



Salmonid Monitoring Protocol for the San Francisco Area Network

Standard Operating Procedures - Version 4.0

Natural Resource Report NPS/SFAN/NRR—2010/203



ON THE COVER

From top left clockwise: adult coho salmon on John West Fork , Olema Creek (photograph by: Greg Brown); juvenile coho salmon on Olema Creek (photograph by: Sarah Carlisle); smolt coho salmon on Redwood Creek (photograph by: Casey Del Real).

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List of Acronyms

AUC	Area Under the Curve
CCCESU	Central California Coast Evolutionarily Significant Unit
CCNB	Conservation Corps North Bay
CDFG	California Department of Fish and Game
CESA	California Endangered Species Act
CSRP	Coho and Steelhead Restoration Project
CSMP	Coho and Steelhead Monitoring Program
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ENSO	El Niño Southern Oscillation
ESA	Endangered Species Act
FGDC	Federal Geographic Data Committee
GOGA	Golden Gate National Recreation Area
GSS	General Systematic Survey
GUID	Globally Unique Identifier
I&M	Inventory and Monitoring Program
JOMU	John Muir National Historic Site
MCOSD	Marin County Open Space District
MMWD	Marin Municipal Water District
MUWO	Muir Woods National Monument
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NPS MTE	National Park Service Metadata Tools and Editor Program
NRDT	Natural Resource Database Template
ODFW	Oregon Department of Fish and Wildlife
PDO	Pacific Decadal Oscillation
PINN	Pinnacles National Monument
PLD	Peak Live + Cumulative Dead
PORE	Point Reyes National Seashore
QA/QC	Quality Assurance/Quality Control
RSCS	Report of Specimens Collected or Salvaged
SCP	Scientific Collecting Permit
SCWA	Sonoma County Water Agency
SFAN	San Francisco Area Network
SJSU	San Jose State University
SPAWN	Salmon Protection and Watershed Network
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
YOY	Young of the year

SOP 1. Basinwide GSS Juvenile Coho and Habitat Survey*Version 3.6***Revision History Log**

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	Jan. 2007	Marcus Koenen	Added revision log, removed sampling site description, focused on field methods.	Clarification and remove redundancy	3.1
3.2	Feb. 2007	Michael Reichmuth	Revised changes and updated to reflect current monitoring	Clarification and updating techniques used	3.2MR
3.2MR	May 2008	Erin Brown	Changed SOP 1 to basinwide		3.3
3.3	May 2008	Sarah Carlisle	Continued changes suggested by MR		3.4
3.4	June 2008	Sarah Carlisle	Linked data collection with objectives		3.41
4.41	July 2008	Michael Reichmuth	Reviewed and revised protocol	Clarification and revising field techniques	3.5
3.5	August 2008	Marcus Koenen, Brannon Ketcham	Editorial Review/minor revisions	Clarification and consistency with Protocol Narrative	3.51
3.51	November 2008	Michael Reichmuth	Address Darren Fong comments	Clarification and minor edits	3.52
3.52	November 2008	Dawn Adams	Formatting	For peer review	3.53
3.53	December 2008	Michael Reichmuth	Minor Edits	For peer review	3.54
3.54	November 2009	Michael Reichmuth	Added Lit Cited	Peer review response	3.55
3.55	February 2010	Michael Reichmuth	Final edits and formatting	Editor and internal review comments	3.6

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Overview

This standard operating procedure (SOP) details the Basinwide General Systematic Survey (GSS) field methods used to collect habitat data, and abundance estimates of juvenile coho salmon using electrofishing and snorkeling during summer and fall base flow conditions. The information collected during these surveys is used to determine long-term trends in distribution, abundance, and condition of juvenile coho salmon, monitoring objective 3. Collected information will also be used to identify gross habitat changes, monitoring objective 5. Surveys are conducted annually between July and October. Surveys are performed continuously once creeks have reached summer base flow conditions. The sampling design includes habitat inventory with a systematic approach for selecting pool units to be snorkeled with a subset of those pools calibrated using multiple pass electrofishing. Although the surveys are focused on coho salmon, information on other fish species is also gathered while electrofishing (see potential list of species encountered in Appendix A).

Study Area

Basinwide GSS surveys are conducted in select high priority streams and associated tributaries within the San Francisco Bay Area Network (SFAN) in Marin County and which currently contain populations of both coho salmon and steelhead including Redwood Creek, Pine Gulch Creek, and Olema Creek (table SOP 1.1). The start and end points for each survey may be adjusted depending on the water year, observed distribution during spawner surveys, and changes in water quality.

Table SOP 1.1. Basinwide survey reach descriptions.

Watershed	Stream	Survey Length (km)	Fish and Habitat Sampling		
			Survey between Tags	Location Start	Location Stop
Olema	Mainstem	11.8	Tag 36–150	Vedanta Retreat bridge	Randall Gulch confluence
Pine Gulch	Mainstem	10.3	Tag 00–95	MCOSD Bridge	Upstream of Teixeira Ranch
Redwood	Mainstem	8.5	Tag 00–74	Big Lagoon (brackish water)	Upstream of Muir Woods (Tag 74)

Sample Design

The sample design is described in the protocol narrative. Basinwide GSS survey reaches are described in SOP 9 (Sampling Site Descriptions).

Field Methods

Basinwide GSS surveys will utilize techniques described in Dollof et al. (1993). Background information is also provided by Duffy (2005). Surveys consist of two-phase sampling in which snorkel counts are utilized during the first stage sampling and electrofishing is used to calibrate the snorkel count during the second stage. A ratio estimator is then used to determine a basinwide juvenile coho population estimate for each watershed. Sampling effort is focused on pool habitats to decrease sampling time. Data from legacy index reaches on Redwood, Pine

Gulch, and Olema Creeks since 1997 indicates that over 90% of the coho captured during summer juvenile surveys were occupying pool habitat units.

Field Preparations

Beginning in late May, equipment should be inventoried, organized, and repaired or replaced as necessary. Sampling equipment is listed in tables SOP 1.2–3. Personnel should review the protocols and additional supporting documents. If new personnel are being trained, several days should be scheduled each for electrofishing and snorkeling training and practice. We also recommend visiting each site prior to sampling to familiarize new personnel, determine access issues, and assess the amount of change since the previous year.

Table SOP 1.2. Habitat measurements equipment list.

Number Needed	Item
1	30-meter or 50-meter tape measure
2	Chaining pins
1	Metric stadia rod
1	Aluminum clipboard with waterproof datasheets and pencils

Table SOP 1.3. Snorkel surveys equipment list.

Number Needed	Item
1	Wetsuit/drysuit, hood, mask, snorkel for each diver
1	Stop watch
1	Wading boots for each diver
1	Dive light w/ spare batteries
1	Wrist cuff w/ pencil
1	Aluminum clipboard with waterproof datasheets and pencils

Field Work Overview

Summer basinwide surveys are conducted on continuous reaches of each creek mainstem. Starting with the lowest surveyed reach, the habitat survey field crews make their way upstream, classifying habitat units based on characteristics such as length, depth, and complexity. Pools are marked for later survey by a snorkeling field crew. Pools are surveyed using Hankin/Reeves methods (Dollof et. al. 1993) that includes a two-phase sampling design. Every fifth pool is snorkeled (generally 20% of the pools), and a randomly selected sub-sample on 20% of the snorkeled pools are electrofished for calibration. Data sheets are presented in the Appendixes.

Pool Delineation

Starting with the lowest surveyed pool in a stream, every fifth pool thereafter is flagged for sampling via snorkel survey.

Habitat Typing

Initial habitat surveys are conducted prior to snorkeling to determine sampling locations. The habitat portion of a basinwide survey will generally require a team of two people for safety and efficiency, although one person can do it alone if necessary. Beginning at the downstream end of a stream or basinwide survey reach and working upstream, the team identifies, classifies, and numbers sequentially all habitat units. Habitat units are classified to Level III using the CDFG system (Flosi et al. 1998; see Appendix B). The length of each unit should be measured to the nearest 0.1 m using a 50-m tape and the average width visually estimated. A hip chain/string box may be used to measure length but all string must be collected and removed from the stream. The average width of each habitat unit is estimated visually in order to increase sampling efficiency. Measured widths to the nearest tenth of a meter are taken for 20% or every fifth unit to calibrate visually estimated widths. The data collected will be used to determine coho densities and to analyze habitat constraints on salmonid populations.

To maintain consistency, unit classification and width estimation should be done by the same person for the duration of the survey. The maximum depth and crest depth of all pool and flatwater units should be measured to the nearest 0.01 m using a metric stadia rod. The difference between the maximum and crest depths is used to determine residual pool depth, which is an important geomorphic component for salmonid habitat. In general for the SFAN streams, units with a maximum depth greater than 0.3 m are considered pools and those less than 0.3 m in depth are considered flatwater units. For a 20% subsample, the team should flag every fifth pool unit for snorkeling and measure several widths to the nearest 0.1 m with the metric stadia rod after recording the visually estimated width. If a selected pool is unsuitable for snorkeling, the team may skip it and flag and measure the next pool. In addition to pool measurements, 10% or every 10th riffle and flatwater unit will be measured to calibrate estimated widths. All measurements and information should be recorded on the *Basinwide Habitat Survey Datasheet* (Appendix C) along with notes on 100-m tags, tributaries, and other landmarks. Habitat units in side channels are noted but not used in the population estimate or mainstem habitat composition summaries.

Both the number of transects and the distance at which transects are measured will be determined by the measured length of the habitat unit to the nearest whole meter. Two transects will be measured on all habitat units 8 m or less. Three transects will be measured on all habitat units 9 m to 15 m in length. Four transects will be measured on all habitat units 16 m to 25 m in length. Five transects will be measured on all units 26 m to 35 m in length. Six transects will be measured on all units greater than 35 m in length. The locations of transect measurements are calculated in the field by dividing the measured length to the nearest whole meter by the number of transects to be measured plus one (unit length / (t+1)). All calculated transect locations will be rounded to the nearest whole meter.

Snorkel Surveys

Because of the skill necessary to accurately identify and count fish underwater, only experienced divers (diver with at least one season of diving experience), or those trained and cleared by the primary investigators, should conduct snorkel counts. For each unit sampled, the lead diver or field supervisor should assess the conditions and determine how many divers and/or passes

should be used to sample the unit. Snorkelers use dive lights to search around woody debris and undercut banks.

Snorkel surveys should be conducted on pools identified through the habitat survey, using dive lights to search under vegetation, woody debris, and undercut banks. Juvenile coho are counted, and the presence of non-target fish and other aquatic species are noted, as well as cover, habitat complexity, and general survey conditions, and recorded on the *Snorkel Survey* datasheet (Appendix D). When low densities of fish are present, divers may tally observed fish mentally or on a PVC wrist cuff. When many fish are present, it may be easier to call out observations to a data recorder standing on the bank. Underwater visibility will be estimated by the diver with greater than 1 m considered to be good visibility and less than 0.5 m considered too turbid to snorkel. Staff will calibrate for underwater distance using a stadia rod prior to performing surveys on each watershed.

At this time, basinwide snorkel survey estimates should target coho salmon in the mainstem of Pine Gulch, Olema Creek and Redwood Creek. Snorkel data will be used to answer questions relating to population trends within the surveyed watersheds, as well as for comparisons with other regional watersheds.

Calibration for the snorkel surveys will use multiple pass electrofishing results on a 20% random subsample of snorkeled pool units. All calibration pools must contain safe access points for crew members and volunteers that will be performing the electrofishing surveys. If randomly selected calibration pools are deemed inaccessible, then the next accessible pool will be utilized as a calibration pool. Accessibility will be determined by the snorkel survey data recorder to ensure that electrofishing calibration pools are snorkeled without the snorkeler knowing that any given unit will be used as a calibration unit.

In Pine Gulch Creek, where the creek access is most limited, the method of bounded counts (Murphy and Willis 1996) will be evaluated as a calibration technique instead of multiple pass electrofishing. The modification in calibration technique used on Pine Gulch Creek is due to access issues within the sampling area of this watershed. In particular, over 50% of the survey area requires access through private property and remote stream reaches that are inaccessible to electrofishing crews. By utilizing the bounded count method for calibration purposes, a much smaller field crew using National Park Service (NPS) staff only can be used to calibrate the initial snorkel counts. Due to the decrease in the amount of equipment used for snorkel surveys, snorkel crews are able to access remote areas that would be otherwise deemed inaccessible.

Electrofishing

Electrofishing should be conducted as soon as possible after the snorkel counts, preferably the next day. For electrofishing and water quality monitoring protocols, please refer to SOP 3.

Collecting Scale and Tissue Samples

Scales and/or tissue samples will be collected from all juvenile salmonid mortalities in concurrence with the current Section 10 Endangered Species Act permit 1046 modification #2 requirements. Refer to SOP 6 for permitting and tissue collection details.

Data Management

Record and verify data values, both observed and measured. Field datasheets should be completed, and the collected data entered into electronic databases described in SOP 8. Crew members should schedule and perform regular data transfer and backup, as well as conduct regular data verification and correction. Finally, crew members should ensure that field forms, field notebooks, and other hardcopy records are secure, readily available for viewing and reproduction upon request or at the end of the field season. For analysis and reporting of results, please refer to SOPs 8 and 10.

Logistics

Annual Workload and Field Schedule

The summer stream aquatic resource monitoring program is the most intensive, comprehensive, and time consuming portion of the overall monitoring program. The implementation of sampling surveys will begin in late June or early July, continuing through September or October of each monitoring season. The level of intensity is intended to provide equivalent surveys to all SFAN parks with high priority streams. Essentially, weeks are broken out to include two habitat typing days (split crew), two snorkeling days (split crew) and two electrofishing days (full crew).

Staffing Requirements

The basinwide GSS sampling is field intensive. In general required field staff includes two field staff for habitat typing, two field staff for snorkeling, and five field staff for electrofishing. The timing for each survey type (habitat, snorkel, and e-fishing) is staggered during the summer so that each survey may be completed with two to four field staff and additional volunteer help on electrofishing survey days. For electrofishing, field staff is normally assisted by 1 to 3 volunteers per day. Volunteers are not allowed to perform sensitive tasks such as snorkeling, habitat typing, operating the electrofisher, or weighing and measuring fish, but they are valuable in assisting with transport of equipment and fish, recording information, and increasing field safety during electrofishing surveys.

Sampling Frequency and Timing

In general, sampling for each stream should be conducted at about the same time of year on an annual basis. Sampling will begin on Pine Gulch in early July and end on Olema Creek in mid-October. Table SOP 1.4 provides the recommended seasonal timing for sampling each stream.

Table SOP 1.4. Basinwide survey timing.

Watershed	Stream	Dates	Fish and Habitat Sampling: Time Needed		
			Habitat Typing	Snorkel Surveys	Calibration Pools
Olema	Mainstem	September–October	7 days	14 days	8 days
Pine Gulch	Mainstem	July–August	5 days	12 days	5 days
Redwood	Mainstem	August–September	5 days	12 days	8 days

Literature Cited

- Duffy, W. G. 2005. Protocols for monitoring the response of anadromous salmon and steelhead to watershed restoration in California. California Department of Fish and Game, California Cooperative Fish Research Unit, Humboldt State University, Arcata, California.
- Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California salmonid stream habitat restoration manual. Third edition. California Department of Fish and Game, Sacramento, California.
- Murphy, B. R., and D.W. Willis. 1996. Fisheries Techniques. Second Edition. American Fisheries Society, Bethesda, Maryland.

SOP 2. Index Reach Surveys

Version 1.5

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	Jan. 2007	Marcus Koenen	Added revision log, removed sampling site description, focused on field methods.	Clarification and remove redundancy	3.1
3.2	Feb. 2007	Michael Reichmuth	Revised changes and updated to reflect current monitoring	Clarification and updating techniques used	3.2MR
1	May 2008	Sarah Carlisle	Removed Basinwide and GSS survey references to focus on Index Reach Surveys only		1.0
1.0	May 2008	Sarah Carlisle	Updated datasheets and field protocols		1.1
1.1	May 2008	Sarah Carlisle	Linked data collection with project questions		1.11
1.11	July 2008	Michael Reichmuth	Reviewed and revised protocol	Clarification	1.2
1.2MK	August 2008	Michael Reichmuth	Minor Changes	Clarification	1.3
1.3	August 2008	Brannon Ketcham	Moderate changes		1.4
1.4	October 2008	Dawn Adams	Formatting; moved datasheets to SOP 3	For peer review	1.41
1.41	December 2008	Michael Reichmuth	Minor Edits	For peer review	1.42
1.42	November 2009	Michael Reichmuth	Added Lit. Cited	Peer review response	1.43
1.43	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	1.5

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Overview

This standard operating procedure (SOP) details the field methods used to collect abundance estimates for juvenile coho salmon and steelhead trout in index reaches established in parks of the San Francisco Bay Area Network (SFAN) during fall base flow conditions. The information collected during these surveys is used to determine long term trends in density, size, and age composition of coho salmon at preexisting legacy index reach locations, monitoring objective 4. The information collected during these surveys is not intended to represent the entire watershed condition but it will be used to determine fish condition and population trends specific to these legacy index reaches. Survey will be conducted after basinwide GSS surveys are completed in late September or early October and will last until late October. Although the surveys are focused on juvenile coho salmon, information on other species captured will be gathered.

Study Area

Index reach surveys are conducted in select streams and associated tributaries in Marin County which currently contain populations of both coho and steelhead including Olema Creek, Pine Gulch Creek, and Redwood Creek. Because the value of legacy indexes reaches is the length of each data set for each index reach, priority index reaches are delineated in table SOP 2.1 to guide field staff during years when field time is limited.

Table SOP 2.1. Number of index reaches per watershed.

Watershed	Total Number of Legacy Index Reaches	Priority Index Reaches to be Maintained Annually	Number of Priority Index Reaches
Olema	8	Reaches: 2, 3, 5, 6, 7	5
Pine Gulch	7	Reaches: 1c, 2, 3, 5, 6	5
Redwood	5	Reaches: 2, 3, 4, 5, 6,	5

Sample Design

All juvenile salmonids will be sampled at designated index reaches. The overall sampling design is described in the protocol and site locations are described in SOP 9.

Sampling Frequency and Timing

In general, each stream should be sampled at about the same time of year on an annual basis. Sampling should be conducted once basinwide GSS surveys are completed in early fall when water levels are at their lowest levels. By sampling at fall base flow, ultimate fish abundance and condition can be accurately measured within each index reach.

Field Methods

During summer and fall sampling, sampling occurs along index reaches that were established in 1997. Each habitat unit within the index reach is isolated with block nets and sampled separately using standard multiple pass depletion electrofishing methods (Bohlin et al. 1989). Where appropriate, seine hauls may be used in conjunction with electrofishing to reduce indirect injury or mortality from electrofishing. Data are recorded for size (length and weight), genus, species, and age class.

After the fish sampling is completed, measurements and assessments of each habitat unit are made. Measurements include length, average width and depth, substrate composition, and instream shelter complexity are quantified at each sample site. Transects are set up across each sample site. Depth and substrate type are recorded at points along each transect. Additional habitat parameters are determined for the index reach as a whole. The habitat portion of index reach monitoring must be completed the same day as fish sampling or very soon thereafter.

Field Season Preparations

Beginning in late May, equipment should be inventoried, organized, and repaired or replaced as necessary. Personnel should review the protocols and additional supporting documents. If new personnel are being trained, several days should be scheduled each for electrofishing and practice. Visiting each site prior to sampling is useful to familiarize new personnel, determine access issues, and assess the amount of change since the previous year.

Fish Sampling Method

The fish sampling portion generally takes a full work day for each reach, including the habitat survey. Within the index reach, separate habitat units are identified for electrofishing and habitat surveys. The crew will first complete their electrofishing passes on the habitat unit and process captured fish (after each pass). The crew will continue working upstream, electrofishing each habitat unit and leapfrogging the nets, until the top of the index site is reached. Once the electrofishing and fish sampling is completed, habitat surveys are conducted.

Establish Reaches

The top and bottom of each index reach are marked with flagging and aluminum tags labeled with the stream name, index #, and “top” or “bottom”. Each year of sampling, the habitat units within the established index reach are surveyed. The dynamic stream conditions may result in the end of habitat units being outside of the established reach. In these cases, the entire habitat unit should be surveyed.

Sample Water Quality

Collect water quality samples as described in SOP 3.

Set Up Block Nets

To begin sampling, locate the bottom (downstream) tag or flag of the index reach. Starting at the bottom of the pool or flatwater habitat unit nearest this tag and working upstream, identify, number, and isolate each habitat unit with block nets. Sections of dry streambed and other habitat units within the index reach that are not sampled should still be numbered and classified. Install nets perpendicular to the thalweg and seal the bottom and ends with rocks and gravel to ensure no fish can get through. Riffles with a length less than one stream width are not considered separate habitat units and should be included with the downstream unit.

Electrofishing

See SOP 3 for electrofishing methods. Note that with this SOP, pool and flatwater habitat units will be sampled using standard multiple pass depletion electrofishing methods, allowing sufficient time (approximately 5–10 minutes) between passes to allow uncaptured fish to recover and suspended sediments to settle. A minimum of two passes will be conducted in these units, with additional passes as necessary to achieve a good depletion. In general, if the catch of any

species/age class is more than 50% of the previous pass, then another pass should be conducted. Riffles can be sampled with a single pass. A pass consists of a sweep from the bottom (downstream end) of a unit to the top, then back to the bottom. After each pass check the downstream net and remove any fish that have drifted in. Do not remove the net until all passes have been completed. Record information for each electrofishing pass on the *Index Reach Electrofishing Log* (SOP 3, Appendix E), including pass time, number of fish captured, and electrofisher settings.

Seining

Seining is described in SOP 3. A minimum of two passes will be conducted in these units, with additional passes as necessary to achieve a good depletion. In general, if the catch of any species/age class is more than 50% of the previous pass, then another pass should be conducted. Note that after processing, seine captures should not be released until after all electrofishing passes have been completed on a unit. Record the total seine capture on the *Index Reach Electrofishing Log* (SOP 3) datasheet, making sure to differentiate it from the electrofishing passes.

Processing Fish

Methods are described in SOP 3. Fish species and measurement data is entered on the *Electrofishing Datasheet* (SOP 3, Appendix E). Start a new datasheet for each habitat unit; if more than one sheet is used for a unit, record sheet # and total # of sheets on each sheet.

Collecting Scale and Tissue Samples

Scales and/or tissue samples will be collected from all juvenile salmonid mortalities in concurrence with current permit requirements. Refer to SOP 6 for details on tissue collection and permitting.

Habitat Assessment

After electrofishing the entire index reach unit by unit, the next step is to collect habitat information including habitat unit dimensions, substrate, instream shelter, woody debris, and bank erosion and vegetation. The purpose of the habitat assessment is to record site descriptions, in the event of a drastic change in stream conditions between surveys. All habitat units should be identified to level III using the CDFG classification system (Flosi et al. 1998; Appendix B). Sections of dry stream bed or habitat units that are not sampled for fish should still be numbered, classified, and the length measured. If the habitat assessment occurs on a different day than fish sampling, a copy of the completed *Index Reach Electrofishing Log* (SOP 3) should be used to ensure the habitat units are identified and classified consistently. Table SOP 2.2 presents the list for equipment needed to collect habitat data.

Table SOP 2.2. Habitat assessment equipment list.

Number Needed	Item
1	30-meter or 50-meter tape measure
1	Chaining pins
1	Metric stadia rod
1	Aluminum clipboard with waterproof datasheets and pencils

Habitat Components

The following habitat components (figure SOP 2.1) are counted or estimated for the index reach as a whole and recorded on the Index Reach Habitat Datasheet (Appendix E).

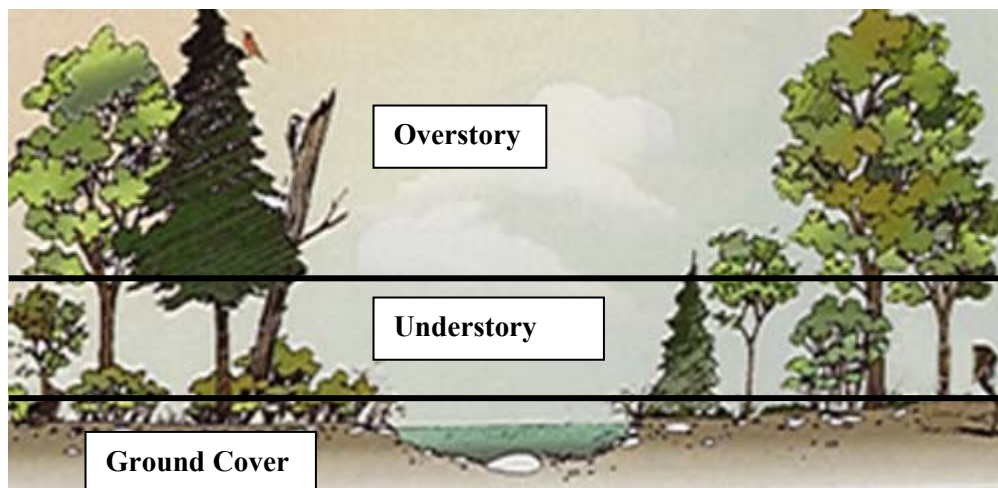


Figure SOP 2.1. Representation of groundcover, understory, and overstory for field habitat characterization.

Bank Vegetative Cover: Visually estimate percent cover for the three layers of riparian vegetation along the entire index reach (figure 11). Tall trees such as mature alders, bays, oaks, firs, and redwoods form the *Overstory* (OS). Lower growing deciduous shrubs and young trees such as elderberry, salmonberry, alders, and hazelnut form the *Understory* (US). *Ground cover* (GC) is composed of grasses, ferns, blackberries, nettles, rushes, and other low growing plants.

Bank Erosion: Identify the length of the stream banks along the index reach and visually estimate the percentage of the channel with active bank erosion. Rate the left and right banks (facing downstream) individually. Also identify potential source of this erosion (channel scour, animal trail, etc.).

Dry Channel/Isolated Pools: Indicate whether there are any pools which are disconnected from adjacent habitat units (i.e., with no surface flow in or out). If there is discontinuous flow along the channel thalweg, visually estimate the percentage of dry channel present in the index reach.

Woody Debris: Count and record all large woody debris (LWD), alive and dead, within the bankfull channel along the index section. Research on hardwood riparian forests have shown that live trees within the bankfull channel, primarily alder and bay in these watersheds, are prominent channel forming features (Opperman 2003). To qualify as LWD, individual logs must meet specific size requirements. Logs must be at least 2 m (6 ft) in length and are tallied in the following diameter classes: 10-20 cm (4-8 in), 20-50 cm (8-20 in), and greater than 50 cm (>20 in). Diameter is measured at the mid-point of the log. Stumps, with the root structure intact, that are less than 2 m long and at least 20 cm in diameter are tallied separately. These “rootwads” are very stable structures and can provide excellent juvenile

fish habitat. Accumulations of more than 10 individual pieces of LWD constitute a large woody debris jam. Each jam is tallied separately. There is no need to tally every individual log in the jam, just record the jam as a whole. Pieces of wood that are between 5 and 10 cm in diameter are considered small woody debris (SWD). We will not be counting individual pieces of SWD. Tally only accumulations of ten or more pieces of SWD as SWD jams.

Transect Measurements

For each habitat unit measure the length to the nearest tenth of a meter and establish up to six transects across the width of the unit, perpendicular to the thalweg, using a metric tape measure with the zero end at right edge of water (REW) when looking downstream. Both the number of transects and the distance at which transects are measured will be determined by the measured length of the habitat unit to the nearest whole meter. Two transects will be measured on all habitat units 8 m or less. Three transects will be measured on all habitat units 9 m to 15 m in length. Four transects will be measured on all habitat units 16 m to 25 m in length. Five transects will be measured on all units 26 m to 35 m in length. Six transects will be measured on all units greater than 35 m in length. The locations of transect measurements are calculated in the field by dividing the measured length to the nearest whole meter by the number of transects (t) to be measured plus one (unit length / (t+1)). All calculated transect locations will be rounded to the nearest whole meter. Along each transect, wetted stream width is measured to the nearest 0.1 m. For pool and flatwater units, the maximum and crest depths should also be measured. Record habitat unit length, width, and depth information on the Index Reach Habitat Unit Transect Datasheet (Appendix E).

Instream Shelter

For each habitat unit, visually estimate the percentage of the water surface area covered by the following instream shelter types (Flosi et al. 1998) and record the appropriate instream shelter class provided on the Index Reach Habitat Unit Transect Datasheet (Appendix E).

Undercut Bank and Bedrock Ledge are rated according to the percentage of the unit's perimeter affected.

Small Woody Debris (SWD) and Large Woody Debris (LWD) are dead branches or logs in the water, at least 2 m (6 ft) in length, and < or > 10 cm (4 in) in diameter respectively. Accumulations of pieces < 2 m long can also be counted if they form significant cover.

Root Mass includes woody root structures in the water or extending out from bank. Root structures even with the bank should be counted as undercut bank. Logs with roots should be divided between *root mass* and one of the *woody debris* categories.

Terrestrial Vegetation consists of live branches, leaves, or herbaceous plants hanging in or very near the water.

Aquatic Vegetation includes watercress, reeds, and other plants rooted in the water. Accumulations of floating vegetation (e.g., duckweed) can also be counted if they form significant cover. Algae mats should not be counted.

Bubble Curtain includes white water, cascades, and plunge pools.

Boulder is >25 cm (10 in) in diameter.

Data Management

Record and verify data values, both observed and measured. Field datasheets should be completed, and the collected data entered into electronic databases described in SOP 8. Crew members should schedule and perform regular data transfer and backup, as well as conduct regular data verification and correction. Finally, crew members should ensure that field forms, field notebooks, and other hardcopy records are secure, readily available for viewing and reproduction upon request or at the end of the field season. For analysis and reporting of results, please refer to SOPs 8 and 10.

Logistics

Annual Workload and Field Schedule

The summer stream aquatic resource monitoring program is the most intensive, comprehensive, and time consuming portion of the overall monitoring program. The implementation of sampling surveys will begin in Pine Gulch and end in Olema in late September and early October of each monitoring season (table SOP 2.3).

Table SOP 2.3. Index reach timing.

Watershed	# of Index Reaches	Index Reach Sampling	
		Sampling Dates	Index Reach Monitoring Time Needed
Olema	6-8	Late September/Early October	6-8 days
Pine Gulch	5-8	Mid October	5-8 days
Redwood	5-7	Late October	5-7 days

Staffing Requirements

Index reach sampling requires at least 5 individuals per day for each index reach. At least two field staff are required to operate the electrofisher and weigh and measure fish while 2 to 3 volunteers may be used to net fish, transport fish, transcribe data, and carry equipment. Volunteers are not allowed to perform sensitive tasks such as operating the electrofisher or weighing and measuring fish.

Literature Cited

- Bohlin, T., S. Hamrin, T. G. Heggberget, G. Rasmussen, and S. J. Saltveit. 1989. Electrofishing: Theory and practice with special emphasis on salmonids. *Hydrobiologia* 173:9–43.
- Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California salmonid stream habitat restoration manual. Third edition. California Department of Fish and Game. Sacramento, California.
- Opperman J. 2003. Large Woody Debris and Anadromous Fish Habitat in California's Mediterranean-climate Watersheds. Master's Thesis. University of California, Berkeley; Department of Environmental Science, Policy and Management April 7, 2003.

SOP 3. Specialized Field Methods

Version 1.5

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	July 2008	Marcus Koenen	Created SOP to synthesize common methods	To remove redundancy from other SOP	1.0
1.0	August 2008	Michael Reichmuth	Minor edits and comments	Clarification	1.1
1.1	August 2008	Brannon Ketcham	Minor edits	Clarification	1.2
1.2	September 2008	Michael Reichmuth	Minor edits	Clarification	1.3
1.3	September 2003	Michael Reichmuth	Removed Presence Non-detect Info	Changed to reflect current funding	1.4
1.4	September 2008	Dawn Adams	Formatting	Peer review	1.41
1.41	December 2008	Michael Reichmuth	Minor Edits	Peer Review	1.42
1.42	November 2009	Michael Reichmuth	Added Lit Cited	Peer review response	1.43
1.43	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	1.5

Tables

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Table SOP 3.1. Electrofishing equipment list.....	SOP 3.4
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Overview

This standard operating procedure (SOP) details the specialized field methods used for fish sampling. This SOP includes electrofishing, seining, water quality sampling, and fish handling techniques. These techniques may be used in conjunction with SOPs 1 and 2. Sampling design, and frequency are described in the narrative and specific technique SOPs. Site descriptions are in SOP 9.

Field Methods

Water Quality

Water quality parameters, including conductivity, should be measured each day prior to sampling activities. Using an YSI 30 or 85 meter, measure and record the water temperature, conductivity and specific conductance, and salinity at the tailout of each of the pools or index reaches immediately before sampling. If using the YSI 85, measure and record dissolved oxygen as well. If sampling in slow moving water, it may be necessary to move the probe slowly and steadily in the water to attain an accurate dissolved oxygen reading. Measurements should be taken before walking in or disturbing the water. Record water quality measurements, habitat unit information, and general reach information on the Index Reach Habitat Log (Appendix E) or Basinwide Electrofishing Log (Appendix G).

For complete calibration and operation techniques for these YSI Probes, refer to the San Francisco Bay Area Network (SFAN) Water Quality Monitoring Protocol SOP 3 (Specialized Field Methods).

Electrofishing

Electrofishing will be conducted for calibration in basinwide GSS surveys (SOP 1) and legacy index reaches (SOP 2). Most sampling will be conducted using a battery powered backpack electrofisher with an 11-inch aluminum anode ring and rat-tail cathode. See table SOP 3.1 for all other equipment needed for electrofishing. There are currently two electrofishing units available to SFAN Parks, a Smith-Root model 12-B at Golden Gate National Recreation Area (GOGA) and a Smith-Root model LR-24 at Point Reyes National Seashore (PORE). Only personnel trained and cleared by the primary investigators will operate the electrofishers. Operators of the electrofishers will be trained using the fundamental techniques and safety precautions presented in the Principles and Techniques of Electrofishing handbook (Kolz et al. 1998). For safety reasons, no individuals who are pregnant or have a pacemaker may participate in electrofishing activities.

To begin, locate the bottom (downstream) end of the selected pool. Install nets perpendicular to the thalweg and seal the bottom and ends with rocks and gravel to ensure no fish can get through. Once both upper and lower ends have been blocked, begin electrofishing using standard methods.

A pass consists of a sweep from the bottom (downstream end) of a unit to the top, then back to the bottom. For index reach sampling: multiple passes will be used as described in SOP 2. For basinwide GSS calibration sampling: multiple passes will be used as described in SOP 1.

Table SOP 3.1. Electrofishing equipment list.

Number Needed	Item
1	Backpack electrofisher with rat-tail cathode and anode probe w/ 11" anode ring
3	Charged electrofisher batteries
1	Spare anode ring with 7/16" wrench (can be left in vehicle)
2	Long handled capture nets (wood or fiberglass handles; not aluminum)
>3	4' x 10' seines, carried in holey plastic tub (which doubles as live car)
1	YSI 30, YSI 85, or other instrument to measure water temp and conductivity
6	Clean 5-gallon buckets
5	Battery powered clip-on aerators with tubes, airstones, and spare D batteries
>3	Aquarium dip-nets, various sizes
1	Measuring board with mm scale
1	Electronic scale with weighing hook in padded plastic case, w/ spare batteries
1	Nylon mesh weighing bag
1	Plywood weighing stand
1	Plastic tool box containing:
20	Alka seltzer tablets in ziploc bag
20	Coin envelopes and blotter paper (for scale/tissue samples) in ziploc bags
1	Surgical scissors
1 ea.	Pesola scales (100g x 1g and 1000g x 10g)
20	Ziploc bags, spare batteries, pens, pencils, airstones, aerator tubes, etc.
1	Aluminum clipboard with waterproof datasheets and pencils
N	Waders for crew

After each pass check the downstream net and remove any fish that have drifted in. Record information for each electrofishing pass on datasheets (i.e., Basinwide Electrofishing Log, Appendix G; Index Reach Log, Appendix H), including pass time, number of fish captured, and electrofisher settings.

For most of the stream conditions and fish species/age classes encountered, a direct-current setting (P16 on the model 12-B) at 150-200 volts (100 volts for riffles and other shallow areas) has been found to be most effective with minimal negative effects to juvenile salmonids and other fish, and is consistent with National Marine Fisheries Service (NMFS) guidelines (NMFS 2000). For specifics on the settings and operation of each electrofisher unit, refer to the appropriate model's instruction manual.

