Appendix B: Stress and Threat Analysis Methodology

B.1. Summary

NMFS used several tools to develop and perform a threat and stress assessment, and to develop methods to score additional threat and stress categories. These tools included The Nature Conservancy's Conservation Action Planning (CAP) process, best professional judgment, climate change models and predictions, and empirical data. NMFS used these tools to ascertain current watershed condition, identify severity and scope of stresses, assess the contribution and irreversibility of identified threats, create additional threat and stress categories, and develop population profiles for each population in the SONCC coho salmon ESU. NMFS used the CAP process as a conceptual framework for the threats assessment. The threats assessment process spanned four years and the methodology evolved over time in response to new information, to incorporate new stresses and threats, and in recognition of the limitations of the initial tools (Table B - 1, Table B - 2).

Underlying the entire threat and stress assessment process was the use of best professional judgment, in consideration of available data. Empirical data were acquired, compiled into a database, summarized, and then entered into an initial set of CAP workbooks. Stress and threat ratings in the CAP workbooks were then revised to include professional judgment for additional stresses and threats. NMFS then utilized best professional judgment to assess the accuracy and reliability of the resulting CAP summary tables, produce a comprehensive stress and threat assessment, and develop individual population profiles that detail the current condition of each population area.

The following sections summarize the components of the stress and threats methodology, including the development of the initial CAP workbooks, revision of the CAP workbooks, creation of GIS maps, refinement of the stress and threat summary tables, and the development of additional stress and threat categories (climate change, estuary/mainstem condition, and fishing/collecting).

Table B - 1. Methods used by NMFS to assess stresses in the SONCC coho salmon ESU.

Stress	Assessment Methods		
	Initial CAP	Revised CAP	Latest Stress Summary Tables
Adverse Fishery-Related Effects	Not included	Not included	Professional judgment
Adverse Hatchery-related Effects	Not included	Professional judgment	Professional judgment
Altered Hydrologic Function	Qualitative indicators	Professional judgment, qualitative indicators	Professional judgment, qualitative indicators
Altered Sediment Supply	Numeric indicators	Numeric indicators, professional judgment	Numeric indicators, professional judgment
Barriers	Numeric indicators	Numeric indicators, professional judgment	Numeric indicators, professional judgment
Degraded Riparian Forest Conditions	Numeric & qualitative indicators	Numeric & qualitative indicators, professional judgment	Numeric & qualitative indicators, professional judgment
Impaired Estuary/ Mainstem Function	Not included	Not included	Professional judgment
Impaired Water Quality	Numeric indicators	Numeric indicators, professional judgment	Numeric indicators, professional judgment
Increased Disease/ Predation/Competition	Not included	Numeric indicators, professional judgment	Numeric indicators, professional judgment
Lack of Floodplain and Channel Structure	Numeric & qualitative indicators	Numeric & qualitative indicators, professional judgment	Numeric & qualitative indicators, professional judgment

Table B - 2. Methods used by NMFS to assess threats in the SONCC coho salmon ESU.

Threat	Assessment Methods		
	Initial CAP	Revised CAP	Latest Threat Summary Tables
Agricultural Practices	GIS analyses	GIS analyses, professional judgment	GIS analyses, professional judgment
Channelization/Diking	GIS analyses	GIS analyses, professional judgment	GIS analyses, professional judgment
Climate Change	Not included	Professional judgment	Computer models, professional judgment
Dams/Diversion	Not included	Professional judgment	Professional judgment
Fishing and Collecting	Not included	Professional judgment	Professional judgment
Hatcheries	Not included	Professional judgment	Professional judgment
High Intensity Fire	Not included	Professional judgment	Professional judgment
Invasive Non-Native/ Alien Spices	Not included	Professional judgment	Professional judgment
Mining/Gravel Extraction	Not included	Professional judgment	Professional judgment
Roads	GIS analyses	GIS analyses, professional judgment	GIS analyses, professional judgment
Road-Stream Crossing Barriers	Not included	Professional judgment	Professional judgment
Timber Harvest	Not included	Professional judgment	Professional judgment
Urban/Residential/ Industrial	GIS analyses	GIS analyses, professional judgment	GIS analyses, professional judgment

B.2. Background Information about the CAP Process

As part of the assessment of the viability and condition of SONCC coho salmon populations and their habitat in the SONCC ESU, NMFS performed a series of conservation planning and assessment exercises based upon the Nature Conservancy's Conservation by Design concept (TNC 2006). This concept utilizes Conservation Action Planning (CAP) tools and workbooks to

develop a threat and stress assessment. The CAP process is designed to recognize the shifting nature of knowledge and the challenges that causes, by allowing for a regular, iterative process of successive approximations (TNC 2006). The CAP process provided NMFS with a tool to capture the best understanding of the current situation, and build a set of recovery actions built on that understanding. This understanding included the use of best professional judgment and other tools. NMFS utilized this process to identify conservation targets, assess the current status of the selected targets, identify critical threats and stresses occurring in the landscape, and develop a threat and stress assessment that described current population and environmental conditions across the landscape.

NMFS completed the following planning and assessment activities:

1. Identified conservation targets
2. Assessed the current status of conservation targets
3. Determined potential stresses and threats
4. Compiled available literature, empirical data, and best professional knowledge on the condition of the landscape
5. Rated these stresses and threats across the landscape
6. Developed recovery actions to decrease or eliminate the stresses and threats.

The first step in the process was to identify the conservation targets, which were the life stages of coho salmon in the SONCC coho salmon ESU. Next, NMFS assessed the current status of conservation targets by reviewing all available monitoring data on coho salmon population trends.

NMFS then used the best available information to identify the stresses affecting coho salmon populations and the sources of the stresses, also known as threats. Most stresses are caused by incompatible human uses of land, water and natural resources. Stresses destroy, degrade or impair conservation targets by impacting a key ecological attribute relating to their size, condition or landscape context (TNC 2006). Natural factors such as rainfall and marine productivity (ocean conditions, El Niño) were identified as factors for the decline of SONCC coho salmon (62 FR 24588). NMFS elected to not describe these natural factors as threats, for two reasons. First, SONCC coho salmon evolved to live with natural variation in rainfall and marine productivity, and it was likely a combination of these factors with habitat degradation, fishing, and other human-caused threats that led to their decline. Populations that are fragmented or reduced in size and range are more vulnerable to extinction by natural events (62 FR 24588), and NMFS chose to focus on the causes of population fragmentation and reduced size rather than natural factors. Second, there is little that recovery actions can do to affect change in natural factors such as rainfall or marine productivity. NMFS developed recovery actions to reduce the detrimental effects of the result of that rainfall (e.g., droughts and floods). For example, water resources can be managed to ensure sufficient water remains in waterways when coho salmon need it, and land can be managed to promote bank stability and reduce the likelihood that floods will release large amounts of sediment into coho salmon habitat. Similarly, in years when

marine productivity is expected to be poor, fishing effort can be moderated to allow sufficient spawner escapement, as described in the current management of ocean salmon fisheries (Sharr et al. 2000). In short, the recovery plan addresses the causes of population fragmentation and decline that can be improved by human actions. Therefore, stresses are the destruction, degradation or impairment of SONCC coho salmon habitats and ecosystem processes caused directly or indirectly by human sources. A threat is the proximate cause of a stress. The stresses and threats considered are either current stresses or have high potential to occur in the next ten years under current circumstances and management (TNC 2006). The threats and stresses selected for inclusion in the CAP workbooks are the same as those identified at the time of listing. A total of 8 stresses and 11 threats were identified at this time and analyzed using the CAP toolbox (Table B - 1 and Table B - 2). After completing the CAP exercises, three additional categories were created and assessed using the other tools available. More information on these additional threats and stresses are explained later.

After threats and stresses were selected, a large amount of data, literature, and other information were acquired to inform the assessment of stresses and threats. The CAP process uses a simple grading scale was used to assess the current status of key threats and stresses –Very High, High, Medium, Low. This four-part grading scale is based on over 20 years of similar application by natural heritage inventory programs throughout the United States (TNC 2003). It provides a sufficient degree of distinction among the four scores and allows for a reasonable confidence level, while recognizing the current lack of information that would be needed to provide more precise grades (TNC 2003).The final step was to develop a list of recovery actions designed to decrease or eliminate the stresses and threats. These actions were prioritized to address the most important stresses and threats and to focus effort on the coho salmon populations with the most promising prospects for recovery.

B.3. Development of Initial CAP Workbooks Based on Data

The initial set of CAP workbooks were produced using only empirical data only, with the exception of inclusion of pre-existing USFS and ODFW professional judgments.

