a scaling factor was applied.

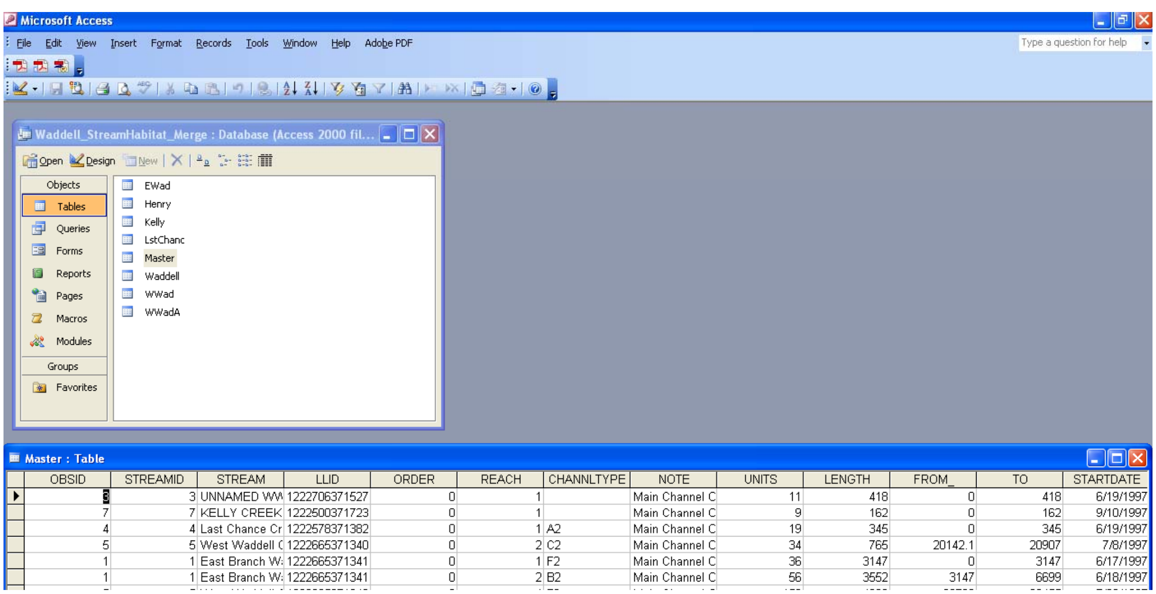


Figure 6: Reach Summary data screen shot

5. Technical notes on mapping procedures

Some terse notes here are provided to assist those who may need to accomplish similar tasks in the future.

5.1. Calibration of Hydrography

Calibration using field maps and notes provides greater position accuracy of habitat units and channel type locations. Some habitat surveys had approximately every 10th habitat unit location recorded with a GPS unit, and these data points were used to create a more precise calibration of the habitat surveys to the underlying GIS streams layer (Figure 7).

The habitat database files were matched to a routed GIS layer of 1:100,000 streams (created by Mike Byrne at DFG in the mid-1990s, and revised by Colin Brooks and Zeb Young) using the Arc/Info calibration and dynamic segmentation process. A more detailed 1:24,000 streams layer became available from the California Department of Forestry and Fire Protection as part of the North Coast Watershed Assessment Program, but was not used in order to maintain consistency.

- Create an arcmap_calibration.mxd document
- If you know where your creek is go ahead and zoom in on that area in ArcMap. If you do not know the location of your creek click on the "Selection Menu" and then choose "Select by Attributes". Change the layer to the "Streams" layer. Double click on the (Name) field and then click on compile list. Double click on name again, and single click on the "=" (equals) button. Next double click on the name of your stream and click "Apply". Click the close button. Right click on the Streams layer in the table of contents and left click "Selection". Then left click "Zoom to Selected Features". You should now be zoomed to your creek.
- At this point you take the comments and landmarks sheets that were produced for your creek during the database export process. On this sheet you want to pick several key intersections that are easily identifiable such as road intersections, bridges, GPS coordinates, ect.
- Metric measure values that correspond to calibration points must be obtained so look at the chosen landmarks and write down the position listed for that comment. Create an excel sheet with these points and lengths.
- Create a point shapefile comprised of these landmark points. In ArcCatalog right click and create new shapefile, name stream_name_calibration_points, and import Geospatial data.
- With all routes and points in hand its time to calibrate the routes. Click on the editor toolbar and start editing

- Click on the editor toolbar again, then options, in the general tab make sure that the snapping tolerance is set to 100 map units and click ok
- Click on the editor toolbar again and then start editing. Under task choose calibrate route
- Next select the stream you are calibrating by clicking on it so that it turns bright blue.
- Next go to view tab and make sure the route editing tools are on by clicking on view then clicking on toolbars and checking route editing
- Click on the calibrate route button. Once the calibrate route window pops up, click on the pencil sketch tool in the toolbar
- Now move the mouse over the first of the calibration points created when the cursor snaps to calibration point click on that point. Enter the measures (meters) value in the “new M’ field of your note sheet in excel that corresponds to that calibration point. If it’s the start enter zero otherwise enter the measure value from the landmarks and comments sheet.
- In the calibrate route window make sure all these are checked: Interpolate between points, extrapolate at the beginning, extrapolate at the end, and use distance.
- Once you have done all the points and recorded the old values on the excel sheet and added the new m values click on the calibrate route button
- Finally go to the editor menu and click on save edits and then stop editing
- You can then use your excel data sheet to calculate the percentage difference between the original data layer and the newly calibrated one.

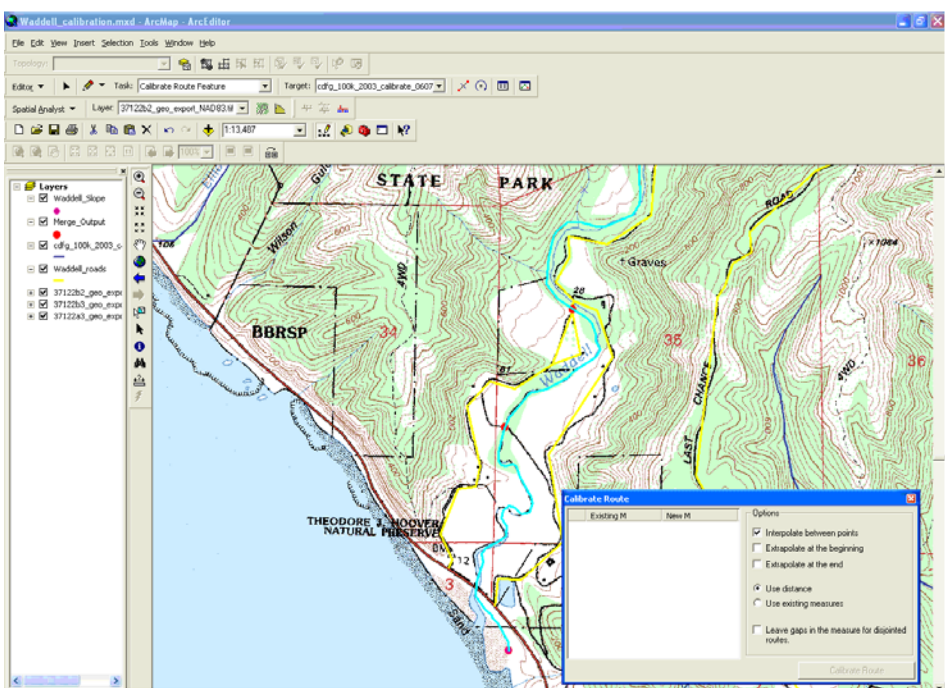


Figure 7: Screen shot of ArcGIS calibration process

5.2. Dynamic Segmentation

The dynamic segmentation of this data set allows for a stream route system to be created and linking it with associated habitat characteristics.