Electrofishing should be conducted with a minimum of three people, one to operate the electrofisher and two netters to capture stunned fish. Additional people can help transfer captured fish into holding buckets. To keep a consistent effort per unit, staff and volunteers should retain the same job function for the entire sampling time in each sampling unit and all passes. All captured fish should be immediately placed into clean 5-gallon holding buckets containing fresh

stream water, with larger sculpin kept in separate buckets to avoid predation on young of the year (YOY) salmonids and other smaller fish. Buckets should be approximately half full to ensure sufficient water and oxygen for the fish. Avoid filling buckets too full as this may allow fish to jump out. Also avoid overcrowding; redistribute fish among buckets if necessary. Buckets should be kept in the shade as much as possible, and aerators should be placed in buckets if fish will be held for more than 5-10 minutes.

If the number of personnel is limited, the fish from each electrofishing pass should be processed before continuing with the next pass. With enough people, one group can process fish while the other group continues electrofishing. Fish from different passes should be held in separate buckets and processed in the order they were captured. Once all electrofishing passes on a habitat unit have been completed and all captured fish have been processed and allowed to recover, the bottom net can be moved upstream to net off any remaining units and the fish released back into the unit from which they were captured.

Seining

When possible, one or more passes with a seine will be conducted prior to electrofishing to reduce the potential risk of injuries to fish or red-legged frogs. Open units with minimal amounts of woody debris or other obstructions that may snag a net are good candidates for seining. Seines should be knotless woven nylon, 1/8 inch or similar sized mesh. Fish captured by seine should be placed in holding buckets and processed in the same way as electrofishing captures. Fish from different seine passes in the same unit may be combined and processed as a single pass event. After processing, seine captures should not be released until after all seine passes have been completed on a unit. Record the total seine capture on the appropriate datasheet, making sure to differentiate it from the electrofishing passes.

Handling Captured Fish

All captured fish will be processed after each electrofishing or seine pass. All handling and processing of salmonids will be performed by personnel trained and cleared by the project lead. Fish identification is important; see Appendix A for a list of species that may be encountered in the study area. To minimize handling of fish, a randomly selected subsample of ten coho, ten steelhead YOY, and ten steelhead 1+ will be measured to the nearest millimeter and weighed to the nearest hundredth of a gram within each unit and pass. For the rest, individuals should be tallied. To ensure that all fish are selected for measuring at random, field staff will select each fish by making a blind grab, with a dipnet, from the holding bucket.

Also identify, measure, and weigh non-salmonid fish; if more than ten of any species then weigh and measure ten and tally the rest. Based on analysis of past weight/length data, a subsample of ten randomly selected fish of each species, per pass, per unit will result in a sample size that is adequate for developing a weight-length relationship for salmonids in each mainstem (Carlisle et al. 2008)

Sampled salmonids should be sedated using carbon dioxide (Alka-Seltzer®) to facilitate handling and minimize stress to the fish. Other fish may also be sedated prior to handling if needed. Fill a clean, 5-gallon bucket (white works best) with a couple inches of fresh stream water and add half of an Alka-Seltzer® tablet (use only plain, unmedicated Alka-Seltzer®). Place a few fish at a time into the treated water and wait a couple minutes until they are

adequately sedated. Fish should be processed once they are sluggish enough for easy handling but before they begin to turn over. If fish do turn over they should be processed and/or returned to an aerated holding bucket immediately. Adjust the number of fish sedated at a time as necessary: if fish are turning over, add fewer at a time; if waiting for fish to become adequately sedated is holding up the processing, more can be added at a time. More Alka-Seltzer® may be added if necessary, but be conservative (no more than a quarter tablet at a time) and monitor fish closely if the dosage is increased. It may be necessary to change the water periodically, particularly on hot days and when processing large numbers of fish.

Processing will ideally involve two people: one to measure fish and one to record the information on datasheets. Fish species and measurement data is entered on the datasheet (i.e., Basinwide Electrofish Log; Appendix F) Start a new datasheet for each habitat unit; if more than one sheet is used for a unit, record sheet # and total # of sheets on each sheet. On the computer all units are entered into the same file. Data collected during these surveys will be used to answer questions relating to population trends and salmonid distribution in coastal watersheds.

All salmonids are identified to species and age class (YOY or 1+) and counted. An appropriate (see above) sub-sample should be measured (fork length) to the nearest mm, and weighed to the nearest 0.01 g (until 2004 fish were measured to the 0.1 g) using an electronic scale. The 1+ category includes all fish older than one year (i.e., we do not attempt to differentiate 1+, 2+, etc.). In general, steelhead >100 mm fork length are considered 1+ and those steelhead <100 mm are considered YOY. This size break may be adjusted up or down if there is an obvious gap in the distribution of observed lengths.

After processing each fish, place it in an aerated recovery bucket, again keeping larger sculpin in separate buckets to avoid predation on smaller fish. The recovery bucket should be a different color (preferably blue or other dark color) or located away from the holding buckets to avoid confusing fish that have and have not been processed. Monitor the recovery bucket to insure sedated fish recover fully before being released.

With enough people, one group can process fish while the other group continues electrofishing in the next sample pool. Once the electrofishing pass on a habitat unit have been completed and all captured fish have been processed and allowed to recover, the nets can be removed and the fish released back into the unit from which they were captured.

Collecting Scale and Tissue Samples

For any juvenile salmonid mortality, scales and/or tissue samples will be collected in accordance with current permit requirements. Refer to SOP 6 for sample collection, handling, and permitting details.

Literature Cited

Carlisle, S., M. Reichmuth, E. Brown, and S. C. Del Real. 2009. Long-term coho salmon and steelhead trout monitoring in coastal Marin County 2007: annual monitoring progress report. Natural Resource Technical Report NPS/SFAN/NRTR—2009/269. National Park Service, Fort Collins, Colorado.

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SOP 4. Spring Smolt Trapping

Version 3.6

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	Jan. 2007	Marcus Koenen	Added revision log, removed sampling site description, focused on field methods.	Clarification and remove redundancy	3.1
3.1	Feb. 2007	Michael Reichmuth	Added revisions to reflect current monitoring	Changes in sampling	3.2MR
3.2MR	May 2008	Sarah Carlisle	Updated datasheets and field protocols, continued changes as recommended by MR		3.3
3.3	May 2008	Sarah Carlisle	Linked data collection with project questions		3.31
3.31	July 2008	Michael Reichmuth	Review and make edits	clarification	3.4
3.4	August 2008	Brannon Ketcham	Review and edit	Clarification	3.5
3.5	October 2008	Dawn Adams	Formatting	For peer review	3.51
3.51	December 2008	Michael Reichmuth	Minor Edits	For Peer Review	3.52
3.52	November 2009	Michael Reichmuth	Added Lit Cited	Peer Review Response	3.53
3.53	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	3.6

Tables

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Overview

This SOP details the field methods used to determine long-term trends in abundance and condition of juvenile coho salmon, monitoring objective 2. Downstream migrant traps are typically constructed in late March and removed in late May. The trapping period is consistent with the seasonal outmigration of coho smolt. Once constructed, downstream migrant traps are checked and maintained daily. All juvenile coho are counted and a subset are measured and weighed to obtain a measure of fish condition.

Study Area

Trap sites located at the mouths of Olema, Redwood, and Pine Gulch Creeks. Refer to SOP 9 for specific locations of sampling sites.

Sample Design

The sample design is described in the protocol narrative.

Field Methods

Field Preparations

Once the winter spawning season is over, staff should begin preparations for the smolt trap operations. The field crew should ensure that all equipment is restocked and operable in the two weeks prior to trap installation. The fish program has smolt trap monitoring equipment stored in the water resources garage at Point Reyes National Seashore (PORE). The trap hardware, including pipes, screen and live boxes are stored in a barn at the Pacific Coast Learning Center. Sand bags to hold stream gravel, erosion cloth to assist in impounding water, t-posts, and a post-pounder will also be necessary for the installation. A list of supplies by storage location is given in tables SOP 4.1–2.

Table SOP 4.1. Fyke/pipe trap set-up supply list in Hagmaier barn storage.

Number Needed	Item
2 per site	trap box (make sure each has a rectangular divider screen, thick plywood piece with 6" round hole, and a plywood piece over opening at each end (1 solid and 1 with 6" round hole and rubber gasket)
1-3 20' sections per site	white 6" PVC pipes (also take some of the shorter sections)
30 per site	t-posts of various length and gage (it doesn't matter if the flat piece has fallen off the end, but they should be straight)
40' per site	wire mesh hardware cloth (round 40' per site, maybe more for Olema Creek; can take used pieces if they are in good shape & not too cut up, otherwise take one of the new rolls to each site)
50 per site	white sand bags
40-50' per site	black erosion cloth

Equipment Set Up

As sites are known, equipment should be transported and staged in mid-March. Traps should be set up by mid- to late March. Trap installation is weather dependent. Installation takes approximately one or two days per site.

Table SOP 4.2. Fyke/pipe trap set-up supply list in RM garage or basement (PORE).

Number	Item
Many	various sizes of plastic zip ties
Pair per worker	gloves
	shovels, Pulaskis, McLeods
	tin snips for cutting hardware cloth
1 per site	post pounders
	baling wire and small wire cutters (yellow tool box)
3-5	traffic cone or small bucket
	plug pipe during setup and processing
1	4' x 5' x 20' fyke net

Fyke/Pipe Trap Construction

The fyke/pipe trap on the mainstem of Olema, Pine Gulch, and Redwood Creeks are based on a design used by CDFG on the Noyo River (Gallagher 2000; Barrineau and Gallagher 2001). A 4' × 5' × 20' fyke net is supported by t-posts with a fence line extending from each t-post to direct fish into the mouth of the fyke net. The trap fence is constructed of 4-ft-wide, ½-in mesh hardware cloth, fence posts, rocks, and sand bags that span the width of the stream in a downstream pointing V. T-posts are installed to secure the fyke net fitting at the apex of the V, along the fence line at 2-ft intervals. Near the edge of the stream where water is shallower, the t-post spacing may be wider. The hardware cloth should be placed against the upstream side of the t-posts, with the bottom 8-12 in buried upstream as a footer into the substrate to prevent water from scouring under the weir. Line the downstream side of the weir with sandbags to prevent scour. Erosion cloth should be spread over the screen and extending upstream to prevent piping of flow under the screen. The erosion cloth and wire-mesh screen should be anchored with a few sandbags filled with stream gravel. Stream gravel should also be spread over the erosion cloth and screen area to make it appear as a natural stream bottom. The water should pool at the fyke net mouth, concentrating flow through the pipe. A small gap is left between the fence line and the stream bank on one side to allow steelhead migrating upstream to pass.

The throat of the fyke net is attached to a series of pipes, which is attached to a plywood trap box. The pipe consists of 6-in-diameter PVC in 20-ft sections. Schedule 80 pipe is light enough for two people to carry a section. Once the structure is in place, adjust the live box up or down to moderate the flow into the box. Flow should be sufficient to carry fish into the box, but not so much that fish are entrained by excessive current within the trap box. A screen should be placed near the rear of the live box to allow an area of refugia for smaller fish from larger salmonids and sculpin. The trap box should remain closed when not attended, and secured with a padlock if in an area with any public access. A traffic cone or small bucket is used to plug the upstream end of the pipe at the weir and reduce flow into the box when it is being checked.

Debris screens are placed upstream of the fyke net mouth to prevent clogging of the fyke net, pipe, and live box by excessive debris accumulation. Debris screens are constructed using two t-

posts with hardware cloth secured on the upstream side. The hardware cloth should only extend a few inches below the water surface so only debris floating on top of the water is captured. Lowering the debris screens too far could alter the direction of flow going into the trap.

In addition to setting up the trap, a hobo temperature logger is set up to measure stream temperature. The temperature logger is set to collect data at 15-minute intervals and remains in the box through the trapping season.

Upstream Migration Bypass

A small section of the fencing across the channel is left open to allow for continued upstream access to adult Pacific lamprey and salmonids, including adult steelhead. The goal of this bypass is to have good flow leading up to the gap from the downstream perspective. Upstream it is important to place a sandbag that minimizes flow and essentially masks the area from fish moving from upstream to downstream. The bypass should be located far enough away from the fyke net mouth that it does not draw too many fish out this open way.

Sampling Schedule

Outmigration of coho smolts in central California typically begins in mid-March and peaks in mid-May (Shapovalov and Taft 1954). In Lagunitas Creek (Marin County), results from smolt trapping from 1983 to 1985 indicated that coho emigration begins in early April and ends in late June (Bratovich and Kelley 1988). Steelhead emigration generally begins in early March and ends by June (Bratovich and Kelley 1988). In SFAN trapping experience, outmigration has been observed primarily in April and May, with the peak occurring in late April to early May. Traps should be installed in mid-March when stream conditions allow for trap construction and no major storm events are forecast. Trap operations generally end in late May to early June after peak outmigration has occurred and coho smolt captures have diminished to only a few smolts per week.

Sampling Frequency

Traps are checked daily during the smolt trapping season. Traps are checked more frequently if adult steelhead are observed in or near the trap, or when storm events are predicted. Spring rainfall conditions are highly variable. Because of the downstream location of the traps, significant fluctuations in flow can effect the operation and efficiency of the trap. Olema Creek, Pine Gulch Creek and Redwood Creek are highly responsive, with peak runoff typically occurring 2-4 hours after peak rainfall. To avoid potential or excess mortality, in anticipation of storm events, traps are opened to allow flow through, rather than subjecting the trapped fish to unknown flow conditions within the box.

During storm events when stream flow increases, the trap should be checked more frequently than once per day and, if necessary, the fyke net should be unzipped and the live box should be opened to relieve pressure and prevent the trap from blowing out. Opening the trap during storm events will reduce the overall trap efficiency but helps ensure the operation may be restarted quickly following the elevated storm flow. In general the trap should only be opened when either fish mortalities are likely to occur due to increased water velocities within the trap or if loss of equipment may occur due to high flows and debris accumulation.

Operation of Fyke/Pipe-Style Traps

Daily trap operation will involve one or two people. Table SOP 4.3 lists supplies needed for checking the traps. Upon arriving at the trap, the field crew should check trap condition and ensure that all parts are working appropriately, particularly flow into the trap box. Fill out a data sheet (Appendix I) with site information, date, time, and water temperature. Check inside the trap box to determine approximate number of fish, and clean debris from inside of screen if necessary. Remove fish from trap box using appropriate nets and place them in holding buckets containing fresh stream water for processing. In general, sculpin should be placed in a separate bucket from age 1+ salmonids and salmonid fry.

Table SOP 4.3. Pipe trap monitoring supplies.

Number Needed	Item
1	short handled large square green net
1	silver handled landing net
2-3	small green aquarium dip nets 2 or 3 sizes
1	data sheets, clipboard, and pencils
5	5-gallon buckets (one or two dark in color)
4-5	aerators with tubes, air stones, and extra batteries
Many	alka seltzer in Ziploc bag
1	NovAqua water conditioner and fish protectant
Many	coin envelopes and filter paper in Ziploc bag
1	gray toolbox with small scissors etc.
1	yellow tool box for trap repairs
1	plywood scale box w/ digital scale in black plastic box, with extra AA batteries
1	fish rulers
1	temp logger (to be stationed in trap)
1	Photonic tag injector in Pelican case
1	Photonic marking solution in small cooler

Processing Fish

The processing is most efficient when there is one person to weigh and measure fish and another to record the information on data sheets.

Each fish that is to be weighed, measured, and/or marked should be sedated using carbon dioxide to facilitate handling and minimize stress to the fish. Fill a clean 5-gallon bucket (white color works best) with a couple inches of fresh stream water and add a half of an Alka-Seltzer® tablet (use only plain, unmedicated). The Alka-Seltzer® adds carbon dioxide to the water, effectively slowing the fish down and sedating them. Place no more than two fish at a time into the treated water and wait until they are adequately sedated. This is typically when the fish are sluggish enough for easy handling but before they begin to turn over. If fish do turn over they should be processed and/or returned to an aerated holding bucket immediately. More Alka-Seltzer® can be added if necessary, but be conservative (no more than a quarter tablet at a time) and monitor fish

closely if the dosage is increased. It may be necessary to change the water periodically, particularly on hot days and when processing large numbers of fish.

Salmonids are identified to species and life stage (fry, parr, presmolt, smolt, resident, or adult), measured (fork length is measured nose to fork of caudal fin) to the nearest mm, and weighed to the nearest 0.01 g using an electronic scale. Non-salmonid fish and other aquatic species should also be identified, aged if possible, measured, and weighed. Age 1+ steelhead and coho are separated into the following morphological categories: smolt (faint or absent parr marks, silver body, deciduous scales, black fin margins), parr (smaller size, parr marks present), and pre-smolt (intermediate characteristics; Bratovich and Kelley 1988; Nelson 1994). Occasional runback steelhead spawners are trapped on their way back out to sea; they are generally >40-cm long and are classified as adults. Steelhead which are smolt-sized or larger with no smolt characteristics, and which exhibit rainbow trout characteristics are classified as residents. Any mortality or injury is recorded, as well as the probable cause of death. In general, coho measuring more than 70 mm in the spring are assumed to be one year old and potential smolts. Smolts undergo physical change in their body, becoming silvery, and developing black tips on their caudal fin (this is true of both coho and steelhead). Smolts also have looser scales, and are losing their parr marks and spots. While descriptions can be made, the judgment between smolt and presmolt is truly based on appearance of the fish and determination in the field. At the downstream monitoring locations, it is much easier identify smolt because the fish have fully transitioned. Life stage classification by length may be delineated in the future by using length frequency histograms. The corresponding age classes will be verified by scale samples and used to determine age-length relationships.

Mark/Recapture Techniques

Mark/recapture methods will be used to estimate trap efficiency and smolt population size, and determine biotic information on outmigrating smolts. Daily, no more than 30 smolts (or 50% of the catch that day) of each species (coho and steelhead) will be anesthetized with carbon dioxide, weighed, measured and marked with small but identifiable fin clips or dye on fins using a needleless injector. Marked smolts will be released immediately in an open trap box at a predetermined site no more than 200 m above the trap site. Mark combinations will be alternated weekly. All adults, parr, fry, and recaptured smolts will be released immediately after measurement in low velocity areas below the trap.

Studies using similar methods have demonstrated little marking mortality and no fish will be held for retention or survival tests (Thedinga et al. 1994). A study using the same methodology on five northwestern California streams revealed that trap mortality was less than 1% for smolts and less than 3% for fry (Manning 2001). The highest mortality rates were associated with high flow. Trap operations will be suspended if either smolt or fry mortality exceeds 5% during a one-week period.

Processing 1+-Aged Fish

A random sub-sample of steelhead parr, coho and steelhead presmolts, coho and steelhead smolts, and steelhead residents are measured and weighed each day for development of biotic condition information. This sub-sample is normally 10 of each species; however, all smolts anesthetized for mark/recapture purposes, should also be weighed and measured. Sub-samples are obtained by taking blind scoops out of the holding bucket with a small aquarium dip net. All

steelhead parr, coho and steelhead presmolts, coho and steelhead smolts, and steelhead residents are identified and counted.

Any adult steelhead encountered in the trap should be released downstream immediately. Estimate the size of the adult, but do not attempt to weigh or measure it. Use a landing net if it is available to transfer the adult steelhead from the live box to the stream.

Processing Young of Year Salmonids

After the 1+ salmonids and other larger fish have been processed and released, carefully net out all salmonid fry from the trap box. Use caution with the larger nets to avoid crushing fry with the rim of the net. All fry are identified to species and counted. Daily, random sub-samples of 10 coho fry and 10 steelhead fry are measured (fork length to the nearest mm). Sub-samples are obtained by taking blind scoops out of the holding bucket with a small aquarium dip net.

Although identification of salmonid fry can be difficult, it is important that the species (coho and steelhead) are differentiated. As long as both species are present, it is rather simple to see the distinct differences. Problems may arise when only one or the other is present. The best reference for field identification between species is the “Field Identification of Coastal Juvenile Salmonids” (Pollard et al 1997). This reference includes color photographs and descriptions of each species at the 40 to 50 mm size. In general, the coho at all sizes have a pinker hue, while steelhead have an orange or yellow hue. In addition, the dorsal and anal fins of coho are longer, sickle-shaped, and more pointed than those of steelhead. For the few individuals that can’t be identified by overall appearance or shape of fins, counting the anal fin rays can differentiate between coho and steelhead fry.

Processing Other Species

Although not a focal effort of this monitoring program, all other species encountered during this trapping effort are documented. Daily, random sub-samples of 10 individuals of each species are measured and fish over 40 mm are weighed. Sub-samples are obtained by taking blind scoops out of the holding bucket with a small aquarium dip net. All others should be counted and released downstream.

Fish Recovery and Release

After processing each fish, it is placed in an aerated recovery bucket, keeping larger sculpin in separate buckets to avoid predation on smaller fish. The recovery bucket should be a different color (preferably blue or other dark color) or located away from the holding buckets to avoid mixing releasable fish with those that have not been processed. The dark-colored bucket allows the fish to darken their color, which is beneficial when they are released back to the pools. Fish in the recovery bucket should be monitored to insure sedated fish recover fully before being released.

Fish Mortality

In case of fish mortality during trapping or processing, scales and/or tissue samples will be collected in concurrence with current permit requirements (refer to SOP 6).

End-of-Season Procedures

Trap operations close in early June, which corresponds with reduced stream flow and very low numbers of fish passing through the trap. The fyke net, live box, pipe, and fencing should be completely removed and returned to storage. The sandbags full of gravel should be removed from the stream channel and emptied. The sandbags may last a second season, but do decay with each use.

Data Management

The following data management procedures should be followed. Record and verify data values, both observed and measured. Field datasheets should be completed, and the collected data entered into electronic databases. Crew members should schedule and perform regular data transfer and backup, as well as conduct regular data verification and correction. Finally, crew members should ensure that field forms, field notebooks, and other hardcopy records are secure, readily available for viewing and reproduction upon request or at the end of the field season. For detailed data management procedures refer to SOP 8. For data analysis and reporting requirements refer to SOP 10.

Logistics

Annual Workload and Field Schedule

The spring outmigrant smolt traps need to be checked on a daily basis (including weekends) over a two- to three-month period between March and June. Checking traps at the three existing sites takes six hours. Field staff should also allocate five hours per week for data management.

Staffing Requirements

It is expected that this monitoring can be accomplished with two field staff to check all downstream traps on a daily basis. Initial trap construction and removing traps at the end of the season will require at least three field staff. Field staff should consist of one fisheries ecologist and one additional field crew member. Recruiting volunteers to assist with the trapping and processing has been done in the past and may continue into the future.

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SOP 5. Spawner Survey

Version 3.5

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	Jan. 2007	Marcus Koenen	Created this SOP to focus on Spawner Survey.	Reduce redundancy among protocols and SOP	3.2
3.2	Mar. 2007	Michael Reichmuth	Review SOP	Update protocol to current survey methods	3.2MR
3.2MR	May 2008	Sarah Carlisle	Updated datasheets and field protocols		3.3
3.3	May 2008	Erin Brown	Mike's suggested changes	Sections: Overview, carcasses, data management, maps	3.3
3.3	August 2008	Michael Reichmuth, Marcus Koenen	Reviewed and revised	Clarification	3.4
3.4	September 2008	Dawn Adams	Formatting	Peer review	3.41
3.41	December 2008	Michael Reichmuth	Minor Edits	For peer review	3.42
3.42	November 2009	Michael Reichmuth	Added Lit Cited	Peer review response	3.43
3.43	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	3.5

Figures and Tables

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Overview

This standard operating procedure (SOP) details the methods used to determine long-term trends in distribution and abundance, size (length and weight) of spawning coho salmon, monitoring objective 1. Typically, surveys are conducted between late November and early February. Timing of surveys, however, is highly dependent upon the precipitation accumulations during the season. Surveys are conducted approximately every week, although storms and high stream flows often dictate less frequent surveys. All salmonid redds, live fish, and carcasses are counted. Although the surveys are focused on coho spawning, some information on steelhead spawning is also gathered due to the overlap in spawning periods for both species.

Study Area

Spawner surveys are conducted in select High Priority streams and associated tributaries in Marin County which currently contain populations of both coho salmon and steelhead including Olema, Pine Gulch, and Redwood Creek (table SOP 5.1; for detailed directions and maps, see SOP 9. Sampling Site Descriptions). One reach is also sampled on Cheda Creek. Reaches are typically 2–4 km sections of streams.

Table SOP 5.1. Location of 14 spawner survey reaches in San Francisco Bay Area Network parks.

Creek	Number of Spawner Reaches	Start/Stop Points (for details see SOP 9)
Olema Creek	7	1 km above the confluence with Lagunitas Creek to the Highway 1 culvert at milepost 19.94
Pine Gulch Creek	3	Olema-Bolinas Road Bridge to 2 km above the Texeira Ranch
Redwood Creek	3	Pacific Way Bridge to a small waterfall within Mt Tamalpais state park just upstream of monument tag #74
Cheda Creek	1	A total of about 1.2 km is typically surveyed, including a 0.8 km reach below the fish passage improvement and 0.4 km above.

Sample Design

The sample design is described in the protocol narrative. Sample sites are described in SOP 9.

Field Methods

Field Season Preparations and Equipment Set Up

Prior to the rainy season, staff should check all access points for spawner survey reaches, and walk reaches to insure that aluminum monument markers are present. Where necessary, markers should be replaced, and the monument log should be updated to reflect locations of each tag. The tags, stamps to mark the tags, and aluminum nails are contained within the fisheries program garage at Point Reyes National Seashore (PORE). All monument tags are spatially located with UTM coordinates. Replacement or relocation of any tag (e.g., a fallen tree) should include an update of the tag UTM coordinates. Tags are lost through a variety of means including fallen trees, animal gnawing, and even tree growth (we have observed alders with the last bit of the tag sticking out of the bark). Surveys to replace tags should be conducted annually prior to the spawner surveys, with UTM coordinated collected at the time of replacement.

Field staff should check waders, repairing the leaky ones, and make sure there is an adequate supply (at least 15) of wading rods marked to the nearest centimeter. These rods are used for measuring fish and visibility, as well as probing undercut banks and helping the surveyor balance on the uneven substrate.

Most importantly, spawner survey kits should be checked to insure that all supplies are included for the survey. These kits should also be refilled following each field survey event. Each kit should include equipment in table SOP 5.2.

Table SOP 5.2. Equipment list for spawner surveys.

Number Needed	Item
1	Clipboard and waterproof copies of the datasheet
1	Species identification cards
3	Pencils
1	List of monument tags
1	Polarized sun glasses*
1	Hole punch
1	Tweezers
1	Knife
1	Coin envelopes
1	Filter paper
20	Plastic bags
1	Biodegradable survey flagging
3	Sharpie permanent markers

*Recommended, although not included in most kits.

Timing of Field Surveys

As the rains begin, staff should ready themselves for the winter survey season. Normally the salmonid watersheds need 5–7 inches of rain within a 30 day period to initiate flows necessary for fish to swim upstream. Often spawner response is concentrated in one or two storm related flow or freshet events. In particular, Redwood Creek is cut off from ocean access by a sand bar. Fish cannot enter the system until flows are great enough to breach the bar. Typically the flows required to breach the sand bar on Redwood Creek, or allow fish to migrate up Olema or Pine Gulch Creeks, are described as the first flush (a water quality term indicating that the hydrologic network within the watershed is connected and flowing). Surveys should be initiated with the onset of rains to determine exactly which flow and when fish are able to access these smaller coastal watersheds. Based on female redd residency times watersheds should be surveyed weekly to accurately capture the timing of spawning (Burton et al. 2002; van den Berghe and Gross 1986). Because the surveys are confounded by environmental factors (stream discharge and turbidity) the surveys are often less frequent.

Conducting Field Spawner Surveys

Once program biologists determine survey dates, the staff will coordinate with local volunteers to assist surveys. For safety, teams of at least two people should be assigned to each survey reach. Each team is provided with a spawn survey kit, datasheets, clipboard, map, and list of monument tags within each reach.

Each team begins the survey from the downstream end of a predetermined reach and walk upstream. Water clarity should be measured at the start of each survey using the 2-m survey rod. Water clarity should be measured by lowering the survey rod into the nearest pool until the end of the survey rod is barely visible. For the purpose of this project water clarity is defined as the distance in centimeters from the water surface to the end of the survey rod and gives us an estimate of our survey efficiency when visibility is limited.

To conduct survey, team members walk in the channel and on the banks, avoiding pool tailouts and redds. Inspect the stream for live fish and carcasses by probing banks, woody debris, and pools with a 2-m survey rod (see section on equipment). It is important to remain observant and use your senses while conducting the survey. Look upstream ahead of you, fish may seek cover when observers are as much as 30 m downstream. Females splash when constructing redds and fish can be heard migrating through riffles. Carcasses often emit a pungent odor and may have been carried onto the stream bank by a scavenger. The techniques for collecting live fish, carcass, and redd data are described below. All information should be entered into the Spawner Survey and Redd Survey Datasheets (Appendixes J and K).

Recording Location

To monitor the distribution of spawning within a watershed, the location of all live fish, carcasses, and redds must be recorded. These locations are recorded in reference to the 100 m stream section markers that are located along the mainstem of Olema, Pine Gulch, Redwood, and Cheda Creeks (see SOP 9).

When recording spawner survey information use the last two or three digits of the code (the hundreds of meters upstream). Record location of an observation as these last two or three digits, on the **closest downstream** monument tag (see SOP 9), plus the estimated distance upstream. For example, if a redd is found 40 m above tag OL 01 48 you would note the location as 48 + 40. Each row on the datasheet should contain the location of a single observation (either a live fish, carcass, or redd). If there are multiple observations of live fish or carcasses at a single location, repeat the location information on each new row. All redd observations should receive a unique location in order to eliminate the possibility of duplicate site locations.

If you cannot locate a tag within 100 m, please note your approximate location in the comments section of the datasheet. If large portions of a survey reach have missing tags, clearly note the missing tag numbers and reference the live fish, carcass, and redd observations to permanent landmarks such as bridges and buildings. Spawner kits for each survey reach should contain a map and a list of tag numbers and locations for that reach.

Species and Sex Identification

Identifying the species and sex of all observations is necessary to accurately determine the total number of returning coho and steelhead adults as well as the sex ratio of returning salmonid

adults. Place a check mark in one of the three categories in the species column of the datasheet. All observers will be trained in species identification. However, it is often difficult to identify spawning fish in the field. Use the ? option if you are unable to identify the species. A comprehensive spawning fish identification key is provided in each spawner survey kit. This summary of coho and steelhead ID characteristics should be carried in the field by all survey teams.

Most coho salmon are three years old at spawning. However, a variable proportion of precocious two year old males also return to spawn. These smaller males are commonly referred to as “jacks”. Age can not be accurately determined without carefully analyzing annual growth rings on scales. However, most jacks are less than 50 cm (20 in) long and are much smaller than the three-year olds.

Live Fish

Note the sex and approximate length to the nearest 5 cm of all live fish. If you cannot positively identify a fish’s sex, use the ? option. Surveyors should make every effort not to disturb spawning fish. Actively spawning fish can be observed safely from a vantage point on the bank.

Carcasses

For all intact carcasses, note the sex and measure the fork length (figure SOP 5.1) (tip of the jaw to fork of the tail) in centimeters using a graduated survey rod. To confirm the gender of the carcass, slice open the body cavity beginning at the anus and inspect the gonads. Note the approximate number of eggs retained by the females. In the comments section of the datasheet, note the general condition of the carcass (e.g., fresh intact or skeleton). For partial carcasses or carcass fragments do your best to ID species and sex based on whatever features are present (e.g., tail, anal fin, color of gums). Record estimated lengths of partial carcasses in the comments.

In addition to counting and noting the location of carcasses, we are also interested in collecting tissue samples and scales for genetic and age analysis. The removal of tissue will also serve as a mark to prevent double counting of carcasses in subsequent surveys. The genetic analyses will be performed by researchers at the National Marine Fisheries Service Genetics Laboratory. Inspect the carcass for holes punched in the operculum (figure SOP 5.1) or any hatchery marks such as adipose and maxillary clips. If the fish is already marked, note the number of punches from one side of the fish in the datasheet column labeled **Recap Code**. If the fish has any hatchery marks, cut off the upper portion of the head from the tip of the snout to behind the eye and store it in a zip lock bag for future analysis.

Redd Identification

Program staff will train observers in redd identification. After storms, areas of excavated gravel are often difficult to distinguish from the surrounding riffle and females may construct numerous “false” redds before choosing a suitable spawning site. Use the ? option in the datasheet column labeled **Def** (definite) / ? if you are not certain that a feature is actually a redd. All definite redds should have a distinct pit and tailspill feature . If possible identify the species that constructed the redd. This is not always possible since coho and steelhead spawning periods overlap and redd construction may look similar. Use the survey rod to measure the total length (top of pit to end of tail spill) and average width in meters (figure SOP 5.2). Measure new redds only if redd

excavation by spawning adults is completed. Re-measure new redds observed on the previous spawning survey to ensure an accurate post redd excavation measurement was recorded. Do not step on redds. The eggs are typically buried beneath the tail spill. Each redd should be marked with plastic or biodegradable survey flagging to prevent double counting and trampling in subsequent surveys. Write the date, location, and species on a piece of flagging and tie it to vegetation (a few feet above the water) near the redd. If there are numerous redds at a particular location, assign a location and flag for each redd observed. If a fish is observed holding on a redd location, record the species and number of fish holding on the redd. A print out of the number of redds and redd locations from the previous week will be carried on each survey to decrease double counting of redds and to determine the number of new redds in areas of superimposition. If there is flagging at the location from a previous survey conducted this season, hang a new flag only if there has been recent excavation. Please make notes in the comment section if numerous redds are observed at the same location.

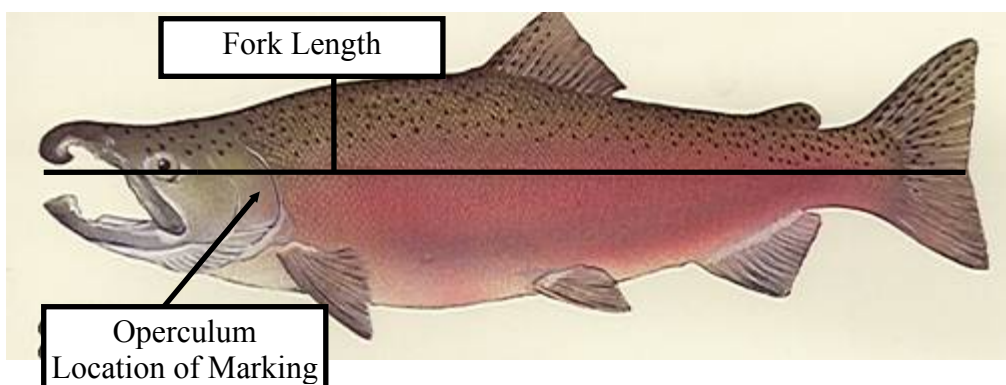


Figure SOP 5.1. Illustration of a male adult coho salmon showing fork length and the location of the operculum (adapted from Lusch 1985).

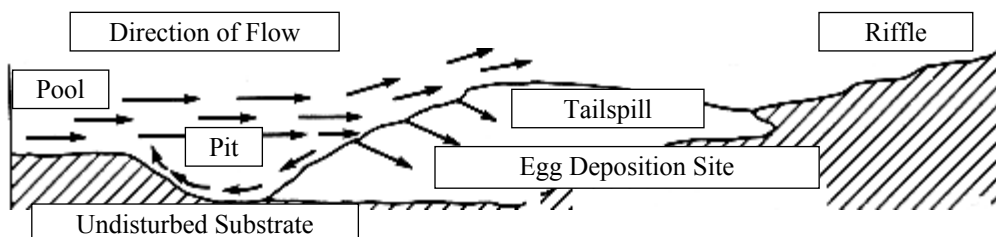


Figure SOP 5.2. Cross section of a redd (from Sandercock 1991).

Post-Collection Procedures

Field sheets should be collected by program staff at the end of each survey. Because these sheets are often wet, staff should insure that the information on the sheet is legible. Surveyors are requested to put contact information on the sheet, so any questions can be followed up quickly.