For the six stresses included in the initial set of CAP workbooks, one or more indicators of aquatic habitat suitability were identified to quantitatively assess that stress. To minimize data gaps, the list of indicators was tailored to match the specific data metrics widely available for populations in the SONCC coho ESU, rather than a comprehensive idealized list. For each indicator, NMFS developed a set of benchmarks for rating habitat suitability for coho salmon on a four-category scale (poor, fair, good, very good) based on the best available scientific literature (Kier Associates and NMFS 2008)(Table B - 3). A few of the indicators are not quantitative, but rather reflect previous professional judgments by USFS and ODFW. In addition, some threats were quantitatively assessed using GIS analyses (Table B - 4).

Table B - 3. Indicators of aquatic habitat suitability for coho salmon, with reference values. Table adapted from Kier Associates and NMFS (2008).

Stress	Indicator	Poor	Fair	Good	Very Good
Altered Hydrologic Function	Flow Restoration Needs (ODFW judgment)	3.5-4	2.5-3.5	1.5-2.5	1-1.5
Altered Hydrologic Function	Water Quantity/Flow Regime (USFS judgment)	Altered	Partially Altered		Unaltered
Altered Sediment Supply	Embeddedness (%)	>45%	30.1-45%	25.1-30%	<=25 %
Altered Sediment Supply	Fines (Dry Sample) (% <1 mm)	>12.6%	11.1-12.6%	8.9-11.1%	<8.9%
Altered Sediment Supply	Fines (Wet Sample) (% <1 mm)	>17%	15-17%	12-15%	<12%
Altered Sediment Supply	Sand (Dry Sample) (% <6.4 mm)	>25.8%	21.5-25.8%	12.9-21.5%	<12.9%
Altered Sediment Supply	Sand (Wet Sample) (% <6.4 mm)	>30%	25-30%	15-25%	<15%
Altered Sediment Supply	Silt/Sand Surface (% riffle area)	>17	15-17	12-15	<12
Altered Sediment Supply	Turbidity (hours/year >25 FNU)	>720	361-720	120-360	<120
Altered Sediment Supply	VStar	>0.25	0.21-0.25	0.15 - 0.21	<0.15
Barriers	Fish Passage (% of Dry Habitat Types)	>5%	1-5%	<1%	0%
Degraded Riparian Forest Conditions	Canopy Cover (% Shade)	<60% shade	60-70% shade	70.1-80% shade	>80% shade
Degraded Riparian Forest Conditions	Canopy Type (% Open + Hardwood)	>40%	30-40%	20-30%	<20%
Degraded Riparian Forest Conditions	Riparian Condition (conifers >36" dbh / 1000ft)	<75	75.0-125	125-200	>200
Degraded Riparian Forest Conditions	Stream Corridor Vegetation (USFS judgment)	Impaired	Functioning At-risk		Properly Functioning
Impaired Water Quality	Aquatic Invertebrates (B-IBI NorCal)	<40	40-60	60.1-80	>80
Impaired Water Quality	Aquatic Invertebrates (EPT)	<=12	12.1-17.9	18-2523	>23

Stress	Indicator	Poor	Fair	Good	Very Good
Impaired Water Quality	Aquatic Invertebrates (Rich)	<25	25-30	30-40	>40
Impaired Water Quality	D.O. (COLD) (mg/l 7-DAMin)	<6.0 mg/l	6-6.5 mg/l	6.5-7.0 mg/l	>7.0 mg/L
Impaired Water Quality	D.O. (SPAWN) (mg/l 7-DAMin)	<9 mg/l	9-10 mg/l	10-11 mg/l	>11.0 mg/l
Impaired Water Quality	pH	>8.75	8.5-8.75	8.25-8.5	<8.25
Impaired Water Quality	pH (annual maximum)	>8.75	8.5-8.75	8.25-8.5	<8.25
Impaired Water Quality	Temperature (MWAT) (C)	>17ºC	16-17ºC	15-16ºC	<15ºC
Impaired Water Quality	Temperature (MWMT) (C)	>18.3ºC	17-18.3ºC	16-17ºC	<16ºC
Lack of Floodplain and Channel Structure	D50 (median particle size) (mm)	<38 or >128	38-50 or 110-128	50-60 or 95-110	60-95 mm
Lack of Floodplain and Channel Structure	Floodplain Connectivity (USFS judgment)	Impaired	Functioning At-risk		Properly Functioning
Lack of Floodplain and Channel Structure	Pool Depth (Ave. in Feet)	<2 Ft	2-3 ft	3-3.3 ft	> 3.3 ft.
Lack of Floodplain and Channel Structure	Pool Frequency (% by Area)	<10%	10-20%	20-35%	>35%
Lack of Floodplain and Channel Structure	Pool Frequency (% by Length)	<35%	35-40%	40-50%	>50
Lack of Floodplain and Channel Structure	Wood Frequency ODFW (key pieces/100m)	>1	1-2	2-3	>3
Lack of Floodplain and Channel Structure	Wood Frequency USFS: streams <20 ft. wide	>35 pieces/mi	35-53	54-84	<85
Lack of Floodplain and Channel Structure	Wood Frequency USFS: streams >30 ft. wide	>16 pieces/mi	16-33	33-60	<60
Lack of Floodplain and Channel Structure	Wood Frequency USFS: streams 20-30 ft	>25 pieces/mi	26-36	37-64	<65

Table B - 4. Metrics used to assess threats. Table adapted from Kier Associates and NMFS (2008).

Threat	Metric	Low	Medium	High	Very High
Timber Harvest	Harvested area, as percent of watershed	<10%	10-25%	25-35%	>35%
Agricultural Practices	Pasture/hay and cultivated crops, as a percent of watershed	<2%	2-5%	5-10%	>10%
Roads	Road Density (mi/sq mi)	<1.6	1.6-2.5	2.5-3.0	>3.0
Urban/Residential/ Industrial	Total Impervious Area (TIA), as a percent of watershed	<5%	5-10%	10-25%	>25%

Indicator and threat data were acquired, reformatted, and compiled into a Microsoft Access database. Data were tagged with stream name and either spatial coordinates or GIS-linked stream reach codes (LLID), so that summaries for SONCC CAP populations or other spatial units could be produced as needed.

Data were gathered from all available sources including grey literature, peer reviewed literature, data from monitoring and research efforts, and county and state planning efforts. Datasets were generally used only if similar information was widely available across the SONCC coho salmon ESU. Data contributors include the California Department of Fish and Game (CDFG), Oregon Department of Fish and Wildlife (ODFW), U.S. Forest Service (USFS) Region 5 (R5) and Region 6 (R6), California State Water Resources Control Board (SWRCB), Oregon Department of Environmental Quality (ODEQ), California Department of Forestry and Fire Protection (CAL-FIRE), U.S. Environmental Protection Agency (EPA), the Bureau of Reclamation (BOR), the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (USFWS), the Yurok Tribe, Karuk Tribe, Hoopa Tribe, U.S. Fish and Wildlife Service (USFWS), Resource Conservation Districts (RCDs), Utah State University's (USU) Bug Lab, Klamath Resource Information System (KRIS), the Conservation Biology Institute (CBI), South Coast and Lower Rogue Watershed Councils, Mattole Restoration Council, Mattole Salmon Group, and other contributors. A complete list of datasets utilized is included in Table B - 8at the end of this profile.

A master CAP workbook template was created. Then a set of custom Python computer programs was used to summarize information from the database to the population level and transfer the summaries into a separate CAP workbook for each population. This methodology ensured that all workbooks used the same criteria and setup, and avoided labor-intensive and error prone manual data entry. This initial set of CAP workbooks for each population was created in June 2007.

B.4. Revised CAP workbooks Incorporating Professional Judgment

Data are lacking for some indicators and threats that are recognized as affecting coho salmon or their habitats. NMFS staff conducted an extensive review of literature for SONCC coho salmon population watersheds to derive values for those factors. Documents included federal agency watershed analyses, TMDL reports, restoration plans and locally driven watershed assessments.

These supplementary values were the incorporated into the Microsoft Access database and a revised set of CAP workbooks was created in November 2008.

B.5. GIS Maps

NMFS also created GIS maps using the instream monitoring and landscape data compiled for each population. These maps are included as an Electronic Appendix H to this recovery plan on the NMFS website in Adobe Acrobat (PDF) format and are designed to be used as electronic documents, not printed. The many layers in the maps can be toggled on/off and users can zoom in to see more detail. There are two PDF maps included for each population. The main set of maps contains the stress and threats data, in addition to base layers such as coho IP and streams, and was completed in May 2010. The second set of maps was completed in December 2009 and includes canopy change over various time periods and tree size. Due to the large number of layers in the maps, full legends could not be included within the individual maps; therefore, a separate legend PDF is provided for each of the two map types. These maps were used to analyze and interpret habitat condition across the landscape. Additionally, boundary maps for each population unit showing land ownership, coho distribution, and IP habitat are included as the first figure in each population profile.