- To begin with add the .dbf file created by Stream Habitat for the stream of your choosing by clicking on add data button and navigate to the directory where you exported that dbase file
- This will bring up the source view of the table of contents –click on the display tab to switch back to normal view of the table of contents
- Now click on the tools menu, then the add route events menu option. The add route events window will pop up.
- In the add route events window make sure that the route reference is the "streams layer" Set the event table to the DBF that goes with your stream. You'll also set the route identifier as LLID. Set the type of event to line events. Mare sure the from-measure is set to "From" and the to-measure is set to "To". Click on the OK button.
- Next Click export data and choose use the same coordinate system as this layers source data in the export window.
- The resulting shapefile will be added to the top of your table of contents

5.3. Data Layers

The accompanying maps contain the following layers, a list of their sources and any changes made to these layers during the course of making the maps published as metadata at http://ccows.csumb.edu/scdp/.

Arc Data Layer	Source of Data	Original Metadata Included?	Edited for Maps?
pad_january2006.shp	CalFish	yes	yes
cnty_24k97.shp	CaSIL	yes	yes
Shaded.shp	USGS	yes	yes
CHRPD_Central_Coast_060503.shp	Holycross	yes	yes
fveg02_2.shp	frap	yes	yes
local_roads.shp	CaSIL	yes	yes
majrdsa.shp	CaSIL	yes	yes
calwater_221.shp	CaSIL	yes	yes
restoration_north.shp restoration_south.shp	Holycross	yes	yes
cdfg_100_2003_6.shp	CDFG	yes	yes
DOQ.tiff	CaSIL	yes	no
DRG.tiff	CaSIL	yes	no
kbf.shp	USGS	yes	yes
_Habitat_Level.shp	CCoWS	n/a	yes
_Reach_Level.shp	CCoWS	n/a	yes
_Spawning.shp _Spawning50.shp	CCoWS	n/a	yes
_LB_Erosion _RB_ Erosion	CCoWS	n/a	yes
_Precipition.shp	Oregon Climate Service at Oregon State University	yes	yes
_Landslide.shp	USGS	yes	yes
_Land_Zoning.shp	CCoWS	yes	yes
_Growth.shp	CCoWS	yes	yes

Table 3: Metadata for the layers used in maps

Details on individual layers are as follows:

pad_january2006.shp

Extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox. Metadata included is from the California Cooperative Anadromous Fish and Habitat Data program (CalFish) download site:

ftp://ftp.streamnet.org/pub/calfish/PAD_January2006.zip

Original layer was projected in Teale Albers (NAD83) and re-projected to GCS_North_American_1983

cnty_24k97.shp

This layer was extracted to the map extents, and the geographic location of the California Watersheds Boundary Layer. Metadata included from the California Spatial Information Library (CaSIL) download site:

/casil/boundaries/cnty24k

Original Layer was projected in local coordinates:

Left: -374353.468750
Right: 540166.812500
Top: 449853.875000
Bottom: -604674.562500

The original layer was then re-projected to GCS_North_American_1983

calwater_22.shp

This layer was extracted to the geographic location of the California Streams Layer. Metadata included from the California Spatial Information Library (CaSIL) download site:

http://gis.ca.gov/casil/hydrologic/watersheds/calwater/

Original Layer was projected in bounding coordinates and re-projected to GCS_North_American_1983.

Shaded.shp

This layer was created from the DEM by running a process in TNTMips called “elevation” as well as the process called “filter”. This process

fveg02_2 acquired.shp

Extracted by geographic extents from California Watersheds Boundary layer by setting layer as a mask, and using Arc’s spatial analyst reclassify tool to reclassify raster image by lifeform. Metadata included is from:

http://frap.cdf.ca.gov/data/frapgisdata/select.asp

Original Layer was projected in Albers Equal Area, NAD27 and re-projected to GCS_North_American_1983 and re-projected to GCS_North_American_1983.

local_roads.shp

Extracted by geographic extents from California Counties Boundary layer using analysis clip tool located in ArcToolbox. Metadata included from the California Spatial Information Library (CaSIL) download site:
http://gis.ca.gov/casil/transportation/census_2000/
Original Layer was projected in NAD_1927_Albers and re-projected to GCS_North_American_1983.

majrdsa. shp

Extracted by geographic extents from California Counties Boundary layer using analysis clip tool located in ArcToolbox. Metadata included from the California Spatial Information Library (CaSIL) download site:
http://gis.ca.gov/download.epl?catalog=casil&data_title=Major
Original Layer was projected with Bounding_Coordinates:

West_Bounding_Coordinate: -124.0000
East_Bounding_Coordinate: -114.0000
North_Bounding_Coordinate: 42.0000
South_Bounding_Coordinate: 32.0000

The original layer was then re-projected to GCS_North_American_1983

restoration_north. shp
restoration_south. shp

Extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox. Metadata included is from CalFish download site:
ftp://ftp.streamnet.org/pub/calfish/CHRPD_070518_ALL.zip
The original data layer was projected in NAD_1983_California_Teale_Albers and re-projected to GCS_North_American_1983.

cdfg_100_2003_6. shp

Calibrated using Arc Editor calibrate route editor tool then extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox. The original layer was acquired from the California Department of Fish and Game (CDFG) download site:
\\013-127-10856\E$\CDFG\Map_Layers\Streams\CDFG_Streams_Layers\Data\cdfg_100k_2003_6.shp
The original layer was projected in GCS_North_American_1983.

kbf. shp

Extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox. Metadata included is from and re-projected to GCS_North_American_1983.

_Habitat_Level.shp
Exported .dbf (IV) habitat_output files from Stream Habitat and used Arc's add route event tool to dynamically segment the calibrated streams layer using the LLID as the route identifier. Original Layer is projected in GCS_North_American_1983.

_Reach_Level.shp
Exported .dbf (IV) reach summary files from Stream Habitat and used Arc's add route event tool to dynamically segment the calibrated streams layer using the LLID as the route identifier. Original Layer is projected in GCS_North_American_1983.

_Spawning.shp
_Spawning50.shp

Created from data supplied by DFG from existing exported .dbf (IV) reach summary files from Stream Habitat and used Arc's add route event tool to dynamically segment the calibrated streams layer using the LLID as the route identifier. Original Layer is projected in GCS_North_American_1983.

_LB_Erosion.shp
_RB_Erosion.shp
Created from data supplied by DFG from existing exported .dbf (IV) reach summary files from Stream Habitat and used Arc's add route event tool to dynamically segment the calibrated streams layer using the LLID as the route identifier. Original Layer is projected in GCS_North_American_1983.

_Precipition.shp
Extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox. Metadata included is from Oregon Climate Service at Oregon State University download site:
http://nationalatlas.gov/atlasftp.html
The original data layer was projected as GCS_North_American_1983.

_Landslide.shp
Extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox. Metadata included is from US Geological Survey download site:
http://nationalatlas.gov/atlasftp.html
The original data layer was projected as GCS_North_American_1983.

_Land_Zoning.shp
Extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox.. The original data layer was projected as GCS_North_American_1983.

_Growth.shp
Extracted by geographic extents from California Watersheds Boundary layer using analysis clip tool located in ArcToolbox. Metadata included is from CCoWS . The original data layer was projected as NAD_1927_Albers.