End of Season Procedures

Following each survey, and at the end of the season, field staff should keep a table showing results of each watershed survey. Typical reporting should summarize the peak number of fish counted during surveys. Because the same fish may be counted in multiple surveys, results are generally not additive and addition of totals between surveys should not be included as part of this preliminary reporting process. If possible, staff should designate a species for all redds in which the species field was not defined. This can be determined using both the redd size information and the date in which the redd was first observed. In general steelhead redds are smaller than coho redds and most of the steelhead spawning occurs during the end of the coho spawning period.

Field kits should be cleaned and stored. An inventory of survey supplies should be completed for future reorder needs.

Data Management

The following data management procedures should be followed. Record and verify data values, both observed and measured. Field datasheets should be completed, and the collected data entered into electronic databases. Crew members should schedule and perform regular data transfer and backup, as well as conduct regular data verification and correction. Finally, crew members should ensure that field forms, field notebooks, and other hardcopy records are secure, readily available for viewing and reproduction upon request or at the end of the field season. See also SOP 8 (Data Management). Refer to SOP 10 for analysis and reporting of results.

Logistics

Annual Workload and Field Schedule

Spawner survey times are variable throughout the winter months with surveys performed between winter storm events. In general surveys are performed on a weekly basis starting with the first major rain event in late November or early December and ending in early February. At least one survey should be performed on each high priority watershed between storm events which often requires performing surveys on weekends and holidays. Surveys typically require two to four hours to complete and field staff should allocate four hours per week for data management.

Staffing Requirements

It is expected that this monitoring can be accomplished with four to eight field staff depending on the length of stream to be surveyed. Field crews must consist of at least one fisheries biologist, two additional field crew members, and at least three volunteers. Recruiting volunteers to assist with spawner surveys is essential to ensure proper coverage and safety. Volunteers should be scheduled for field surveys at least one to two days prior to conducting each survey.

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SOP 6. Permit Requirements

Version 2.1

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.0	Mar. 2007	Michael Reichmuth	Review SOP	Make sure the protocol reflects current methodology	1.1
1.1	May 2008	Erin Brown	Table of content, overview, permitting requirements and reporting, added scale and tissue stuff, and references	Work list changes	1.2
1.2	August 2008	Brannon Ketcham	Edit and review	Updates and clarification	2.0
2.0	Sept 2008	Dawn Adams	Formatting	Peer review	2.01
2.01	December 2008	Michael Reichmuth	Minor edits	For peer review	2.02
2.02	November 2009	Micheal Reichmuth	Added Lit Cited	Peer review response	2.03
2.03	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	2.1

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Figure SOP 6.2. Illustration of male coho salmon showing body locations for scale and tissue sample collection.....	SOP 6.7
Figure SOP 6.3. Example of a tissue sample envelope and field descriptions.	SOP 6.7

Overview

This SOP describes the permitting process that is required in order for the NPS to conduct coho salmon and steelhead trout monitoring within the SFAN network.

The National Park Service (NPS) is authorized by the National Marine Fisheries Service (NMFS) under Section 10 of the Endangered Species Act (ESA; permit #1046 modification #2) to take adult and juvenile federally endangered coho salmon (*Oncorhynchus kisutch*), threatened steelhead (*O. mykiss*), and Chinook salmon (*O. tshawytscha*) associated with fish population and habitat studies in drainages on, and proximate to, NPS lands in Marin County, California within the central California coast ESU/DPS. Types of studies for which federal ESA listed fish are authorized to be taken include: 1) salmonid smolt outmigration monitoring, 2) juvenile salmonid diet composition, 3) adult salmonid spawner monitoring, 4) summer/fall juvenile salmonid distribution, population abundance, and habitat monitoring 5) juvenile salmonid winter habitat utilization, 6) adult salmonid spawner escapement monitoring, and 7) juvenile salmonid rescue and relocation.

All principal investigators are required to obtain a California Department of Fish and Game (CDFG) scientific collecting permit (SCP) 2081(b), prior to sampling for coho salmon, steelhead, California red-legged frog (*Rana aurora draytonii*), California freshwater shrimp (*Syncaris pacifica*), and tidewater goby (*Eucyclogobius newberryi*). Although California red-legged frogs, California freshwater shrimp, and tidewater gobies are not the focus of the I&M program monitoring efforts, this permit is necessary for the incidental catch of these organisms during coho and steelhead monitoring. The CDFG permit would apply to NPS research and monitoring activities in drainages proximate to NPS lands in Marin County, San Francisco County, San Benito County, Contra Costa County, and Monterey County, California. Stream segments on non-federal lands in Marin County on which NPS research and monitoring activities may occur include:

- Devil's Gulch (tributary to Lagunitas Creek) within Samuel P. Taylor State Park
- Redwood Creek and tributaries within Mt. Tamalpais State Park
- Pine Gulch and tributaries on private and Marin County Open Space District (MCOSD) land
- Easkoot Creek and other Bolinas Lagoon tributaries on private and local government lands
- Tomales Bay tributaries on state, local government, and private lands.

In addition, the NPS is authorized under U.S. Fish and Wildlife Service (USFWS) permit # PRT-702631 (subpermit #GGNRA-2) to take federally listed California red-legged frogs, California freshwater shrimp, and tidewater gobies in conjunction with salmonid presence/absence surveys and population studies for the purpose of enhancing the salmonid survival. All principal investigators must be approved by USFWS prior to conducting salmonid surveys.

Permit Types

Endangered Species Act Section 10 Permit

NMFS has authorized the NPS to take federally endangered coho salmon, threatened steelhead, and Chinook salmon associated with fish population and habitat studies. The current permit is valid from November 30, 2006 through February 29, 2012. It is suggested that researchers apply for the Section 10 permit one year in advance of proposed activities (table SOP 6.1).

The NPS is only authorized to take a certain number of coho, steelhead and Chinook salmon, at each life stage, for each of its monitoring programs. For the authorized amounts of annual take of ESA-listed salmonids please refer the Section 10 permit. A copy of the permit will be located in the glove box of the fisheries field vehicle at all times, as well as in the file cabinet in fisheries division of the Natural Resources office in Point Reyes National Seashore (PORE). All new principal investigators must submit a written request to NMFS prior to conducting monitoring activities.

CDFG Scientific Collecting Permit

The SCP authorized by the CDFG is required for all primary investigators. A SCP application must be obtained by each principal investigator prior to conducting monitoring activities. The permit is valid for two years of study and must be renewed on a biannual basis (table SOP 6.1). Applications for the permit should be submitted to the CDFG at least eight months prior to the expiration of the most current permit as processing can take up to this amount of time. The most current permit is valid through the end of 2012. Copies of the permits will be located in the fisheries field vehicle at all times as well as in the fisheries office.

U.S. Fish and Wildlife Service Section 10 Permit

Due to the potential for incidental catch of California red-legged frogs, California freshwater shrimp, and tidewater gobies, which can occur during regular monitoring efforts, the NPS is required to possess a valid Section 10 permit issued by the USFWS under the ESA to handle these organisms. Individuals on the project team must meet training requirements to be added to the permit. A resume including all pertinent training and work experience must be submitted to the USFWS for each principal investigator prior to conducting monitoring activities. The USFWS Section 10 permit is managed by the GOGA Aquatic Ecologist. The current permit expires in May of 2012.

Table SOP 6.1. Permit requirements.

Permit	Who the Permit Covers	Application Time Frame	Reporting Cycle
NMFS Section 10 Permit 1046	Principal Investigator	12 months in advance, valid until February 24, 2012	Annually by May 1
CDFG scientific collection permit 2081(b)	Individuals	8 months in advance, permits issued for 2 years	Bi-annually, at the end of permitting cycle
USFWS Section 10 Permit	Principal Investigator	90 days in advance, permit is valid until May 12, 2012	Annually by January 31

Permit Reporting Requirements

NMFS Section 10

The NMFS requires annual ESA permit reports and a final report, which is to be submitted at the end of each Section 10 permitting period. All reports are conducted online and due to the NMFS on May 1.

CDFG Scientific Collection

The CDFG requires that a Report of Specimens Collected or Salvaged (RSCS) be submitted within 30 days of the expiration of the SCP permit. Permits are valid for two years; therefore, reports will be submitted on a bi-annual basis. Each individual to whom a SCP is issued must provide their own RSCS. Even if the applicant is not renewing a permit, he is required to submit a final report within 30 days of the expiration of the permit.

For detailed directions on how to complete an RSCS refer to the CDFG website:

www.dfg.ca.gov/licensing/pdf/SC_REPT.xls. The CDFG also requires records of field observations of threatened, endangered, or special concern species to be submitted to the Natural Diversity Data Base. The California Native Species Survey Form and instructions for completing it are posted on the CDFG website at www.dfg.ca.gov/whdab/html/animals.html.

USFWS Section 10

An annual report of activities shall be submitted to the Recovery Permit Coordinator at the Sacramento USFWS Office by January 31 of each year. The report should include (1) an introduction addressing the reasons and objectives for taking the species; (2) methodologies used for data collection and analysis; (3) a results section that summarizes the data collected on any federally listed species while conducting monitoring efforts under the permit; and (4) a conclusion that provides recommendations for the recovery of the species.

Collecting Scale and Tissue Samples

Scales and/or tissue samples will be collected from all juvenile salmonid mortalities and adult carcasses found during monitoring activities. Tissue collection will be conducted in a manner consistent with the guidelines of the NMFS Pacific Southwest Research Center, Genetics Laboratory.

Scale Samples

When sampled for scales, salmonids should be sedated using carbon dioxide (Alka-Seltzer) to facilitate handling and minimize stress to the fish. Using the open blade of a pair of surgical scissors, gently scrape “against the grain” to collect scales from the side of the fish, above the lateral line and slightly behind the dorsal fin (figure SOP 6.1). Collect three to six scales from each fish since some scales may be difficult to age due to false annuli, regeneration, and other anomalies (Collins 2003). Wipe scales off blade of scissors onto a piece of blotter and place in sample envelope. Avoid scraping off too much of the protective slime coating, and be careful not to take too many scales from one spot on the fish.

Fish should be allowed to recover in a recovery bucket containing a fish conditioner to ward off potential of infection associated with the scale sampling.

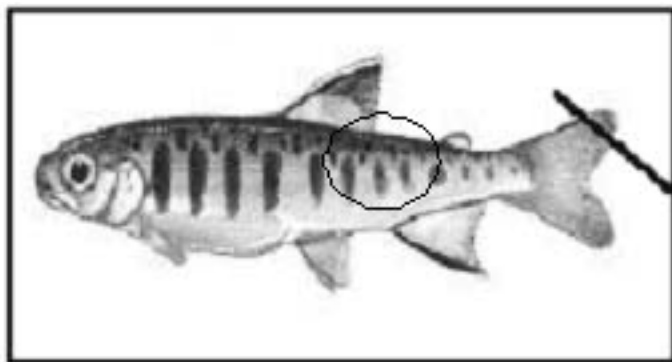


Figure SOP 6.1. Location of scale and tissue samples and size of fin clip required for a 90 mm fish; clipped material should be at least as big as illustrated above. A larger fish would have a smaller proportion of caudal fin clipped.

Juvenile Tissue Samples (from Draft NMFS Tissue Collection Protocol)

Fin clips are used for genetic analysis of fish. This work is conducted primarily through the NOAA-Fisheries Laboratory in Santa Cruz, California. Tissues have been used to develop the population genetics structure of salmonids in California. In particular, collection of tissue samples from coho salmon occurring in previously undocumented watersheds (Pine Gulch Creek) has been used to determine the expansion of source populations to new watersheds.

Tissue samples should be collected from the upper caudal fin of the fish. Scissors should be used to clip a small portion (approximately 1 cm²) of the upper caudal fin (figure SOP 6.1). Under most circumstances, tissue samples should not be collected from fish less than 90 mm fork length. Special circumstances, including juveniles documented in a new watershed, may necessitate sampling of smaller fry.

Place fin clip on blotter paper and place in envelope. Samples need to dry; sun drying in the field works best and can be done quickly. Fungus and bacteria become a problem if tissue samples are not adequately dried within 8 hours from time of collection.

Adult Tissue Samples

Tissue is removed from both opercula (gill covers) with a hole punch. The number of punches (1–4) corresponds to the survey number. The Project Leader will determine the number of punches prior to beginning field work. Record the number of punches in the “Mark Code” column of the data sheet. Use the tweezers to remove the punches and place all collected tissue in a folded piece of filter paper. Scale samples should be collected from all fresh fish (fish with both eyes clear) that have not been mauled by predators. Use the tweezers to remove 5 to 10 scales from the side of the fish between the lateral line and dorsal fin (figure SOP 6.2). Rinse the hole punch and tweezers in the stream before and after sampling each carcass to prevent cross contamination between samples. Because fungal growth degrades the quality of the samples, the samples should be thoroughly air-dried after the survey, preferably in the sun, and stored in a dessicator.

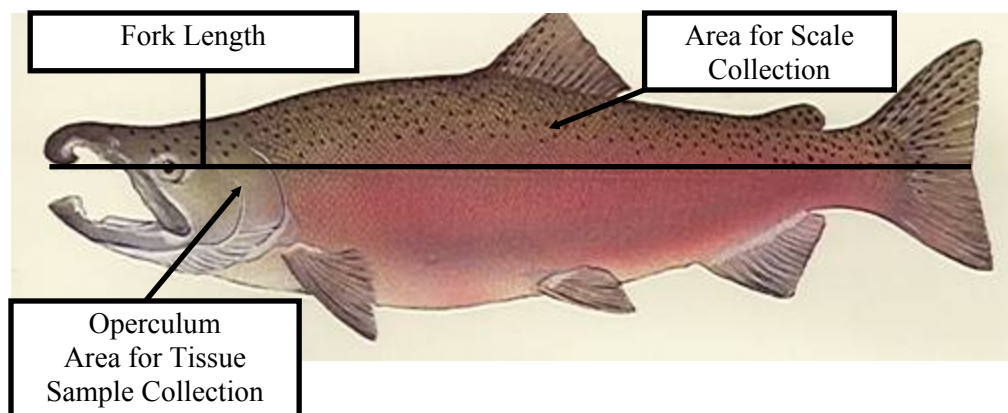


Figure SOP 6.2. Illustration of male coho salmon showing body locations for scale and tissue sample collection (adapted from Lusch 1985).

Sample Storage and Processing

For scale and tissue samples, rinse scissors thoroughly before and after each sample to prevent cross-contamination. Place each sample on a piece of blotter paper approximately 2 cm x 4 cm, folded over, so the sample is sandwiched between the two halves, and insert into a sample envelope. Scale and tissue samples from the same fish should be placed on separate pieces of blotter paper, but may be put into the same envelope. Figure SOP 6.3 is an example of the data form on the sample envelope and field descriptions.

ID	Spec	ID:	Location number for Spawner Surveys. Predetermined ID for all other surveys.
Stream	Leng	Stream:	Stream name or code
Reach	Wght	Reach:	Reach name/number, location description, or monument tag #
Date	Sex	Date:	Date (mm/dd/yy)
Coll	Note	Coll:	Collector's initials
		Spec:	Species/age code
		Leng:	Fork length in mm
		Wght:	Net weight to the nearest 0.1g
		Sex:	M/F for adult carcass samples (leave blank for juvenile salmonids)
		Note:	indicate type of sample (scales, tissue, or both) and note information about fish

Figure SOP 6.3. Example of a tissue sample envelope and field descriptions.

Upon returning from the field, all scale and tissue samples should be thoroughly air dried, preferably in the sun. After drying, samples can be stored in an airtight container containing desiccant. Samples should be left in their original field collection envelopes until further processing. If envelope replacement is necessary, make sure to copy all information onto the new envelope and double-check for transcription errors. Information from each envelope should be

entered into the fish database using the Scale/Tissue Form. Record a unique sample ID # on each sample envelope. An example of the sample ID format is OL-03-017: the first part is a two-digit letter code for the stream, the second part is a two-digit number code for the year, and the last part is a three-digit sequential number for that stream and year. The example is for the 17th sample from the Olema Creek watershed in 2003.

Tissue Sample Submittal to the NMFS Genetics Lab

Tissue samples will be divided in half. Half of the genetic materials will be sent to the NMFS Genetics Laboratory in Santa Cruz, California, and half retained and archived by the SFAN Fisheries program. Sample collection follows NMFS protocol and is performed as part of the Section 10 permit 1046.

Literature Cited

Collins, B. W., editor. 2003. Interim restoration effectiveness and validation monitoring protocols, California Coastal Salmonid Restoration Monitoring and Evaluation Program. California Department of Fish and Game, Fortuna, California.

SOP 7. Protocol Revision

Version 1.3

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	4 June 2008	Sarah Carlisle	Created SOP 7		1.0
1.0	July 2008	Sarah Carlisle, Marcus Koenen	Completed addressing reviewer comments		1.1
1.1	August 2008	Dawn Adams	Formatting	Peer review	1.11
1.11	December 2008	Michael Reichmuth	Minor Edits	For peer review	1.12
1.12	November 2009	Michael Reichmuth	Added and addressed reviewer comments	Peer Review Comments	1.2
1.2	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	1.3

Tables

	Page
Table SOP 7.1. Current SFAN Salmonid Monitoring Protocol documents.	SOP 7.4

Appendixes

	Page
Appendix SOP 7A: PWR Protocol Review Checklist.....	SOP 7.5
Appendix SOP 7B: Peer Review Comments to 2005/2006 Draft and Responses from Protocol Authors	SOP 7.9
Appendix SOP 7C: Peer Review Comments to 2009 Draft and Responses from Protocol Authors	SOP 7.26

Overview

This standard operating procedure (SOP) explains how to make changes to the Salmonid Monitoring Protocol and accompanying SOPs, and explains procedures for tracking these changes. San Francisco Bay Area Network (SFAN) or park staff members that edit the protocol narrative or any SOP need to follow this procedure to eliminate confusion in data collection and analysis methods. All SFAN aquatic resources staff should be familiar with this SOP in order to identify and use the most current methodologies.

This SOP also contains a table listing the most current version of the protocol narrative and each of the SOPs. This table will provide a single reference for ensuring that the most current documents are being used. Also included is a section containing comments from protocol review, responses to those comments and approvals.

Protocol Revision Procedures

1. The authors of the Salmonid Monitoring Protocol Narrative and accompanying SOPs have made every effort to incorporate the most scientifically sound methodologies for collecting and analyzing fisheries data. However, all protocols require editing as new and different sample collection, analysis, and data management information becomes available. Required edits should be made as soon as they are deemed necessary and appropriate reviews conducted.
2. All edits will be reviewed for grammatical and technical accuracy and overall clarity. Minor changes or additions to existing methods will be reviewed “in-house” by the SFAN aquatic professionals and other appropriate network staff. However, if a complete change in methods is anticipated, then an outside review is required. Subject matter experts familiar with fish monitoring and data analysis will be utilized as reviewers.
3. Edits and protocol revisions will be documented in the Revision History Log that accompanies the Protocol Narrative and each SOP. Only changes in the Protocol Narrative or specific SOP that is edited will be logged. “Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02, etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number” (Peitz et al. 2002).
4. Notify the SFAN Lead Data Manager of any changes to the Protocol Narrative or SOP so that the new version number can be incorporated in the Metadata of the database. The Data Manager will then edit the database per any changes to the Protocol Narrative and SOPs.
5. Post new versions on the internet and notify all individuals known to have a previous version of the Protocol Narrative or SOP. A list of current protocol and SOP version numbers is maintained in table SOP 7.1.
6. When any significant changes in the sampling protocol occur such as changes in techniques or equipment, or changes in staff, there should be an “overlap” of methods and personnel (Oakley et al. 2003). This requires using both the old and new techniques

on a given measurement or activity and having both the outgoing and new staff members perform the measurements concurrently.

Table SOP 7.1. Current SFAN Salmonid Monitoring Protocol documents.

Document Name	Current Version	Version Date
San Francisco Bay Area Network Salmonid Monitoring, Protocol Narrative	4.0	Feb. 2010
SOP 1. Summer/Fall Basinwide Juvenile Coho and Habitat Surveys	3.6	Feb. 2010
SOP 2. Summer/Fall Index Reach Surveys	1.5	Feb. 2010
SOP 3. Specialized Field Techniques	1.5	Feb. 2010
SOP 4. Spring Smolt Trapping	3.6	Feb. 2010
SOP 5. Spawner Survey	3.5	Feb. 2010
SOP 6. Permit Requirements	2.1	Feb. 2010
SOP 7. Protocol Revision	1.3	Feb. 2010
SOP 8. Data Management	1.3	Feb. 2010
SOP 9. Sampling Site Descriptions	1.2	Feb. 2010
SOP 10. Data Summaries and Analyses	3.9	Feb. 2010
SOP 11. Personnel Training and Safety	1.5	Feb. 2010

Protocol Review

Reviewer Comments

Appendix SOP 7A contains the PWR Protocol Review Checklist used by peer reviewers. Appendix SOP 7B summarizes comments and responses from the writing team.

Review Approval and Distribution

Key personnel involved with the development, implementation, and review of this monitoring protocol will be on the electronic mailing list for receipt of this document and subsequent major revisions. These include:

- Jennie Skancke, Water Quality Specialist San Francisco Bay Area Network
- Brannon Ketcham, Hydrologist Point Reyes National Seashore
- Tamara Williams, Hydrologist Golden Gate National Recreation Area
- Darren Fong, Aquatic Ecologist Golden Gate National Recreation Area
- Marcus Koenen, I&M Coordinator San Francisco Bay Area Network
- Paul Johnson, Wildlife Biologist Pinnacles National Monument

Appendix SOP 7A: PWR Protocol Review Checklist

Section 1 Overall Organization and Presentation of Protocol Narrative

1. Is the overall monitoring protocol well-organized with sections clearly delineated?
2. Does the protocol have a title page with authors' names, protocol version number and date? (Protocol version numbers should be constructed to allow for both major and minor changes.) Is there a Table of Contents, abstract, and the three basic sections: 1-Narrative, 2-Standard Operating Procedures (SOPs), and 3-Supplementary Materials or Appendixes recommended in the NPS standards published by Oakley et al. 2003 (<http://science.nature.nps.gov/im/monitor/protocols/ProtocolGuidelines.pdf>).
3. Is there a complete and accurate table of contents with page numbers? (Chapters should be paginated consecutively, i.e. Chap. 1 (pp. 1-20), Chap. 2 (pp. 21-28), Chap. 3 (pp. 29-44), etc. to allow for modular updates.)
4. Are the tables and figures clearly labeled and understandable?
5. Is the protocol bound so that it lies flat, preferably in a 3-ring binder?

Section 2 A. Background and Objectives (Chapter 1)

1. Does the protocol narrative provide a rationale or justification for why a particular resource or resource issue was selected for monitoring? Is the history and background for this resource issue well-referenced with supporting literature cited?
2. Does the protocol narrative discuss the linkages between this and other monitoring projects?
3. Does the protocol narrative describe how monitoring results will inform management decisions?
4. Does the protocol narrative contain careful documentation of the monitoring objectives or monitoring questions being asked?
5. Does the protocol narrative identify specific measurable objectives such as thresholds or trigger points for management actions?

Section 3 B. Sampling Design (Chapter 2)

1. Is there a clear and logical rationale for selecting the sampling design over others?
- 2a. Were the criteria for site selection clearly discussed including stratification, spatial design, and whether this monitoring will be co-located and/or integrated with other VS monitoring protocols? (See Checklist, Section 1A2.)
- 2b. Has the target population or "sampling frame", and the sampling units, been identified? In other words, is the desired level of inference clear?
3. Is the sampling frequency and replication identified?
4. Is the timing of sampling defined?
5. Are the location of sampling sites clearly identified?
6. Is the level of change that can be detected for the amount or type of sampling being instituted identified? (See Checklist, Section 1A5.)

Appendix SOP 7A. PWR Protocol Review Checklist (continued)

Section 4 C. Field Methods (Chapter 3)

1. Are preparations for the field season and equipment setup included? Are requirements for permitting and compliance discussed?
2. Does the protocol include clear and detailed information on taking measurements with example survey forms included? (Protocol variables and measurements may be discussed in detail in a SOP. A complete set of forms should be included in either the supplementary materials or a SOP.)
3. Is the method of access for sampling sites provided?
4. Is there an overview of procedures for establishing, monumenting, and maintenance of plots discussed in one or more SOPs?
5. Does the protocol include details for the post-collection processing of samples or vouchers?
6. Does the protocol include procedures to be followed at the end of the field season?

Section 5 D. Data Handling, Analysis and Reporting (Chapter 4)

1. Does the protocol provide an *overview* of the process for entering, editing, and storing data, identification of database software, and whether the database is consistent with the recommended I&M database template structure? (For water quality protocols, see specific water quality guidance in Part B or WRD's General Comments 15, and checklist items in Section 2, items 8-10, below.)
2. Are quality assurance (QA) and quality control (QC) procedures presented for the various levels of data collection and analysis? (See water quality Part B guidance or General Comments 15 as appropriate.)
3. Is the data structure clearly presented and sufficient to capture the required information to meet the stated goal? Is there an overview of the database design?
4. Are there recommendations for routine data summaries and statistical analysis to detect change?
5. Is there a recommended reporting schedule?
6. Is there a recommended report format with examples of summary tables and figures?
7. Is there a recommendation for long-term trend analysis (e.g. every 5 or 10 years)?
8. Does the protocol narrative include an adequate description of metadata and data archival procedures?
9. Does the protocol narrative describe the frequency of testing and review of protocol effectiveness?

Section 6 E. Personnel Requirements and Training (Chapter 5)

1. Does the narrative include a listing of the personnel and describe their roles and responsibilities, and qualifications?
2. Does the protocol include a discussion of training procedures for personnel?

Section 7 F. Operational Requirements (Chapter 6)

1. Are facility, vehicle and equipment needs identified?

Appendix SOP 7A. PWR Protocol Review Checklist (continued)

2. Is there a summary of key partnerships with agencies, organizations and individuals that are part of the monitoring program and a description of their contribution? Is there a list of relevant cooperative agreements and other partnership agreements, if applicable?
3. Is a schedule for the annual fieldwork and administrative needs required to implement this protocol included?
4. Is there an overall budget that summarizes the annual and periodic costs of implementation of the protocol? Does it seem reasonable?
5. Does the staffing plan and budget demonstrate that adequate resources have been allocated to data management, analysis, and reporting activities (ca. 30% are recommended)?

Section 8 **G. Literature Cited (Chapter 7)**

1. Are the literature citations relevant, sufficient and consistently formatted?

Section 9 **Standard Operating Procedures (Selected essential SOPs in addition to those mentioned in the narrative outline are identified in the checklist below. For Water Quality protocols, Part B Guidance or WRD's General Comments 15 should be consulted when developing SOPs.)**

1. Is there a table of contents for the SOPs?
2. Are changes to each SOP clearly identified with a title, version number **or** revision date, and page numbers? Changes to protocol modules (Chapters or SOPs) should be reflected in the overall protocol version number and protocol revision history log either through a minor or major revision; however, you may also wish to develop a numbering scheme for SOPs, e.g. SOP 1.00, 1.01...
3. Is there a SOP with instructions for revising the protocol and a revision history log?
4. Is there a SOP with instructions for preparation before the field season? Is there a SOP with instructions for procedures and equipment storage during and after the field season? (Also see numbers 10 and 11 below.)
5. Is there a SOP for training field personnel?
6. Is there a SOP that clearly defines protocol variables and how to measure them? (See Checklist, Section 1C2.)
7. Are there clear and detailed driving and other navigational instructions to sampling sites?
8. Are the details of Data Management identified in one or more SOPs? Topics to be included are at minimum identified in Section 1D and may include customized data management routines. Specifically for water quality monitoring data, does the SOP specify how data will be reported to WRD for entry into the Environmental Protection Agency's STORET database?
9. For water quality monitoring and other monitoring as appropriate, is there a quality control SOP associated with each protocol that adequately documents QC objectives for measurement sensitivity (detection limits), measurement precision, measurement systematic error (bias as percent recovery), data completeness (including adequacy of planned sample sizes and statistical power – this topic may be in the SOP on Sampling Design), and (if applicable for lab measurements only) blank control? Are instrument calibration details included either in the QC SOP or in a separate calibration SOP?

Appendix SOP 7A. PWR Protocol Review Checklist (continued)

10. For water quality protocols, is there a SOP that includes an explanation of how data comparability (a quality assurance basic) was considered in choosing which protocols and chemical labs to utilize? Do protocol SOPs contain enough field and lab method details to allow others to determine if data produced is comparable enough to other regional data sets to be considered credible by regulatory agencies interested in the data?
11. Do aquatic protocol SOPs adequately describe the details of all Sampling Protocols (Field and Laboratory), as well as equipment needs and operation, sampling techniques, sample preservation and handling and logistics?
12. Are all major procedures required for the protocol sufficiently explained? Are any SOPs missing?
13. Are the literature citations with the SOP relevant, sufficient and consistently formatted?

Section 10 Supplementary Materials or Appendixes

1. Is there a table of contents with Section 3 – Supplementary Materials that clearly identifies the materials provided in this section of the protocol?
 2. Are the supplementary materials relevant, sufficient and consistently presented? Consistent formatting is desirable, but not always possible.
 3. Are data collection forms provided either in this section or in an SOP?
 4. Is there a section for the Administrative Record that provides the history of protocol development and refinement? (The published protocol may be presented either in Section 2 or Section 3 depending upon its contribution to the current protocol.)
-

Appendix SOP 7B: Peer Review Comments to 2005/2006 Draft and Responses from Protocol Authors

This appendix is the product of a query run on a MS Access protocol review database developed to track 118 reviewer's comments on the 2005/2006 draft protocol and responses made by the writing team.

<i>SOP Number</i>	<i>Reviewer Comment</i>	<i>Response</i>
<i>Narrative</i>		
	Insufficient information on analytical techniques, power analysis, database design, metadata, data summaries, and trend analysis were provided in this document.	Revised sampling design and data analysis sections.
	Provide a single map showing all proposed study areas.	Narrative Fig,2 shows all Parks where monitoring will be performed.
	If not on a map, provide a table indicating which streams are in which park.	Both a map is provided in Narrative along with tables in SOP 8
	How will NPS standardize techniques with other institutions and are comparison and calibration studies proposed?	We currently use standard techniques and calibration methods as stated in narrative. Comparisons will be made in trend and synthesis reporting as stated in data analysis SOP.
	Reports on vertebrate and invertebrate assemblages are proposed but no measurable objective is provided.	Monitoring questions and objectives were revised.

Salmonid Monitoring Protocol for the San Francisco Area Network: Standard Operating Procedures

<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
	Why are spring assemblage surveys proposed for PINN and JOMU. How will these be combined with permanent systems in other parks.	Index reaches are already established in other parks and we can look at species assemblage changes in all parks described. PINN is not part of the protocol.
	Why are adult counts not proposed for MUWO.	Adult counts are performed in MUWO and it is now clearly documented in the SOP.
	How will NPS calibrate survey results from snorkeling?	Stated in Basinwide survey sampling design in protocol narrative.
	40-50 random sites are needed to assess an entire drainage.	Sampling design revised.
	Are there standards to reduce data entry errors and analytical errors?	Addressed in SOP 7
	How will data generated through applying the SOPs be synthesized into overall population and assemblage assessments?	Data analysis section expanded and enhanced.
	To much detail on SOPs in this document. Reduce the size of this document so it is not redundant in SOPs	Redundancy reduced throughout protocol and SOP.
	The sampling design was not clearly presented.	Sampling design was revised.

Salmonid Monitoring Protocol for the San Francisco Area Network: Standard Operating Procedures

<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
	Reviewer encourages coordination with Olympic, Redwood, and Northern Cascades National Parks? Are they using the same monitoring? Method comparability	Coordination with Redwood National Park may be helpful but would be more useful to compare with watersheds in closer proximity.
	It may be appropriate to look at entire drainages in order to use one as a control for doing restoration on another. Especially if trends between drainages are similar.	Created annual reports instead of watershed reports explained in Data Analysis SOP. Also, monitoring focus is now on population trends. Not on evaluating effectiveness of management efforts.
	What is the sampling design chosen? Make clear.	Sampling designs were revised based on power analyses. Clarified in both the protocol and SOPs.
	However, the mixture approach to basin-wide abundance estimates conflicts with standard methods. Explain why this approach would provide more info than standard methods.	Index reaches can not be applied to the entire stream so Basinwide surveys provide this information. Index reaches are also no longer used as calibration points as described in a previous draft of the protocol.
	The monitoring questions provided a mixture of those that could be addressed directly with data gathered using the protocols presented and those that would require more specific research efforts. Make these clear.	Objectives were revised.
	Implications of summer surveys on detecting change due to management actions. What level of detection do we expect to gain from SOP1 and will this protocol be able to detect changes caused by management actions?	Level of detection based on power analysis is presented.
	What habitat constraints exist in the parks that currently impede or limit salmon recovery efforts?	Habitat and environmental constraints briefly discussed.

Salmonid Monitoring Protocol for the San Francisco Area Network: Standard Operating Procedures

<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
	Clarify the use of terms community, and assemblage. Also make sure use of the word "data" is plural.	Reviewed terms and usage seems to be fine.
	Make clear how the protocols will answer some of the complex monitoring questions that address the attempts to understand the mechanisms causing any changes through time.	The protocol is designed to monitor trends. Determining cause and effect is not the goal. Monitoring questions were refined to clarify.
	Describe management activities that impaired or currently impair fish.	Described in the rational for selecting this resource section.
	Reviewer suggests modeling the entire salmonid life cycle to determine if factors not described by dry-season monitoring would increase knowledge on population dynamics. This would help explain annual variation.	This is what our multiple life stage sampling will accomplish, see data analysis fig 4.11 for an example of how limiting factors will be determined.
	For PINN and JOMU a limited index site approach is suggested	Index reaches are already used in JOMU. PINN is not part of the protocol.
	Bohlin, Brown, Moyle 1991, Ketcham et al 2004a, and Solazzi et al are not cited. Percy needs editor and publisher. References should include city.	References updated.
	Section 2.4 should be headed genetic monitoring and should have similar construction to other sections in the document.	Genetic analysis removed as part of protocol.
	No reference found for Stillwater Sciences 2004, Serpa 1994, 1996, 1997, 1998.	Freshwater Shrimp are no longer in the document. All references checked.
	How will data from vertebrate assemblages be converted into quantitative indicators? Will IBIs, O/E models, or both be employed.	Monitoring objectives revised. Focus is on population trends of coho salmon and steelhead trout.

Salmonid Monitoring Protocol for the San Francisco Area Network: Standard Operating Procedures

Narrative, SOP1

SopNum

Reviewer Comment

Response

Use mark recapture instead of multiple pass electrofishing.

This is not appropriate for sampling endangered species and is not permitted by NOAA fisheries.

How does NPS define stable population and what characteristics is this based on?
How will contradictions among the indicators be resolved?

Monitoring objectives were revised.

How will the effects of nonnatives be assessed?

Nonnatives were removed from the main objectives and questions.

Non-random index sites cannot be used for inferring to other sites or reaches. This requires random or probabilistic sampling design.

Sampling design was refined.

Narrative, SOP1-2

Each monitoring question should be linked to a measurable objective, a test hypothesis, a study design, and quantitative indicator.

Both questions and objectives were refined.

Narrative, SOP1-3

There is no set of testable hypothesis and objectives do not include detection capability.

Detection capability is included.

Salmonid Monitoring Protocol for the San Francisco Area Network: Standard Operating Procedures

<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
	Provide Greg Brown's title and affiliation.	Affiliation updated.
	The database design is not clear.	Data management SOP updated and revised.
<i>Narrative,SOP1</i>	Past and proposed rehabilitation actions should be described and followed by explicit study designs, indicators, calculations, and detection limits.	Focus of protocol shifted away from evaluation of specific management efforts to population monitoring.
<i>Narrative,SOP1-3</i>	Statistical analysis to detect change were not extensively described	Sampling design and data analysis were enhanced.
	The use of volunteers and other staff on crews adds considerable crew error and safety concerns.	Added to Chapter 5 in protocol narrative.
	No rationale or criteria were provided for site selection, replication, sampling frequency, site number, or detection limits.	Sampling design was revised

Salmonid Monitoring Protocol for the San Francisco Area Network: Standard Operating Procedures

<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
	Statistical analysis to evaluate the effects of restoration were not described	Removed restoration monitoring objectives from the protocol.
<i>Narrative,SOP2</i>	Have prey refuges in traps been considered? Explain fish screen and current techniques.	addressed in trap setup in SOP 2
<i>Narrative,SOP3</i>	Are carcasses marked to avoid recounting and to evaluate carcass loss?	Addressed in SOP 3 in field methods.
<i>Narrative/SOP1</i>	We should acknowledge that index reaches are systematically selected rather than sequential independent sampling and describe the pros and cons.	Addressed in sampling design overview in the narrative.
	Explain increase in snorkeling and bounded counts methods. How will we use bounded counts to strengthen our estimates.	Explained in narrative in sampling design under basinwide survey.
	Describe how sites were selected and consult a statistician on site locations and design before embarking the monitoring plan.	Sampling design revised.