B.6. Creation of Latest Stress and Threat Summary Tables

The CAP workbooks produced summary tables that display the ranking for identified threats and stresses, the severity of the impact on each life stage (egg, juvenile, smolt, adult), and an overall ranking. One summary table for threats and one summary table for stresses are provided for each independent and dependent population (e.g., Table B - 5 and Table B - 6).

Once the summary tables were developed, NMFS used best professional judgment to further analyze and assess the severity of the identified threats and stresses as shown in the CAP table. Best professional judgment was employed to verify the CAP results, override results known to be erroneous, or include information where no current data are available. While empirical data are the preferred information with which to conduct population area condition assessments, develop indicator criteria, and evaluate threats and stresses in an area, these data are not always available or may be too old for current uses. This was the case in many of the areas in the SONCC ESU. When this is the case, professional judgment is applied to improve the strength and accuracy of the threat and stress assessment.

Table B - 5. Example of summary table for identified stresses. Note: table contains ranks for stress Impaired Estuary/Mainstem Function that was not included in the CAP workbooks.

Stresses (Limiting Factors)		Egg	Fry	Juvenile[1]	Smolt	Adult	Overall Stress Rank
1	Impaired Water Quality[1]	Low	Very High	Very High[1]	Very High	Medium	High
2	Impaired Estuary/Mainstem Function	-	High	Very High	Very High	Medium	High
3	Altered Sediment Supply	High	High	High	High	Medium	High
4	Degraded Riparian Forest Conditions	-	High	High	High	High	High
5	Lack of Floodplain and Channel Structure[1]	Low	High	High[1]	High	Medium	High
6	Altered Hydrologic Function	Medium	Medium	Medium	Medium	-	Medium
7	Increased Disease/Predation/Competition	Medium	Medium	Medium	Low	Low	Medium
8	Adverse Fishery-Related Effects	-	-	-	-	Medium	Medium
9	Adverse Hatchery-related Effects	Low	Medium	Medium	Low	Low	Low
10	Barriers	-	Medium	Medium	Low	Low	Low

[1] Key limiting factor(s) and limited life stage(s)

Table B - 6. Example of summary table for identified threats. Note: table contains ranks for the threats Fishing and Collecting and Climate Change that were not included in the CAP workbooks.

Threats		Egg	Fry	Juvenile	Smolt	Adult	Overall Threat Rank
1	Channelization/Diking	Low	Very High	Very High	High	Medium	Very High
2	Hatcheries	High	High	High	High	High	High
3	Climate Change	Low	Medium	Very High	High	High	High
4	Roads	High	High	High	Medium	Medium	High
5	Dams/Diversion	Low	High	High	Medium	Medium	Medium
6	High Intensity Fire	Medium	Medium	Medium	Medium	Medium	Medium
7	Agricultural Practices	Medium	Medium	Medium	Medium	Medium	Medium
8	Urban/Residential/Industrial	Low	Medium	Medium	Medium	Low	Medium
9	Fishing and Collecting	-	-	-	-	Medium	Medium
10	Timber Harvest	Low	Low	Medium	Low	Low	Low
11	Road-Stream Crossing Barriers	Low	Low	Medium	Low	Low	Low
12	Mining/Gravel Extraction	Low	Low	Medium	Low	Low	Low
13	Invasive Non-Native/Alien Spices	Low	Low	Low	Low	Low	Low

After the summary tables were developed, NMFS used best professional judgment to further assess the severity of the identified threats and stresses. Best professional judgment was employed to verify the CAP results, override results known to be erroneous, or include information where no current data are available. While empirical data are the preferred information with which to conduct population area condition assessments, develop indicator criteria, and evaluate threats and stresses in an area, these data are not always available or may be too old for current uses. This was the case in many of the areas in the SONCC ESU. In such cases, NMFS used professional judgment to improve the accuracy of the threat and stress assessment.

Additional Threat and Stress Categories

NMFS also used best professional judgment to develop additional threat and stress categories that are currently impacting the SONCC coho salmon ESU. Some were not identified at the time of listing, but are considered to be affecting SONCC coho salmon populations currently. These categories were developed for Climate Change, Impaired Estuary and Mainstem Function, fishing-related stress and threat ("Adverse Hatchery-Related Effects" and "Fishing and

Collecting"), and hatchery-related stress and threat ("Adverse Fishery-Related Effects" and "Fishing and Collecting"). Since no empirical data are available for these categories, NMFS utilized additional tools to perform the threat and stress assessment and ranking. NMFS utilized professional judgment when ranking and assessing the severity for each life stage for the Estuary and Mainstem Condition category. For Climate Change, NMFS utilized climate change models and predictors that assessed future changes in a variety of environmental conditions. See below for environmental variables selected for the Climate Change category.

Climate Change

Climate change has the potential to dramatically alter the recovery landscape and must be considered in assessing current and future conditions. The impacts that are most likely to affect SONCC coho salmon populations include increasing temperatures, changes in quantity and quality of snowpack, changes in precipitation, and rising sea level. NMFS assessed the climate change threat for each individual population using current conditions along with modeled future conditions based on projections for future greenhouse gas emissions. Current climate was derived from PRISM (Parameter-elevation Regressions on Independent Slopes Model) an analytical tool that uses point data, a digital elevation model, and other spatial data sets to generate gridded estimates of monthly, yearly, and event-based climatic parameters, such as precipitation, temperature, and dew point. Future climate data were derived from climate projections produced using a statistical downscaling method (Vertenstein et al. 2004). These projections were derived from the Community Climate System Model (CCSM-3) (Vertenstein et al.. 2004). We chose the A2 emission pathways, which uses one of the highest rates of greenhouse gas (GHG) emission predictions and the GFDL model, which has a relatively high sensitivity to emissions compared to other IPCC global climate models (California Environmental Protection Agency (CEPA) 2006). Since recent trends in GHG emission are thought to be well above those used in any of the IPCC (2007) models, it is likely that even the “high emission” scenario may underestimate actual emission in the future (Raupach et al. 2007). We chose the time period of 2030 to 2050 to reflect expected short-term changes in climate. For this recovery plan, ten years is the time period assumed for other stresses and threats in the stress and threats assessment. NMFS expects that effects of climate change may take longer to manifest than effects of other stresses, and so chose a longer time period in which to detect its effects.

To develop threat rankings for the climate change threat NMFS analyzed the assigned risks to populations from the various climate change indices and overlaid known life history requirements. Like other threats, the final threat level was based on application of NMFS professional judgment in consideration of available data.

Current Minimum and Maximum Temperature

An assessment of current summer and winter temperatures provided insight into the vulnerability of populations to climate change. Those populations at or near the current thresholds for coho salmon are likely to have a greater threat from climate change based on the increases in temperature occurring. Current temperature regimes were assessed using PRISM data (PRISM Climate Group 2011) averaged for the time period from 1971 to 2000 which was the time period

available through the PRISM Climate Group. The months of January and July were chosen for this analysis to represent winter and summer conditions.

Current Precipitation

Current summer and winter precipitation provided a baseline condition on which to assess future changes in climate. Low precipitation in the summer and high winter precipitation are factors which can increase the threat from climate change based on predicted and ongoing changes in climate (IPCC 2007) and on the environmental requirements of SONCC coho salmon during those time periods. Current precipitation regimes were assessed using PRISM data (PRISM Climate Group 2011) averaged for the time period from 1971 to 2000. The months of January and July were chosen for this analysis to represent winter and summer conditions. The average precipitation does not indicate the rates or types of precipitation, which is another climate factor which can influence coho salmon growth and survival.

Current snowpack

Changes in temperature and precipitation will ultimately affect the snowpack in Southern Oregon and Northern California. Areas that currently have little snowpack will likely have less in the future given the modeled changes in temperature and precipitation for the area (Gleick and Chalecki 1999, Lettenmeier and Gan 1990). Snowpack-driven systems are highly vulnerable to climate change and identification of these sensitive populations helps inform our assessment of the climate change threat. Information about current snowpack was derived from NRCS SNOTEL and Snow Course snow water equivalents for the month of January (NRCS 2011). These data are represented as a percentage of normal and averaged between 1971 and 2000. High risk was assigned to populations that currently have a low snowpack and are snowpack dependent.

Modeled Future Temperature Change

Regional forecasts of temperature changes related to climate change were derived from the statistical downscaling method and Community Climate System Model (CCSM-3) (Vertenstein et al. 2004). The months of January and July are used to represent changes in the summer and winter in terms of mean daily temperature (Figure B - 1 and Figure B – 2). A high risk is assigned to populations where temperatures are already high and future increases in summer temperature are expected. High risk is also assigned to snowpack-dependent populations where increases in winter temperature are expected to decrease snowpack levels.