5.4. Maps

For each watershed a base map was constructed that acted as a template for all subsequent maps. Reach level summaries were used to create the four basic parameter maps:

- Water Temperature
- Riparian Canopy Density
- Primary Pools
- Embeddedness

Other parameters that were mapped using reach and habitat summaries include:

- Slope
- Geology
- Restoration Projects
- Stream Structures and Potential Barriers
- Spawning
- Left Bank Erosion
- Right Bank Erosion
- Habitat Type

Several Maps were also created for the entire South District Basin these maps include:

- Study Area
- Projected Growth
- Precipitation
- Land Zoning
- Landslide

6. Website

The maps and data layers produced during the present project are available from the following web site:

http://ccows.csumb.edu/scdp/

The web site includes both a public and a secure area. The public area contains a total of approximately 542 MB of printable maps (Figure 8). The secure area contains 6 MB of GIS files in *shp*/d*bf* format. The secure web site is not publicly accessible. Access details are available to CDFG staff.

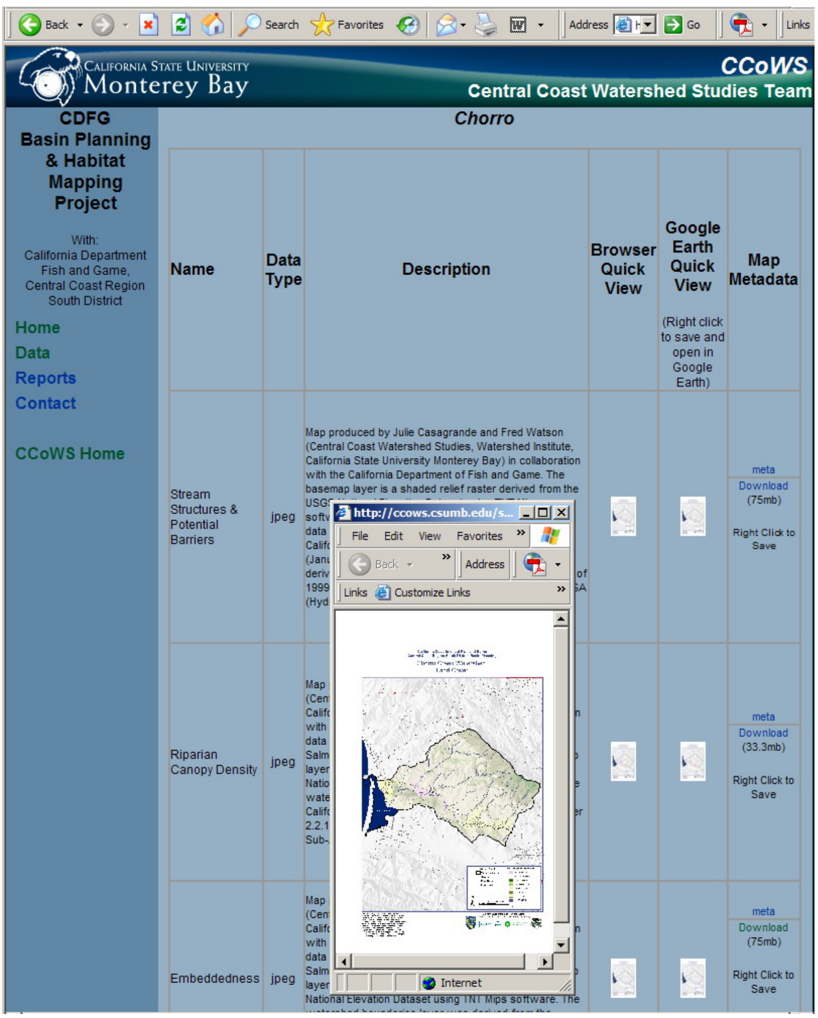


Figure 8. Screen shot of the project web site.

7. Literature Cited

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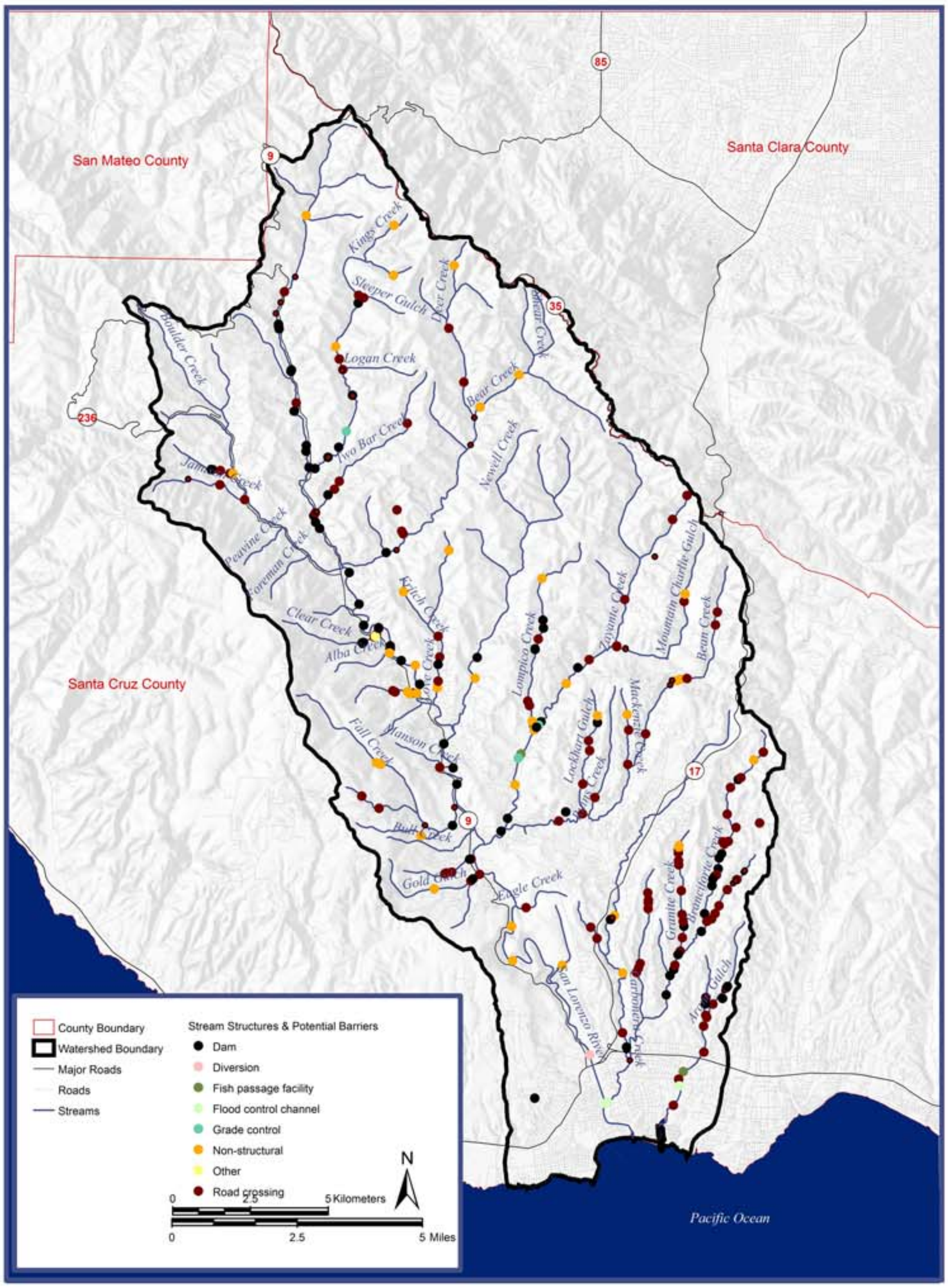
8. Appendix A – Maps

For illustration purposes, this Appendix lists a sample (San Lorenzo and San Simeon only) of the public maps available on the project web site:
http://ccows.csumb.edu/scdp/

Note: Most of the example maps are for San Lorenzo watershed. A few are for San Simeon, covering parameters that were not available for San Lorenzo.