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<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
<i>Narrative/SOP2</i>	Reviewer encourages continued trapping during some storm events but acknowledges that this may not be possible.	We always try our best but it is often not possible, storm events can lead to mortalities if left in place and large storm events can lead to loss of equipment. Smolt traps must be monitored closely during storm events.
<i>SOP</i>	Specify how often the crew reports to the coordinator.	Details on reporting including schedule revised.
<i>SOP1</i>	Has it been determined that steelhead and coho are distinct populations?	Yes, see NOAA fisheries biological opinion and critical habitat delineation for both species.
	What is the sampling reach length for fish assemblage sampling?	In narrative: 100 meters in Index Reach Section.
	What is the assessment unit? Is it a site, reach segment, all stream length in a catchment, or all stream length in the set of catchments?	Sampling design revised.
	Reviewer believes it is useful to include amphibians and all fish in stream assessment.	Limited funding will limit monitoring objectives.

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SopNum

Reviewer Comment

Response

Biomass is often a poor indicator for cold water streams.

Monitoring will also use total count along with biomass to observe trends.

Terrestrial ecosystems only account for half of stream response, what about other sources of variation?

Sources of variation discussed in background information but focus of monitoring is on detecting trends not on identifying cause and effect.

Is NPS satisfied with calibration results for snorkeling vs. electrofishing coho. Fig. 4.9?

Calibration is done each year on each watershed. While you would want the best, the calibration is done just for that one result. The figure that was presented was an example.

Why are 10 salmonids and 5 non-salmonids weighed and measured? Is this sufficient? How will this info be used in assessment?

10 of each species are measured, this is based on past years data, I added reasoning for 10 fish in SOP1. Information is used for fitness.

Clove oil works best as a sedative.

Not approved by USDA and NOAA Fisheries

Seining may produce more injury than e-fishing. Wading rods are efficient at measuring widths than tapes.

It is true that seining can produce more exterior injury if not done properly but this is outweighed by non-external e-fishing injury. Need to refer to NOAA e-fishing guidelines. Both wading rods and tapes have the same level of accuracy.

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<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
	Visual estimates are a lot less precise than measured habitat widths.	Yes but they are needed for sampling efficiency.
	We have found qualitative estimates useful for assessing data quality.	QA/QC enhanced in database.
	Table 4.2 Is there anyway to reduce the confidence intervals? Only large trends will be detected.	Large confidence intervals is still a problem. Additional pilot being considered to refine techniques.
	What level of effort is used in seconds per square meter and is the entire habitat unit fished?	Equal effort is used on each pass, but effort is affected by habitat complexity in the unit. Habitat units were clarified in the protocol.
	No text or data was provided on power analysis, database design, or metadata.	Sample design and data management sections revised.
	I did not see how index reach data for salmonids were used to estimate trends for watersheds.	Inference from Index reach is limited. This is clarified in the protocol.
	Sculpin is a genus and not a species.	Changed species to fish to be more general with sculpin. Added genus to recording on SOP 1 in case species is not determined.
	Monitoring questions should be restricted to the summer index period. Habitat constraints, species distribution, and responses to rehabilitation are likely season specific.	Monitoring question and objectives were refined.

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<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
Franklin Creek methods are not comparable because snorkeling is not performed.	Reasoning already addressed due to water quality.	
Some sort of composite report is needed versus individual basin reports.	Addressed with addition of annual reports instead of watershed reports.	
A memory stick is better than cds.	Storage units will change with technology.	
I did not see citations for Chatham & Neuman, Ketcham & Brown, Kolz et al. Opperman, and Simonson et al. City should be provided for all non-journals.	References checked.	
Appendix D. Sculpin and Lamprey should be ID to species.	Yes they should but this is unrealistic in the field and is not the focus of the monitoring effort.	
No rationale or criteria were provided for site index selection, temporal or spatial replication, site number, or detection limits.	Sampling design was revised.	
What is considered sufficient time for uncaptured fish to recover before doing another pass?	Clarified waiting time between passes in SOPs.	
Include long term trends in steelhead as a measurable objective.	Objectives were refined.	

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<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
Explain why Chalone and Franklin Creeks differ from other creeks.	PINN no longer included in protocol. More information provided on Franklin creek.	
How will ocean conditions be linked to or separated from reach conditions in the park.	These protocols are not intended to describe ocean conditions and so there is no need to link or separate from reach monitoring.	
How will seasonal variation be evaluated?	Season variation was removed from narrative question/objective. NPS will not be evaluating seasonal variations, only annual variations.	
Sampling design was not clearly presented.	Sampling design was revised.	
40 times wetted width or 150 m is needed for precise estimates of species and proportionate abundance.	We do not do 40 wetted widths but 100 meters is the most we can do with one crew in a day. We could only increase this number if we increase our crew size and equipment.	
Snorkeling is inadequate for assessing vertebrate species richness.	Snorkeling has been documented as being accurate to describe a population of salmon by Hankin and Reeves and is widely used on the west coast.	
There is no evidence that electrofishing harms fish populations, which is the level of interest.	Refer to NOAA guidelines and snorkeling is a more efficient way of sampling for a population.	
Table 3.2 Discrepancy in days allotted per reach between table 2.1.	Discrepancy in days fixed with new tables and reorganization.	

Salmonid Monitoring Protocol for the San Francisco Area Network: Standard Operating Procedures

SopNum

Reviewer Comment

Response

By sampling headwater streams first before the mainstem we could be sampling the same fish twice.

Added GSS section to SOP 1 and included stream connectivity close to minimize possibility of double sampling.

Electrofishers should be serviced in winter, Permits should also be done in the winter.

Electrofisher does not require yearly servicing, permits are completed based on the required permit reporting schedule, added clause in reporting narrative reporting schedule.

Do not make basinwide estimates on index sections unless they are randomly selected.

Sampling design revised. Index reaches are no longer used to calibrate basinwide estimates.

I am not convinced that snorkeling and electrofishing produce comparable results. Can data be supplied to confirm the two sampling procedures can be calibrated?

The calibration is described by Dollof et al.

Merging rehabilitation sites with index sites biases assessments.

Rehabilitation based index sites have been removed from the sampling protocol.

SOP1-3

No information on measurements, field forms, or sample processing were provided.

SOP 1-3 has handling procedures and forms with instruction in the appendix.

Appendix G. Allow time for training of staff and train them.

This is allowed.

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<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Respons</i>
<i>SOP2</i>	Lamprey and sculpin should be identified to species.	No field ID characteristics have been established for quick ID of each species.
	Need to address periods when trapping is suspended and what effect this has on annual production estimates.	Addressed issue in SOP 2 Trap Operations section
	What is the watershed of interest and is the trap location appropriate? Does the trap locations allow assessments of the same aquatic resources as the fish and habitat surveys?	Watershed of interest is clearly defined in the locations SOP.
	Why would trapping efficiency decline with time Fig.4.4 in SOP2	Reviewer didn't realize that Fig.4.4 was only an example for that one field season. Efficiency can decline with late spring freshets.
	Did not find citation for Gallagher 2000a. All non-journal articles should include city, state, publisher.	All references reviewed.
	In Fig 1 explain environmental conditions associated with peaks and troughs.	Added analysis for this in SOP 9 to help explain environmental cues.
	No evidence of power analysis	Sampling design was revised.
	Include an objective criteria to define the end of trapping season.	Clarified trapping season in Sampling Frequency and Timing in SOP 2

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SopNum

Reviewer Comment

Response

There is no spatial or temporal replication proposed.

Sample design section revised. Spatial and temporal pattern is fully described to track population trends.

Citation missed for Crone & Bond, Flint, Koski, Lusch, Sandercock, Solazzi, and Taylor & Associates. The Ketcham and Brown poster is not citable other than as pers comm. Provide city for non-journal articles.

References reviewed.

Reviewer does not think that traps are appropriate tools for indicating habitat constraints. Population distribution, response to rehabilitation, and aquatic assemblages.

We have revised the objectives. We are not making inference about distribution, response to rehabilitation, and aquatic assemblages here. The focus is on population trend of coho smolt and steelhead trout.

The monitoring questions should be restricted to the spring index period. Habitat constraints, species distributions, and responses to rehabilitation are likely season specific.

Monitoring objectives were refined.

Prey cover in the trap box would be useful

SOP 2 states that fish screens are used to help against predation. Most predation is caused by sculpin which are ambush predators so cover would only help sculpin prey on juvenile salmonids.

SOP3

Should be coho adult SOP

SOP was revised entirely for clarification.

Are flags removed at the end of the survey?

No, we use biodegradable flagging so that we do not need to remove the flags.

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How is clarity measured?

Section on water clarity is revised.

The field form should include a query and space for information on recent freshets or other environmental conditions that reduce detection effectiveness.

This information gathered by staff gages on all three watersheds. See freshwater dynamics protocol. Water clarity is a field on the form to indicate observer efficiency (See SOP 9).

Use a ski pole instead of a 2m survey rod.

Ski poles are more expensive than the broom sticks that we make into rods. Plus broom sticks are longer.

Reviewer thinks NPS can find people to work on holidays

Yes, deleted out of SOP.

The rationale for the site number, and detection limits are not provided.

Sampling design revised.

Reviewer believes steelhead redds can be distinguished from coho redds. Can adult traps be used to estimate steelhead?

Addressed steelhead vs. coho redds on SOP 3 including how to distinguish between the two post collection. Focus of monitoring objectives is on adult coho; monitoring adult coho not economically possible at this time.

No info on Power Analysis

Sampling design revised.

The monitoring questions are not all specific for this indicator. They are largely driven by ocean conditions.

Monitoring questions and objectives were revised. Main question for SOP3 is timing and distribution of spawning which is not driven by ocean conditions.

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<i>SopNum</i>	<i>Reviewer Comment</i>	<i>Response</i>
	The sampling sites are listed but the rationale, criteria, and procedures for their selection are not provided.	This was clarified in the narrative. Sites are based on access and reach length.
<i>SOP4</i>	No monitoring questions, measurable objective, testable hypothesis are presented. Also lacking graphic and tabular results.	Monitoring objectives revised. Additional information and examples provided in data analysis SOP.
<i>SOP5</i>	No SOP 5 provided for shrimp monitoring	Will not be included in this protocol
<i>SOP9</i>	How will fish assemblage extent, condition, annual variation, and fish assemblage themselves be described?	Monitoring objectives revised to focus on coho and steelhead.
	What data will NPS use to compare status and trends with other watersheds?	Addressed in SOP 9 Data Analysis in annual reports section.

Appendix SOP 7C: Peer Review Comments to 2009 Draft and Responses from Protocol Authors

A draft of the SFAN Salmonids Monitoring Protocol was submitted to Dr. James Agee, PWR Protocol Review Coordinator, and Dr. Penny Latham, PWR Regional I&M Coordinator in January 2009. Dr. Agee forwarded the protocol to two anonymous peer reviewers. In April 2009, review comments on the protocol were received. This appendix summarizes the deficiencies and suggested corrective actions noted by the reviewers. The text in italics represents the authors' changes to the document based on the reviewers' comments. Hard copies of reviewer comments are on file.

Italic represents authors change in text in response to reviewer comment.



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April 20, 2009

The scientific review for “Salmonid Monitoring Protocol for the San Francisco Area Network” is complete. The protocol receives the following decision:

Acceptable with Minor Revision

Attached to this letter are review and informational documents: (1) a PWR Protocol Review Checklist. Each question is addressed in the left column; if scientific, it is addressed by the letter “S” by me and if administrative is addressed as “A” by a separate reviewer, with relevant comments in bold. (2) The individual reviews are included with author’s names erased, and reviewers are identified as R1 or R2 [my comments are PRC]. The reviews are self-explanatory, but what I attempt to do here is place them in an integrated context beyond the abbreviated response in the PWR Protocol Review Checklist. In general, this was a clearly written protocol. The two peer reviewers were pleased with the effort shown. Usually protocols contain too little detail about the protocol, so I discount somewhat the administrative reviewer’s comment that the protocol is “too long” and has “extraneous detail”. However, this reviewer’s suggestions on the budget detail are relevant and should be addressed. Also, the consecutive numbering of pages is good, but sometimes the tables and figures in the text have an old (apparently) numbering scheme and one figure (figure 5) was left out, throwing off all the subsequent figure numbers. An SOP for training field personnel and ensuring safety is needed.

Reviewer 1 suggests that electrofishing of index reaches be discontinued, while reviewer 2 suggests they be continued (as “low effort juvenile sampling”). Given the tenor of the comments, it seems that there is value for electrofishing (length of record, other issues identified by reviewer 2), so I would agree with reviewer #2 on this, given that acknowledgment of the potential biases of this method are stated. The remainder of the comments of the peer reviewers are clear and can be addressed individually.

Please respond with a revised protocol that includes a clearly delineated response to each of the points raised by reviewers as a separate “response to review” document. Unless there is substantial disagreement on the reviews, this protocol will likely not be submitted for another outside peer review.

Sincerely,

A handwritten signature in black ink that reads 'James K. Agee'.

James K. Agee
PWR Protocol Review Coordinator

PWR PROTOCOL REVIEW CHECKLIST

A = administrative guidance, S = an item related to scientific merit,

C = general reviewer comment, *R = response from protocol authors*

	Overall Organization and Presentation of Protocol Narrative
A	1. Is the overall monitoring protocol well-organized with sections clearly delineated? Yes, the protocol sections are clearly delineated. However, the protocol seems too long (261 p, 44 tables, 66 figures) and has extraneous detail for work in a low number of streams. I suggest reducing numbers of tables and figures to those that are most relevant.
R	In general, this was a clearly written protocol. The two peer reviewers were pleased with the effort shown. Usually protocols contain too little detail about the protocol, so I discount somewhat the administrative reviewer's comment that the protocol is "too long" and has "extraneous detail". <i>Excerpted from peer review guidance by Dr. Agee</i>
A	2. Does the protocol have a title page with authors' names, protocol version number and date? (Protocol version numbers should be constructed to allow for both major and minor changes.) Is there a Table of Contents, abstract, and the three basic sections: 1-Narrative, 2-Standard Operating Procedures (SOPs), and 3-Supplementary Materials or Appendixes recommended in the NPS standards published by Oakley et al. 2003 YES (http://science.nature.nps.gov/im/monitor/protocols/ProtocolGuidelines.pdf).
A	3. Is there a complete and accurate table of contents with page numbers? (Chapters should be paginated consecutively, i.e. Chap. 1 (pp. 1-20), Chap. 2 (pp. 21-28), Chap. 3 (pp. 29-44), etc. to allow for modular updates.) YES
S	4. Are the tables and figures clearly labeled and understandable? Overall, yes.
A	5. Is the protocol bound so that it lies flat, preferably in a 3-ring binder? YES
Section 1	A. Background and Objectives (Chapter 1)
S	1. Does the protocol narrative provide a rationale or justification for why a particular resource or resource issue was selected for monitoring? YES. Is the history and background for this resource issue well-referenced with supporting literature cited?
A	2. Does the protocol narrative discuss the linkages between this and other monitoring projects? YES. Table 1 and page 7.
A	3. Does the protocol narrative describe how monitoring results will inform management decisions? YES. In particular, guiding restoration efforts. Another important management implication may be the detection of non-native fish species in the future?
S	4. Does the protocol narrative contain careful documentation of the monitoring objectives or monitoring questions being asked? The monitoring objectives are specifically outlined in a stand-alone section.
S	5. Does the protocol narrative identify specific measurable objectives such as thresholds or trigger points for management actions? YES, p.12.
Section 1	B. Sampling Design (Chapter 2)

S	1. Is there a clear and logical rationale for selecting the sampling design over others? YES.
S	2a. Were the criteria for site selection clearly discussed including stratification, spatial design, and whether this monitoring will be co-located and/or integrated with other VS monitoring protocols? (See Checklist, Section 1A2.) YES.
S	2b. Has the target population or “sampling frame”, and the sampling units, been identified? In other words, is the desired level of inference clear? YES.
S	3. Is the sampling frequency and replication identified? YES.
S	4. Is the timing of sampling defined? YES, broadly. Could benefit from more specifics such as in Table 4.
R	<i>Also see Table 5</i>
S	5. Are the location of sampling sites clearly identified? YES.
S	6. Is the level of change that can be detected for the amount or type of sampling being instituted identified? (See Checklist, Section 1A5.) YES.
Section 1	C. Field Methods (Chapter 3)
A	1. Are preparations for the field season and equipment setup included? YES. Are requirements for permitting and compliance discussed? YES, p. 44
S	2. Does the protocol include clear and detailed information on taking measurements with example survey forms included? YES. (Protocol variables and measurements may be discussed in detail in a SOP. A complete set of forms should be included in either the supplementary materials or a SOP.) YES.
A	3. Is the method of access for sampling sites provided? YES, via maps and tables.
S	4. Is there an overview of procedures for establishing, monumenting, and maintenance of plots discussed in one or more SOPs? Plots (transects) are not permanent.
R	<i>Location information and documentation is clearly documented in SOP 8 and SOP 9. The location and sampling areas are not related to plots but to stream segments. The Stream segments are related to stream monuments that are used to document spatial location.</i>
S	5. Does the protocol include details for the post-collection processing of samples or vouchers? YES.
A	6. Does the protocol include procedures to be followed at the end of the field season? YES for data.
Section 1	D. Data Handling, Analysis and Reporting (Chapter 4)
A	1. Does the protocol provide an <i>overview</i> of the process for entering, editing, and storing data, identification of database software, and whether the database is consistent with the recommended I&M database template structure? (For water quality protocols, see specific water quality guidance in Part B or WRD’s General Comments 15, and checklist items in Section 2, items 8-10, below.) YES, SOP 8.
S	2. Are quality assurance (QA) and quality control (QC) procedures presented for the various levels of data collection and analysis? (See water quality Part B guidance or General Comments 15 as appropriate.) YES, p. 128.
S	3. Is the data structure clearly presented and sufficient to capture the required information to meet the stated goal? Is there an overview of the database design?

	YES.
S	4. Are there recommendations for routine data summaries and statistical analysis to detect change? YES.
A	5. Is there a recommended reporting schedule? YES.
A	6. Is there a recommended report format with examples of summary tables and figures? YES.
S	7. Is there a recommendation for long-term trend analysis (e.g. every 5 or 10 years)? YES.
S	8. Does the protocol narrative include an adequate description of metadata and data archival procedures? YES.
S	9. Does the protocol narrative describe the frequency of testing and review of protocol effectiveness? YES.
Section 1	E. Personnel Requirements and Training (Chapter 5)
A	1. Does the narrative include a listing of the personnel and describe their roles and responsibilities, and qualifications? YES.
S	2. Does the protocol include a discussion of training procedures for personnel? YES, p. 42, but this is brief. It would be good to incorporate safety considerations in main protocol. An SOP for training field personnel and ensuring safety is needed. <i>Excerpted from peer review guidance by Dr. Agee</i>
R	<i>Based on comments SOP 11 was developed to include training and safety of field personnel.</i>
Section 1	F. Operational Requirements (Chapter 6)
A	1. Are facility, vehicle and equipment needs identified? YES for equipment. Not sure about facility or vehicle.
R	<i>See revised budget Table 6, facility needs are discussed throughout the document narrative and SOP 1-5 when necessary.</i>
A	2. Is there a summary of key partnerships with agencies, organizations and individuals that are part of the monitoring program and a description of their contribution? Is there a list of relevant cooperative agreements and other partnership agreements, if applicable? YES
A	3. Is a schedule for the annual fieldwork and administrative needs required to implement this protocol included? YES.
S	4. Is there an overall budget that summarizes the annual and periodic costs of implementation of the protocol? YES. Does it seem reasonable? No. From Table 6, the program annually relies on \$92,500 from Cal. Dept. of Fish and Game. This is 62% of the total budget, and only guaranteed thru FY 10. This is an issue that needs to be addressed relative to objectives and proposed monitoring.
R	<i>See revised budget Table 6. "The current budget is augmented by grants through FY2013. The monitoring program has received funding from the CDFG competitive grants program since 2002. Given the past and current level of funding, combined</i>

	<i>with the current status of the CCC ESU coho populations, CDFG will likely continue their support of this monitoring program. In case grant or match funds are not available, the monitoring program would be reduced to cover only the higher priority monitoring components, as outlined in table 7.”</i>
A	5. Does the staffing plan and budget demonstrate that adequate resources have been allocated to data management, analysis, and reporting activities (ca. 30% are recommended)? The data management is \$7,000 of \$75,000. This seems excessive on an annual basis, particularly after database construction. The crews should be able to enter and conduct QA/QC. The project lead creates summaries and meets reporting requirements.
R	<i>Note the budget Table 6 has been revised. Comments from other reviewer and general I&M guidance suggests that this amount is well within reason given the extent of data collection.</i>
Section 1	G. Literature Cited (Chapter 7)
S	1. Are the literature citations relevant, sufficient and consistently formatted? NO. see PRC comments following this list.
R	<i>Made new literature citations for each SOP and revised the literature cited for the protocol narrative.</i>
Section 2	Standard Operating Procedures (Selected essential SOPs in addition to those mentioned in the narrative outline are identified in the checklist below. For Water Quality protocols, Part B Guidance or WRD’s General Comments 15 should be consulted when developing SOPs.)
A	1. Is there a table of contents for the SOPs? YES. Xiv. But it would be best to have single TOC
R	<i>Current guidance is to have a general TOC in the narrative with a separate and more detailed TOC for each SOP.</i>
A	2. Are changes to each SOP clearly identified with a title, version number or revision date, and page numbers? Changes to protocol modules (Chapters or SOPs) should be reflected in the overall protocol version number and protocol revision history log either through a minor or major revision; however, you may also wish to develop a numbering scheme for SOPs, e.g. SOP 1.00, 1.01... YES. xviii.
A	3. Is there a SOP with instructions for revising the protocol and a revision history log? YES. Xviii
A	4. Is there a SOP with instructions for preparation before the field season? Is there a SOP with instructions for procedures and equipment storage during and after the field season? (Also see numbers 10 and 11 below.) No, but was addressed in text. An SOP for training field personnel and ensuring safety is needed. from Agee Letter
R	<i>SOP 11 Personnel Training and Safety SOP was added to protocols to address this issue.</i>
S	5. Is there a SOP for training field personnel? No.
R	<i>SOP 11 Personnel Training and Safety was created and is now part of the salmonid monitoring protocols.</i>
S	6. Is there a SOP that clearly defines protocol variables and how to measure them?

	(See Checklist, Section 1C2.) No.
R	PRC: “I would conclude YES but not all in one SOP, which seems fine” <i>Protocol Narrative, Table 2, and SOPs 1-5. Variables are defined in monitoring questions and how they will be measured in the monitoring objectives. SOPs 1-5 also explain how variables will be measured. SOP 10 also includes details on Analysis and reporting.</i>
A	7. Are there clear and detailed driving and other navigational instructions to sampling sites? I did not see these but may have missed.
R	PRC: “Map details of SOP #9 seem to be sufficient.” <i>SOP 9 includes maps and a narrative description of all sampling sites and stream reaches.</i>
S	8. Are the details of Data Management identified in one or more SOPs? Topics to be included are at minimum identified in Section 1D and may include customized data management routines. YES. Specifically for water quality monitoring data, does the SOP specify how data will be reported to WRD for entry into the Environmental Protection Agency’s STORET database? Water quality collection is limited to data to adjust electrofisher.
S	9. For water quality monitoring and other monitoring as appropriate, is there a quality control SOP associated with each protocol that adequately documents QC objectives for measurement sensitivity (detection limits), measurement precision, measurement systematic error (bias as percent recovery), data completeness (including adequacy of planned sample sizes and statistical power; this topic may be in the SOP on Sampling Design), and (if applicable for lab measurements only) blank control? Are instrument calibration details included either in the QC SOP or in a separate calibration SOP? NA
S	10. For water quality protocols, is there a SOP that includes an explanation of how data comparability (a quality assurance basic) was considered in choosing which protocols and chemical labs to utilize? Do protocol SOPs contain enough field and lab method details to allow others to determine if data produced is comparable enough to other regional data sets to be considered credible by regulatory agencies interested in the data? NA
S	11. Do aquatic protocol SOPs adequately describe the details of all Sampling Protocols (Field and Laboratory), as well as equipment needs and operation, sampling techniques, sample preservation and handling and logistics? YES
S	12. Are all major procedures required for the protocol sufficiently explained? Are any SOPs missing? YES
S	13. Are the literature citations with the SOP relevant, sufficient and consistently formatted? YES
Section 3	Supplementary Materials or Appendixes
A	1. Is there a table of contents with Section 3 – Supplementary Materials that clearly identifies the materials provided in this section of the protocol? YES. It’s on page xvi, might be repeated as page 207.
A	2. Are the supplementary materials relevant, sufficient and consistently presented? Consistent formatting is desirable, but not always possible. YES
A	3. Are data collection forms provided either in this section or in an SOP? YES.
A	4. Is there a section for the Administrative Record that provides the history of

	protocol development and refinement? A summary event table is highly recommended in addition to the supporting materials required in the Protocol Review File Checklist, e.g. the initial study plan or protocol development summary, the results of protocol development studies, peer review comments and responses during the development phase, and/or any published protocol on which a major portion of the methodology included in this protocol is based. (The published protocol may be presented either in Section 2 or Section 3 depending upon its contribution to the current protocol.) YES, p. xviii
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Individual Comments and Responses

	Additional comments from Administrative Reviewer:
C	I reviewed the protocol entitled, “Salmonid Monitoring Protocol V.3.67” by Ketcham et al. 2008. I specifically addressed the scientific and some administrative items in the Protocol Review Checklist. The protocol represents a significant body of work, high levels of effort, and an important contribution by NPS to coho salmon monitoring efforts along the California Coast. I believe that the implementation of this protocol represents an important component of monitoring for the SFAN network. The monitoring of multiple life history stages of fish provides very useful information with much management relevance.
C	Overall, I found the protocol and corresponding SOP’s to be very cumbersome to wade through, and believe that the authors overindulge in detail and analysis. The protocol and SOP’s would be greatly improved after a more concise and reduced presentation of information. The length of the protocol/SOP’s (261 pages) coupled with 44 Tables and 66 Figures seems excessive for a program directed primarily at counting coho salmon in four streams. Many of the tables have redundant information, and could be combined. In its current format, I believe that the protocol lacks a “plug and play” practicality that is important for new staff.
R	In general, this was a clearly written protocol. The two peer reviewers were pleased with the effort shown. Usually protocols contain too little detail about the protocol, so I discount somewhat the administrative reviewer’s comment that the protocol is “too long” and has “extraneous detail”. <i>Excerpted from peer review guidance by Dr. Agee</i>
C	The protocol is designed to intensively monitor much of the entire lengths of four streams (out of SFAN=7 watersheds; 43 streams). There is much merit to the decision/philosophy to do a few things well under limited budgets, but the protocol should recognize the “cost” and possible lack of representation from this approach. In other words, the sampling design limits the application of the data collected. The protocol would benefit from some discussion and explanation about inference and ability (or lack thereof) to extrapolate.
R	<i>The following paragraph was added to the Rational for Selecting this Resource to Monitor section of the narrative to address the comment stated above.</i> <i>“This protocol is designed to intensively monitor the entire extent of usable coho habitat in three major watersheds found within the SFAN. The park realizes that this currently limits our ability to make inferences on the health of many of the other streams contained within</i>

	<i>the parks. However, this monitoring protocol does allow for direct relationships to park management activities surrounding the three major watersheds that are intensively monitored. If program funding increases it is anticipated that the monitoring will be expanded to increase coverage in non-coho bearing streams.”</i>
C	The sampling design and methods appear to focus primarily on the monitoring of one species, coho salmon. The origin of these coho salmon remains unknown to the reader as to whether these fish are wild, natural, or hatchery produced. The protocol may be more aptly titled, “A Monitoring Protocol for Coho Salmon in Four SFAN Streams”. It remains unclear as to what types of useful information will be attained on the fish assemblages (e.g. other species in streams). It seems like there is excellent opportunity to characterize the entire assemblage via snorkel, trapping, and electrofishing surveys, but such information is only casually mentioned throughout the document. In other words, why not record and analyze data for all species encountered during snorkel and trapping surveys.
R	<i>Chapter 1 states “Because coho salmon and steelhead trout live for more than a year in freshwater, and the conditions required to support wild coho and steelhead are highly restrictive, the species are susceptible to anthropogenic impacts to the stream and riparian systems.” Also “In the mid-1980s, local citizen groups began informally documenting wild coho spawning in Lagunitas and Olema Creeks.” Also “The life history of winter run steelhead follows the same general life cycle pattern...” The protocol was not changed from salmonid monitoring protocol because ancillary data is collected on steelhead. Although we realize the focus of the objectives are on coho, ancillary data such as fish size, redds, and number of adults are collected on steelhead. Information on non-salmonid species is also collected but our sampling techniques would require significant revisions to monitor trends for other species.</i>
C	Perhaps the greatest issue that needs to be addressed is the budget. From Table 4, it appears that the program relies heavily upon the California Fish and Game and Americorps for \$92,500 each year. This represents 62% of the entire annual monitoring budget, and those funds are only guaranteed through FY 10. That suggests that this program is not viable in the future at the proposed and current level of sampling.
R	<i>Revised Table 6 and added to budget. Monitoring priorities and budget shortfall section was also clarified along with Table 7.</i>
C	I think that the Salmonid Monitoring Program is critical, but it is doubtful that the proposed extent and intensity of sampling can be achieved thru the existing Inventory and Monitoring budget. If that high level of sampling is desired by the SFAN network, the Inventory and Monitoring program should provide additional annual funds for this protocol.
R	<i>See revised budget Table 6 and 7. While it would be ideal that funding would come from a sustainable source such as the I&M program, it has also been the vision that funding for the inventory and monitoring program will not be able to cover all costs. It is to the NPS's benefit to capitalize on opportunities such as seeking outside funding to enhance our ability to monitor NPS resources. The partnership with CDFG is a great example of sharing costs for long-term monitoring. We recognize that there are potential pitfalls in that CDFG could reduce their share of the budget. It should also be recognized that since I&M is also congressionally funded, our own funding is far from secure. The priorities outlined in table</i>

	<i>7 give us flexibility to adapt to changing funding circumstances.</i>
	I highly recommend that the authors construct a line-item budget that defines the actual costs of annual spawner surveys, habitat surveys, smolt trapping, snorkel surveys, and calibration surveys. This budget should specifically define what CDFG actually contributes (e.g. smolt trap or other) to the program. With that information, the authors can then define and implement a core monitoring program for the \$75,000 provided by the Inventory and Monitoring Program. Anything provided by other entities would add to the core NPS monitoring program. Also, the budget should account for a more realistic estimate of equipment costs (>\$2,500), particularly based on this equipment intensive protocol. There will be costs associated with replacing and maintaining electrofishers, dive suits, traps, water quality instruments, waders, nets, etc.. I recognize that the park programs probably contribute equipment, but the costs will likely exceed \$2,500/year.
R	<i>Revised Budget and Budget in Operational Requirements section of narrative, see Tables 6 and 7. The equipment cost was changed to represent the true costs. Currently the funds from CDFG are integrated into the monitoring program and it is not expected to change in the foreseeable future. The revised table 6 now shows the funds that CDFG contributes to the program and Table 7 reflects the minimum cost for each survey type.</i>
C	Lastly, I think it is great to use volunteers for monitoring, but redd counting is not conducive to volunteer efforts. It is clear that redd counting can result in high observer variability, particularly with reliance on volunteers with little experience. I recommend the use of highly trained fisheries technicians to accomplish this important work.
R	<i>As noted in the narrative “No inexperienced volunteers are used as survey reach leads. All survey leads are trained staff or trained volunteers with “experience” that can independently identify both redds and spawners.” At SFAN we have the benefit of working with many very experienced volunteers – many who have more experience than some paid technicians starting out. The monitoring program will continue to train and use volunteers for in order to meet specific monitoring objectives.</i>
C	Thank you for the opportunity to review this important monitoring program. I hope the comments prove useful to the authors, and I hope that this protocol is implemented. I wish to remain anonymous.
R	<i>Yes, the comments are very helpful.</i>
	The following line specific comments are meant to improve the clarity, brevity, and precision of the manuscript: Line Specific: [Page # correspond to January Consolidated Draft – all correlate with Narrative Protocol Section]
C	Page 2. It seems as though the “Life History” section should appear later in the document. Also, I thought this protocol was monitoring the entire fish assemblage, not solely coho and steelhead?
R	<i>Since the title of the protocol is “Salmonid Monitoring Protocol” we feel that it is important</i>

	<i>to describe the life history near the beginning of the protocol. Based on our review of the protocol objectives, information collected through this program will be focused on salmonids in order to meet the protocol objectives.</i>
C	Figure 2. Caption for Figure 2 should read “life cycle”. Images in the copy provided to reviewer were of low resolution.
R	<i>Fixed life cycle on figure2 in Life History section of narrative. Resolution seems reasonable on digital and our printer copy. We apologize if reviewer received a poor copy.</i>
C	Page 3, paragraph 1. Unclear whether authors are referring to summer or winter steelhead. I presume winter steelhead.
R	<i>Added to Life History section of narrative “The life history of winter run steelhead follows the same general life cycle pattern...” In general we only have winter run steelhead in this area so there is not a need to discuss various run types in depth.</i>
C	Page 4, top. It is important to note that the effectiveness of monitoring salmon is compromised by high variability in Pacific salmon populations and by their migratory nature. These pose inherent challenges to detecting significant trends.
R	<i>See Rational for Selecting this Resource. Ocean variability is discussed in this paragraph. Also see Power Analysis summary in narrative for discussion on ability to detect trends given the high variability.</i>
C	Page 6, Figure 3. Caption for Figure 3 should read “life cycle”. Images in the copy provided to reviewer were of low resolution.
R	<i>Fixed life cycle on figure2 in Life History section of narrative. Resolution seems reasonable on digital and our printer copy. We apologize if reviewer received a poor copy.</i>
C	Page 7, Table 1. A column at the end that shows “Duration of Monitoring” would be helpful (e.g. 1980-1999).
R	<i>I agree this would be nice however we don’t currently have this information for other agencies.</i>
C	Page 8. I recommend more specific monitoring questions and objectives. I also recommend including only those objectives that will be answered or addressed by this protocol. The sentence, “The following questions may be answered in part.....” seems unsatisfactory. As written, the monitoring objectives do not appear to be true objectives. Instead, what about 1.) Determine long-term trends in the distribution and abundance of adult coho salmon within reference??? sites of four SFAN streams; 2). Determine long term trends....juvenile coho.....
R	<i>The monitoring objectives are focused and seem reasonable. The monitoring questions stated after the objectives are retained as guidance for future efforts if funding increases or additional opportunities for focused research arise. The statement “but additional information will need to be gathered through park or partner efforts.” also clarifies that it is not the intent of this program to currently answer these questions.</i>
C	Page 10, Figure 4. I found this Figure to be too busy and confusing.
R	<i>Although we acknowledge that this is a busy figure, we feel that this figure should remain in the document as it links the monitoring proposed in the protocol directly to management issues such as introducing non-native species. This figure has been a useful tool used to explain our monitoring program to resource managers.</i>

C	Page 19 , last paragraph. Could the habitat surveys be conducted less frequently to reduce costs?
R	<i>No, see Dolloff et al 1993, habitats will change annually due to variations in flow.</i>
C	Page 21, paragraph 2. Redd surveys can be effective for steelhead, and should be considered. Disagree with the last sentence in the paragraph. These surveys are used widely throughout Oregon and Washington to estimate returns of adult steelhead. If you have the crews during the spawning period, it would be good to consider surveys for steelhead.
R	<i>In narrative, Sampling Design Overview, Winter Season, the last sentence was removed and replaced with the following sentence. “Field crews will indentify steelhead redds, live fish, and carcasses when possible but will not have the available resources to perform surveys during the entire steelhead spawning period (December through May).” The author agrees with the reviewer that steelhead spawner surveys are possible but as stated before the program has decided to focus on coho since their habitat is more confined within the monitored watersheds. In addition steelhead have a spawning window of over five months and the added cost to continue surveys does not justify the loss in personnel time for other surveys such as smolt trapping.</i>
C	Page 29, Table 4. This table is useful, but would benefit from more specificity. For instance, could you: 1) define months for summer, winter, and spring; 2) add a column on frequency of surveys and number of surveys; etc.
R	<i>Revised table 4 as requested.</i>
C	Page 39, first sentence. Does this mean project lead and two technicians for 26 pp?
R	<i>See Ch. 7 Operational Requirements revised itemized budget in Table 6.</i>
PRC Comments	
C	The salmonid protocol initially covered more streams than at present. There is no current plan to monitor fish at PINN or JOMU (at least nothing outlined in the plan) so references to those two parks should be removed.
R	<i>Revised the narrative Study Area section to clarify the issue of various parks. Author feels the need to keep reasoning behind excluding JOMU and PINN in the protocol since these are two other parks served by the network I&M program.</i>
C	The “double-strike” font (p. ii, p. xiv, and other places) is visually disruptive. Please convert these to a regular-looking font. the consecutive numbering of pages is good, but sometimes the tables and figures in the text have an old (apparently) numbering scheme and one figure (figure 5) was left out, throwing off all the subsequent figure numbers. An SOP for training field personnel and ensuring safety is needed.
R	<i>Double strike font ws removed. An SOP on training field personnel and safety was added.</i>
C	A single table of contents would be helpful (for narrative, SOPs and Appendixes) moving the TOC for SOPs from page xiv to v 9and also the TOC for Appendixes)

R	<i>The list of SOPs was augmented to the main TOC. However, the list of Appendixes are provided after the list of tables and figures to be consistent with other TOC developed by the network. Detailed TOC are now provided for longer SOPs within those SOPs.</i>
C	Figure 5 (priority watersheds) was left off the figure numbering system, so all the figures listed on p. x after Figure 4 should be renumbered (current 5 to 6, 6 to 7, etc.).
R	<i>Fixed caption issue with figure 5 which fixed the numbering system throughout the document.</i>
C	Although on page 1 several SFAN parks are listed, in reality only four streams in the GOGA/PORE/MUWO area are proposed for monitoring. The protocol needs to be clear about this.
R	<i>Removed JOMU from Introduction and Purpose on page 1 so that only GOGA, PORE, and MUWO are stated.</i>
C	P1. Fong et al. in press is not in literature cited.
R	<i>Corrected on page 53 of Literature Cited “Fong, D., D. Press, and M. Koenen. 2009. San Francisco Bay Area Network (SFAN) streamflow monitoring protocol v2.87. Natural Resource Report. National Park Service, Fort Collins, Colorado.”</i>
C	P8. There are no procedures to monitor fish at JOMU or PINN, so how can “the following questions..be answered in part by this monitoring protocol?”, specifically how is fish diversity changing within Franklin Creek at JOMU and within Chalone Creek at PINN?
R	<i>This monitoring question has been removed from the document.</i>
C	P15. Study area does not encompass JOMU and PINN. Last paragraph: so is JOMU a medium priority, as PINN is specifically excluded but JOMU not?
R	<i>Revised Narrative Ch. 2 Sampling Design, Study Area “Medium priority streams include watersheds that lie within GOGA, PORE and JOMU.”</i>
C	P17, par. 1 l.4: ‘its’, not ‘it’s’
R	<i>Corrected</i>
C	P20, par 3, l2. Dolloff et al. (1993)
R	<i>Corrected</i>
C	P20, last par. The references to tables and figures need to be updated. I think the tables and figures originally were modular (starting with table and figure 1 in each SOP) and now are continuous. Table 1 of SOP 9 is now table 23, and Figures 1-2 would be Figures 34-36.
R	<i>Fixed number issue especially with figures and with Seasonal Sampling Design section of Narrative to reflect the continuous numbering currently present in the document.</i>
C	P22. Figure 1 should be Figure 6. References to Figures 5 and 6 in last par. should be 6 and 7. As the figures are all off by 1 from now on, I won’t further mention that these need to be renumbered and carefully referenced in the text.