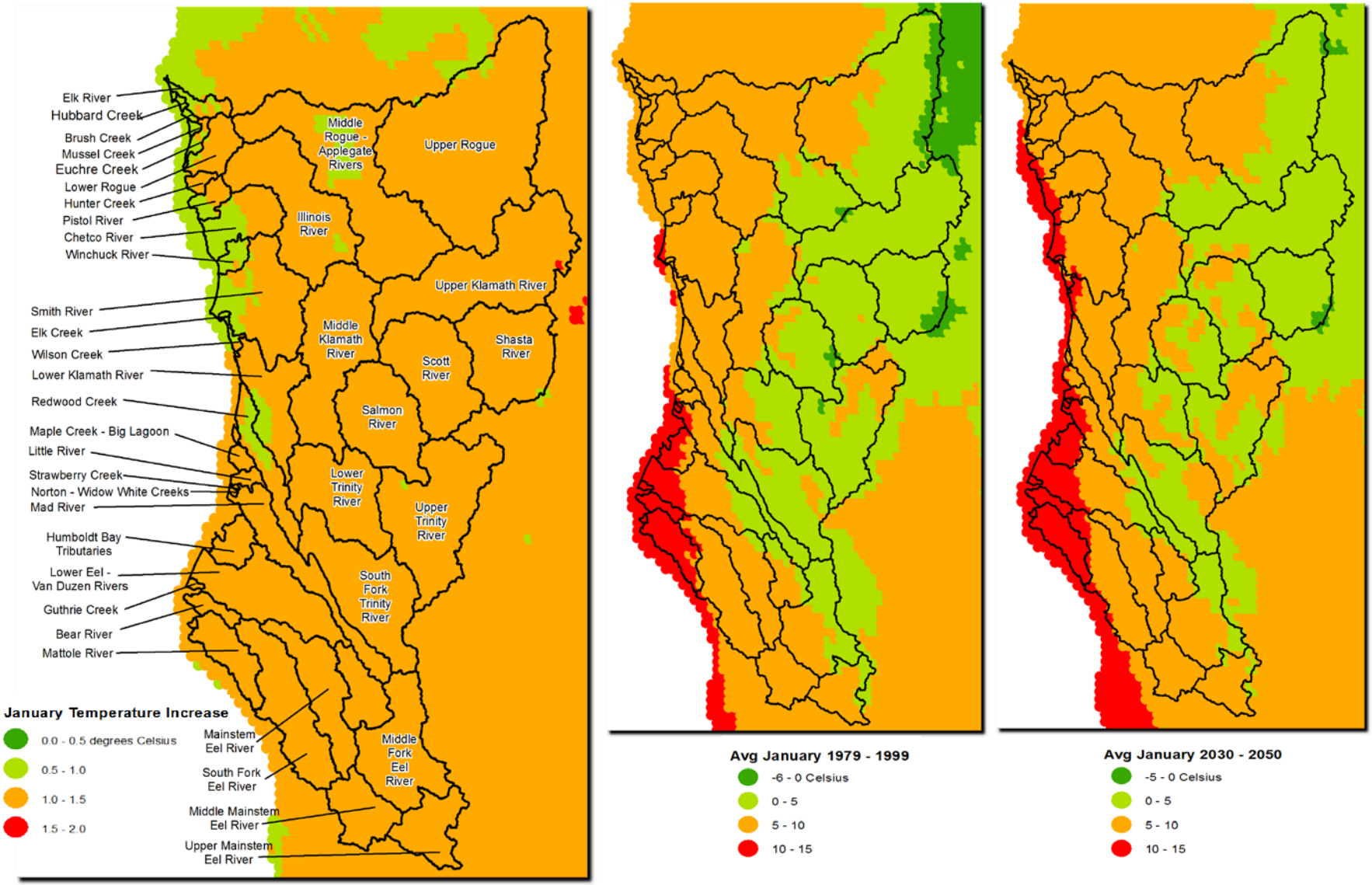

Figure B - 1. Modeled average January temperatures for the years 1979 to 1999 (middle panel) and 2030 to 2050 (right panel), and the difference between the two time periods (left panel). Datasets generated by the Community Climate System Model (CCSM) model for the IPCC 4th Assessment Report, and were downloaded from http://www.gisclimatechange.org/. The 1979-1999 data are from the 20th Century Experiment and the 2030-2050 data are from emissions scenario A2. Boundaries of the coho salmon populations in the SONCC coho salmon ESU are also shown.

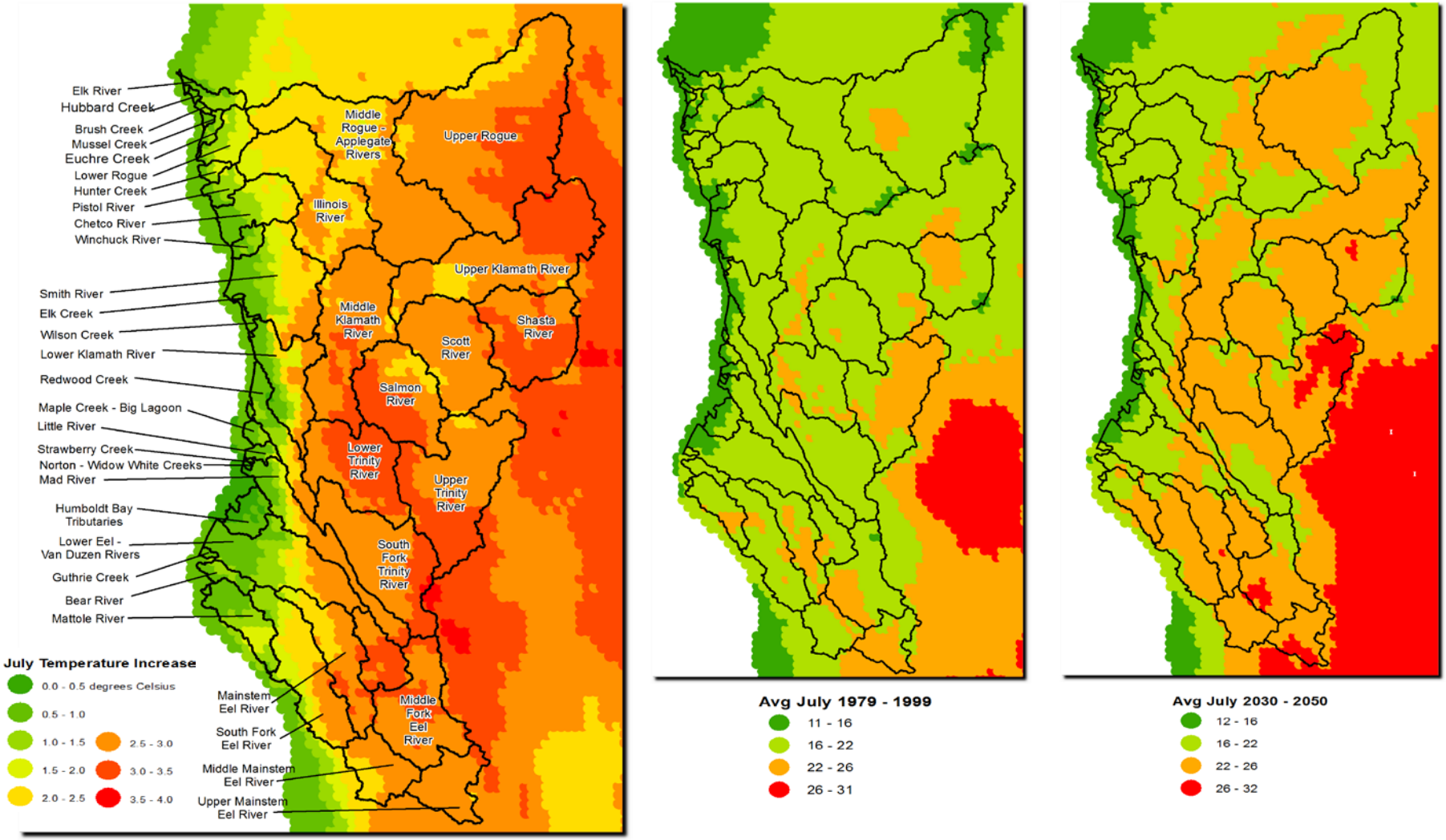

Figure B - 2. Modeled average July temperatures for the years 1979 to 1999 (middle panel) and 2030 to 2050 (right panel), and the difference between the two time periods (left panel). Datasets generated by the Community Climate System Model (CCSM) model for the IPCC 4th Assessment Report, and were downloaded from http://www.gisclimatechange.org/. The 1979-1999 data are from the 20th Century Experiment and the 2030-2050 data are from emissions scenario A2. Boundaries of the coho salmon populations in the SONCC coho salmon ESU are also shown.