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed
Stream Structures & Potential Barriers



Map produced by Julie Casagrande and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The stream structures and potential barriers data layer was extracted from the PAD GIS dataset - California Fish Passage Assessment Database Project (January, 2006). The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1, updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

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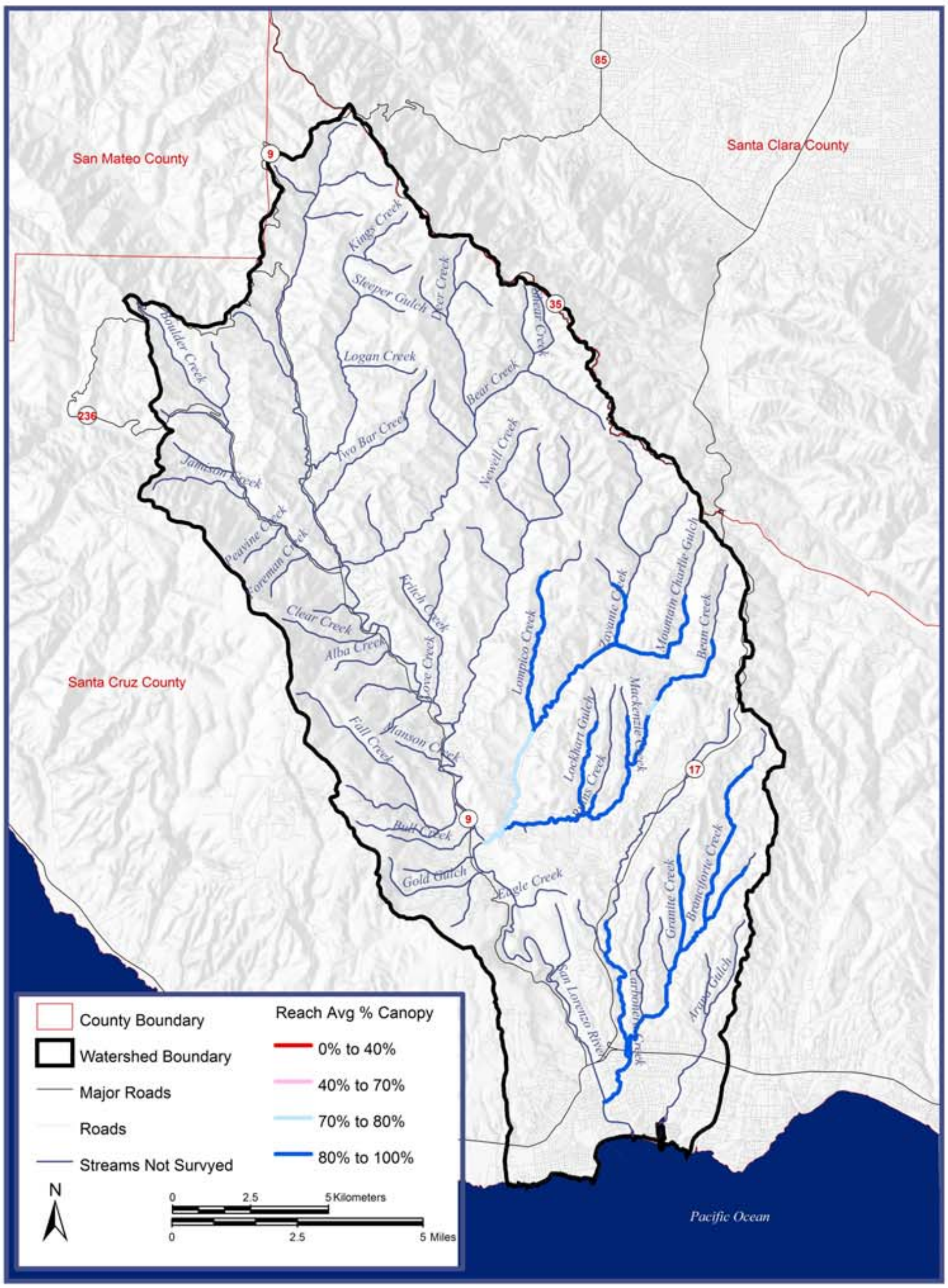
Central Coast Region South District Basin Planning

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed
Riparian Canopy Density

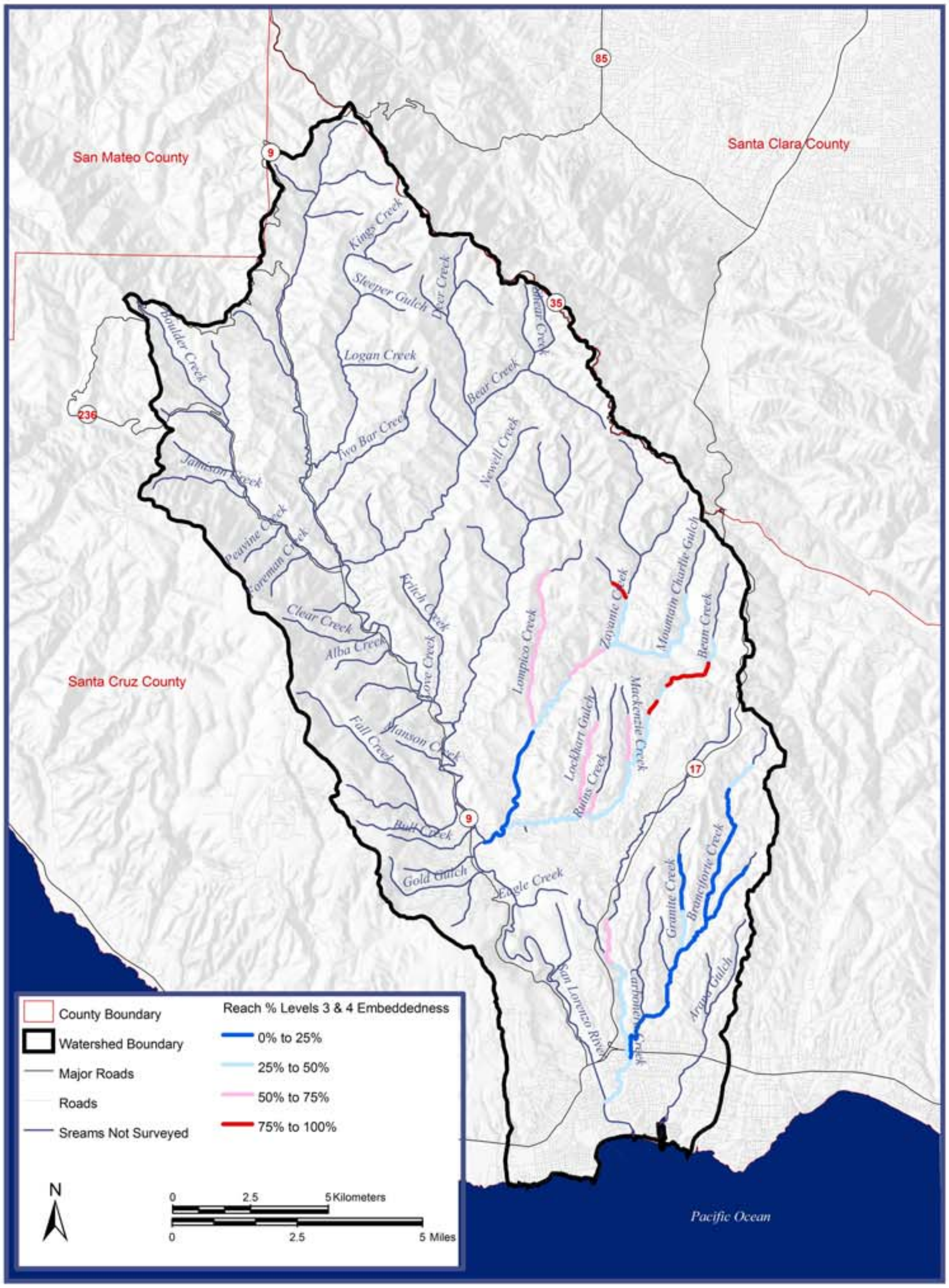


Map produced by Julie Casagrande and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The data presented in map were collected during the CDFG Salmonid Habitat Surveys (Summer 1995,1996 &1997). The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1,updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