R	<i>Corrected figure numbers</i>
C	P27, last line: Dolloff et al. (1993).
R	<i>Corrected</i>
C	Literature cited. This needs a major cleanup. Of the 82 citations, only 38 are cited in the text. The other should be removed.
R	<i>These other citations were in the SOPs. We have removed them and now made Literature Cited for each SOP.</i>
C	The ones I found in the text include Anderson and McGuire, Bjorkstedt, Brown and Ketcham, Brown et al. 1994, CDFG (all four) Carlisle et al., Collins, Cooperrider and Carson, Dolloff et al., Downie and Petersen, Duffy, Garza and Gilbert-Horwath, Gurka, Hankin and Reeves, Irvine et al., Johnston et al., Ketcham et al. (the 2004 ones), Moyle et al., ODFW, Palmer, Percy, PFMC, Piepho and Oguto, Pollard et al., Press, Reichmuth et al. (all three), Rodgers et al., Schwarz, Starceвич, Van Leeuwen et al., and Williams et al.
R	<i>Removed all SOP specific citations, added missing citations, and removed citations that were not in the text.</i>
C	Individual citations that need editing: Bjorkstedt: change the font on web citation. CDFG: order by year: 1978 first, etc. Fong et al (from p. 1) missing Garza and Gilbert-Horwath. Latter author needs initials Ketcham et al. (last one) – assume this is 2004c from page 5? Reichmuth et al. there are two of these, both listed as 2006. One needs to be “a” and one “b”. P169. For Bi-annual CDFG permit, it’s “principal investigator” P253-256 missing, text goes from 252 to handwritten 257.
R	Bjorkstedt: citation.- <i>citation is now within NRTR guidelines</i> CDFG: order by year: 1978 first, etc.-<i>fixed</i> Fong et al (from p. 1) missing- <i>found and fixed “(Fong et al. 2009)”</i> “Garza and E.Gilbert-Horwath.” <i>Corrected.</i> Ketcham et al. (last one) – assume this is 2004c from page 5?- <i>Yes, fixed</i> Reichmuth et al. there are two of these, both listed as 2006. One needs to be “a” and one “b”. – <i>fixed smolt report is “a” and watershed report is “b”</i> P169. For Bi-annual CDFG permit, it’s “principal investigator” – <i>(R) corrected</i> P253-256 missing, text goes from 252 to handwritten 257. – <i>(R) I do not see this mistake on my digital copy.</i>

	Reviewer #1 Comments:
	Overview: This is an impressive document that describes the rational for and elements of a program for monitoring salmon and steelhead in San Francisco Bay area National Parks. The presentation of information is straightforward and, for the most part, easy to follow. The authors should be commended for documenting and seeking peer review of their monitoring program.
	Background and objectives: This section provides adequate background for the monitoring program. I offer the following comments for helping the reader understand this section: 1. The background (chapter 1) describes the SFAN and states that data collected will help evaluate changes in fish communities in the SFAN. Monitoring described here is, however, restricted to the Point Reyes National Seashore streams. I recognize that their may be agency requirements for this description of the area, but it would be more accurate to focus on Redwood, Olema and Pine Gulch creeks or PORE. 2. The conceptual model presented is process oriented and not very helpful in understanding linkages among life stages being monitored. I encourage the authors to consider simplifying this model and focusing on what the information from each life stage is providing. 3. The objectives are constructed around sampling methods for different life stages, leading to redundancy and some confusion. For example: objective 3 includes gathering information on condition from snorkel surveys – something that is not possible. I encourage the authors to think about response measures (abundance, size, condition) and to use these measures in stating objectives.
R	1. <i>Monitoring is proposed for both PORE and GOGA streams and is focused on Redwood, Olema, and Pine Gulch Creeks as stated in the Study Area section of the protocol narrative.</i> 2. <i>Authors feel that it is necessary to provide linkages to management. The conceptual model provides a direct link from monitoring to processes that may be managed by the parks. This will be an important tool for parks to use when developing a natural resources maintenance backlog that can be utilized to prioritize funding allocations.</i> 3. <i>Objectives were reworded so that they are constructed around desired trend. Sampling methods are retained in the objective to be clear about how trend will be determined. I understand the ambiguity with using the word “snorkel” in objective 3 and agree that condition can not be obtained using snorkel surveys alone. The word “snorkel” was removed from objective 3 as these surveys include both snorkel and electrofishing phases. The revised objective which states GSS implies the use of snorkel surveys combined with electrofishing as a calibration measure.</i>
	Sampling design:

	The sampling designs for adult salmon and smolts are appropriate and defensible. The sampling design for juvenile salmon, however, incorporates both randomized snorkel observations of pools and electrofishing of index reaches. The continuation of sampling index reaches should be reconsidered. Discontinuing long-term data sets is always problematic. However, if these long-term data sets are providing biased information they compromise their usefulness. The authors acknowledge that previous reviewers have cautioned that index reach sampling cannot be used to make inferences about basin (population) responses. Furthermore, making inferences about the population status is implicit in the objectives stated earlier. The basic problem is that habitat conditions change with hydrology. During wet years, coho salmon will use areas unavailable during drier years. Conversely, during dry years, the area occupied by coho salmon will contract. Imagine an index reach located in an area of transitional habitat. During drier years you might find few coho salmon in this reach and conclude that abundance declined when in fact the distribution simply shifted downstream. I recommend phasing out index reach electrofishing as follows: 1) begin using electrofishing to validate snorkel observations such as suggested by Hankin and Moore. 2) if overlap of randomly selected sites with index sites is insufficient, include some index reaches, and finally 3) set a time for comparing index reach data with randomly selected site data. Test for differences and move on.
<i>R</i>	Reviewer 1 suggests that electrofishing of index reaches be discontinued, while reviewer 2 suggests they be continued (as “low effort juvenile sampling”). Given the tenor of the comments, it seems that there is value for electrofishing (length of record, other issues identified by reviewer 2), so I would agree with reviewer #2 on this, given that acknowledgment of the potential biases of this method are stated. The remainder of the comments of the peer reviewers are clear and can be addressed individually. <i>Excerpted from peer review guidance from Dr. Agee. We acknowledge that there is bias with this method and note this in the text.</i>
	Analytical techniques: The analytical techniques described in the report are current and appropriate. My only concern is with the smolt trapping methodology. My observations have been that expanded estimates of smolt movement can be strongly biased by: 1. Failure of marked coho salmon smolts to move after capture. That is, a smolt is capture and marked, then re-introduced so as to test trap efficiency. If for behavioral reasons, that fish does not continue migration the number of marked fish at large is, in effect, smaller than assumed in calculations. 2. A basic assumption of all mark-recapture experiments (smolt trapping) is that the proportion of marked individuals does not change during the experiment. However, salmon smolts respond to environmental cues and often move in pulses. Assume you mark some constant fraction of the smolts entering the trap. If on day one you capture 5 smolts and mark all 5 of them (100%), then on day 2 a pulse of 50 smolts enters your trap. Instead of having 100% of the population marked you have only

	10% of the population marked. This day-to-day variation in proportion of marked individuals, I think, contributes to inflation of production estimates. Neither of these problems is unique to this monitoring program and are not stated as criticisms. Rather, I bring them up in hopes that you may find a creative solution to them.
<i>R</i>	<i>We will do our best to find a creative solution for the problems in the future. In the meantime, we are using the best available and accepted methods and the current estimator for smolts from the peer reviewed literature.</i>
	Reviewer #2 Comments
	The sampling protocol is relatively well thought out, and I support most of the protocol. The following comments deal with clarifications or changes that I feel would substantially strengthen the monitoring effort. Report locations in <u>bold underline</u> relate to the comments preceding the references.
	General Overview of Challenges for Sampling 1. Coho in central (and much of northern) California are substantially locked in a 3 year life cycle of production, since most females are 3 years old at maturity. One consequence is that tracking abundance should follow the 3 relatively independent cohorts (as recommended in the protocol). A second is that the impacts of “bad” years and weak year classes can repeat as a legacy every 3 years. In addition, the fixed life cycle and early winter spawning means that central coast coho are subject to substantial risk of year class failure or suppression due to winter drought (or even rainfall delay) affecting adult access, or to smolt outmigration during drought or to redd destruction by large mid to late winter storms. Even in the freshwater, stochastic events can be major potential drivers of year class abundance. The more recent impacts of adverse ocean conditions have had further devastating impacts upon coho year class strength. <u>Therefore</u>: the most substantial implication of the above conditions is that analyzing “power of test” to detect a decades-long 10% or 30% or even a 50% change in coho populations may not be biologically realistic for populations that have shown 2 orders of magnitude difference in density between the 3 different year classes (1994 vs 1995 and 1996) or even between individual years of the same year class (1994 to 1997 to 2000). <u>(page 13, 1st paragraph and throughout the protocol)</u> <u>Therefore</u>: even the index sampling reaches are capable of detecting the large differences in year class strength that have been observed over the 15+ years. The electro-fishing sampling of index sampling reaches should be continued as a low effort juvenile sampling because of their long-term record and as a source of age and size data for juvenile coho (see below).
<i>R</i>	<i>We plan to maintain the index reach monitoring as a low effort juvenile monitoring study.</i>
	At very low spawner density the few fish present frequently spawn and “disappear” without being

	detected by even the intensive spawner surveys. Juvenile fish are often present (often at substantial densities in small streams, where a few redds can nearly saturate rearing habitat) when apparently no adults were present. <u>Therefore:</u> in poor spawner years the monitoring effort may have to be increased to gage abundance or even presence of adults. A similar problem exists for fall sampling in poor years, when the few juveniles may be very spotty in their distribution within the watershed and within a few pools (usually the “best”) even in reaches where they are present. <u>(Page 21, spawner reaches, last paragraph) (page 28, Winter Surveys)</u>
R	<i>Sampling for adults is currently performed at its maximum frequency while maintaining a safe work environment. It is not possible to complete stream coverage more than once a week with our current crew size. Conducting multiple life stage monitoring will also help us gage our survey accuracy.</i>
	3. Deviations from the 3 year life cycle are a potentially crucial factor for monitoring. Adult returns will include a variable, but significant, fraction of males that spend only 1 summer in the ocean. These 1 year ocean male are important for maintaining gene flow between the 3 numerically relatively independent year classes. Demographically, the potentially large differences between strength of consecutive year classes, means that 2 year old males must be recorded separately from 3 year old males in the adult spawner counts (which the protocol calls for but does not emphasize the importance of accurately distinguishing age). In a very weak year class preceding a strong year class, it is possible for a majority (or most) of the adults to be (precocial) males. A large “adult run” may have very low potential egg and juvenile production. <u>(page 2, life history is correct “in general”, but the deviations are of substantially ecological significance)</u> <u>Therefore:</u> Scales may have to be taken from many intermediately-sized fish (among carcasses) to clearly determine the appropriate rearing age class. <u>(page xxii, monitoring object 1 on winter surveys)</u>
R	<i>Scales are currently sampled from all carcasses for the purpose of ageing. Although a scale analysis is not part of our current monitoring objectives, we are currently working with researchers from U.C. Berkeley to analyze both adult and juvenile scale samples. For live fish precocial males are visually estimated based on size and clearly noted when presenting results. See SOP 5 Live Fish Section “Most coho salmon are three years old at spawning. However, a variable proportion of precocious two year old males also return to spawn. These smaller males are commonly referred to as “jacks”. Age can not be accurately determined without carefully analyzing annual growth rings on scales. However, most jacks are less than 50 cm (20 in) long and are much smaller than the three-year olds.</i> <i>Live Fish:</i> <i>Note the sex and approximate length to the nearest 5 cm of all live fish. If you</i>

	<i>cannot positively identify a fish's sex, use the ? option. Surveyors should make every effort not to disturb spawning fish. Actively spawning fish can be observed safely from a vantage point on the bank. "</i> <i>Also see carcass section "In addition to counting and noting the location of carcasses, we are also interested in collecting tissue samples and scales for genetic and age analysis."</i>
	Similarly, a portion of juvenile coho spend more than 1 year in freshwater. In Waddell and Scott creeks in Santa Cruz County, the small percentage (about 2%) of yearlings cannot readily be recognized by size difference (length-frequency), because the fish grow relatively little in their 2 yearst in the stream. These holdovers are not the runts (runts don't survive the 1st winter) but are from the larger half of the young-of-year. Yearlings tend to be among the larger half of the juveniles, but because of substantial variation in fish size within and between sites, they can only be distinguished by checking scales. In a weak year class following a strong year class, the small percentage of holdover yearlings can constitute a substantial portion (in some cases in Scott and Waddell, all) of the weak "year class". In Prairie Creek the percentage of yearling coho has been found to be substantially larger because of generally very slow coho growth. The situation in Marin streams may be similar to Santa Cruz or somewhere between Prairie Creek and Santa Cruz. <u>Therefore:</u> scale samples should be taken from coho captured during fall electro-fishing and from spring smolt trapping to determine ages in at least the weaker year classes. Because of their somewhat larger size, and having survived 1 previous winter, yearling coho may have disproportionally high winter survival and be a much higher proportion of smolts. Coho juvenile ages are given passing mention in the protocols, but should be emphasized as a crucial monitoring metric. Analysis (back-calculation) from smolt scales also provides information on how much of the smolt's size was due to growth in late winter and spring (which probably substantially varies among years due to water temperatures and turbidity). <u>(page xxii, monitoring objectives 2, 4, smolt and fall sampling objectives) (page 28, Index Reach Surveys and Spring Surveys)</u>
R	<i>Although we are interested in taking scales from juvenile and smolt life stages we currently can only do such sampling on years when fish abundance is low due to the current staffing level and work load. During years of high coho abundance field staff are completely absorbed with collecting size information and marking fish.</i>
	4. Smolt numbers and sizes are a better measure of freshwater production than fall juvenile numbers because of the importance of over-winter mortality. However, a potentially substantial number of smolts may be inefficiently sampled in late winter and spring because of movement during storm flows. Even with a large and expensive weir, the Shapolvalov and Taft (1954) study at Waddell Creek cautioned that their smolts counts had problems in some years and that they had no way of checking on the magnitude of winter movements that were missed. <u>(page 12, 1st paragraph, smolt surveys)</u> <u>Therefore:</u> both fall juvenile sampling (with measurement of fish sizes) and spring smolt sampling (with fish sizes and scales, #2) is needed. Stream flow related cautions in using smolt "counts" and attempts to determine trapping efficiency in higher flows are needed.

	<u>(page xxii, monitoring objective 2, smolt trapping)</u>
<i>R</i>	<i>We agree with this comment and this is one of the reasons why we are using a multiple life stage monitoring design in this protocol and why smolt trapping is prioritized above juvenile monitoring in case of reduced funding.</i>
	5. Although coho sampling is the subject of this set of protocols, the value of enumerating other fish species is mentioned as a way monitor watershed condition. However, sculpins (<i>Cottus asper</i>, <i>C. aleuticus</i> and <i>C. gulosus</i>) are difficult to sample with an electro-fisher. Their cryptic nature and concentration is cover or in shallow, fast-water habitats also means that observational data have little validity. Getting good sculpin numbers requires too much effort and subjects salmonids to additional electrofisher effort; the informational value for assessing stream health is minimal compared to the substantial effort and reduced salmonid sampling efficiency. This is especially true for the high densities of <i>C. gulosus</i> found in upper Redwood Creek. <u>Therefore</u>: Noting general abundance and species composition of sculpins (and threespine stickleback) is probably sufficient; population abundance data should not be a goal. <u>(page xxii, last sentence of 1st paragraph, other species)</u>
<i>R</i>	<i>Changed sentence in Executive Summary “and any other species incidentally encountered during sampling.”</i>
	6. The coho sampling protocol emphasizes sampling pools, where most of the coho are normally found. However, at progressively higher densities coho spread out from the deeper pools to shallower or simpler pools and then to shallow glide and run habitats. The protocol calls for systematic sampling of pools (including potentially all depths and qualities, but the electro-fisher sampling will include some other habitats that may show this shift. For steelhead most yearlings are also in pools, but a substantial percentage of young-of-year fish are in shallow habitats (runs and riffles). When coho are abundant they also substantially exclude young-of-year steelhead from the pools. The coho protocols will not give good proportional information on the year to year abundance of steelhead. <u>Therefore</u>: Sampling for steelhead will have to be modified and include more sampling of riffle and run habitat by electro-fishing. Additionally, where and when coho are abundant, coho abundance will be a (the) dominant factor in steelhead abundance, and affect interpretations of steelhead “trends” <u>(page xxii, last sentence of 1st paragraph, steelhead sampling).</u>
<i>R</i>	<i>For this very reason we have clearly stated throughout the protocol that we are focusing monitoring efforts on one species, coho salmon. If more resources become available we will expand the monitoring program to increase our knowledge on the status of steelhead within the parks. Past observations in these watersheds are consistent with this comment. However, we are using the methods described by Dollof et. al. in 1993 which is focused on pools and has not been adapted for other unit types.</i>
	Other minor comments:

	Page 7, Table 1 and 1 sentence in paragraph 1. Waddell/Scott creeks are in Santa Cruz County, but sampling has also been conducted on Gazos Creek in San Mateo County.
<i>R</i>	<i>See Narrative, Other Regional Monitoring Programs, Table 1 added Gazos Creek, fixed county of origin, and added NMFS to agency for Redwood, Gazos, Waddell, and Scott Creeks.</i>

SOP 8. Data Management

Version 1.3

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
NA	July 2008	D. Press	First draft of SOP.		1.0
1.0	August 2008	D. Adams	Formatting	NRTR template	1.1
1.1	December 2008	Michael Reichmuth	Minor edits	For peer review	1.2
1.2	November 2009	Michael Reichmuth	Added Lit Cited	Peer review response	1.21
1.21	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	1.3

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Overview

Two critical long-term goals of the San Francisco Bay Area Network (SFAN) Inventory and Monitoring Program (I&M) are to:

- integrate natural resource inventory and monitoring information into National Park Service (NPS) planning, management, and decision making
- share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives

For the stream fish monitoring program to meet I&M Program goals, a detailed management plan is needed to ensure data quality, interpretability, security, longevity and availability.

This SOP describes how the monitoring protocol meets these data management objectives through data entry specifications, database design, quality assurance and control measures, metadata development, data maintenance, data storage, and data archiving. In this SOP, particular attention is paid to the use of three Microsoft Access project databases used to store and maintain winter spawner, spring smolt, and summer juvenile stream fish monitoring data. Procedures for data handling and quality assurance/quality control for all monitoring protocols implemented by the SFAN monitoring program are detailed in the program's Data Management Plan (Press 2005) and in the National I&M Program's Data Management Plan (National Park Service 2008). All literature cited references are provided in the protocol narrative.

Database Designs

Smolt Monitoring Database

The SFAN staff has continued to use a relational Microsoft Access database for the smolt monitoring program originally designed in 1999. The database has undergone some fundamental design modifications since the SFAN I&M program began its oversight of the program, but the basic data fields stored in the database have remained relatively unchanged. The last significant changes to the database occurred in the winter of 2005 when the SFAN data management staff performed a thorough review and clean-up of all legacy data stored in the database and modified the table design to its current form. The database is titled *Smolt_MasterXP.mdb*.

The data in the smolt database are simply organized around field events, where a different event is represented for each day and each smolt trap that is checked by the field staff. The survey or event data is related to the counts of fish species collected in the trap on that day, fish measurements (weight and fork length), and the list of field staff present on the survey.

Table Structure: Table relationships for the stream fish smolt database are presented in SOP 8.1. The database meets basic compliance with the Natural Resource Database Template (NRDT), an application developed by the NPS I&M Program. Data organization is based on the concept of surveys, occurring at a specified date, time, and location, recorded in an event table. The EventID field in the event table serves as the database primary key, and links to related tables in the database associated with the survey events. The LocationID field in the event table links to the locations table, thus providing a geo-spatial reference to the data. EventID and LocationID codes provide the unique keys for databases built on the NRDT model.

Event data is represented in the smolt database by the table *tblSmoltSurveys*. A new record is generated each time a smolt trap is checked. *TblSmoltSurveys* stores data relating to date, time, location, general weather and stream conditions, and additional comments on the status of the smolt trap.

Each record in *tblSmoltSurveys* is linked to *tblLocations* by the LocationID field. In general, the field staff places smolt traps in the same location on each monitored stream every year. However, smolt trap locations have and will continue to vary slightly over the years due to access issues and stream conditions. The LocationID value is an information-rich text code that identifies the stream, based on the stream code, and years of use for each smolt trap location. For example, OL-01-SMOLT-2000-2005 would represent the smolt trap location on the Olema Creek Mainstem (stream code OL-01) for the years 2000 to 2005. Fields in *tblLocations* that provide a spatial reference for the smolt trap locations include X_Coord, Y_Coord, Coord_System, Datum, and UTM_Zone. A descriptive location and directions to the smolt trap can be provided in the memo field Loc_Notes.

TblSmoltCounts catalogs the counts of each species collected in the smolt trap each time it is checked. For some species, such as coho salmon and steelhead trout, it is essential that separate count records are entered for each life stage of the species captured. For example, separate fish count records should be entered for coho smolts, parr, and fry. The count record for each species/life stage is divided into the live count and dead count. In addition, the number of new fish, recaptured fish, and fish marked is indicated in the count record. The total number of fish caught for each species/life stage can be calculated by summing LiveTotal plus DeadTotal or by summing New plus Recaptured. The field Species uses codes to denote the species captured, which is linked to the look-up table *thuSpecies*. *ThuSpecies* indicates scientific name, common name, and TSN for each species.

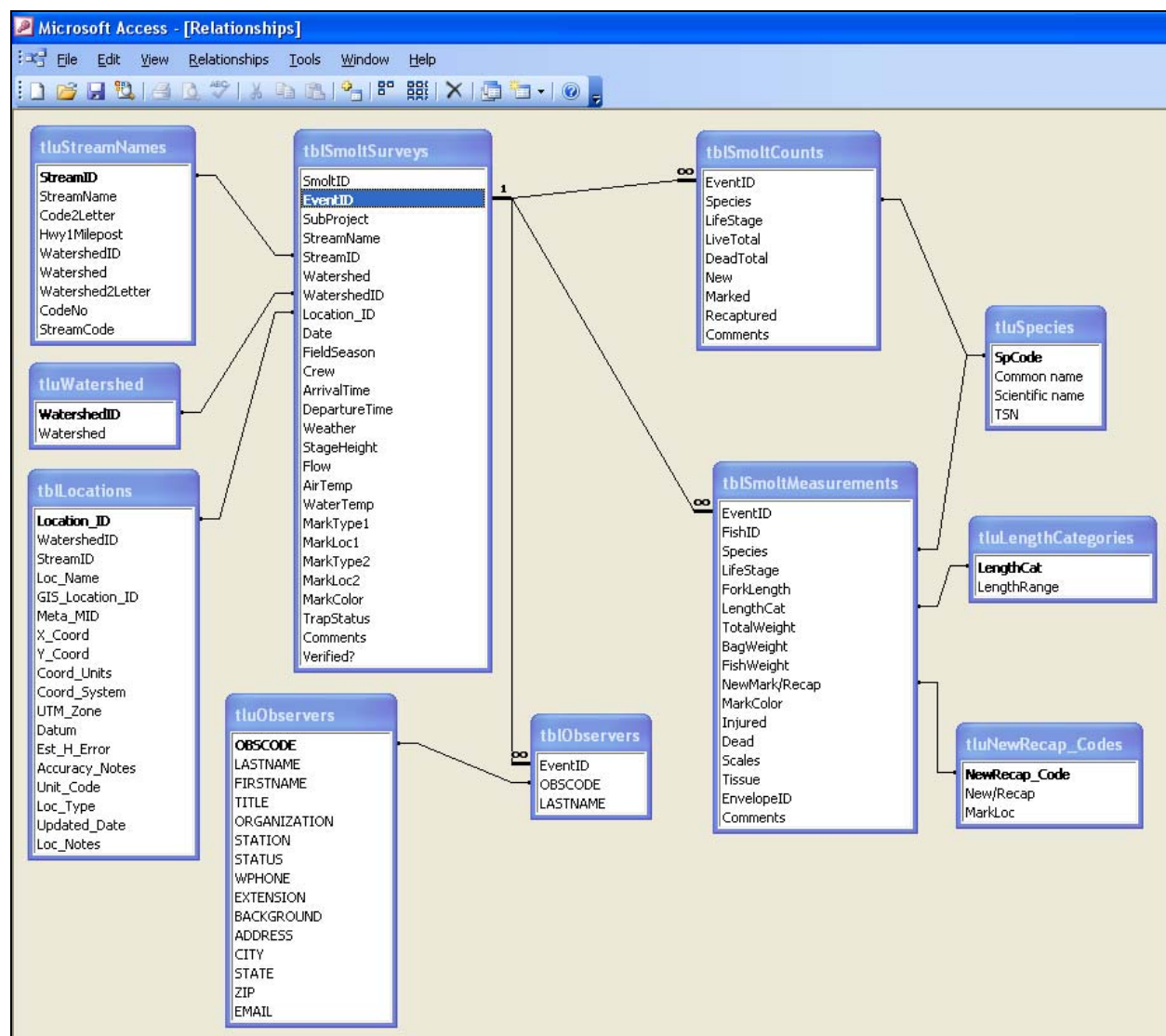


Figure SOP 8.1. Table relationships in the master smolt database, Smolt_MasterXP.mdb.

Not all fish that are captured are measured (see SOP 4. Spring Smolt Trapping), but records of those fish that are measured are entered into *tblSmoltMeasurements*. The table stores individual fish fork length, fish weight (TotalWeight-BagWeight), fish mark location if applicable, and fish mark color if applicable. Check boxes note if the measured fish was injured or dead. Mark location code and mark color fields are applicable to both newly marked fish and recaptured fish, with the difference noted in the mark location code used. For example, values of NLC and RLC in the NewMark/Recap field stand for new and recaptured lower caudal mark locations, respectively. The mark location codes are linked to and defined in the look-up table *tluNewRecap_Codes*. For ease of summarizing and reporting, each fish is assigned a numeric length category based on fork length. The field LengthCat is linked to *tluLengthCategory*, in which each LengthCat value is defined by a 5 mm length range. For example, a fork length of 108 mm is assigned a length category of 19, which indicates a length range of 106-110 mm. Finally, each fish in the fish measurements table is assigned a numeric FishID value, a simple

AutoNumber field. The FishID helps to keep the records listed in the order in which they were entered, which is essential for error-checking the data.

Field staff and volunteers present when checking the smolt traps are listed in *tblObservers*. Codes based on the first two letters of the last name and first name are used to record observers. Each observer code is listed in *tblObservers*, where the corresponding observer's first name, last name, and contact information are maintained.

The EventID field is used to link the primary table *tblSmoltSurveys* with related records in the secondary tables, *tblSmoltCounts*, *tblSmoltMeasurements*, and *tblObservers*. As recommended in guidance for the NRDT Version 3.1 (National Park Service 2006), the EventID is an automatically generated globally unique identifier (GUID). In MS Access, a GUID is a type of binary autonumber field that is sometimes referred to as a Replication ID. Like integer autonumbers, GUIDs are automatically generated but are extremely unlikely to be repeated among different MS Access databases. *tblSmoltSurveys* has an additional SmoltID field, which is a simple AutoNumber field. The SmoltID field is primarily used to perform quick searches for particular records of interest.

User Interface and Data Entry: The smolt monitoring database employs one simple data entry form, *frmSmoltSurveys*, within which are embedded three subforms for entering fish count, fish measurement, and observer records (figure SOP 8.2). The subforms are respectively titled *sbfSmoltCounts*, *sbfSmoltMeasurements*, and *sbfObservers*. The observers subform passes data through the query *qryObserver_DataEntry*, which allows for display of the full name of the corresponding OBSCODE in the data entry window.

The macro titled *mcrSmoltForm* runs a few actions within the smolt data entry form. First, once the stream name is entered, the StreamID, Watershed, and WatershedID fields in *tblSmoltSurveys* are automatically generated by looking up these related values in *tblStreamNames*. Second, the macro opens *frmObservers* when the "Add New Observer" button is clicked. Once the user has entered the new observer name and contact information into the form, the macro requeries the OBSCODE drop-down list in the observer subform.

Visual Basic code embedded in the fish measurements subform performs two operations. First, the FishWeight value is calculated by subtracting the BagWeight from the TotalWeight. Second, the appropriate LengthCat (length category) code is generated based on the ForkLength value.

Pipe Trap

**National Park Service
Downstream Migrant Trap Data**

Add Record Close Form

Date: 5/26/2007 Water Temp: 12
 Stream: Redwood Creek Mainstem Weather: overcast, cool
 Arrival Time: 11:00 Departure Time: 11:40
 Stage Height: This Week's Mark: Type 1: Panjet
 Comments: one recap smolt escaped Location 1: Anal Color: blue
 TrapStatus: Working Type 2: Location 2:

Observers

OBSCODE	Full Name
KEME	Kelso, Megan
CASA	Carlisle, Sarah

Record: 1 of 2
Add New Observer

Fish Measurements

fishID	Species	LifeStage	ForkLength	TotalWeight	BagWeight	FishWeight	LengthCat	NewMark/Recap	MarkColor	Dead	Ir
20462	CO	Smolt						RAAC	blue	☐	
20463	CRAY		110				19			☐	
20464	RSN		155				28			☐	
20465	SH	Fry	66	3.14	0.5	2.64	11			☐	
20466	SH	Fry	46	1.04	0.01	1.03	7			☐	
20467	CO	Smolt	102	10.74	0.58	10.16	18 NA		blue	☐	
20468	CO	Smolt	110				19 RAAC		blue	☐	

Record: 1 of 22

Fish Counts

Species	LifeStage	LiveTotal	DeadTotal	New	Marked	Recaptured	Comments
CO	Smolt	10	0	5	4	5	
SH	Fry	12	0	12	0	0	
CRAY		1	0	1	0	0	
RSN		1	0	1	0	0	
*		0	0	0	0	0	

Record: 1 of 4

SmoltID: 1486
Verified: ☒

Record: 1486 of 1490

Figure SOP 8.2. Smolt monitoring data entry form.

Spawner Monitoring Database

The SFAN staff has continued to use a relational Microsoft Access database for the spawner monitoring program originally designed in 1997. The database has undergone some fundamental design modifications since the SFAN I&M program began its oversight of the program, but the basic data fields stored in the database have remained relatively unchanged. The last significant changes to the database occurred in the winter of 2005 when the SFAN data management staff performed a thorough review and clean-up of all legacy data stored in the database and modified the table design to its current form. The database is titled Spawner_MasterXP.mdb.

The data in the spawner database are simply organized around field events, where a different event is represented for each survey of a particular stream reach performed by the field staff and volunteers. The survey or event data is related to the observations of spawning coho salmon or steelhead trout and the measurements of redds encountered during the survey. See SOP 5 (Spawner Survey) for additional survey information and methods.

Table Structure: Table relationships for the stream fish spawner database are presented in Figure SOP 8.3. The database meets basic compliance with the NRDT, an application developed by the NPS I&M Program. Data organization is based on the concept of surveys, occurring at a specified date and time, recorded in an event table. The EventID field in the event table serves as the database primary key, and links to related tables in the database associated with the survey events. The SectionCode field in the fish and redd measurement tables links to the stream tag table, thus providing a geo-spatial reference to the data. The SectionCode field, which represents a 100 m stream length, marked in the field at the downstream end with a tree tag, is equivalent to the LocationID field in the NRDT.