Modeled Future Precipitation Change

Regional forecasts of precipitation changes related to climate change are derived from projections of temperature produced using a statistical downscaling method (Vertenstein et al. 2004). These projections are derived from the same A2 emission pathway and the Community Climate System Model (CCSM-3) (Vertenstein et al. 2004). The same time period is used to create model output. We used the general trends of the predicted changes in precipitation (i.e., increasing, decreasing, or stable) instead of the exact predicted values. High risk is assigned to populations where precipitation was already low and the expected trend was for decreasing precipitation over the next 20 years.

Modeled Sea Level Rise

Sea level rise has the potential to have a dramatic impact on salmon habitat in some SONCC coho salmon populations. To assess this aspect of climate change we use a coastal vulnerability index (CVI) provided by the U.S. Geological Survey (Thieler and Hammar-Klose 2000). This classification is based upon the variables geomorphology, regional coastal slope, tide range, wave height, relative sea-level rise, and shoreline erosion and accretion rates. The combination of these variables and the association of these variables to each other furnish a broad overview of regions where physical changes are likely to occur due to sea-level rise (Figure B - 3).

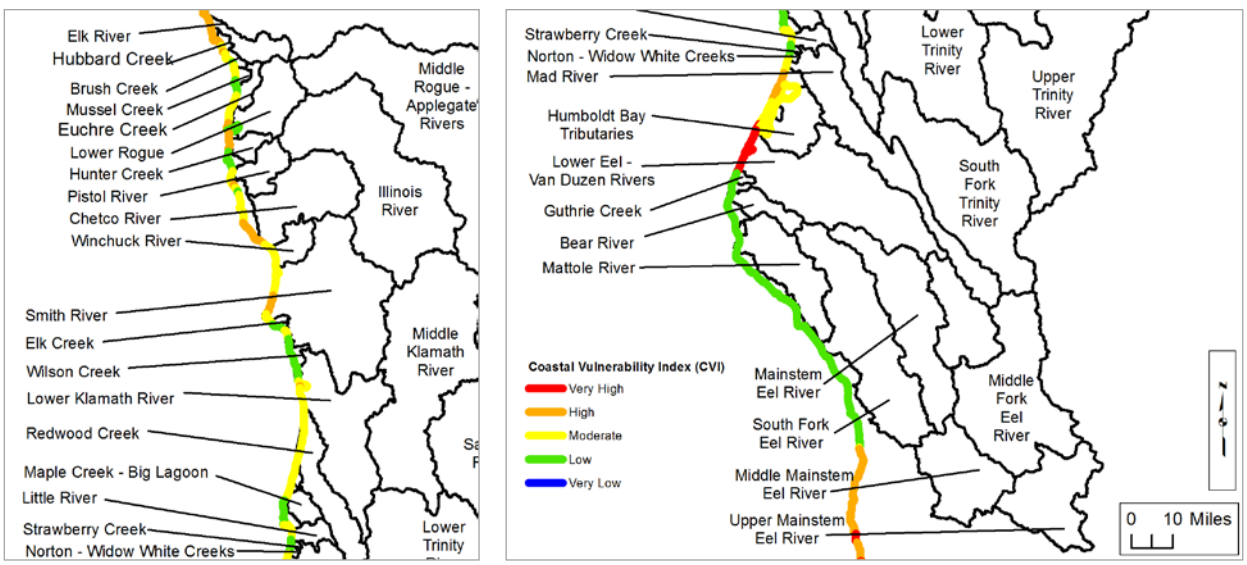

Figure B-3. Coastal Vulnerability Index (CVI) (Thieler and Hammer-Klose 2000) and boundaries of coho salmon population in the northern (left panel) and southern (right panel) portions of the SONCC coho salmon ESU.

Impaired Estuary and Mainstem Function

Due to the lack of numeric data that covered the entire ESU, no numeric values or categories were used to develop rankings for this stress. Instead, professional judgment was used based on a series of information about the current state of estuarine or mainstem habitat and environmental conditions. Important considerations included the extent of development in the estuarine

floodplain; known or presumed former extent of estuary habitat, availability of diverse and well-connected off-channel, pond, and wetland estuary and mainstem habitat; water quality; presence of dams and other obstacles to migration; and extent of diking and ditching in the estuary. Life stage specific factors were also considered to contribute to this stress level. For fry, the stress level was elevated if there was a known fry migrant life history or the occurrence of fry migrants in the populations. For juveniles, the occurrence of estuarine life history types, accessibility issues (such as barriers block access to tributary rearing habitat), the extent and quality of rearing habitat, and water quality issues were all used in developing stress rankings. Smolts were considered to be impacted by this stress if there were predation issues in the mainstem or estuary, poor migratory conditions (such as exposure to stressful water quality conditions, parasites, or diseases) that could reduce survival and growth, a lack of refugia or holding habitat in the mainstem and/or estuary, and ocean accessibility issues (such as a seasonal berm). The adult life stage was ranked based on the accessibility of the watershed, poor migratory conditions in the estuary and/or mainstem which could reduce survival, and the availability of holding habitat in the estuary.

Adverse Fishery-Related Effects (stress) and Fishing and Collecting (threat)

The percent of observed adults of hatchery origin is used as an indicator of relative genetic risk to a coho salmon population. Use of less than 5 percent as the threshold for low risk is consistent with the approach described in Williams et al. (2008). Williams et al. (2008) does not provide guidance regarding degree of risk above 5 percent. The status review for Oregon salmon and steelhead populations in the Willamette and Lower Columbia basins (McElhany et al. 2007) describes categories of genetic risk from hatcheries with break points at 10 percent and 30 percent, and this convention was adopted. Ecological effects of hatcheries are accounted for in the Medium stress and threat rank, which is assigned if there is a salmonid hatchery in the basin.

Table B - 7. Criteria for ranking fishing- and collecting-related stress (Adverse Fishing- and Collection-Related Effects) and threat (Fishing and Collecting).

Rank	Definition
Low	Less than 5 percent of observed adults are of hatchery origin.
Medium	Greater than or equal to 5 percent and less than or equal to 10 percent of observed adults are of hatchery origin OR there is a salmonid hatchery in the basin.
High	Greater than 10 percent and less than 30 percent of observed adults are of hatchery origin.
Very High	Greater than or equal to 30 percent of observed adults are of hatchery origin.

B.7. Limiting Factor Analysis

A limiting factor refers to any condition that is required by a species which becomes insufficient or absent in a habitat. When particular needs are not met individuals of the population start to die off or fertility becomes inhibited. Some common examples of limiting factors are food,

water, predation or lack thereof, water, shelter, gases (i.e., oxygen), and organic chemical compounds. The limiting factor works as a control that prevents unchecked growth in a population or can be one that causes a population to decline and disappear from a habitat. A limiting factors analysis is designed to identify physical limitations to fish production that may be addressed by habitat restoration or enhancement. This approach assumes that when habitat required by a species during a particular season is in short supply, a bottleneck results and this habitat becomes limiting (Reeves et al. 1989). Without information on limiting factors, resources may be allocated with little or no benefit to the species. Key limiting factors were identified as the stresses most limiting particular life stages. NMFS utilized the CAP workbooks and summary tables, and best professional judgment, and a narrative was developed to document the results. The results of these exercises were then considered when the recovery team developed both the population level recovery recommendations and the stratum level recovery actions. Recovery actions and recommendations were developed to address all key limiting factors.

B.8. Datasets Utilized in the Stress and Threat Analysis

Table B - 8. Data type, state, year, and reference for data to inform GIS maps, CAP workbooks, and resultant summary tables. Datasets were generally used only if similar information was widely available across the SONCC coho salmon ESU.

Data Type	State/year	Reference
Amount of Impervious Surfaces	California/ Oregon	Homer, C. C. Huang, L. Yang, B. Wylie and M. Coan. 2004. Development of a 2001 National Landcover Database for the United States. Photogrammetric Engineering and Remote Sensing, Vol. 70, No. 7, pp 829-840
Agricultural Practices	California/ Oregon	Homer, C. C. Huang, L. Yang, B. Wylie and M. Coan. 2004. Development of a 2001 National Landcover Database for the United States. Photogrammetric Engineering and Remote Sensing, Vol. 70, No. 7, pp 829-840
Road Density	California - inland areas	LEGACY-The Landscape Connection Long Range Strategy: Creating a Biodiversity Conservation Network. Released April 29, 1999 By Curtice Jacoby, Noel Soucy, Daniel Boiano, Steven Day, Shayne Green, KayDee Simon, Keith Slauson, and Chris Trudel Produced by LEGACY – The Landscape Connection
	California - coastal areas	CAL FIRE Forest Practices GIS for coastal areas.
Road Density	Oregon	Southwest Oregon Province (SWOP). 1998. Unpublished data released on a CD of GIS Data.
Timber Harvest	California	CAL FIREForest Practices GIS - only harvest on non-public lands and harvest not conducted as part of Non-Industrial Timber Management Plans.