California Department of Fish and Game
Central Coast Region South District Basin Planning

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed Embeddedness

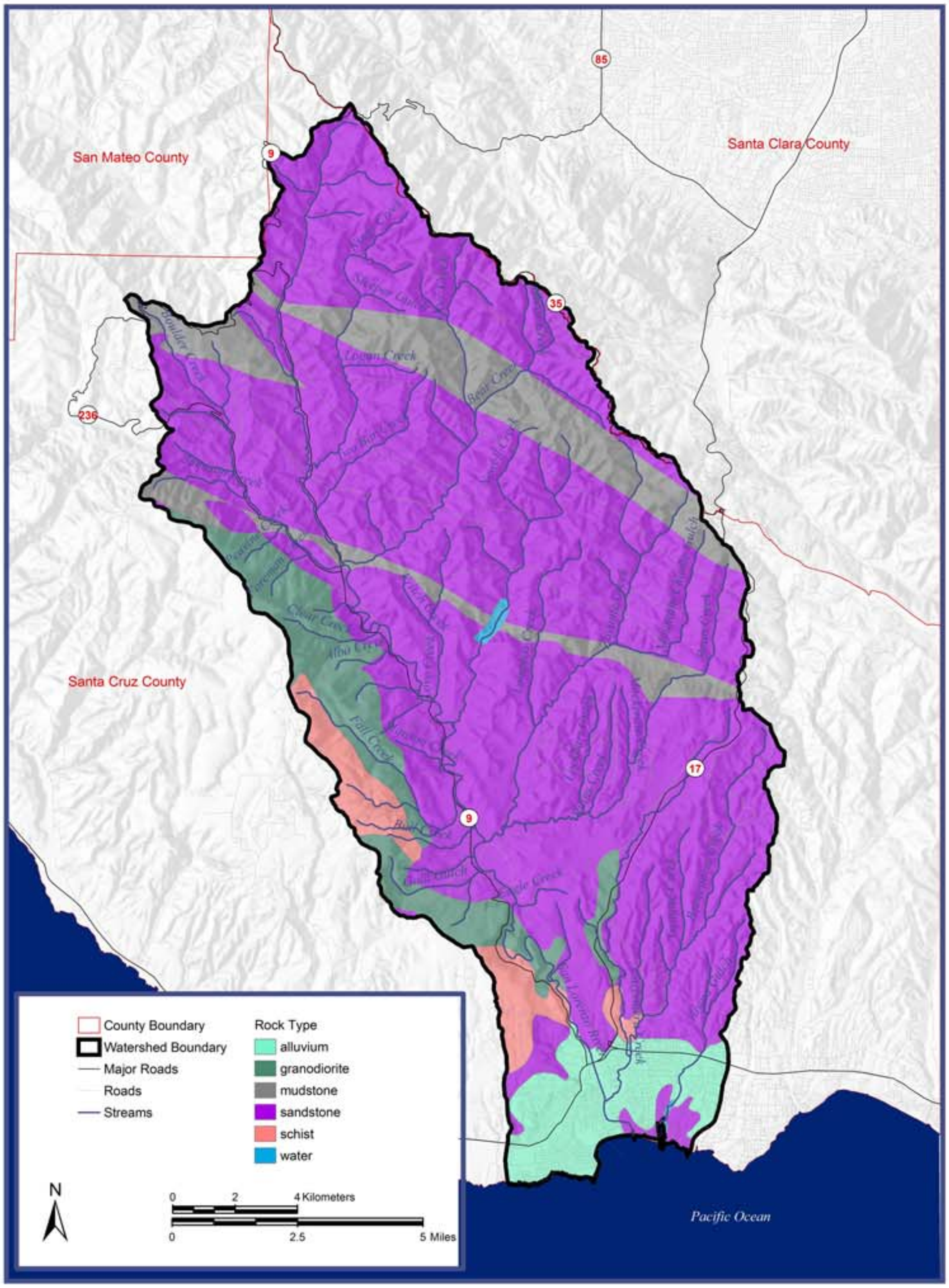


Map produced by Julie Casagrande and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The data presented in map were collected during the CDFG Salmonid Habitat Surveys (Summer 1995, 1996 & 1997). The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1,updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

California Department of Fish and Game
Central Coast Region South District Basin Planning

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed
Geology



Map produced by Jessica Watson and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The geology layer was extracted from the US Geological Survey cageol_dd.pat data set (2005).The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1,updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

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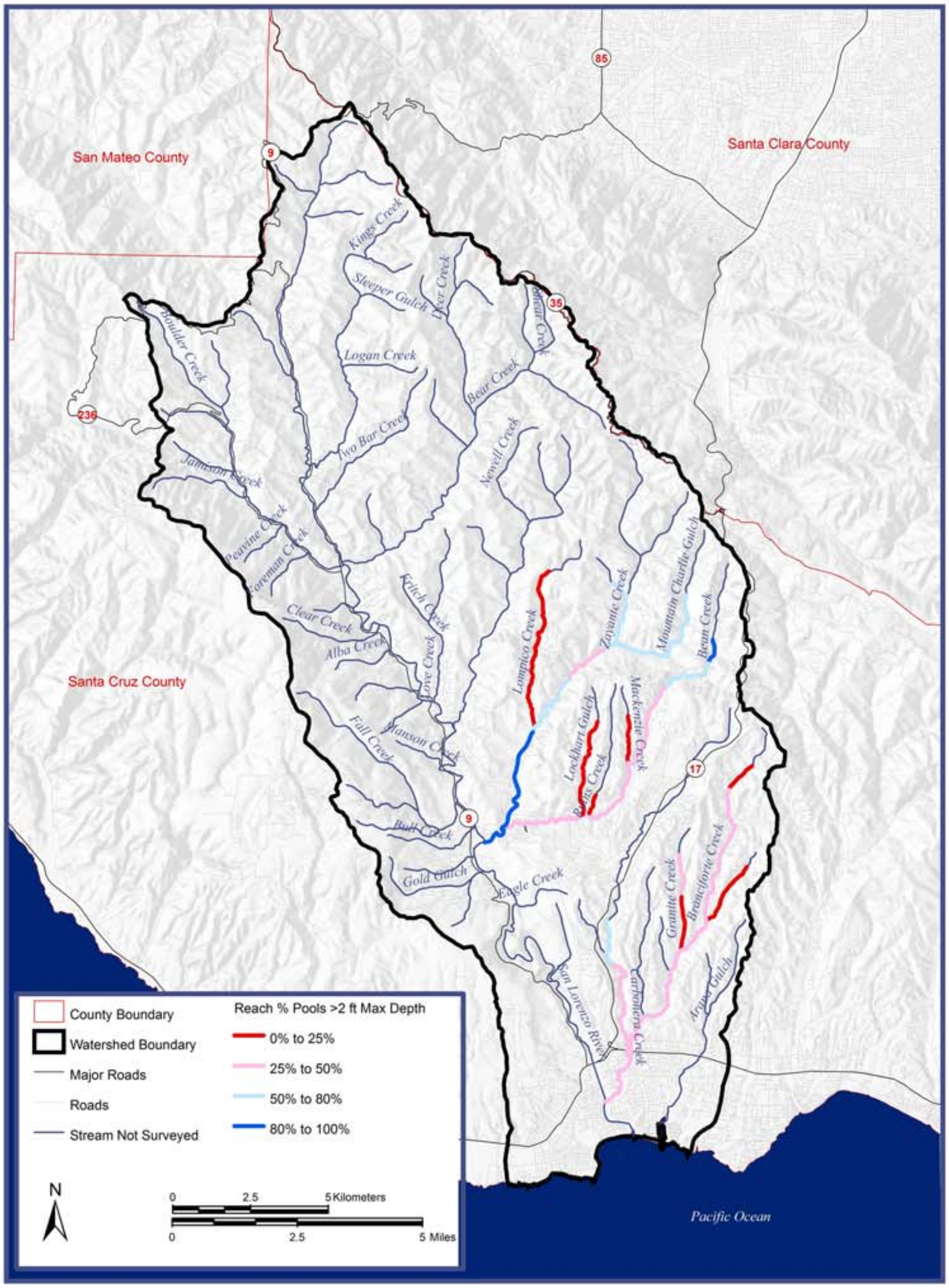
Central Coast Region South District Basin Planning