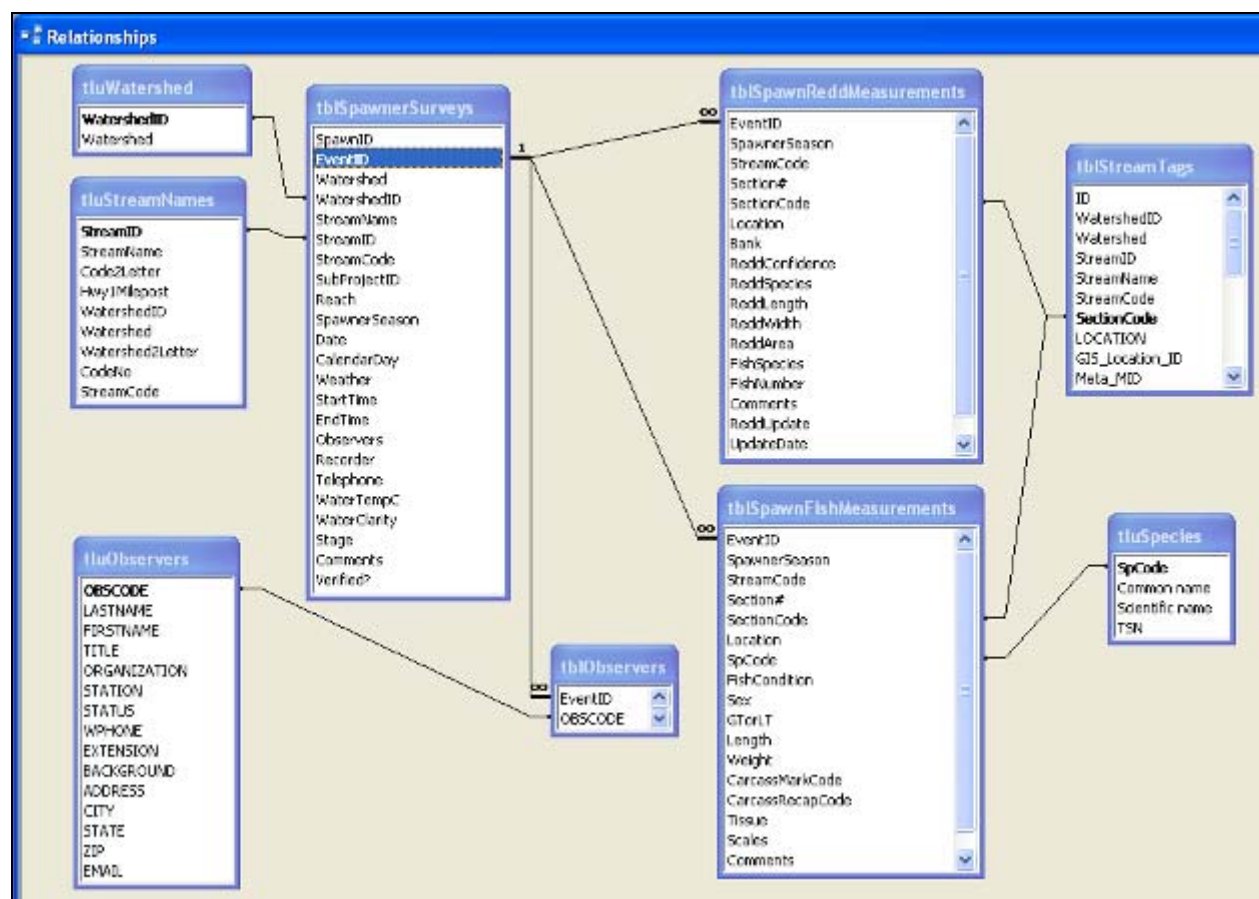


Figure SOP 8.3. Table relationships in the spawner monitoring database, Spawner_MasterXP.mdb.

Event data is represented in the spawner database by the table *tblSpawnerSurveys*. A new record is generated each time a survey is performed on a particular stream or stream reach.

TblSpawnerSurveys stores data relating to stream name, survey reach, date, time, general weather and stream conditions, and additional comments. To assist with grouping and summarizing the data by field season, each survey is attributed to a spawner season, such as 2007-2008. This is particularly helpful since the runs of spawning salmonids in the SFAN parks generally occur between December and February.

TblSpawnFishMeasurements stores all coho salmon and steelhead trout encountered during the survey. The field SpCode uses codes to denote the species observed which is linked to the look-up table *tluSpecies*. *TluSpecies* indicates scientific name, common name, and TSN for each species. Both live and dead fish are recorded in the table, which is specified in the field FishCondition. Fish length measurements are stored in the table, which must be estimated for live fish. Fish carcass information additionally includes weight, checkboxes if tissue and scales are taken, and an indication of the carcass mark code if one was applied or observed (see SOP 5).

Redd measurement data is stored in the table *tblSpawnReddMeasurements*. All redds observed are attributed to either coho or steelhead, if known, in the ReddSpecies field. The position of the redd is noted as right bank (RB), left bank (LB), or mid-channel (MC) in the Bank field. The table calculates redd area from the redd length and redd width fields. In addition, the species and number of fish attending the redd when it is observed are recorded in the table. Finally, because redds may be encountered on multiple surveys and their dimensions may change over time, the ReddUpdate and UpdateDate fields indicate if and when the data relating to a particular redd is changed.

The location of each fish or redd observed during a spawner survey is referenced to the nearest downstream 100 m section tag. Each tag, entered into the SectionCode field, represents the beginning of a 100 m stream section. The Location field indicates how many meters upstream from the nearest tag that the observation was made. For example, SectionCode “RW-01-38” and a Location value of 20 indicates that an observation was made 3.8 km plus 20 m upstream on the Redwood Creek Mainstem (stream code RW-01). Stream codes for each stream monitored are cataloged in the table *tluStreamNames*. Stream tag locations are stored in *tblStreamTags*. Fields in *tblStreamTags* that provide a spatial reference for the tag locations include X_Coord, Y_Coord, Coord_System, Datum, and UTM_Zone. In addition, the Loc_Notes field indicates the tree species and stream bank where the tag is located.

As with the stream fish smolt database, field staff and volunteers that conduct the spawner survey are listed in *tblObservers*. Each observer code is listed in *tluObservers*, where the corresponding observer’s first name, last name, and contact information are maintained.

The EventID field is used to link the primary table *tblSpawnerSurveys* with related records in the secondary tables, *tblSpawnFishMeasurements*, *tblSpawnReddMeasurements*, and *tblObservers*. As recommended in guidance for the NRDT Version 3.1 (National Park Service 2006), the EventID is an automatically generated GUID. *TblSpawnerSurveys* has an additional SpawnID field, which is a simple AutoNumber field. The SpawnID field is primarily used to perform quick searches for particular records of interest.

User Interface and Data Entry

The spawner database employs one simple data entry form, *frmSpawnerSurveys*, within which are embedded three subforms for entering fish observations, redd observations, and observer records (figure SOP 8.4). The subforms are respectively titled *sbfSpawnFishMeas*, *sbfSpawnReddMeas*, and *sbfObservers*. The observers subform passes data through the query *qryObserver_DataEntry*, which allows for display of the full name of the corresponding OBSCODE in the data entry window.

The macro titled *mcSpawnerForm* runs a few actions within the spawner data entry form. First, once the watershed and stream names are entered, the WatershedID, StreamID, and StreamCode fields in *tblSpawnerSurveys* are automatically generated by looking up these related values in

Spawner Survey Data

EventID: {5F1BA6D-B263-498B-9FB7-3EE07CE5A410} Spawner Season: 2006-2007

Watershed: Olema Creek SubProject: SPAWN SpawnID: 8724

Stream Name: Olema Creek Mainstem Reach: 5 Date: 1/10/2007

Weather: cloudy

Start Time: 10:32 End Time: 14:05 Recorder: CDR

Water Temp C: Water Clarity (cm): 100 Stage (ft):

Comments:

Observers

OBSCODE	Full Name
KEME	Kelso, Megan
DECA	Del Real, Casey

Record: 1 of 2

Fish Measurements

Section	SectionCode	Loc	SpCode	Cond	Sex	Length	C_Mark	C_Recap	Tissue	Scales	Comments
108	OL-01-108	25	CO	Live	F	60					just above redd
108	OL-01-108	40	CO	Live	M	65					holding in base of riffle
108	OL-01-108	40	CO	Live	F	70					holding in base of riffle
108	OL-01-108	80	CO	Live	M	70					holding in pool
108	OL-01-108	80	CO	Live	M	75					holding in pool
116	OL-01-116	95	CO	Carc	F						decomposed and eaten
118	OL-01-118	80	CO	Carc	M	70	2				two hole punches
120	OL-01-120	30	CO	Live	M	40					jack

Record: 1 of 17

Redd Measurements

Section	SectionCode	Loc	Bank	ReddSpecies	Confidence	Length	Width	FishSpecies	Number	Comments
106	OL-01-106	90	MC	CO	Definite	3.2	1.8			
122	OL-01-122	80	MC	CO	Definite	2.8	1.2			carcass just downstream
123	OL-01-123	90	RB	CO	Definite	4.4	1.2	CO	1	
129	OL-01-129	35	MC	CO	Definite	5.3	1.9	CO	2	

Record: 1 of 4

Update Redds

Close

Record: 755 of 785

Figure SOP 8.4. Spawner monitoring data entry form.

tluWatershed and *tluStreamNames*. For each fish and redd observation, the macro creates the correct SectionCode based on the StreamCode and Section# values. Finally, the macro opens *frmObservers* when the “Add New Observer” button is clicked. Once the user has entered the new observer name and contact information into the form, the macro queries the OBSCODE drop-down list in the observer subform.

Database users should only enter data collected on newly observed redds in the redd measurement subform embedded within *frmSpawnerSurveys* (figure SOP 8.4). For older redds for which new measurements have been recorded in the field, the user must first select the “Update Redds” button in order to open the redd search form, *frmReddSearch* (figure SOP 8.5). When it opens, the redd search form default values for spawner season, watershed, and stream

name are set equal to the current values in *frmSpawnerSurveys*. The user must enter the section code (i.e., OL-01-98) and then select the “FindRedds” button in order to bring up the redd record that they wish to edit. The form *frmReddUpdate* (figure SOP 8.6) will only display redd records that match the search criteria set in *frmReddSearch*. The user then simply finds the redd for which they have new measurements or information, edits the record, checks the update checkbox, and notes the date that the new information was collected in the re-survey date field.

Figure SOP 8.5. Redd search form, with default values based on sample record in figure SOP 8.4.

Section No.	Section Code	Location	Bank	Redd (Definite/Not Definite)	Species (CO/SB/P)	Redd Length (m)	Redd Width (m)	Redd Update?	Re-Survey Date	Comments
106	OL-01-106	70	LB	Definite	CO	2.6	1.2	☒	1/24/2007	no fish on redd
106	OL-01-106	90	MC	Definite	CO	3.2	1.8	☒	1/24/2007	
*	*							☒		

Figure SOP 8.6. Redd measurement update form, with records based on criteria set in figure SOP 8.5.

Summer Monitoring Database

The SFAN staff has continued to use a relational Microsoft Access database for summer stream fish monitoring activities since the program began in 1997. Although, the core database has undergone several fundamental design modifications over the years, the core data elements stored in the database have not changed significantly. The current database design was completed in 2005 under the guidance of the SFAN I&M program just prior to the start of the 2005 summer monitoring season. The last significant changes to the database occurred in the winter of 2006 when the SFAN data management staff completed reporting tools for basinwide habitat and fish population summaries. The database is titled Summer_MasterXP.mdb.

The data in the summer database are organized around field events, where a different event is represented for each summer monitoring activity, including habitat typing, snorkeling, and electrofishing. Habitat typing event records exist for each day that a particular stream is habitat typed, with the related data records being the stream units measured and cataloged during that survey. Separate event records are maintained for each stream unit that is snorkeled, with snorkel pass information and fish species counts for each pass related to each snorkel event record. Finally, separate event records are created for each stream unit that is electrofished, with pass information, fish counts, fish measurements, and fish population estimate data related to each electrofishing event record. The summer database also houses data related to index reach habitat assessments, which is not a primary I&M monitoring activity. See SOP 1 (Basinwide GSS Juvenile Coho and Habitat Survey) and SOP 2 (Index Reach Surveys) for additional summer survey information and methods.

Table Structure: Table relationships for the stream fish summer database are presented in figure SOP 8.7. The database meets basic compliance with the NRDT. Data organization is based on the concept of surveys, occurring at a specified date and time, recorded in an event table. The EventID field in the event table serves as the database primary key, and links to related tables in the database associated with the survey events. The SubProject field identifies the event record as a snorkel, electrofishing, habitat typing, or index reach habitat assessment record. The SectionCode fields in the electrofishing event table, snorkeling event table, and stream habitat unit measurement table links to the stream tag table, thus providing a geo-spatial reference to the data. The SectionCode field, which represents a 100 m stream length, marked in the field at the downstream end with a tree tag, is equivalent to the LocationID field in the NRDT.

Event data is represented in the summer database by the table *tblEvents*. A new record is generated each time a monitoring activity is performed on a particular stream section or habitat unit. Event records are generated for each stream unit electrofished, each stream unit snorkeled, each index reach habitat assessment, and each habitat typing survey. *TblEvents* stores basic data common to all of these monitoring activities, such as stream name, field season, date, time, and data entry date.

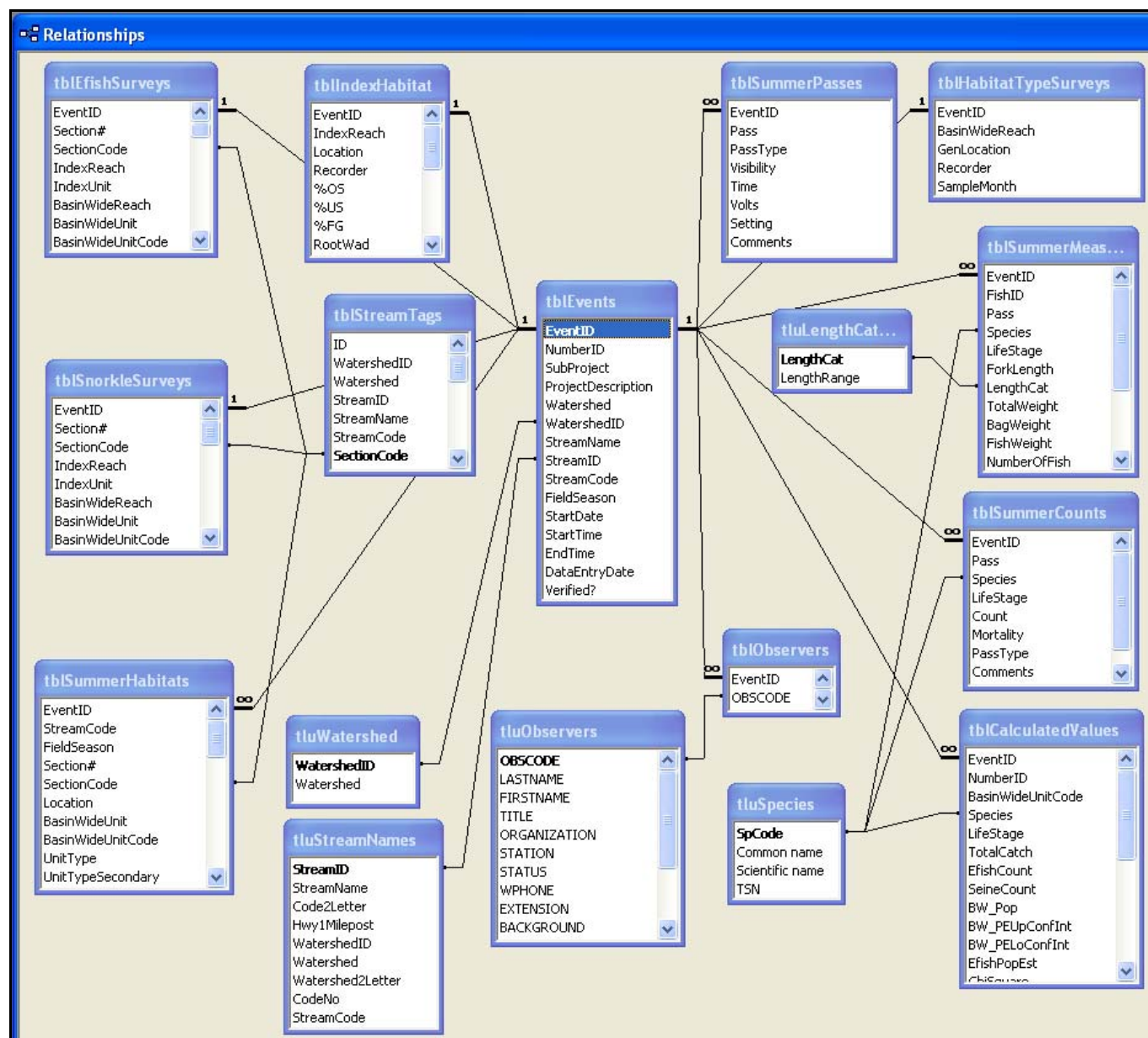


Figure SOP 8.7. Table relationships in the summer monitoring database, Summer_MasterXP.mdb.

The summer database relates *tblEvents* to a series of tables equivalent to the NRDT's *tbl_Event_Details* by one-to-one relationships, depending on the activity performed and noted in the SubProject field. These tables store event or survey data specific only to that activity type. For example, the habitat unit type, number of passes, and basinwide unit code for each stream unit snorkeled is entered into *tblSnorkelSurveys*.

For each summer monitoring activity, staff and volunteers who conduct the field work are listed in *tblObservers*. Codes based on the first two letters of the last name and first name are used to

record observers. Each observer code is listed in *thuObservers*, where the corresponding observer's first name, last name, and contact information are maintained.

The EventID field is used to link the primary table *tblEvents* with all related tables in the summer monitoring database. As recommended in guidance for the NRDT Version 3.1 (National Park Service 2006), the EventID is an automatically generated GUID. *TblEvents* has an additional NumberID field, which is a simple AutoNumber field. The NumberID field is primarily used to perform quick searches for particular records of interest.

The location of each stream habitat unit cataloged during habitat typing surveys and subsequently snorkeled and/or electrofished is referenced to the nearest downstream 100 m section tag. Each tag, entered into the SectionCode field, represents the beginning of a 100 m stream section. The Location field indicates how many meters upstream from the nearest tag that the observation was made. For example, SectionCode "RW-01-38" and a Location value of 20 indicates that data was collected 3.8 km plus 20 m upstream on the Redwood Creek Mainstem (stream code RW-01). Stream codes for each stream monitored are cataloged in the table *thuStreamNames*. Stream tag locations are stored in *tblStreamTags*. Fields in *tblStreamTags* that provide a spatial reference for the tag locations include X_Coord, Y_Coord, Coord_System, Datum, and UTM_Zone. In addition, the Loc_Notes field indicates the tree species and stream bank where the tag is located.

During habitat typing surveys, each stream habitat unit is assigned a sequential basinwide habitat unit code representing the stream location, unit number, and year. For example, the basinwide unit code RW-01-244-2007-H indicates that this stream unit is on the Redwood Creek Mainstem (stream code RW-01), is the 244th stream habitat unit from the downstream survey start point, and is from the 2007 field season. The basinwide unit code is again recorded if and when the unit is re-visited during the season for electrofishing or snorkeling. Standardized documentation of basinwide unit codes allows the SFAN staff to easily create queries to compare fish counts fish between snorkel surveys and electrofish surveys or compare unit measurements (length, width, depth) recorded during separate field events.

Habitat Typing Data: Records for each habitat typing survey during the summer monitoring season are stored separately in the summer database. It may take several surveys to completely habitat type one of the stream fish study streams. Habitat typing event data is stored in *tblEvents* and *tblHabitatTypeSurveys*. A SubProject value of HABITAT_TYPE in *tblEvents* indicates that a related record exists in *tblHabitatTypeSurveys*. Very little information is stored in *tblHabitatTypeSurveys*, including the general start and end points of the survey and the name of person who recorded the data.

TblSummerHabitats stores separate records for each stream habitat unit (scour pool, flatwater, riffle, etc.) documented during the habitat typing survey. Each habitat unit, and therefore each record, is referenced to a stream section code and assigned a basinwide unit code. Measurements for each habitat unit include length, estimated width, measured width (if applicable), estimated surface area, measured surface area (if applicable), and maximum depth. In addition, counts of woody debris are conducted within each habitat unit, both instream and on the adjacent stream banks.

Electrofishing Data: Records for each stream unit electrofished during the summer monitoring season are stored separately in the summer database. Electrofishing event data is stored in *tblEvents* and *tblEFishSurveys*. SFAN I&M staff may conduct electrofishing work in the network parks for a variety of monitoring and management reasons, which are indicated in the *tblEvents* *SubProject* field. *SubProject* values that indicate related records in *tblEFishSurveys* include *EFISH_INDEX*, *EFISH_BASIN*, *EFISH_GSS*, *RESCUE*, and *RESTORATION*. Each *SubProject* value is defined in the look-up table *tblProjects*. The section code, basinwide unit code, index reach and unit number (if applicable), stream unit measurements (length, width, depth), water quality measurements, and habitat data for each stream unit electrofished are stored in *tblEFishSurveys*.

TblSummerPasses contains information about each electrofishing pass conducted in the stream unit, including the pass time, volts, and current setting. Because stream units are sometimes initially cleared of fish with one or more seine passes before electrofishing commences, *tblSummerPasses* also has a pass type field.

TblSummerCounts catalogs the counts of each species captured through each pass of the electrofisher. Both the pass number and pass type are indicated in *tblSummerCounts*. For some species, it is essential that separate count records are entered for each life stage of the species captured. For example, separate fish count records should be entered for steelhead young of year (YOY) versus older year classes (1+). The count record for each species/life stage is divided into the live count and dead count. The total number of fish caught for each species/life stage can be calculated by summing the Count plus Mortality fields. The field Species uses codes to denote the species captured, which is linked to the look-up table *tblSpecies*. *tblSpecies* indicates scientific name, common name, and TSN for each species.

Not all fish that are captured during electrofishing are measured (see summer SOPs), but records of those fish that are measured, and the pass number during which they were captured, are entered into *tblSummerMeasurements*. The table stores individual fish fork length and fish weight (TotalWeight-BagWeight). Check boxes note if the measured fish was injured or dead. For ease of summarizing and reporting, each fish is assigned a numeric length category based on fork length. The field LengthCat is linked to *tblLengthCategory*, in which each LengthCat value is defined by a 5 mm length range. For example, a fork length of 108 mm is assigned a length category of 19, which indicates a length range of 106-110 mm. At times, bulk weights of unmeasured fish are recorded. For this reason, the field NumberOfFish indicates the number of fish that each data record corresponds to. Finally, each record in the fish measurements table is assigned a numeric FishID value, a simple AutoNumber field. The FishID helps to keep the records listed in the order in which they were entered, which is essential for error-checking the data.

For each species/life stage collected in an electrofished stream unit, a population estimate for the stream unit is calculated following methods developed by the U.S.D.A. Forest Service for Microfish 3.0, a software product designed for fisheries biologists and resource managers for the purpose of analyzing fisheries data (Van Deventer and Platts 1985, 1989). Among other calculated values, data stored in *tblCalculatedValues* include the basinwide unit code, species

and life stage, total catch, population estimate, population estimate confidence intervals, standard error, and fish density.

Snorkeling Data: Records for each stream unit snorkeled during the summer monitoring season are stored separately in the summer database. Snorkeling event data is stored in *tblEvents* and *tblSnorkelSurveys*. A SubProject value of SNORKEL in *tblEvents* indicates that a related record exists in *tblSnorkelSurveys*. The section code, basinwide unit code, index reach and unit number (if applicable), unit type, and number of snorkel counts (or passes) for each stream unit are stored in *tblSnorkelSurveys*.

TblSummerPasses contains information about each snorkel pass conducted in the stream unit, including the pass time and visibility. The pass type is by default always set to “Snorkel”.

TblSummerCounts catalogs the counts of each species observed during each snorkel pass. Both the pass number and pass type are indicated in *tblSummerCounts*. For some species, it is essential that separate count records are entered for each life stage of the species captured. For example, separate fish count records should be entered for steelhead young of year (YOY) versus older year classes (1+). The field Species uses codes to denote the species observed, which is linked to the look-up table *tluSpecies*. *TluSpecies* indicates scientific name, common name, and TSN for each species.

Index Habitat Data: Although not intended for long-term trend analyses at this point, the SFAN fisheries staff collects ancillary habitat data on each stream index reach monitored during the summer field season. The data is nevertheless housed in the summer monitoring database. Index habitat data is stored in *tblEvents* and *tblIndexHabitat*. A SubProject value of INDEX_HABITAT in *tblEvents* indicates that a related record exists in *tblIndexHabitat*. The index reach number, woody debris tally, vegetation cover values, and stream bank condition assessment for each index reach are stored in *tblIndexHabitat*.

User Interface and Data Entry

Habitat Typing Data

Database users enter habitat typing data into the form *frmHabitatSurveys* (figure SOP 8.8). Because habitat typing data is stored in both *tblEvents* and *tblHabitatTypeSurveys*, the control source for the habitat typing data entry form is the query *qryHabitatTypeDataEntry*, which passes data into the appropriate tables. So that the query only returns and then displays habitat typing records in the data entry form, the query limits records to those with a *tblEvents* SubProject value of HABITAT_TYPE.

Two subforms embedded within *frmHabitatSurveys* are used for entering stream habitat units and observer records. The subforms are respectively titled *shfSummerUnits* and *shfObservers*.

frmHabitatSurveys : Form

Basinwide Habitat Surveys

EventID:
 Watershed:
 Field Season:
 DataEntryDate:

NumberID:
 Stream Name:
 Date:
 Verified?: ☒

SubProject:
 Reach:
 Sample Month:
 Recorder:

General Location:

Field Staff

OBSCODE: Full Name:

REMI:
 DECA:

Record: of 2

sbfSummerUnits

BWUnit	Section#	Loc	UnitType	UnitType2	SideCha	Length	EstW	No. wid	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	TranLen	AvgDepth	MaxDepth	CrestDepth	RootW
540	64		FW	R	☐	16.8	2.3	0	0	0	0	0	0	0			0.25	0.05	0
541	64		R		☐	3.9	3.4	0	0	0	0	0	0	0					0
542	64		FW		☐	10.2	3.2	3	2.8	2.3	3.1	0	0	0	2		0.2	0.09	0
543	64		R		☐	9.6	3.2	0	0	0	0	0	0	0					0
544	64		FW		☐	8	3.5	0	0	0	0	0	0	0			0.14	0.03	0
545	64		R		☐	8.6	3.3	0	0	0	0	0	0	0					0
546	64		MC		☐	17.6	3.5	4	3.1	3	3.4	4.3	0	0	3		0.4	0.06	0
547	64		R		☐	2.3	2	0	0	0	0	0	0	0					0
548	64		FW		☐	6.2	1.8	0	0	0	0	0	0	0			0.25	0.06	0
549	64		R		☐	10.8	2.7	0	0	0	0	0	0	0					0
550	64		FW		☐	16.5	2.8	0	0	0	0	0	0	0			0.22	0.09	0
551	65		R		☐	9.7	2.5	0	0	0	0	0	0	0					0
552	65		MC		☐	9.4	3.3	0	0	0	0	0	0	0			0.34	0.1	0
553	65		R	FW	☐	17.2	2	0	0	0	0	0	0	0					0
554	65		FW		☐	17.3	3.2	0	0	0	0	0	0	0			0.26	0.05	0
555	65		R		☐	6.6	3	0	0	0	0	0	0	0					0
556	65		SC		☐	25.1	2.3	0	0	0	0	0	0	0			0.35	0.03	0
557	65		R	FW	☐	30.9	2	5	2.3	2	1.5	2.2	1.3	0	5				0
558			FW		☒	6.7	1.9	0	0	0	0	0	0	0			0.2	0.05	0
559	66		FW		☐	6.7	3	0	0	0	0	0	0	0			0.15	0.04	0
560	66		FW		☐	10	2	0	0	0	0	0	0	0			0.28	0.03	0
561	66		R		☐	9.3	3	0	0	0	0	0	0	0					0
562	66		MC		☐	13.2	3.5	3	3.5	4	4.6	0	0	0	3		0.6	0.03	0
563	66		FW		☐	11.3	2	0	0	0	0	0	0	0			0.21	0.08	0
564	66		R		☐	3.7	1.8	0	0	0	0	0	0	0					0
565	66		FW		☐	7.5	2.5	0	0	0	0	0	0	0			0.15	0.05	0

Record: of 50

Record: of 117

Figure SOP 8.6. Habitat typing data entry form.

The observers subform passes data through the query *qryObserver_DataEntry*, which allows for display of the full name of the corresponding OBSCODE in the data entry window.

The macro titled *mcrHabitatForm* runs a few actions within the snorkeling data entry form. First, once the watershed and stream names are entered, the WatershedID, StreamID, and StreamCode fields in *tblEvents* are automatically generated by looking up these related values in *tblWatershed* and *tblStreamNames*. In addition, the macro opens *frmObservers* when the “Add New Observer” button is clicked. Once the user has entered the new observer name and contact information into the form, the macro requeries the OBSCODE drop-down list in the observer subform.

Within *sbfSummerUnits*, each stream unit documented in the field is entered in numerical sequence. For each stream unit, the macro *mcrHabitatForm* creates the correct SectionCode based on the StreamCode and Section# values. The macro generates the correct basin wide unit

code for the habitat unit based on the stream code, basin wide unit number, and field season. Finally, the macro calculates average width, estimated surface area, measured surface area, and residual pool depth based on data collected for each stream unit.

Electrofishing Data

Database users enter electrofishing data into the form *frmEfishSurveys* (figure SOP 8.9). Because electrofishing survey data is stored in both *tblEvents* and *tblEfishSurveys*, the control source for the electrofishing data entry form is the query *qryEfishDataEntry*, which passes data into the appropriate tables. So that the query only returns and then displays electrofishing records in the data entry form, the query limits records to those with the following *tblEvents* SubProject values: EFISH_INDEX, EFISH_BASIN, EFISH_GSS, RESCUE, and RESTORATION.

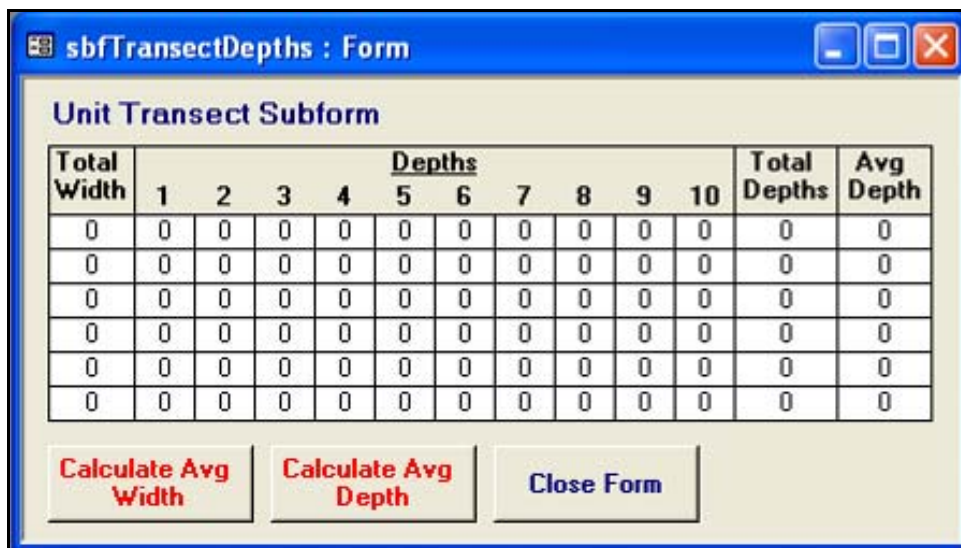
Five subforms embedded within *frmEfishSurveys* are used for entering pass information, fish counts, fish measurements, fish population estimates, and observer records. The subforms are respectively titled *sbjElectrofishingPasses*, *sbjElectrofishingCounts*, *sbjSummerMeasurements*, *sbjCalculatedValues*, and *sbjObservers*. The observers subform passes data through the query *qryObserver_DataEntry*, which allows for display of the full name of the corresponding OBSCODE in the data entry window.

The macro titled *mcrEfishForm* runs a few actions within the electrofishing data entry form. First, once the watershed and stream names are entered, the WatershedID, StreamID, and StreamCode fields in *tblEvents* are automatically generated by looking up these related values in *tblWatershed* and *tblStreamNames*. For each stream unit electrofished, the macro creates the correct SectionCode based on the StreamCode and Section# values. The macro generates the correct basin wide unit code for the electrofished habitat unit based on the stream code, basin wide unit number, and field season. The macro also calculates the habitat unit's surface area and volume based on the length, average width, and average depth. Finally, the macro opens *frmObservers* when the "Add New Observer" button is clicked. Once the user has entered the new observer name and contact information into the form, the macro requeries the OBSCODE drop-down list in the observer subform.

Selecting the "Enter Transect Data" button in the electrofishing data entry form opens a subform, *sbjTransectDepths*, for entering stream unit depth measurements along separate transects (figure SOP 8.10). The user enters the transect width, depth measurements across each transect, and the number of depth measurements per transect, and then the macro *mcrEfishForm* calculates the average depth for each transect. Although none of the data values in *sbjTransectDepths* are permanently stored in the database, *mcrEfishForm* will use them to calculate the stream unit average width and average depth by clicking the corresponding buttons. These values are stored in *tblEfishSurveys*.

Selecting the "Enter Substrate Tallies" button in the electrofishing data entry form opens a subform, *sbjSubstrateTally*, for entering stream unit substrate tallies collected at each depth measurement point along separate transects (figure SOP 8.11). Substrate tallies are not entered for each transect, but for all transects combined. Clicking the "Calculate Substrate Percentages" button, however, will calculate the percentage of each substrate category observed in the stream unit and store these values in *tblEfishSurveys*.

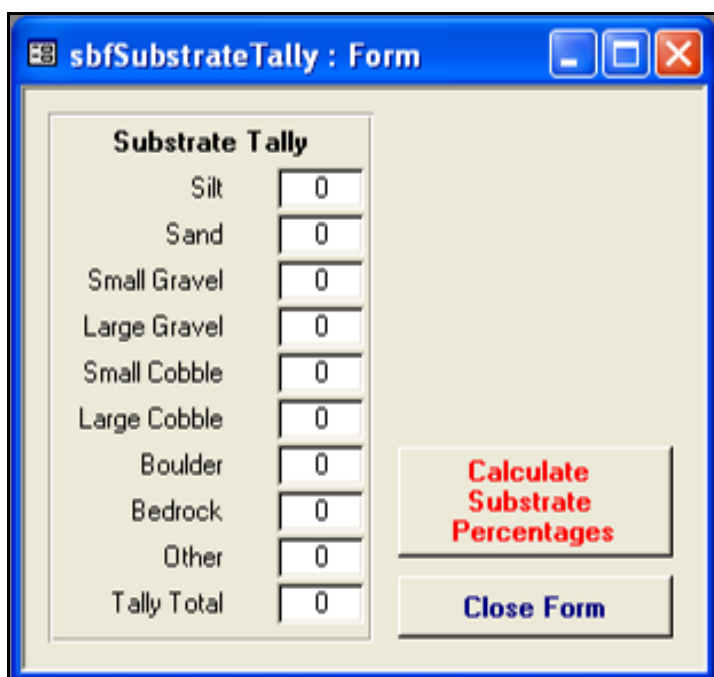
SOP 8.19



Total Width	1	2	3	4	Depths						Total Depths	Avg Depth
					5	6	7	8	9	10		
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0

Calculate Avg Width Calculate Avg Depth Close Form

Figure SOP 8.8. Transect width and depth data entry subform.



Substrate Tally	
Silt	0
Sand	0
Small Gravel	0
Large Gravel	0
Small Cobble	0
Large Cobble	0
Boulder	0
Bedrock	0
Other	0
Tally Total	0

Calculate Substrate Percentages Close Form

Figure SOP 8.9. Substrate tally data entry subform.

Visual Basic code embedded in the fish measurements subform performs two operations. First, the FishWeight value is calculated by subtracting the BagWeight from the TotalWeight. Second, the appropriate LengthCat (length category) code is generated based on the ForkLength value.

Selecting the “Microfish Calculations” button generates population estimate values for all fish captured within the stream unit and stores the values in *tblCalculatedValues*. Clicking the button

executes Visual Basic code that performs the calculations following methods developed by the U.S.D.A. Forest Service for Microfish 3.0, a software product designed for fisheries biologists and resource managers for the purpose of analyzing fisheries data (Van Deventer and Platts 1985, 1989). In order for the population estimate to calculate correctly, a fish count record must be entered for each fish species/life stage and each fish pass, even if no fish were captured and the count was zero.

Snorkeling Data

Database users enter snorkeling data into the form *frmSnorkelSurveys* (figure SOP 8.12). Because snorkeling survey data is stored in both *tblEvents* and *tblSnorkelSurveys*, the control source for the snorkeling data entry form is the query *qrySnorkelDataEntry*, which passes data into the appropriate tables. So that the query only returns and then displays snorkeling records in the data entry form, the query limits records to those with a *tblEvents* SubProject value of SNORKEL.

Three subforms embedded within *frmSnorkelSurveys* are used for entering pass information, fish counts, and observer records. The subforms are respectively titled *sbfSnorkelPasses*, *sbfSnorkelCounts*, and *sbfObservers*. The observers subform passes data through the query *qryObserver_DataEntry*, which allows for display of the full name of the corresponding OBSCODE in the data entry window.