Data Type	State/year	Reference
	Oregon	Bredensteiner, K., K. Palacios, and J. Strittholt. 2003. Assessment of Aquatic Habitat Monitoring Data in the Rogue River Basin and Southern Oregon Coastal Streams. Performed under grant from David and Lucille Packard Foundation by the Conservation Biology Institute, Corvallis, OR. 42 p. Chapter 1-5. Chapter 6. Chapter 7. Chapter 8 + Appendices.
Barriers	California - Mendocino, Humboldt, Del Norte, Trinity, and Siskiyou County	Five Counties Salmonid Conservation Program. 2008. Five Counties Salmonid Conservation Program (5C) Final Report. Contract P0510327. CA Department of Fish and Game, Fisheries Restoration Grant Program March 2007 – July 2008
	California	California Department of Fish and Game Fish Passage Assessment Database -
	Oregon	Oregon Department of Fish and Wildlife Fish Passage Barriers database -
Coho Distribution	California	Shape files from California Department of Fish and Game Calfish database -
	Oregon	Oregon Department of Fish and Wildlife (ODFW). 2010. Oregon Fish Habitat Distribution. Electronic map dataset published 3/9/2010 (http://nrimp.dfw.state.or.us/nrimp/default.aspx?pn=fishdistdata). Oregon Dept. of Fish and Wildlife, Salem, Oregon.
SONCC coho salmon intrinsic potential	California and Oregon	Williams, T. H. and others. 2008. Framework for Assessing Viability of Threatened Coho Salmon in the Southern Oregon/Northern California Evolutionary Significant Unit. Southwest Fisheries Science Center. Santa Cruz, CA.
Coho brood year information	California	California_Coho_Status_Review_Brood_Year_Investigation.shp, version 11/3/2009, received 11/2/2009 from CDFG. Supplemental information: Atlas_Hydro_SONCC.shp, version 10/22/2009, received 11/3/2009 from CDFG.
	California	California Department of Fish and Game (CDFG). 2002a. North Coast California Coho Salmon Investigation (NCCCSI) .
Change Scene and tree size data	California only	Tree size data downloaded from: http://www.reo.gov/monitoring/reports/10yr-report/map-data/index.shtml

Data Type	State/year	Reference
	California and Oregon	Methods for tree size and change scene data: Moeur, M., T.A. Spies, M. Hemstrom, J.R. Martin, J. Alegria, J. Browning, J. Cissel, W.B. Cohen, T.E.Demeo, S. Healey, and R. Warbington. 2005. Northwest Forest Plan- the first 10 years (1994 to 2003): status and trend of late-successional and old-growth forest. Gen. Tech. Rep. PNW-GTR-646. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 142 p.
Aquatic Invertebrates (B-IBI NorCal)	2000	Rehn, A.C. and P.R. Ode. 2005. Draft Development of a Benthic Index of Biotic Integrity (B-IBI) for Wadeable Streams in Northern Coastal California and its Application to Regional 305(b) Assessment. CDFG Aquatic Bioassessment Laboratory, Rancho Cordova, CA. 24 p.
Aquatic Invertebrates (EPT)	1980 -1998	PL [Pacific Lumber Company]. 1998. Sustained yield/Habitat Conservation Plan for the properties of The Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation. Public Review Draft.
	California	Salmon River Restoration Council (SRRC). 1994. Unpublished data of macroinvertebrate samples for the year 1994 in tributaries of the Salmon River: Salmon River Macroinvertebrate Reconnaissance Study. Data included in the "Aquatic Inverts: EPT Richness Index Three Salmon River Tribs Fall 1994" topic of the Klamath Resource Information System. Salmon River Restoration Council, Somes Bar, CA.
Aquatic Invertebrates (Rich)	1980-1996	PL [Pacific Lumber Company]. 1998. Sustained yield/Habitat Conservation Plan for the properties of The Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation. Public Review Draft.
Canopy Cover (% Shade)	1991	California Department of Fish and Game (CDFG). 2007. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1991-2003, acquired from Ron Rogers in 2007. California Department of Fish and Game, Sacramento, CA.
	1994	California Department of Fish and Game (CDFG). 2009. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1994-2008, acquired from Karen Wilson in 2009. California Department of Fish and Game, Sacramento, CA.
Canopy Cover (% Shade)	2002-2003	Mattole Salmon Group (MSG). 2003. Final Report: Mattole Basin Channel Monitoring 2002-2003. Petrolia, CA.

Data Type	State/year	Reference
	2005	Mattole Restoration Council (MRC). 2008. Unpublished spreadsheet of stream habitat information for the Mattole River for the years 2005-2007, acquired from Nathan Queener on 5/15/2008. Mattole Restoration Council, Petrolia, CA.
Canopy Type (% Open + Hardwood)	1991-2003	California Department of Fish and Game (CDFG). 2007. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1991-2003, acquired from Ron Rogers in 2007. California Department of Fish and Game, Sacramento, CA.
Canopy Type (% Open + Hardwood)	1994-2008	California Department of Fish and Game (CDFG). 2009. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1994-2008, acquired from Karen Wilson in 2009. California Department of Fish and Game, Sacramento, CA.
D.O. (COLD) (mg/l 7-DAMin)	1995	U.S. Fish and Wildlife Service. 1995. Unpublished Klamath River water quality data for the year 1995. Data are included in the "Temperature: Salmonid Stress Klamath River at Blue Creek 1995" topic of the Klamath Resource Information System (KRIS) Klamath-Trinity. U.S. Fish and Wildlife Service, Arcata, CA.
D.O. (COLD) (mg/l 7-DAMin)	1994-2003	Asarian, E. and J. Kann. 2006. Klamath River Nitrogen Loading and Retention Dynamics, 1996-2004 (Appendix C: updated version of Klamath TMDL water quality database). Kier Associates Final Technical Report to the Yurok Tribe Environmental Program, Klamath, California. 56pp + appendices.
D50 (mm)	1998 -200	Dresser, A. T., C. Cook, and M. Smith. 2001. Long Term Trend Monitoring Program for the South Fork Trinity River watershed. Data are included in the "Sediment: Median Particle Size (3) - Hyampom (1998, 2000)" topic of the Klamath Resource Information System (KRIS) Klamath-Trinity
D50 (mm)	1992	Knopp, C. 1993. Testing indices of cold water fish habitat. Final report for development of techniques for measuring beneficial use protection and inclusion into the North Coast Region's Basin Plan by Amendment of the.....Activities, September 18, 1990. Data are included in the " Sediment: V* by NCRWQCB, 1992" topic of the Klamath Resource Information System (KRIS) Mattole. North Coast Regional Water Quality Control Board in cooperation with California Department of Forestry. 57 pp.
D50 (mm)	2001-2003	Mattole Salmon Group (MSG). 2003. Final Report: Mattole Basin Channel Monitoring 2002-2003. Petrolia, CA.

Data Type	State/year	Reference
D50 (mm)	1979-1995	Redwood National and State Parks. 2002. Unpublished particle size distribution data for Redwood Creek at locations of gaging stations from 1979 to 1995. Data included in the "Sediment: D50 from Cross-Sections at Redwood Creek at Gauging Stations" topic of the Klamath Resource Information System (KRIS) Redwood. Redwood National and State Parks, Orick, CA.
D50 (mm)	2000-2008	Aquatic and Riparian Effectiveness Monitoring Program (AREMP). 2009. Unpublished database of aquatic habitat monitoring and temperature data for Northern California and Southern Oregon for the years 2000-2008, collected as part of the Northwest Forest PlanInteragency Regional Monitoring Program, acquired from Mark Isley on 12/4/2009. United States Forest Service, Corvallis, OR.
Embeddedness (%)	2002-2003	Mattole Salmon Group (MSG). 2003. Final Report: Mattole Basin Channel Monitoring 2002-2003. Petrolia, CA.
Embeddedness (%)	1991-2003	California Department of Fish and Game (CDFG). 2007. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1991-2003, acquired from Ron Rogers in 2007. California Department of Fish and Game, Sacramento, CA.
Embeddedness (%)	1994-2008	California Department of Fish and Game (CDFG). 2009. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1994-2008, acquired from Karen Wilson in 2009. California Department of Fish and Game, Sacramento, CA.
Embeddedness (%)	2005-2007	Mattole Restoration Council (MRC). 2008. Unpublished spreadsheet of stream habitat information for the Mattole River for the years 2005-2007, acquired from Nathan Queener on 5/15/2008. Mattole Restoration Council, Petrolia, CA.
Fines (Dry Sample) (% <1 mm)	2002	Trinity County Resource Conservation District (TCRCD). 2003. South Fork Trinity River Water Quality Monitoring Project - Agreement No. P0010340 Final Report. Data included in the "Sediment: SF Trinity - Cumulative Percent Fines <0.85 mm, GMA 2002" topic of the Klamath Resource Information System (KRIS) Klamath-Trinity .Prepared for California Department of Fish and Game by TCRCD, with assistance from Graham Matthews. Weaverville, CA. 77 pp.