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed
Percent Pools



Map produced by Julie Casagrande and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The data presented in map were collected during the CDFG Salmonid Habitat Surveys (Summer 1995, 1996 & 1997). The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1,updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

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California Department of Fish and Game
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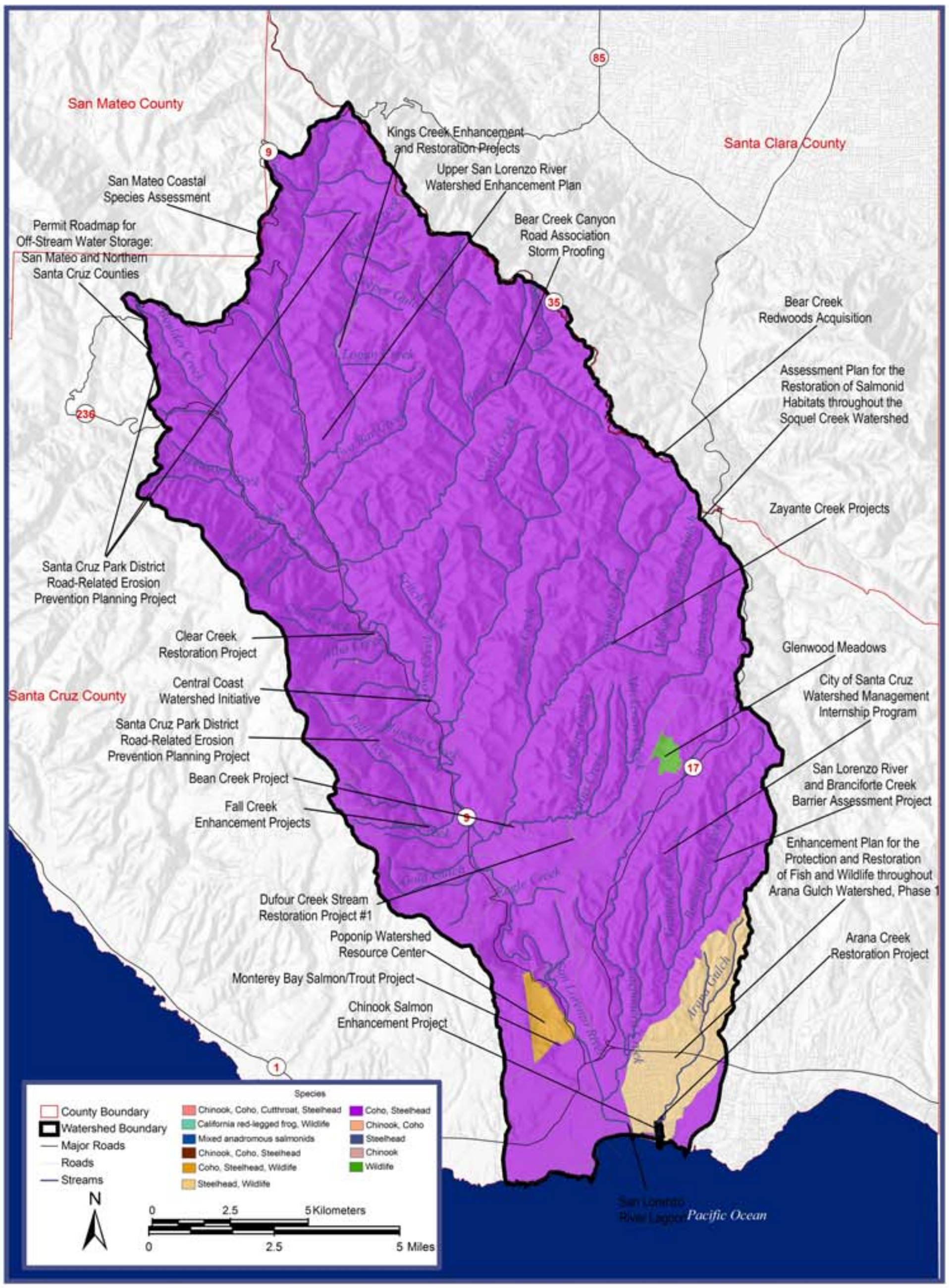
San Lorenzo River Watershed Restoration Projects



Map produced by Jessica Watson and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The restoration projects layer was extracted from the Pacific States Marine Fisheries Commission ongoing and completed salmonid restoration projects database CHRPD_060503_Select.shp (2006). The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1, updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

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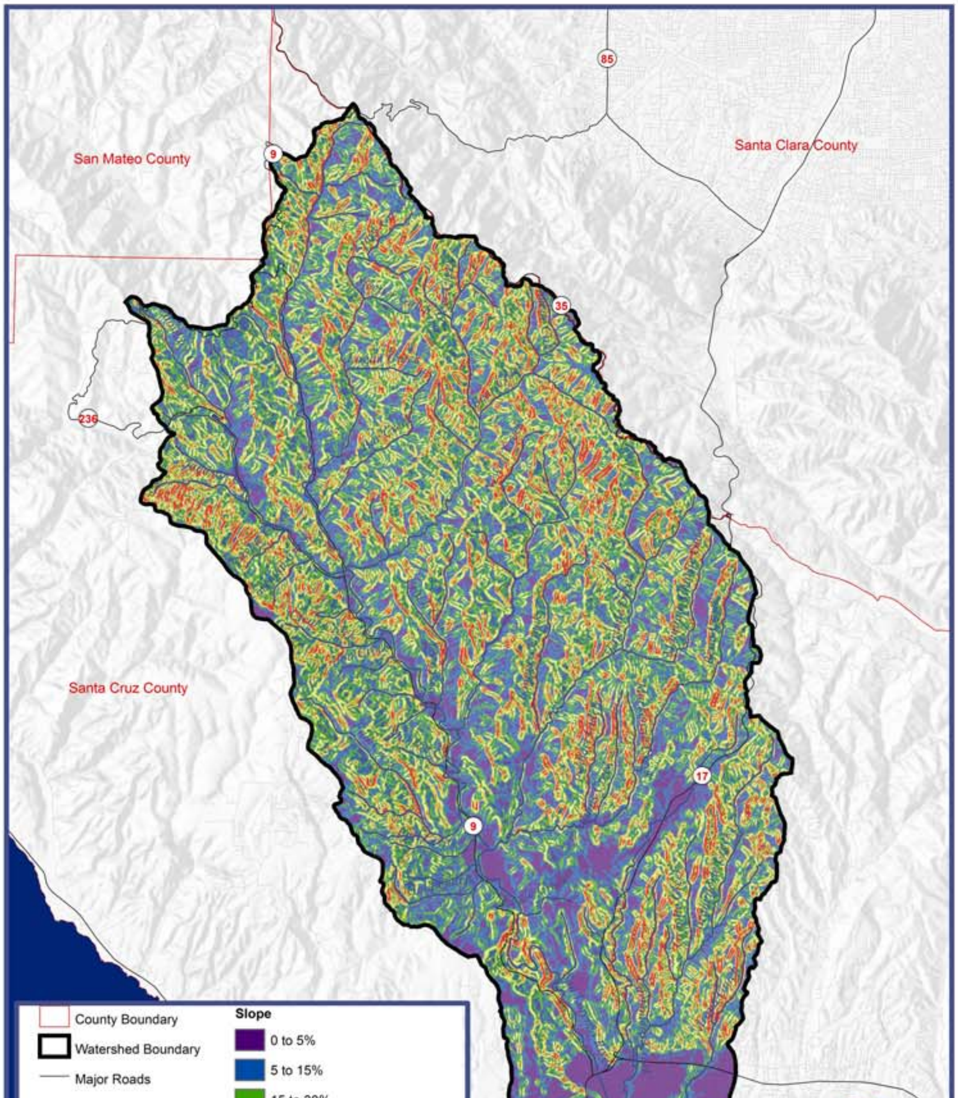
Central Coast Region South District Basin Planning