The macro titled *mcrSnorkelForm* runs a few actions within the snorkeling data entry form. First, once the watershed and stream names are entered, the WatershedID, StreamID, and StreamCode fields in *tblEvents* are automatically generated by looking up these related values in *tblWatershed* and *tblStreamNames*. For each stream unit snorkeled, the macro creates the correct SectionCode based on the StreamCode and Section# values. The macro generates the correct basin wide unit code for the electrofished habitat unit based on the stream code, basin wide unit number, and field season. Finally, the macro opens *frmObservers* when the “Add New Observer” button is clicked. Once the user has entered the new observer name and contact information into the form, the macro requeries the OBSCODE drop-down list in the observer subform. Within the fish count subform, the database user must enter fish count records for each pass for those species/life stages for which a basinwide population estimate will be calculated following methods outlined in Dollof et al. (1993).

frmSnorkelSurveys : Form

Stream Fish Assemblages Snorkeling Form

Add New Record **Add New Observer**

EventID

NumberID

DataEntryDate

Verified? ☒

Watershed FieldSeason

Stream Name Date

Section# Start Time

Section Code End Time

SubProject NumberOfPasses

ProjectDescription

Comments

Recorder

Diver

Basin Wide Unit Info

BW Reach

BW Unit

BW Unit Code

Unit Type

UnitTypeSecondary

Index Unit Info

Reach

Unit

☐ Exclude_BW

☒ Bounded_Count

☐ Calibration_Pool

Field Staff

OBSCODE	Full Name
LEKI	Leising, Kirsten
REMI	Reichmuth, Michael

Record: of 2

Pass Data

Pass	Time	Visibility	Comments	PassType
1	0	0.5-1.5 m		Snorkel
2	0	0.5-1 m		Snorkel
3	0	0.5 m		Snorkel

Record: of 3

Count Data

Pass	Species	LifeStage	Count	Comments
1	CO	YoY	157	
2	CO	YoY	146	
3	CO	YoY	148	
*			0	

Record: of 3

Close Form

Record: of 885

Figure SOP 8.10. Snorkeling data entry form.

Index Habitat Data

Database users enter index habitat data into the form *frmIndexHabitat* (figure SOP 8.13). Because index habitat data is stored in both *tblEvents* and *tblIndexHabitat*, the control source for the index habitat data entry form is the query *qryIndexHabitatDataEntry*, which passes data into the appropriate tables. So that the query only returns and then displays index habitat records in the data entry form, the query limits records to those with a *tblEvents* SubProject value of INDEX_HABITAT.

For entering observer records, one subform, *sbfObservers*, is embedded within *frmIndexHabitat*. The observers subform passes data through the query *qryObserver_DataEntry*, which allows for display of the full name of the corresponding OBSCODE in the data entry window.

The macro titled *mcrIndexHabitatForm* runs a few actions within the index habitat data entry form. First, once the watershed and stream names are entered, the WatershedID, StreamID, and StreamCode fields in *tblEvents* are automatically generated by looking up these related values in *tblWatershed* and *tblStreamNames*. Finally, the macro opens *frmObservers* when the “Add New Observer” button is clicked. Once the user has entered the new observer name and contact information into the form, the macro requeries the OBSCODE drop-down list in the observer subform.

frmIndexHabitat : Form

Index Reach Habitat Data

Add New Record
Add New Observer

EventID: 3FF-9D3C-F0D8043E8652

NumberID: 6087

SubProject: INDEX_HABITAT

DataEntryDate: 11/30/2005

Verified? ☒

Field Staff

OBSCODE	Full Name
HUNE	Huddon-Cossar, Neil
REMI	Reichmuth, Michael
LEKI	Leising, Kirsten
BRDO	Brown, Don
LYEM	Lynch, Emma

Record: 1 of 5

Recorder: huddon-cossar

Watershed: Olema Creek

Stream Name: Olema Creek Mainstem

Index Reach: 8

Date: 08/23/2005

Field Season: 2005

Vegetative Cover

Percent OS	3
Percent US	2
Percent FG	1

Dry Bed

0

Isolated Pools ☐

Comments: no

Woody Debris Tally

Root Wad	LWD Jam	SWD Jam	10-20 cm	20-50 cm	>50 cm
2	0	1	6	2	1

Bank Erosion

Left: 1

Right: 1

Comments:

Close Form

Record: 1 of 55

Figure SOP 8.11. Index habitat data entry form.

Basinwide Habitat and Population Estimates

A series of queries have been developed within the summer database that follows the guidelines developed by Dollof et al. (1993) for calculating basinwide habitat and fish population estimates. The queries and a simple user interface, developed by the SFAN I&M program, allow the database user to easily generate core summary statistics for use in annual reports and long-term trend analyses.

Before performing any calculations, it is essential that the data be thoroughly error-checked and prepped for analysis. The following data preparations are required:

- Within *tblSummerHabitats*, all backwater, side channel units, and units outside of the study area must be excluded from analysis by checking the Exclude_BW check box field.

- Habitat units that were electrofished for the purposes of basinwide population estimates should have the CalibrationPool check box checked in *tblEfishSurveys* or *frmEfishSurveys*.
- Those calibration pools which were electrofished but must subsequently be excluded from analysis must have the Exclude_BW check box field checked in *tblEfishSurveys* or *frmEfishSurveys*.
- Snorkel units in which the bounded count method was performed using several snorkel counts should have the Bounded_Count check box checked in *tblSnorkelSurveys* or *frmSnorkelSurveys*.
- Snorkel units in which the initial snorkel count was calibrated using the bounded count method should have the Calibration_Pool check box checked in *tblSnorkelSurveys* or *frmSnorkelSurveys*.
- Snorkel units that must be excluded from analysis should have the Exclude_BW check box checked in *tblSnorkelSurveys* or *frmSnorkelSurveys*.
- Basin wide unit code values in *tblSummerHabitats*, *tblSnorkelSurveys*, and *tblEfishSurveys* must be properly generated.
- Snorkel fish count records must be entered for each pass and for each species/life stage for which a basinwide population estimate will be calculated.
- Electrofishing fish count records must be entered for each species/life stage captured and each pass.
- All values in *tblCalculatedValues* must be properly and accurately calculated.

Once the data has been prepared with approval from the SFAN Data Manager, records in *thuBasinWide* are created that dictate which basinwide analyses the database is capable of performing. Fields in *thuBasinWide* are stream name, field season, species, and life stage. For example, if the database is prepped for calculating a basinwide population estimate for coho young-of-year in 2008 on the Olema Creek Mainstem, these are the values in *thuBasinWide* that would be entered for species, life stage, field season, and stream name, respectively. For streams and years for which only basinwide habitat calculations will be performed, the species and life stage fields should be left blank.

In order to run the basinwide calculations, the database user must open *frmBasinWide* (figure SOP 8.14). Several features in the form prevent the user from attempting to make calculations for which the database is not prepared. First, the drop-down menus for stream name, field season, species, and life stage are generated from *thuBasinWide* and are limited to values based on the previous fields' selection. For example, if the user selects Bear Valley Creek, coho will not be an option for analysis since this species does not exist in this stream and there is no corresponding coho species value for Bear Valley Creek in *thuBasinWide*. Second, if one of the fields in the form is changed, from Olema Creek Mainstem to Redwood Creek Mainstem for example, all subsequent fields will be cleared and re-queried. Finally, calculations are not possible unless all of the correct fields are filled in. Instead, a message box is displayed alerting

the user that all fields must be complete. Actions that help accomplish these control measures are built into the macro *mcrBW_Form*.

The screenshot shows a software window titled "frmBasinWide : Form" with a blue title bar. The main area has a light beige background and is titled "Basinwide Estimate of Habitat and Fish Populations in Streams". On the left, there are four dropdown menus: "Stream Name" (selected: Olema Creek Mainstem), "Field Season" (selected: 2006), "Species" (selected: CO), and "Life Stage" (selected: YoY). Below these is a "Re-Set Query Values" button. To the right, there are two columns of buttons. The "FISH" column contains "Fish Correlations", "Check df", and "Get Fish #s". The "HABITAT" column contains "Area Correlations", "Check df", and "Get Hab #s". At the bottom right of the form area is a small icon button with a magnifying glass and a plus sign.

Figure SOP 8.12. The basinwide calculation initiation form.

The steps required to run the basinwide fish population and habitat calculations are outlined below.

Fish Population Calculations:

1. Open *frmBasinWide* and fill in values for stream name, field season, species, and life stage.
2. Click the "Fish Correlations" button to view all stream units incorporated into the analysis. These units were snorkeled and then electrofished for calibration, and the corresponding number of fish from snorkel surveys (MaxCount) and electrofishing surveys (BW_Pop) for each unit are displayed. The query that is opened is titled *BW_FishCount_Compare*. Inspect the data for potential errors.
3. Click the "Check df" button to determine the degrees of freedom used in the analysis. The value will be one minus the number of records just viewed in the query *BW_FishCount_Compare*. The form that is opened is titled *frmFish_DF* (figure SOP 8.15).
4. Use a Student's t Distribution table to look up the t-value for this degrees of freedom in the column for $p = 0.025$ (one-tailed probability).

- Click the “Get Fish #s” button and enter the t-value when prompted. The calculated fish values will be displayed in the form *frmBWFish_Report* (figure SOP 8.16). The control source for the form is the query *BWFish_Report*.

frmFish_DF : Form

Degrees of Freedom

(Number of Pools Snorkled and Calibrated with Electrofishing or Bounded Counts) - 1

17

Use a Student's t Distribution to look up the t-value for this df in the column for p = 0.025 (one-tailed probability).

Figure SOP 8.13. Degrees of freedom form for fish population calculations.

frmBWFish_Report : Form

Basinwide Fish Survey Summary Information

Olema Creek Mainstem 2006
CO YoY

Total Survey Length (m)	Total Habitat Units	Total Pools	Total Pools Snorkled	Units w/Fish	Total Raw Count	Total Calibrated Count
11624.3	859	324	75	52	397	415.045454545455

Raw Avg Per Pool	Calibrated Avg Per Pool	Fish/m	Fish/m2	Pop Estimate	Variance	Conf Interval
5.29333333333333	5.53393939393939	0.300829	0.093396089278717	1792.996364	169576.973729	868.818070462619

Total # Calib Pools: 18

Calibration Ratio: 1.04545454545454

Figure SOP 8.14. Basinwide fish population estimate results form.

Habitat Calculations:

- Open *frmBasinWide* and fill in values for stream name and field season.

2. Click the “Area Correlations” button to view all stream units incorporated into the analysis. Stream measurements for these units were both estimated and measured for calibration, and the corresponding estimated and measured surface areas for each unit are displayed. The query that is opened is titled *HABS*. Inspect the data for potential errors.
3. Click the “Check df” button to determine the degrees of freedom used in the analysis. The value will be one minus the number of records just viewed in the query *HABS*. The form that is opened is titled *frmHabitat_DF* (figure SOP 8.17).
4. Use a Student's t Distribution table to look up the t-value for this degrees of freedom in the column for $p = 0.025$ (one-tailed probability).
5. Click the “Get Hab #s” button and enter the t-value when prompted. The calculated habitat values will be displayed in the form *frmHabitat_Report* (figure SOP 8.18). The control source for the form is the query *HABS_Report*.

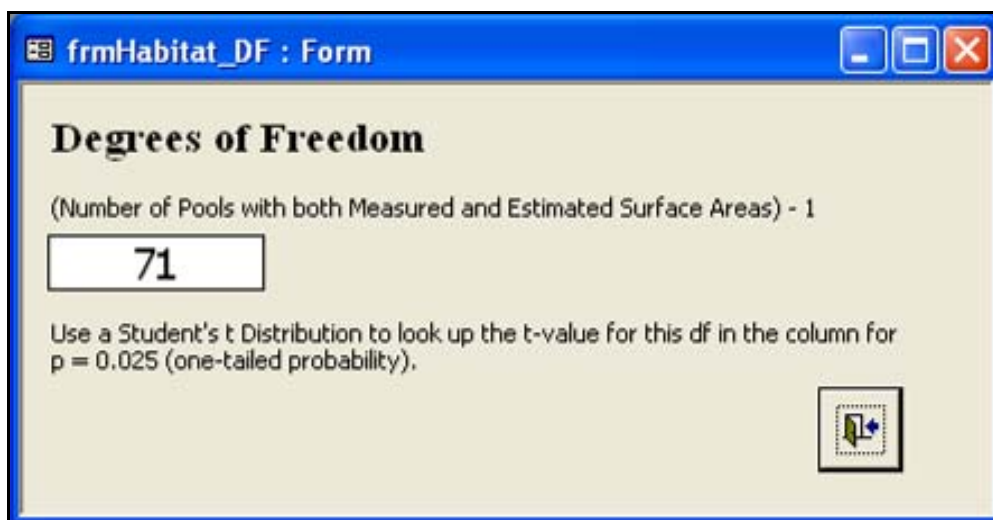


Figure SOP 8.15. Degrees of freedom form for fish population calculations.

Look-up Table Database

Several look-up tables are essential to all three stream monitoring databases. For ease of maintenance and to ensure that the look-up table records are identical in all three databases, these tables are stored and managed in a separate stream fish look-up table database. The database is titled *StreamFish_LU_Tables.mdb*. The look-up tables are established as linked tables within each of the monitoring databases. All of the tables in the look-up database have been described previously, and include:

- *thLengthCategories*
- *thObservers*
- *thSpecies*
- *thStreamNames*

- *thuStreamTags*
- *thuWatershed*

The only table intended for editing via the monitoring databases is *thuObservers*, which is most easily accessed through the form *frmObservers*. The other tables should only be edited or added to by the SFAN Data Manager or the Project Leader.

frmHabitat_Report : Form

Basinwide Habitat Survey Summary Information

Olema Creek Mainstem 2006

Total Habitat Units	Total Survey Length (m)
945	13267.9

Pool Summary

Calibration Units:

Calibration Ratio:

Estimated Total SA:

Variance:

Conf Interval:

Habitat Types

Habitat Type	Count	Percent of Total
▶ Backwater	34	3.60
Dry	72	7.62
Flatwater	225	23.81
Pool	359	37.99
Riffle	255	26.98

Figure SOP 8.16. Basinwide habitat results form.

Annual Data Work Flow

The master monitoring databases contain all smolt, spawner, and summer monitoring data collected to date in the SFAN parks. The SFAN I&M program is still in the process of converting legacy summer monitoring data from the previous to the current database format. The SFAN Data Manager is responsible for managing the master databases and assisting the Project Lead and field staff with any database issues.

Rather than enter monitoring data directly into the master databases, satellite databases are created at the beginning of each monitoring season that parallel the structure of the master databases. The SFAN Data Manager prepares separate databases for the smolt, spawner, and summer field seasons and provides them to the field staff based at Point Reyes National Seashore (PORE). The satellite data tables are blank in each of the databases, but the look-up tables are populated and ready for use. The SFAN Data Manager updates all default values, such as field season, prior to distribution. The databases are provided in MS Access XP format.

Satellite databases should be backed up regularly during the course of the season. CDs are a good option for back-ups. Databases can be also be regularly copied to an archive on the

network, to a hard drive, or both. File names of back-up databases should include the date of the back-up, such as: Smolt08_Satellite_050108_BackUp.

At the end of each season, the stream fish field staff is responsible for proofing the data entry records for all satellite databases against the paper datasheets completed in the field. When complete, the satellite databases are sent or provided to the SFAN Data Manager for additional review and certification. The Data Manager works with the Project Lead and the field staff to complete any final edits or additions to the seasonal dataset. See Section 4.0 Data Verification and Validation Procedures for more information.

Once certified, the Data Manager imports the satellite data into the master database, appends the data to the appropriate tables, and archives the satellite database within the I&M directory. A copy of the final satellite database and a new copy of the master database are provided to the stream fish staff at PORE.

Quality Assurance and Quality Control

The success of the stream fish monitoring program is dependent on the quality of the data it collects, manages, and disseminates. Analyses performed to detect ecological trends or patterns require data that are recorded properly and have acceptable precision, accuracy, and minimal bias. Poor-quality data can limit detection of subtle changes in ecosystem patterns and processes, can lead to incorrect interpretations and conclusions, and can greatly compromise the credibility of the program managing it.

Quality assurance (QA) can be defined as an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the consumer. Quality control (QC) is a system of technical activities that measure the attributes and performance of a process, item, or service relative to defined standards (Palmer 2003). While QA procedures maintain quality throughout all stages of data development, QC procedures monitor or evaluate the resulting data products.

To ensure that the stream fish monitoring program produces and maintains data of the highest possible quality, QA/QC procedures are implemented to identify and minimize errors at each project stage associated with the data life cycle.

Data Collection

Attention to detail during the data collection phase is crucial to overall data quality. Unlike a typographical error that occurs during data entry, an incorrect observation in the field is not easily corrected. The stream fish monitoring program adopts the following guidelines regarding data collection that affect data quality:

- Field crews will receive proper training in data collection and recording.
- Field equipment will be regularly maintained and calibrated.
- Data will be recorded on pre-formatted, project-specific datasheets that reflect the overall design of the project and are designed to minimize the amount of writing necessary to effectively record observations.

- The format of field datasheets will be reflected in the computer data entry interface to help ensure all relevant information is recorded and subsequent data entry errors are minimized.
- Field forms will be reviewed for completion and errors each day in the field.

Data Entry

Data entry is the process whereby the raw data collected in the field are transferred from paper field forms into the project databases. The stream fish field staff performs all data entry into seasonal satellite databases. The goal of data entry is to transcribe field observations into a computer database with 100% accuracy, although errors are unavoidable. Several QA/QC practices help to reduce errors during the data entry phase:

- Data will be entered as soon as reasonably possible after collection
- Data entry will be completed by someone familiar with data collection. The Project Leader or SFAN Data Manager must ensure that data entry staff is familiar with the database software, database structure, and any standard codes in the databases. At a minimum, data entry technicians should know how to open a data entry form, create a new record, edit an existing record, and exit the database properly. They must also learn how to correct mistakes made while typing.
- Data will be entered into pre-designed database forms that resemble field sheets to the greatest extent possible. Data entry forms maximize error control wherever possible, include the use of default values, limiting data entry domains to values in drop-down menus, and auto-generating certain codes (i.e., StreamID, SectionCode, BasinWideUnitCode).
- Data will be entered, one logical "set" at a time. Paper forms are initialed and dated when completed to avoid confusion about what has been entered and what has not.

Data Verification

Following data entry, subsequent data verification is conducted to ensure that the raw data on the paper datasheets matches the entered data. The stream fish field staff verifies all data in the seasonal satellite databases before forwarding on to the SFAN Data Manager. The following steps occur during the data verification phase:

- Data verification is carried out by staff thoroughly familiar with data collection and entry
- A visual review after data entry is performed with one person reading aloud from the original datasheets while a second person checks the corresponding entered data in the database.
- Errors in the data are immediately corrected once discovered.
- When complete, the Verified check-box in the database record is checked and the paper datasheet is initialed and dated.
- All records (100%) are verified against the original source data.
- A subset of randomly selected records (10%) should be reviewed after initial verification by the Project Leader. If errors are found, the entire data set should be verified again.

Data Validation

Data verification checks that the digitized data match the source data, while *data validation* checks that the data make sense. Although data entry and verification can be handled by personnel who are less familiar with the data, validation requires in-depth knowledge about the data. The SFAN Data Manager performs all data validation procedures on the seasonal satellite databases before integrating the data into the master databases. The Data Manager consults with the Project Lead, the field staff, or directly reviews the datasheets to correct any errors that are discovered.

During the data validation phase, the Data Manager checks all three monitoring databases for the following and makes corrections as needed:

- Verified checkbox checked for all data records.
- Erroneously generated records with no actual data.
- Orphaned records within the sub-tables (i.e., no link back to *tblEvents*).
- Data outliers: applies to both numerical and date/time values.
- Logic errors (i.e., start time is after the end time, more fish measured than were actually counted in the smolt trap).
- Accurate generation or calculation of automated fields (i.e., stream ID, basinwide unit code, fish length category, measured surface area).
- Correct values for fields with fixed domains (i.e., species codes, unit types, fish mark codes). Complete data entry for all required fields (i.e., section code, life stage value for all salmonids, redd species).

In addition to the above, the Data Manager regularly checks the seasonal satellite databases for elements specific to each database type.

Smolt Database:

- FishWeight value is equal to TotalWeight-BagWeight.
- The number of marked fish in the measurement table is equal to the marked fish in the count table.
- LiveTotal+DeadTotal is equal to New+Recaptured.
- The number of fish count records is equal to or greater than the fish measurement records.

Spawner Database:

- ReddArea equals ReddLength*ReddWidth.
- Fish species observed on redd corresponds to redd type and fish observation records.
- Weight values not entered for live fish.

Summer Database:

- Basin wide unit code values equal between *tblElectrofishSurveys* and related records in *tblCalculatedValues*.
- Check to see if duplicate habitat measurement, snorkel or electrofish records exist for unique basin wide unit codes.
- Set wood counts from habitat typing and index habitat surveys from null to 0.
- Count records for each species/pass combination are at least equal to the sum of the associated measured fish records.
- Count records for each species/pass combination are equal to the sum of the NumberOfFish values in the associated measured fish records.
- Index Reach/Unit values consistently entered in electrofish and snorkel forms for same basin wide unit code.
- SectionCode values consistently entered for same stream units in habitat, electrofish, and snorkel forms.
- Pass type values consistent between *tblSummerPasses* and *tblSummerCounts*.
- Pass number is equal to the number of related pass records for electrofish and snorkel surveys.
- Pass number value reported in *tblSummerMeasurements* is within the number of passes for the unit.
- Check that there are no duplicate pass counts for the same species/life stage.
- Check that there are no duplicate pass numbers accounted for in the pass table for a single stream unit.
- Prepare all data for basinwide fish population and habitat calculations as described previously (User Interface and Data Entry (Summer Database) – Basinwide Habitat and Population Estimates).

Version Control Guidelines and Database History

Version control guidelines for the stream fish monitoring databases will follow those presented in the SFAN Data Management Plan (Press 2005). Prior to any major changes to the database design, a back-up copy of the database should be made. Once the database design changes are complete, the database should be assigned the next incremental version number. The final copy of the previous database version should be archived with the version closing date incorporated into the database title. Version numbers should increase incrementally by hundredths (e.g., version 1_01, version 1_02, etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2_0, 3_0, 4_0 ...). With proper controls and communication, versioning ensures that only the most current database version is used for queries and analyses. Significant database re-design may require approval by the project manager, review by other data management staff, and revisions to this data management SOP. The database version number should be included in the file title of the database, for example, Smolt_MasterXP_v1_00.

The Data Manager maintains history logs of each of the stream fish monitoring databases. Within the smolt and spawner master monitoring databases, the history log is incorporated directly into the database as table *tblEditLog*. The history log for the summer monitoring database is in a separate Microsoft Word document titled *Summer_Database_Log* located at:

Inpgogamahe1\Divisions\Network I&M\Individual Vital Signs\Streamfish Assemblages\data\databases

All design modifications to the databases are tracked within the history logs and are referenced to changes in database version numbers. Design modifications include changes to the table structure, user interface, or underlying macros and Visual Basic Code. Major changes to the data themselves are also noted in this document, such as when a new set of annual data is uploaded. It is especially important to note edits to the data that will result in changes to final data summaries previously published in annual reports or other media. This will prove invaluable to data users attempting to understand differences in data between years.

The database history may also be used each year to summarize anything that was unique or changed about the year's methodology and is therefore reflected in the annual dataset. Notes on techniques for collection and review of data are also very helpful.

Metadata Procedures

The NPS GIS Committee requires all NPS GIS data layers be described with the NPS Metadata Profile, which combines the Federal Geographic Data Committee (FGDC) standard, elements of the ESRI metadata profile, the Biological Data Profile, and NPS-specific elements. Although no standard has been applied to natural resource databases and spreadsheets, the SFAN will complete the NPS Metadata Profile to the greatest extent possible to document the master stream fish monitoring databases. Because the annual datasets are uploaded into the master databases without alteration, the SFAN will not create separate metadata records each satellite database.

Complete metadata records for the SFAN stream fish monitoring databases will be generated in compliance with current NPS standards by the Network Data Manager. Because the location data for this project is stored as UTM coordinates within the MS Access databases, there are no spatial data products associated with this protocol that require metadata records.

The metadata records for the stream fish monitoring databases will initially be developed in Dataset Catalog v3.0, an MS Access metadata development and catalog tool developed by the NPS I&M Program. Dataset Catalog is currently the preferred tool to begin metadata records for MS Access databases because of its ability to harvest entity and attribute information from this database format.

The metadata records will be exported from Dataset Catalog as XML files and completed in NPS Metadata Tools and Editor v1.1 (NPS MTE), thus allowing for all NPS-specific elements in the metadata records to be completed. When completed, metadata records, but not the data themselves, will be posted to the NPS Data Store for public discovery and consumption. Contact information within the metadata records will direct interested parties to the Network Data Manager for further inquiries. Master database metadata records posted to the NPS Data Store

will be updated annually after the annual data has been uploaded or following database revision to a new version whole number (i.e., v1_3 to v2_0, but not v2_0 to v2_1).

The NPS Data Store can be accessed at:

<http://science.nature.nps.gov/nrdata/>

Data Storage and Archival Procedures

Golden Gate National Recreation Area

All master data files for the stream fish monitoring project are housed at Golden Gate National Recreation Area (GOGA). The SFAN I&M Program office and the SFAN Data Manager are stationed at GOGA. The master databases, all currently in version 1_00, reside within the Master_Databases folder at:

Inpgogamahe1\Divisions\Network I&M\Individual Vital Signs\Streamfish Assemblages\data\databases

Inpgogamahe1\Divisions\Network I&M must always be mapped as the Z drive. The following folders reside within the above “databases” directory:

Master_BackUps: Back-up copies of the active master databases should be stored here. File names of back-up databases should include the date of the back-up, such as:
Smolt_MasterXP_050108_BackUp.

Fish_Dbase_Archives: When a master database is converted to a new version number, the final previous database version should be archived here. Final seasonal satellite databases and all project legacy databases are also stored in this archive directory. There are separate folders for smolt, spawner, and summer monitoring databases.

Lookup_Dbase: This folder stores the look-up table database, StreamFish_LU_Tables.mdb. All stream fish databases at GOGA that link to the look-up table database must be pathed to this directory.

Point Reyes National Seashore

The stream fish field office, field staff, and the Project Lead are all based at PORE. Following error-checking and proofing, all field datasheets are organized in folders or binders and cataloged according to stream name and monitoring activity (smolt trap checks, spawner surveys, habitat typing, etc.). The datasheets are kept in the stream fish field office at PORE. In time, all datasheets will be submitted to the PORE Curatorial Manager for long-term storage.

At PORE, digital data files are housed at:

Inppore05\Resources\Natural_Fish\Databases

Inppore05\Resources must always be mapped as the U drive. The following folders reside within the above directory:

Master_Databases: Copies of the active master smolt, spawner, and summer master databases are stored here. The SFAN Data Manager provides copies of the master databases to PORE each time they are updated.

Working_Databases: Active seasonal satellite databases are stored here. The field staff may also place copies of the master databases or final satellite databases here for creating queries or data summaries.

Lookup_Dbse: This folder stores the look-up table database, StreamFish_LU_Tables.mdb. All stream fish databases at PORE that link to the look-up table database must be pathed to this directory.

Data Distribution

In order for the stream fish monitoring program to inform park management and to share its information with other organizations and the general public, guidance documents, reports, and data must be easily discoverable and obtainable. The main mechanism for distribution of the salmonid monitoring documents and data will be the Internet. The salmonid monitoring protocol, accompanying SOPs, and all annual reports will be made available for download at the SFAN website:

<http://science.nature.nps.gov/im/units/sfan/>

Although the stream fish monitoring database will not be posted for public download, as previously mentioned, metadata records for the master databases will be maintained at the NPS Data Store. The metadata records will direct interested parties to the SFAN Data Manager for further inquiries.

In addition to the NPS Data Store, the NPS I&M Program maintains an online natural resource bibliographic database known as NatureBib. NatureBib records will be created for all of the salmonid monitoring documents, including the protocol, annual reports, and any resulting publications. The public version of NatureBib is in development by the NPS I&M program.

All documents produced by the stream fish monitoring program will be published in either the Natural Resource Report Series or the Natural Resource Technical Report Series following guidance from the NPS Natural Resource Program Center in Fort Collins, Colorado. The Natural Resource Publications Management home page hosts a list of all documents published in the NRR and NRTR Series. The home page can be found at:

<http://www.nature.nps.gov/publications/NRPM/>

Literature Cited

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SOP 9. Sampling Site Descriptions

Version 1.2

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	January 2007	Marcus Koenen	Excerpted from other SOP	Clarification	1.0
1.0	March 2007	Michael Reichmuth	Review of SOP	Update SOP to current project status	1.01
1.01	May 2008	Sarah Carlisle	Changes suggested by MR		1.1
1.1	July 2008	Sarah Carlisle, Marcus Koenen	Added in maps of monument tags and tables of locations. Edited		1.11
1.12	August 2008	Michael Reichmuth	Reviewed and made minor edits	Clarification	1.12
1.13	September 2008	Michael Reichmuth	Add GPS Coordinates	Update SOP	1.13
1.13	September 2008	Dawn Adams	Formatting	For peer review	1.14
1.14	November 2008	Michael Reichmuth	Remove Presence/Non-detect	Update	1.15
1.15	December 2008	Michael Reichmuth	Minor edits	For peer review	1.16
1.16	November 2009	Michael Reichmuth	Added Lit Cited	Peer review response	1.17
1.17	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	1.2

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Overview

Monitoring efforts will focus primarily on watersheds in Golden Gate National Recreational Area (GOGA), Muir Woods National Monument (MUWO), and Point Reyes National Seashore (PORE), that contain coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*). These watersheds represent the majority of salmonid-bearing streams in Marin County, California, and support the southernmost stable populations of coho salmon on the western Pacific Coast. SFAN park streams and associated tributaries in Marin County which currently contain populations of both coho and steelhead include Redwood Creek, Pine Gulch Creek, Olema Creek, and Lagunitas Creek. This standard operating procedure (SOP) describes all of the sampling sites for this monitoring project.

Monument Tags

Permanent, sequentially numbered monument tags are located at 100-m intervals along the mainstems of Olema Creek, Pine Gulch, and Redwood Creek (Appendix L). These tag locations were marked using GPS during the summer of 2007 and are used to identify sampling sites.

The markers are aluminum tags with plastic survey flagging that have been attached to trees along the stream bank. In areas without trees, the tags were placed on steel “rebar” stakes and driven into the bank. Each tag is imprinted with a unique code that describes the watershed, stream, and distance from the stream mouth. More specifically, the identification scheme is a set of three separate two- or three-digit codes. These tags were spatially located using UTM coordinates.

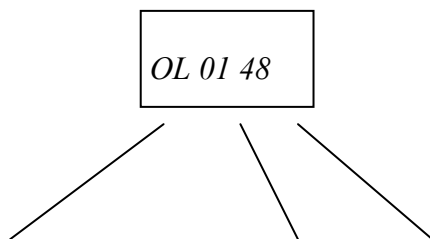
XX-##-##

The first code is the watershed designation. The two-letter abbreviations are:

Lagunitas Creek	LG
Olema Creek	OL
Pine Gulch Creek	PG
Redwood Creek	RW

The second numerical code identifies the specific stream within a watershed. The mainstem is always designated as 01. The tributary codes are listed on maps for each watershed and will be provided by the PORE and GOGA staff.

The third numerical code identifies the stream segment and corresponds with the measured linear distance upstream from the mouth. The beginning point for each of the segmented streams has been labeled as 00 (meter 0). The first 100-m segment receives the code 01. The 15th segment (1500 m upstream from the mouth) receives the code 15. For example, a monument tag may appear as:



The translation is Olema Creek watershed, mainstem, 4,800 m.

Replacing Tags

During summer basinwide habitat surveys, any missing tags will be noted on the datasheet. At the end of the summer monitoring season or prior to the start of winter spawner surveys, field crews will make a return visit to the locations of the missing tags. Using the GPS coordinates, they will locate where the tag is supposed to be. If intensive searching reveals the tag to be truly missing, then the tag will be replaced. If the object to which the tag was attached is no longer there, then the nearest comparable object will be used in its place. This new location will be marked using either a Trimble or Garmin GPS unit, and the coordinates along with location descriptions will be downloaded and added to the database upon returning to the office.

In order to make new tags for replacing those that are lost, take a blank aluminum tag and the stamping kit located in the PORE fish garage; stamp the tag code into the aluminum tag. These tags can be affixed to any large permanent object, preferably a tree, as close to the stream as possible. Place the tag in an obvious spot on the tree and back it with flagging so as to make spotting it on subsequent surveys as easy as possible. Permanent objects include posts or trees. Most often the tag is affixed to an alder; however, redwoods, bays, and fir trees are generally more preferable due to their longevity.

Sampling Sites

Spawner Reaches

The spawner surveys are conducted along spawner reaches which are 2–4 km sections of streams. Teams of 2–4 observers walk upstream along creek margins and banks where possible, and look for live fish, carcasses, and redds.

Olema Creek: A large section (17.6 km) of the mainstem of Olema Creek has been surveyed since 1993. The section is currently divided into 7 survey reaches starting 1 km above the confluence with Lagunitas Creek and ending at the Highway 1 culvert at milepost 19.94 (figures SOP 9.1–5). Reaches are delineated to facilitate sampling based on access, length, and the existence of permanent landmarks for reach boundaries.

- Spawner reach 1: Is rarely surveyed. It goes from 1 km above the confluence with Lagunitas Creek to the Bear Valley Road Bridge in the town of Olema (1.6 km). Access the reach through the marsh below the house at Olema Marsh. Drive through the gate to

the park residence. Enter the stream by crossing the wetland below the house and following the trail to the creek. The reach ends at the Bear Valley Road Bridge.

- Spawner reach 2: Goes from the Bear Valley Bridge to the confluence with Truttman Creek (3.2 km). Park at the pullout next to the bridge, and access the creek on the upstream side of the bridge. The reach ends at the confluence with Truttman Creek. Exit the creek by back tracking approximately 50 m to a spot flagged on the right bank of the stream. There is a steep trail that goes up the ridge to the Truttman house.
- Spawner reach 3: Goes from Truttman Creek to the horse trail crossing at the Stewart Ranch (2.6 km). It starts at the Truttman Creek confluence with Olema Creek mainstem. Pull out and park at the Truttman house. Access is via a path that starts below the barn and ends at the creek. This path follows the fence line for a time before going downhill into the creek, and is flagged. The reach ends at the horse crossing at Stewart Ranch. Exit the creek by climbing the left bank and finding the Rift Zone Trail. Follow Rift Zone Trail back to the Stewart Horse Camp.
- Spawner reach 4: Goes from the Stewart Ranch at the horse trail crossing to the first Hwy. 1 bridge at Five Brooks (1.3 km). Park at the Stewart Horse Camp and follow Rift Zone Trail downstream until reaching the horse crossing at the Ranch itself. The reach ends at the first Highway 1 bridge at the Five Brooks turnoff. Exit the stream by climbing the right bank into the open field beyond the confluence of Giacomini Gulch.
- Spawner reach 5: Goes from the Highway 1 bridge next to the Five Brooks to the abandoned Lime Kilns (2.8 km). Turn off into the pullout just past Giacomini Gulch and before John West Fork. Access the creek by crossing the open grassy area and moving downstream along the shoreline before putting in at the bridge. The reach ends at the abandoned Lime Kilns. Exit the stream at the Lime Kilns and climb the hill to Highway 1.
- Spawner reach 6: Goes from the Lime Kilns to the abandoned Randall ranch house (1.7 km).
- Park at the pull out on Highway 1 between mile markers 22.22 and 22.07, at the top of the hill beyond John West Fork. Walk down the hill towards the stream, angling upstream. When you hit the stream, walk upstream until coming to the abandoned lime kilns, at the start of the survey reach. The reach ends at the old Randall house. To exit, follow one of the paths near the Randall Gulch confluence with Olema Creek mainstem up to Highway 1.
- Spawner reach 7: Goes from the Randall house to the Hwy. 1 culvert at milepost 19.94 (4.1 km). Pull out in front of the Randall house and park. Cross Highway 1 to Olema Creek and enter at the confluence of Randall Gulch and Olema Creek mainstem. The reach ends at the Highway 1 culvert crossing at mile post 19.94. Exit the stream there and climb to the road side. This survey reach is rarely surveyed due to unsafe stream conditions and a decrease in spawning activity upstream of the Randall Gulch confluence.