Data Type	State/year	Reference
Fines (Dry Sample) (% <1 mm)	1983-1995	North Coast Regional Water Quality Control Board. 2002. Unpublished fine sediment data for the Redwood Creek Basin for the years 1983-1995. Data included in the "Sediment: Percent Fines <1mm at Redwood Creek Mainstem Sites" topic of the Klamath Resource Information System (KRIS) Redwood. North Coast Regional Water Quality Control Board, Santa Rosa, CA.
Fines (Wet Sample) (% <1 mm)	1967-1996	PL [Pacific Lumber Company]. 1998. Sustained yield/Habitat Conservation Plan for the properties of The Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation. Public Review Draft. Salmon Creek, 1994" topic of the Klamath Resource Information System (KRIS) Humboldt Bay. Arcata CA. 81 pp. without appendices.
Fines (Wet Sample) (% <1 mm)	1967-1996	Barnard, K. 1992. Physical and Chemical Conditions in Coho Salmon (Oncorhynchus kisutch) Spawning Habitat in Freshwater Creek, Northern California. Masters Thesis. Humboldt State University. Some data included in the " Sediment: Fines <0.85mm
Fines (Wet Sample) (% <1 mm)	1992	Hoopa Valley Tribe Fisheries Department. 1997. Pine Creek Sediment Monitoring Project. Grey literature report submitted to USFWS Yreka, in fulfillment of a Klamath Task Force funded evaluation report of restoration in Pine Creek. Some data included in the "Sediment: Pine Creek Coho Expected Emergence, 1992-1993" topic of the Klamath Resource Information System (KRIS) Klamath Trinity Hoopa Valley Tribe Fisheries Department, Hoopa, CA.
Fines (Wet Sample) (% <1 mm)	1990	Preston, L. 2002. Unpublished data of wet sieve McNeil samples from Lost Man Creek and seven mainstem Mattole sites in 1990 by Larry Preston. Data included in the "Sediment: Fines <4.7 mm Mattole South Subbasin, 1990" topic of the Klamath Resource Information System (KRIS) Mattole. California Department of Fish and Game, Eureka, CA.
Fines (Wet Sample) (% <1 mm)	1974	North Coast Regional Water Quality Control Board. 2002. Unpublished fine sediment data for the Redwood Creek Basin for the years 1983-1995. Data included in the "Sediment: Percent Fines <1mm at Redwood Creek Mainstem Sites" topic of the Klamath Resource Information System (KRIS) Redwood North Coast Regional Water Quality Control Board, Santa Rosa, CA.
Fish Passage (% of Dry Habitat Types)	1991-2003	California Department of Fish and Game (CDFG). 2007. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1991-2003, acquired from Ron Rogers in 2007. California Department of Fish and Game, Sacramento, CA.

Data Type	State/year	Reference
Fish Passage (% of Dry Habitat Types)	1994-2008	California Department of Fish and Game (CDFG). 2009. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1994-2008, acquired from Karen Wilson in 2009. California Department of Fish and Game, Sacramento, CA.
Floodplain Connectivity (USFS judgment)	2000	U.S. Forest Service. 2000. Rating Watershed Condition: Reconnaissance Level Assessment for the National Forest of the Pacific Southwest Region in California. U.S.D.A. Forest Service, Region 5, San Francisco, CA. 31 p.
Flow Restoration Needs (ODFW judgment)	1998	Oregon Department of Fish and Wildlife (ODFW). 1998. Stream Flow Restoration Priority GIS Data for the Rogue and South Coast Basins. Oregon Department of Fish and Wildlife, Salem, OR.
pH (Annual Maximum)	1995	U.S. Fish and Wildlife Service. 1995. Unpublished Klamath River water quality data for the year 1995. Data are included in the "Temperature: Salmonid Stress Klamath River at Blue Creek 1995" topic of the Klamath Resource Information System (KRIS) Klamath-Trinity U.S. Fish and Wildlife Service, Arcata, CA.
pH (Annual Maximum)	1990-2003	Asarian, E. and J. Kann. 2006. Klamath River Nitrogen Loading and Retention Dynamics, 1996-2004 (Appendix C: updated version of Klamath TMDL water quality database). Kier Associates Final Technical Report to the Yurok Tribe Environmental Program, Klamath, California. 56pp + appendices.
pH (Annual Maximum)	1995-2004	Oregon Department of Environmental Quality (ODEQ). 1997. Unpublished water quality data from the ODEQ Laboratory Analytical Storage and Retrieval (LASAR) database, exported and acquired from Robb Keller, 4/17/2007. Oregon Department of Environmental Quality, Salem, OR.
Pool Depth (Ave. in Feet)	1991-2003	California Department of Fish and Game (CDFG). 2007. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1991-2003, acquired from Ron Rogers in 2007. California Department of Fish and Game, Sacramento, CA.
Pool Depth (Ave. in Feet)	1994-2008	California Department of Fish and Game (CDFG). 2009. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1994-2008, acquired from Karen Wilson in 2009. California Department of Fish and Game, Sacramento, CA.
Pool Depth (Ave. in Feet)	2005-2007	Mattole Restoration Council (MRC). 2008. Unpublished spreadsheet of stream habitat information for the Mattole River for the years 2005-2007, acquired from Nathan Queener on 5/15/2008. Mattole Restoration Council, Petrolia, CA.

Data Type	State/year	Reference
Pool Depth (Ave. in Feet)	1990-2003	Oregon Department of Fish and Wildlife (ODFW). 2007. Unpublished geo-referenced stream survey data "Aquatic Inventories Project Habitat and Reach Data", downloaded from ODFW's statewide database. Oregon Department of Fish and Wildlife, Salem, OR.
Pool Depth (Ave. in Feet)	1990-1995	United States Forest Service. 1995. Unpublished geo-referenced stream survey data for the Rogue River-Siskiyou National Forest for the years 1989-1995, acquired from the Conservation Biology Institute (who compiled the data from multiple files). Rogue River-Siskiyou National Forest, Medford, OR.
Pool Depth (Ave. in Feet)	1995-2006	United States Forest Service. 2006. Unpublished geo-referenced stream survey data for the Rogue River-Siskiyou National Forest for the years 1995-2006, acquired from the Rogue River-Siskiyou National Forest. Rogue River-Siskiyou National Forest, Medford, OR.
Pool Depth (Ave. in Feet)	2000-2008	Aquatic and Riparian Effectiveness Monitoring Program (AREMP). 2009. Unpublished database of aquatic habitat monitoring and temperature data for Northern California and Southern Oregon for the years 2000-2008, collected as part of the Northwest Forest Plan Interagency Regional Monitoring Program, acquired from Mark Isley on 12/4/2009. United States Forest Service, Corvallis, OR.
Pool Frequency (% by Area)	1990	Oregon Department of Fish and Wildlife (ODFW). 2007. Unpublished geo-referenced stream survey data "Aquatic Inventories Project Habitat and Reach Data", downloaded from ODFW's statewide database. Oregon Department of Fish and Wildlife, Salem, OR.
Pool Frequency (% by Area)	1990-1195	United States Forest Service. 1995. Unpublished geo-referenced stream survey data for the Rogue River-Siskiyou National Forest for the years 1989-1995, acquired from the Conservation Biology Institute (who compiled the data from multiple files). Rogue River-Siskiyou National Forest, Medford, OR.
Pool Frequency (% by Area)	1995-2006	United States Forest Service. 2006. Unpublished geo-referenced stream survey data for the Rogue River-Siskiyou National Forest for the years 1995-2006, acquired from the Rogue River-Siskiyou National Forest. Rogue River-Siskiyou National Forest, Medford, OR.
Pool Frequency (% by Length)	1991-2003	California Department of Fish and Game (CDFG). 2007. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1991-2003, acquired from Ron Rogers in 2007. California Department of Fish and Game, Sacramento, CA.