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed
Slope



Map produced by Jessica Watson and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The slope data layer is an evlevation raster derived from the USGS National Elevation Dataset using TNT Mips software. The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1, updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

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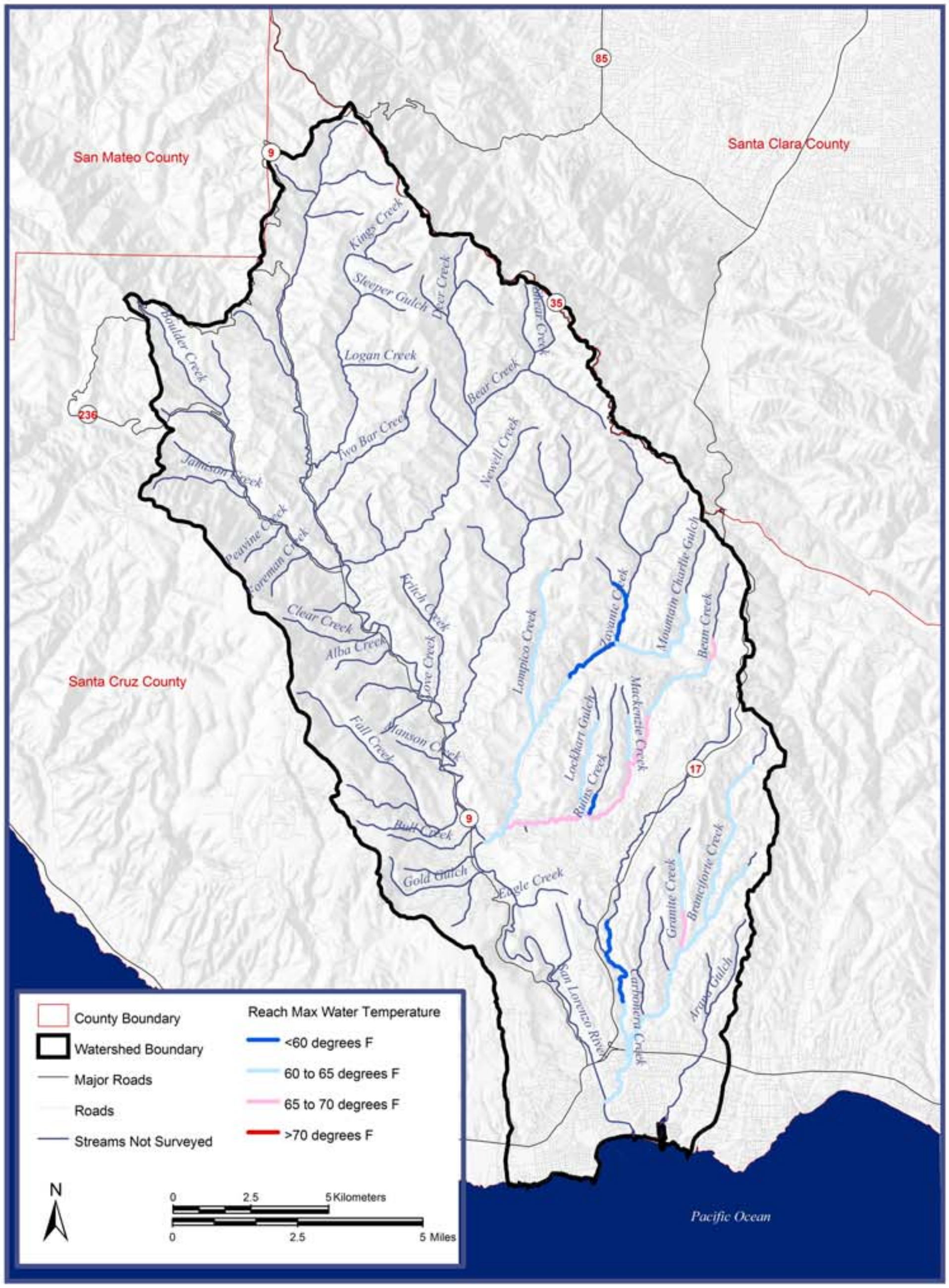
Central Coast Region South District Basin Planning

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed
Water Temperature



Map produced by Julie Casagrande and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The data presented in map were collected during the CDFG Salmonid Habitat Surveys (Summer 1995, 1996 & 1997). The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1,updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

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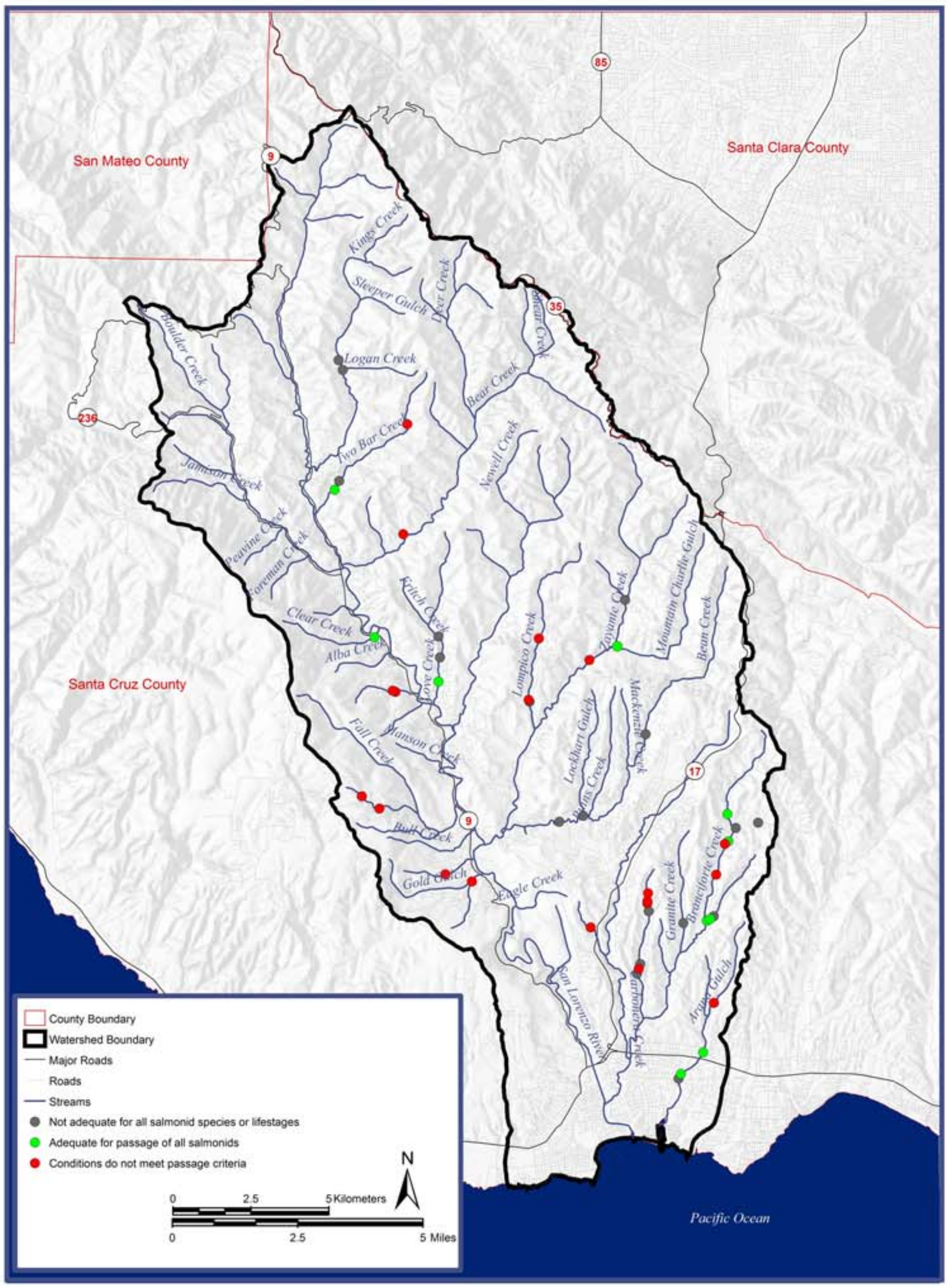
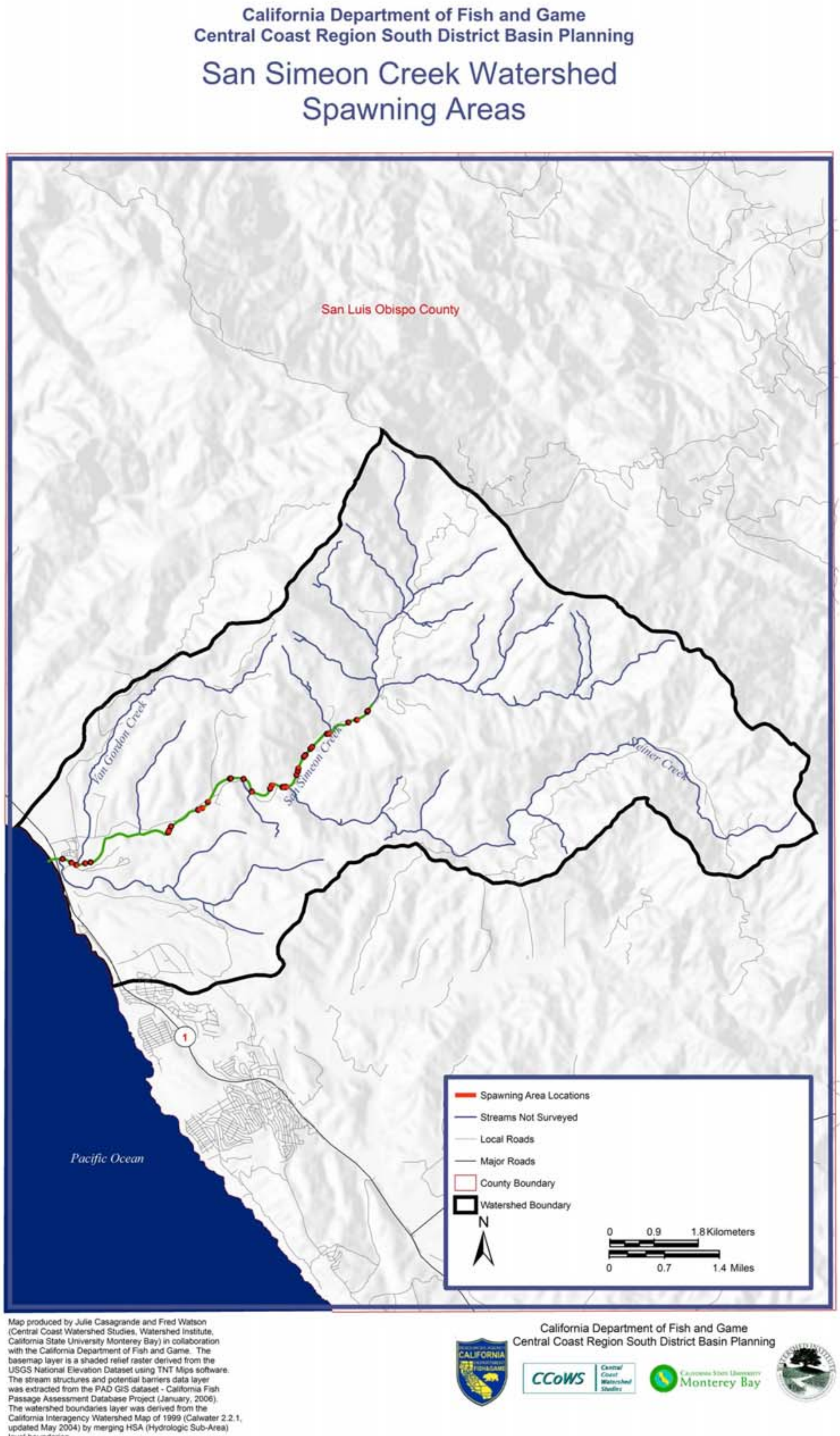
California Department of Fish and Game
Central Coast Region South District Basin Planning

San Lorenzo River Watershed
Passage Classification



Map produced by Jessica Watson, William Perry, and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The passage classification data layer was created from Crossing Inventory and Fish Passage Evaluation for California Department of Fish and Game. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1, updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

California Department of Fish and Game
Central Coast Region South District Basin Planning


California Department of Fish and Game
Central Coast Region South District Basin Planning
San Simeon Creek Watershed
Spawning Areas
San Luis Obispo County
Van Gordon Creek
San Simeon Creek
Steiner Creek
Pacific Ocean
1
Spawning Area Locations
Streams Not Surveyed
Local Roads
Major Roads
County Boundary
Watershed Boundary
N
0 0.9 1.8 Kilometers
0 0.7 1.4 Miles
Map produced by Julie Casagrande and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The stream structures and potential barriers data layer was extracted from the PAD GIS dataset - California Fish Passage Assessment Database Project (January, 2006). The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1, updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.
California Department of Fish and Game
Central Coast Region South District Basin Planning
CCoWS
Monterey Bay

California Department of Fish and Game
Central Coast Region South District Basin Planning

San Simeon Creek Watershed
Left Bank Erosion

Map produced by Jessica Watson, William Perry, and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The bank erosion data layer was created from Crossing Inventory and Fish Passage Evaluation for California Department of Fish and Game. The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1, updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

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California Department of Fish and Game
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San Simeon Creek Watershed
Right Bank Erosion

Map produced by Jessica Watson, William Perry, and Fred Watson (Central Coast Watershed Studies, Watershed Institute, California State University Monterey Bay) in collaboration with the California Department of Fish and Game. The basemap layer is a shaded relief raster derived from the USGS National Elevation Dataset using TNT Mips software. The bank erosion data layer was created from Crossing Inventory and Fish Passage Evaluation for California Department of Fish and Game.
The watershed boundaries layer was derived from the California Interagency Watershed Map of 1999 (Calwater 2.2.1, updated May 2004) by merging HSA (Hydrologic Sub-Area) level boundaries.

California Department of Fish and Game
Central Coast Region South District Basin Planning