Data Type	State/year	Reference
Pool Frequency (% by Length)	1994-2008	California Department of Fish and Game (CDFG). 2009. Unpublished data from a database of stream habitat surveys in Northwestern California for the years 1994-2008, acquired from Karen Wilson in 2009. California Department of Fish and Game, Sacramento, CA.
Pool Frequency (% by Length)	2005-2007	Mattole Restoration Council (MRC). 2008. Unpublished spreadsheet of stream habitat information for the Mattole River for the years 2005-2007, acquired from Nathan Queener on 5/15/2008. Mattole Restoration Council, Petrolia, CA.
Riparian Condition (conifers >36" dbh / 1000ft)	1990-2003	Oregon Department of Fish and Wildlife (ODFW). 2007. Unpublished geo-referenced stream survey data "Aquatic Inventories Project Habitat and Reach Data", downloaded from ODFW's statewide database. Oregon Department of Fish and Wildlife, Salem, OR.
Sand (Dry Sample) (% <6.4 mm)	2002	Trinity County Resource Conservation District (TCRCD). 2003. South Fork Trinity River Water Quality Monitoring Project - Agreement No. P0010340 Final Report. Data included in the "Sediment: SF Trinity - Cumulative Percent Fines <0.85 mm, GMA 2002" topic of the Klamath Resource Information System (KRIS) Klamath-Trinity (available online at http://krisweb.com/krisklamathtrinity/krisdb/webbuilder/st_c49.htm). Prepared for California Department of Fish and Game by TCRCD, with assistance from Graham Matthews. Weaverville, CA. 77 pp.
Sand (Dry Sample) (% <6.4 mm)	1983-1995	North Coast Regional Water Quality Control Board. 2002. Unpublished fine sediment data for the Redwood Creek Basin for the years 1983-1995. Data included in the "Sediment: Percent Fines <1mm at Redwood Creek Mainstem Sites" topic of the Klamath Resource Information System (KRIS) Redwood. North Coast Regional Water Quality Control Board, Santa Rosa, CA.
Sand (Wet Sample) (% <6.4 mm)	1967-1996	PL [Pacific Lumber Company]. 1998. Sustained yield/Habitat Conservation Plan for the properties of The Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation. Public Review Draft.
Sand (Wet Sample) (% <6.4 mm)	1967-1996	Barnard, K. 1992. Physical and Chemical Conditions in Coho Salmon (Oncorhynchus kisutch) Spawning Habitat in Freshwater Creek, Northern California. Masters Thesis. Humboldt State University. Some data included in the " Sediment: Fines <0.85mm Salmon Creek, 1994" topic of the Klamath Resource Information System (KRIS) Humboldt Bay. Arcata CA. 81 pp. without appendices.

Data Type	State/year	Reference
Sand (Wet Sample) (% <6.4 mm)	1992	Hoopa Valley Tribe Fisheries Department. 1997. Pine Creek Sediment Monitoring Project. Grey literature report submitted to USFWS Yreka, in fulfillment of a Klamath Task Force funded evaluation report of restoration in Pine Creek. Some data included in the "Sediment: Pine Creek Coho Expected Emergence, 1992-1993" topic of the Klamath Resource Information System (KRIS) Klamath Trinity Hoopa Valley Tribe Fisheries Department, Hoopa, CA.
Sand (Wet Sample) (% <6.4 mm)	1990	Sommarstrom, S., E. Kellogg and J. Kellogg. 1990. Scott River watershed granitic sediment study: Report for Siskiyou Resource Conservation District, 152 p. plus appendices.
Sand (Wet Sample) (% <6.4 mm)	1990	Preston, L. 2002. Unpublished data of wet sieve McNeil samples from Lost Man Creek and seven mainstem Mattole sites in 1990 by Larry Preston. Data included in the "Sediment: Fines <4.7 mm Mattole South Subbasin, 1990" topic of the Klamath Resource Information System (KRIS) Mattole. California Department of Fish and Game, Eureka, CA.
Silt/Sand Surface (% riffle area)	Oregon 1990-2003	Oregon Department of Fish and Wildlife (ODFW). 2007. Unpublished geo-referenced stream survey data "Aquatic Inventories Project Habitat and Reach Data", downloaded from ODFW's statewide database. Oregon Department of Fish and Wildlife, Salem, OR.
Stream Corridor Vegetation (USFS judgment)	2000	U.S. Forest Service. 2000. Rating Watershed Condition: Reconnaissance Level Assessment for the National Forest of the Pacific Southwest Region in California. U.S.D.A. Forest Service, Region 5, San Francisco, CA. 31 p.
Temperature (MWAT) (C)	1995-1996	PL [Pacific Lumber Company]. 1998. Sustained yield/Habitat Conservation Plan for the properties of The Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation. Public Review Draft.
Temperature (MWAT) (C)	1997-2002	Klamath National Forest. 2003. Unpublished water temperature data for the Middle Klamath River watershed in 1997-2002, compiled by Klamath National Forest's Mark Reichert. Data included in the " Temperature: MWAT at Many Mainstem Klamath Sites by Year 1997-2002 ", "Temperature: MWAT at Many Mainstem Klamath Sites by Year 1997-2002", and "Temperature: MWAT at Many Scott R Sub-basin, by Year 1997-2002" topics of the Klamath Resource Information System (KRIS) Klamath-Trinity
Temperature (MWAT) (C)	2002-2003	Mattole Salmon Group (MSG). 2003. Final Report: Mattole Basin Channel Monitoring 2002 - 2003. Petrolia, CA.

Data Type	State/year	Reference
Temperature (MWAT) (C)	1995-2001	North Coast Regional Water Quality Control Board (NCRWQCB). 2002. Unpublished water temperature data for the Mattole River watershed in 1995-2001. Data included in the "Temperature: MWATs of Mainstem Mattole River (Celsius)" topic of the Klamath Resource Information System (KRIS) Mattole North Coast Regional Water Quality Control Board, Santa Rosa, CA.
Temperature (MWAT) (C)	1974-2001	North Coast Regional Water Quality Control Board (NCRWQCB). 2002. Unpublished water temperature data for the Redwood Creek watershed in 1974-2001. Data included in the "Temperature: MWATs at All Mainstem Redwood Creek Sites (1994-2001)" topic of the Klamath Resource Information System (KRIS) Redwood. North Coast Regional Water Quality Control Board, Santa Rosa, CA.
Temperature (MWAT) (C)	1999-2003	Friedrichsen, G. 2003. Eel River Baseline Temperature Final Report. Performed for the California Department of Fish and Game under Agreement No. P0110546. Humboldt County Resources Conservation District. Eureka, CA. 32 pp.
Temperature (MWAT) (C)	1990-1998	Lewis, T. E., D. W. Lamphear, D. R. McCanne, A. S. Webb, J. P. Krieter, and W. D. Conroy. 2000. Executive Summary: Regional Assessment of Stream Temperatures Across Northern California and Their Relationship to Various Landscape-Level and Site-Specific Attributes. Forest Science Project. Humboldt State University Foundation. Arcata, CA. 14 pp.
Temperature (MWMT) (C)	1994-2008	Green Diamond Resource Company. 2009. Unpublished water temperature data from Green Diamond's northern California land holdings for the years 1994-2008, acquired from David Lamphear. Green Diamond Resource Company, Korbel, CA.
Temperature (MWMT) (C)	1998-2006	Oregon Department of Environmental Quality (ODEQ). 1997. Unpublished water quality data from the ODEQ Laboratory Analytical Storage and Retrieval (LASAR) database, exported and acquired from Robb Keller, 4/17/2007. Oregon Department of Environmental Quality, Salem, OR.
Temperature (MWMT) (C)	1990-1997	Southwest Oregon Province (SWOP). 1998. Unpublished water temperature data released on a CD of GIS Data.
Turbidity (hours >25 FNU)	2001-2007	Kier Associates. 2007. Unpublished turbidity data from multiple data sources within the SONCC coho salmon ESU, derived from various tables in the Klamath Resource Information System (KRIS). Kier Associates, Arcata, CA.

Data Type	State/year	Reference
Turbidity (hours >25 FNU)	2003-2005	Klein, R., W. Trush, M. Buffleben. 2008. Watershed condition, turbidity, and implications for anadromous salmonids in northern coastal California streams. A Report to the California North Coast Regional Water Quality Control Board. Redwood National and State Parks, McBain and Trush, and California Regional Water Quality Control Board North Coast Region: Arcata and Santa Rosa, CA. 89 pp + appendices.
VStar	1992-1999	Halligan, D. and J. P. Fisher. 2001. Appendix F: Freshwater Creek Watershed Analysis - Fisheries Assessment. Review DRAFT. Prepared for Pacific Lumber Company (PALCO). Scotia, CA. 95 pp.
Vstar	1992-2001	Redwood Sciences Lab (RSL). 2001. Unpublished data regarding the proportions of pools filled by fine sediment (Vstar) in several creeks in the Klamath-Trinity watershed measured by Redwood Sciences lab crews in 1992-2001. Data included in the "Sediment: V* Horse Linto Creek 1992-2000" topic of the Klamath Resource Information System (KRIS) Klamath-Trinity. Redwood Sciences Lab, Arcata, CA.
Vstar	1994	Redwood Sciences Lab (RSL). 1994. Unpublished data regarding the proportions of pools filled by fine sediment (Vstar) in several creeks in the Scott watershed measured by Redwood Sciences lab crews in 1994. Data included in the "Sediment: Proportion in Pools (V*) French Creek by Reach 1994" topic of the Klamath Resource Information System (KRIS) Klamath-Trinity. Redwood Sciences Lab, Arcata, CA.
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Data Type	State/year	Reference
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