In addition to the mainstem of Olema Creek, surveys are often conducted on some of the larger tributaries as personnel and flow conditions allow. In particular John West Fork Creek should be

surveyed on the same day as the mainstem of Olema Creek to provide a more accurate PLD count for the watershed. For each tributary, survey reaches start at the mouth and generally continue upstream as long as no passage barriers exist. The tributaries, many of them unnamed on U.S. Geological Survey (USGS) 7.5 minute maps, are listed in order of survey priority:

1. John West Fork located 10.9 km above the mouth of Olema Creek at Hwy. 1 milepost 22.67. (survey reach from tributary mouth to 2 km upstream)
2. Quarry Gulch located close to the Olema Cemetery 4.1 km above the mouth of Olema Creek at Hwy. 1 milepost 25.35.
3. Giacomini Gulch located 10.8 km above the mouth of Olema Creek at Hwy. 1 milepost 22.78
4. Horse Camp Gulch located 9.6 km above the mouth of Olema Creek at Hwy. 1 milepost 23.26.

The headwaters of Olema Creek (considered a tributary for the purposes of the survey due to its physical characteristics) beginning at Hwy.1 milepost 19.94.

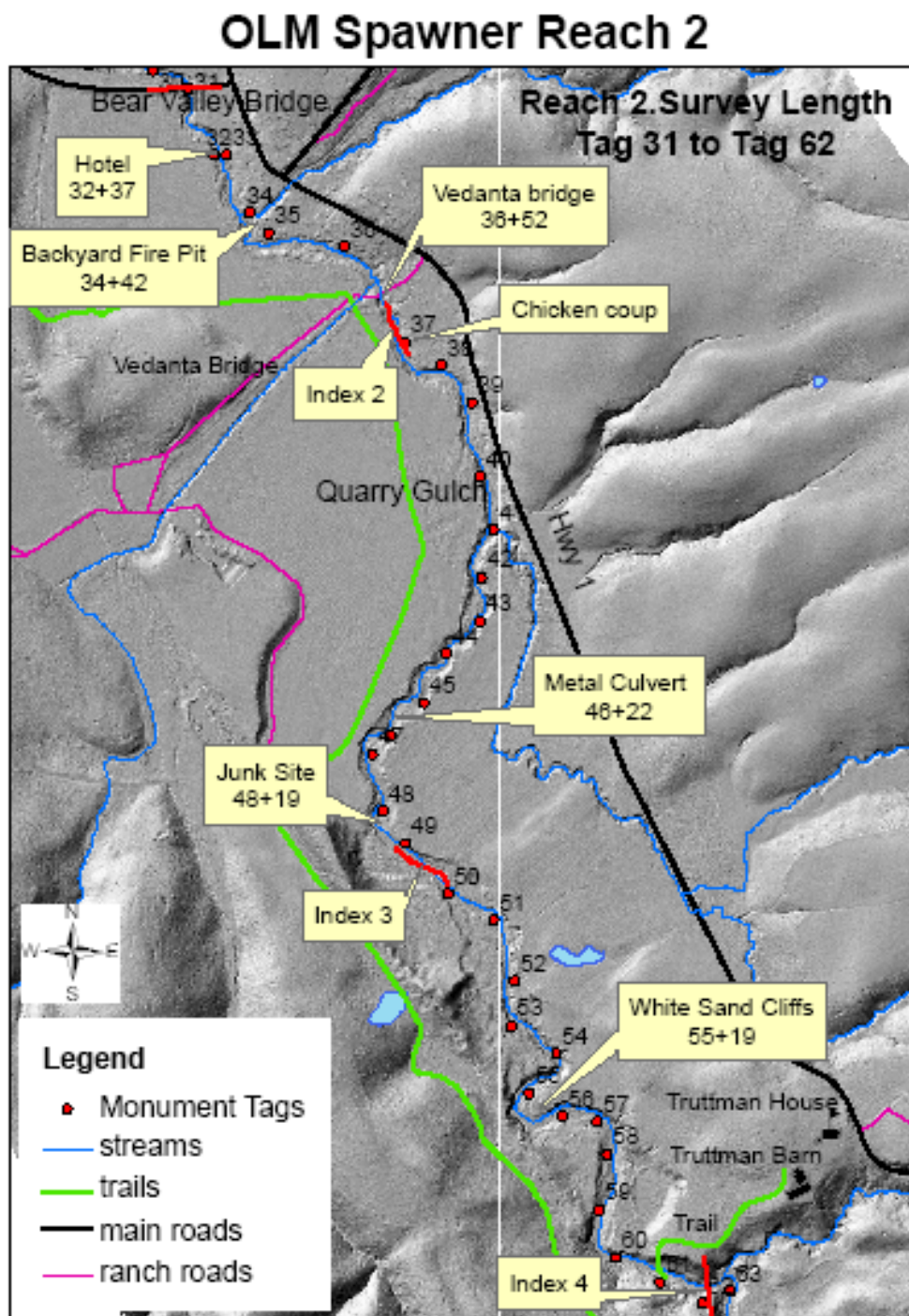


Figure SOP 9.1. Olema Creek mainstem spawner reach 2 with monument tags and index sites included.

OLM Spawner Reach 3

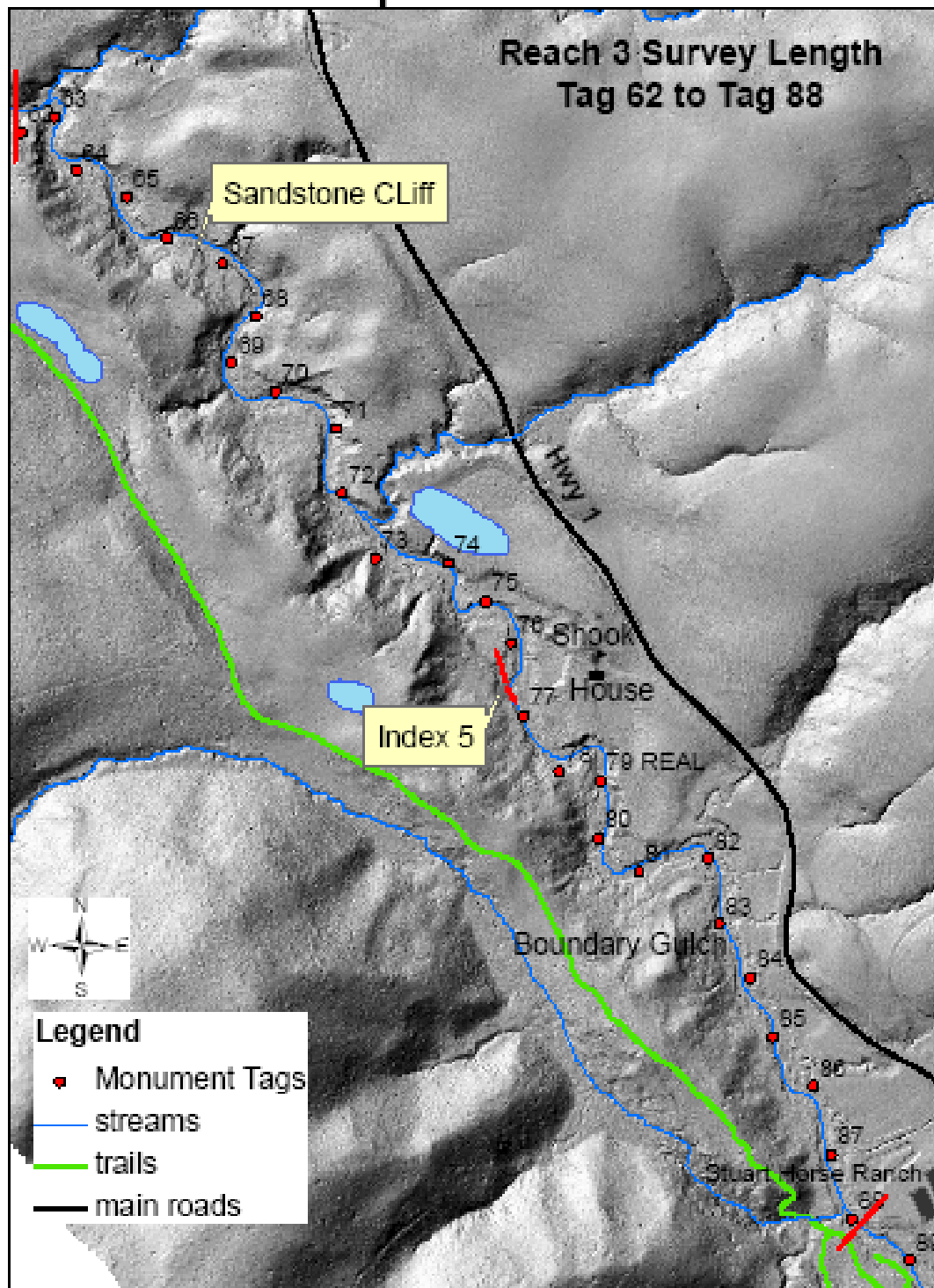


Figure SOP 9.2. Olema Creek mainstem spawner reach 3 with monument tags and index reaches included.

OLM Spawner Reach 4

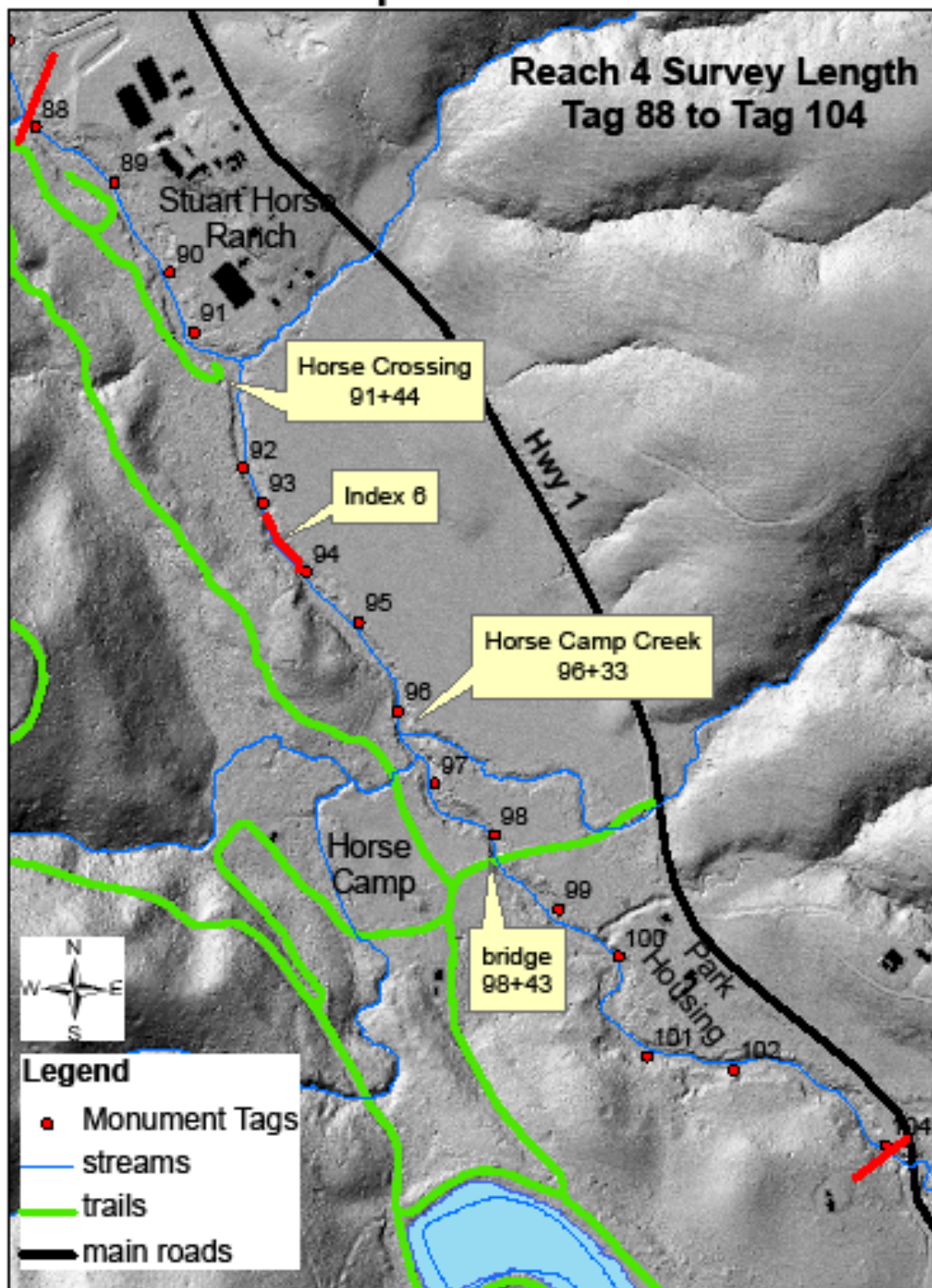


Figure SOP 9.3. Olema Creek mainstem spawner reach 4 with monument tags and index reaches included.

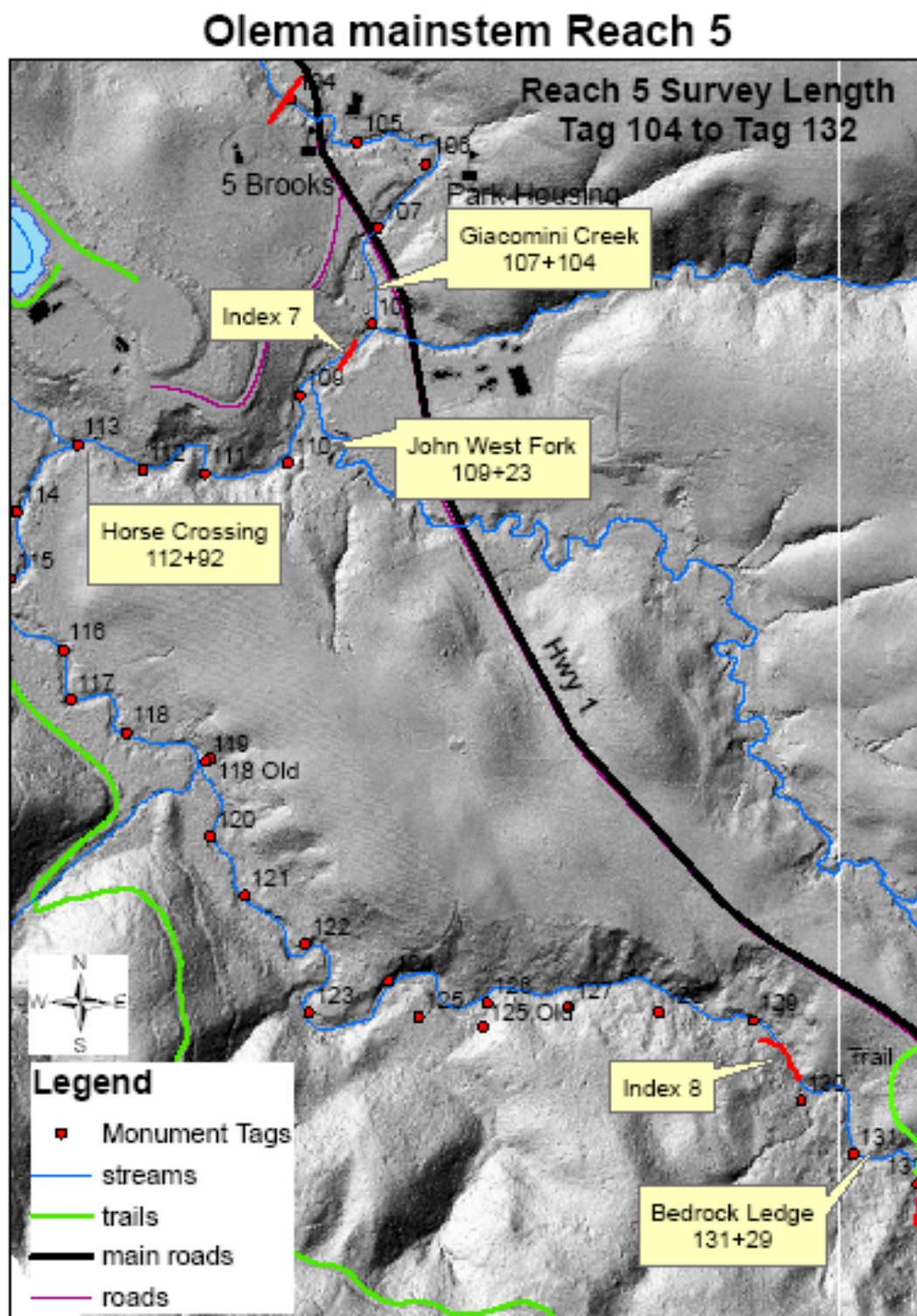


Figure SOP 9.4. Olema Creek mainstem spawner reach 5 with monument tags and index reaches included.

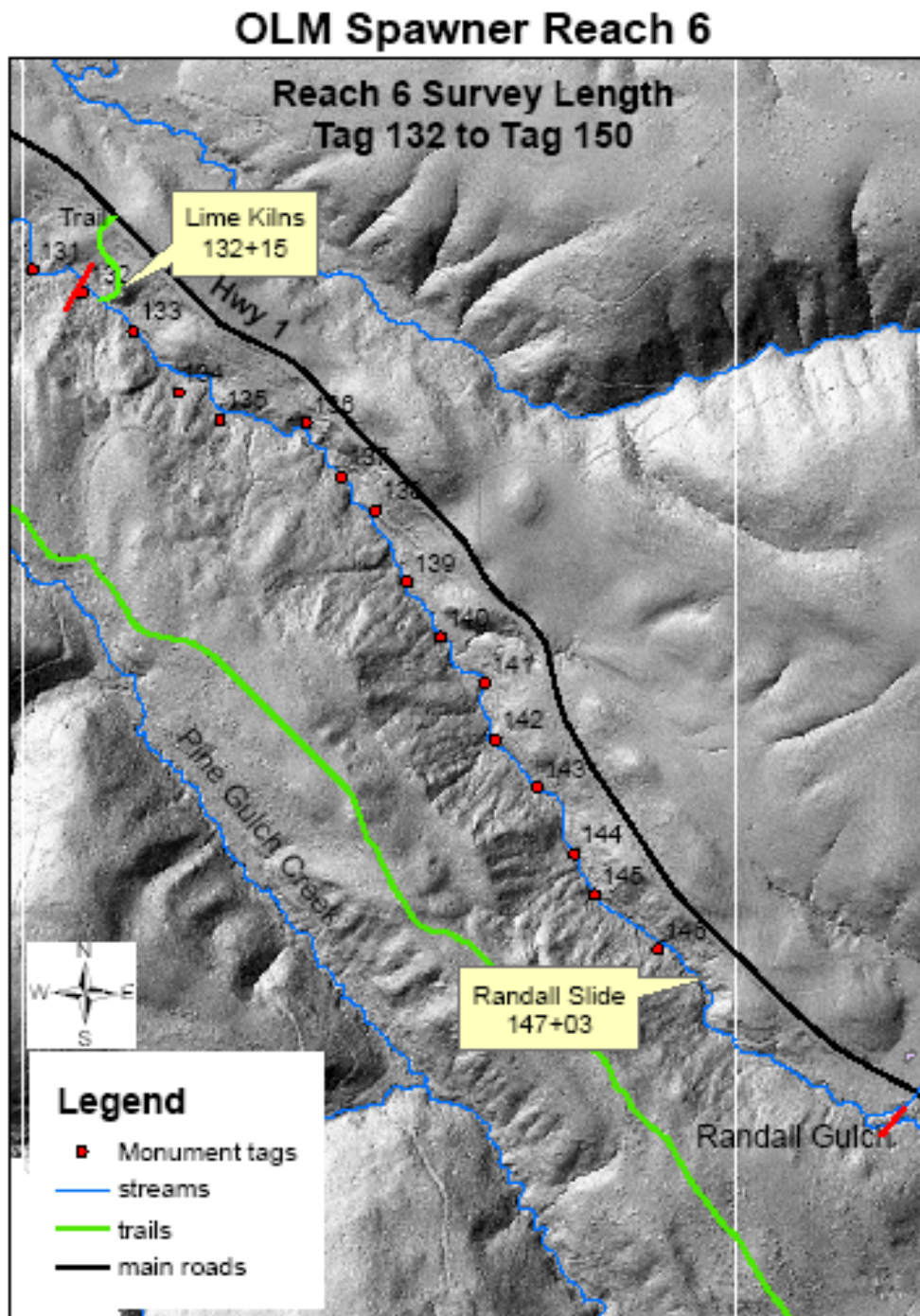


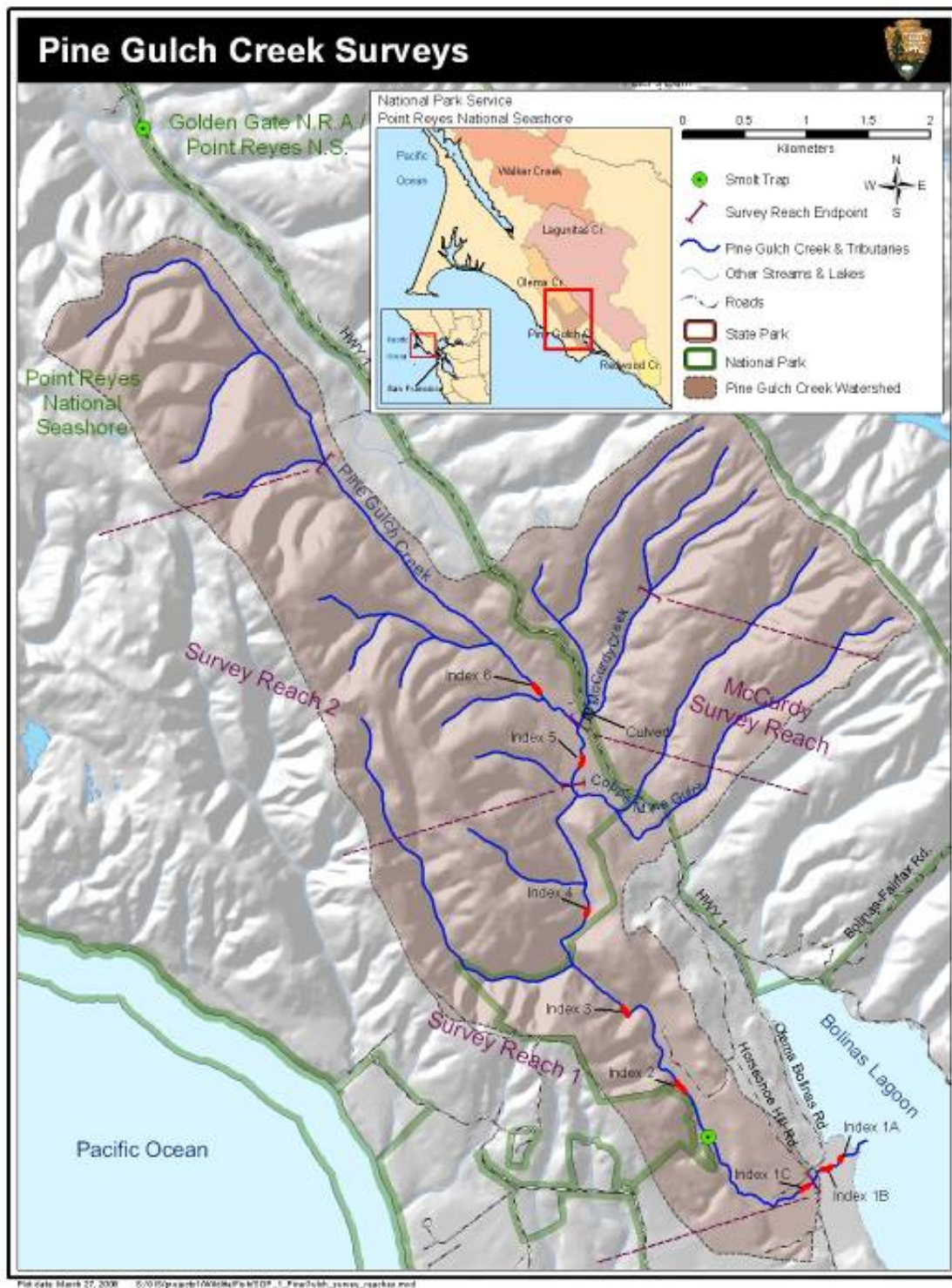
Figure SOP 9.5. Olema Creek mainstem spawner reach 6 with monument tags and index reaches included.

Pine Gulch: Since 1997, the NPS has conducted surveys along a 9-km section of the mainstem of Pine Gulch Creek. Coho salmon were first spotted during surveys in the winter of 2000–2001. Due to private property access issues and the nature of the watershed, the survey reaches are longer than normal (figure SOP 9.6). This requires a solid day to conduct the survey with two teams. Additional surveyors are required to complete the McCurdy tributary.

The spawner surveys start at the Olema-Bolinas Road Bridge and extend upstream to at-least the Teixeira Ranch. Complete surveys should extend up the mainstem to the Pacific Coast Learning Center/Hagmaier complex. The section encompasses most of the stream length that would be potentially used by coho salmon.

- Spawner reach 1. Starts at the Olema-Bolinas Road Bridge and goes to the Teixeira Ranch (6.0 km). Park at the pullout after the bridge and access the creek on the upstream side of the bridge. The end of the reach is at the Teixeira Ranch.
- Spawner reach 2: The reach begins at the Teixeira Ranch (upstream beyond Teixeira) and goes to approximately monument marker 100 (3.5 km). Turn off of Highway 1 at the Teixeira Ranch entrance. Continue across the bridge to the barns, and park next to the smaller barn. Access the creek through the fence alongside the barn. The end of reach two is at monument tag 100. The field crew must hike back down the creek in order to exit.
- Spawner reach 3 (McCurdy Reach): This reach is McCurdy Creek and it is rarely sampled. It goes from Teixeira Ranch up McCurdy Creek tributary (2 km). McCurdy Creek is the most likely tributary to support a significant population of coho salmon and steelhead trout. Fish passage in McCurdy is limited by a culvert under Hwy 1, approximately 130 m from the mouth, which has been identified as one of the highest priority barriers in Marin County (Taylor and Associates 2003). Monitoring would be conducted to quantify response. The survey reach extends 2 km upstream from the confluence with Pine Gulch Creek, to a series of steep cascades 1 km upstream. To access it, park at the pullout for the Olema Valley Trail. Follow the trail until it is parallel to the large stand of eucalyptus before heading towards Pine Gulch Creek. Stay to the left of the eucalyptus grove. Upon hitting Pine Gulch Creek, head downstream until the reaching the confluence of McCurdy Creek and Pine Gulch Creek mainstem. The McCurdy reach starts there. Head upstream, approximately 2 km. To exit the stream, retrace the route taken in.

Figure SOP 9.6. Pine Gulch Creek spawner survey reaches (also shows index reaches).



Redwood Creek: Since 1994, the NPS has conducted annual surveys along a 7.4 km section of the mainstem of Redwood Creek (figures SOP 9.7–9) between the Pacific Way Bridge and a small waterfall within Mt Tamalpais state park just upstream of monument tag #74. The section encompasses most of the stream length used by coho salmon. To facilitate sampling, the section is divided into three reaches:

- Spawner reach 1: Starts at the Pacific Way Bridge and goes to the Kent Creek confluence in Mt. Tamalpais State Park (2.7 km). Access to the creek is on the upstream side of the bridge. The reach goes to the Kent Creek confluence with Redwood Creek mainstem, within Mt. Tamalpais State Park. Exit the creek by following the trail out of the creek up to the footbridge and up to the road.
- Spawner reach 2: Starts at the confluence between Kent Creek and Redwood Creek mainstem and goes to Bridge 1 in MUWO (2.4 km). Park at the pullout closest to the footbridge on Redwood Creek Trail in Mt. Tamalpais State Park. Access is on the upstream side of the footbridge. The reach goes to Bridge 1 in MUWO. Exit by climbing out of the creek and walking back along the boardwalk.
- Spawner reach 3: Starts at Bridge 1 in MUWO and continues to approximately 500 m above Bridge 4 at monument tag 74. Access the creek by parking at the visitor center parking lot and following the boardwalk up to the first bridge. Exit the creek by climbing out of the creek and following the Bootjack Trail back to the parking lot.

Portions of Fern and Kent Creeks, the two largest Redwood Creek tributaries, will also be sampled. The reach on Kent Creek extends from the confluence with Redwood Creek to a water fall, approximately 1 km upstream that is impassable to migrating adults. The Fern Creek section has been surveyed since 1994 and extends between the Redwood Creek confluence and a series of steep cascades 1 km upstream. The upstream limit of surveys on Redwood Creek and the high gradient cascade on Fern Creek are not impassable barriers for steelhead. However, neither coho salmon adults nor juveniles have been observed above these points and they are assumed to be coho barriers.

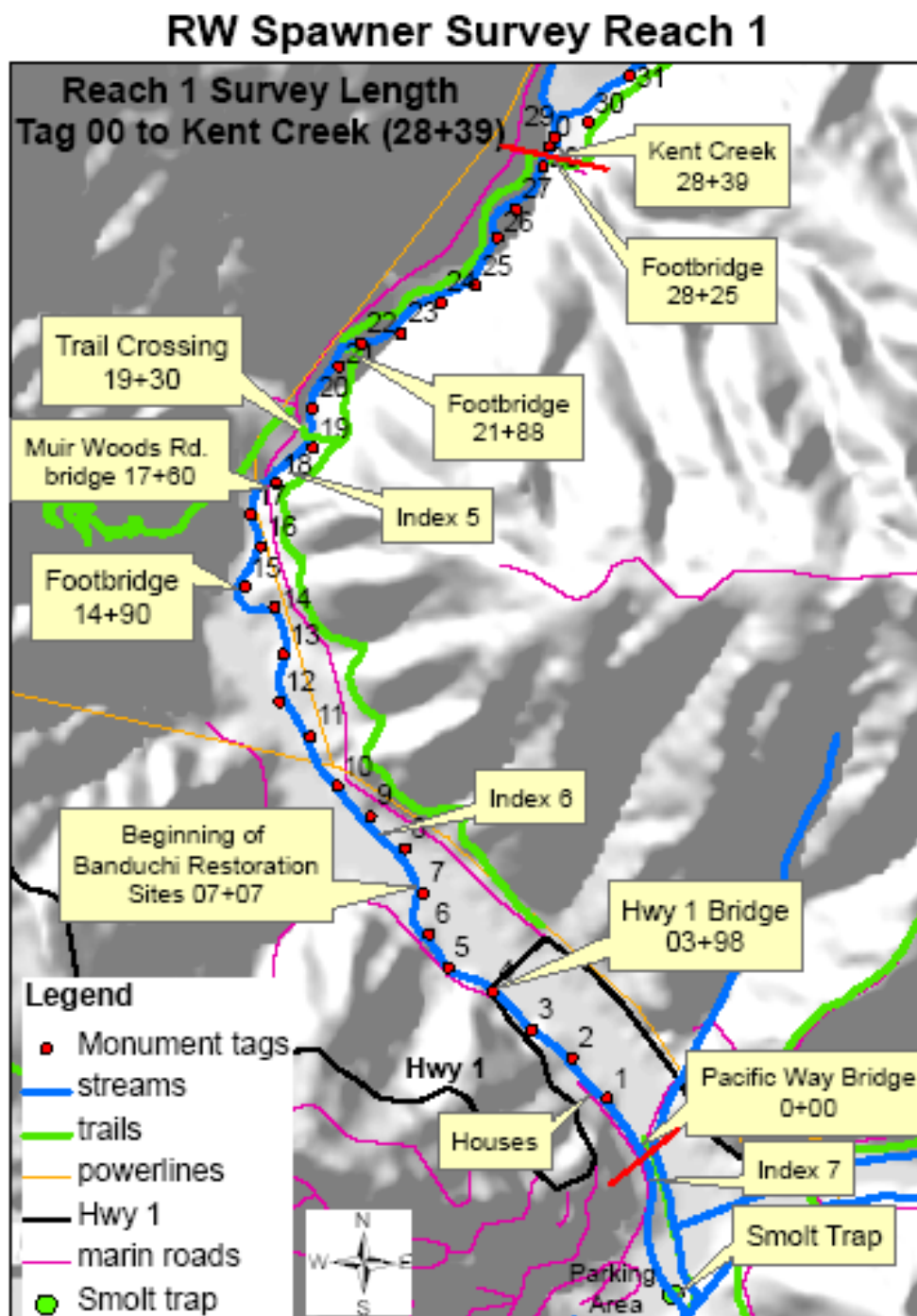


Figure SOP 9.7. Redwood Creek mainstem spawner reach 1 with monument tags and index reaches included.

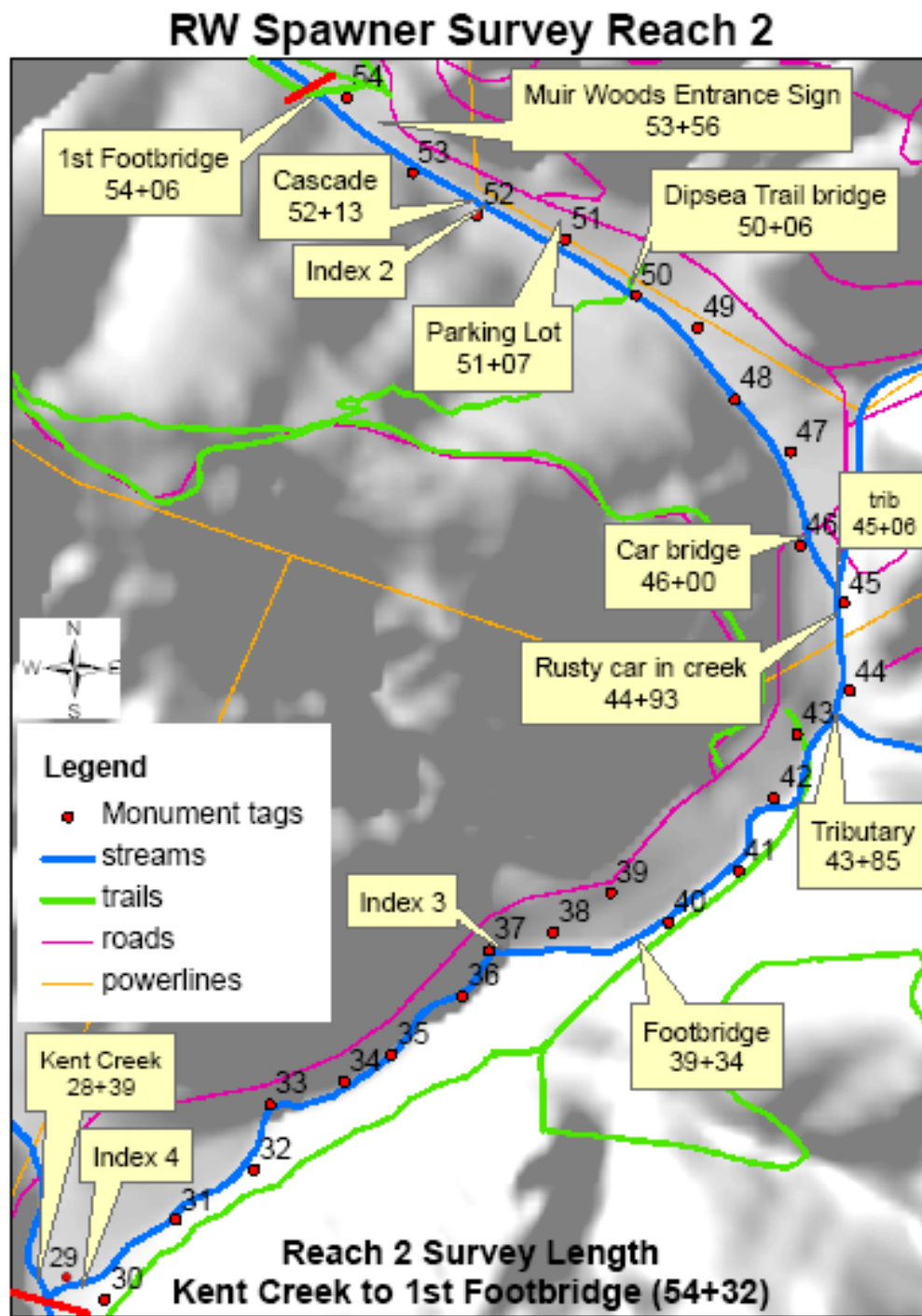


Figure SOP 9.8. Redwood Creek mainstem spawner reach 2 with monument tags and index reaches included.

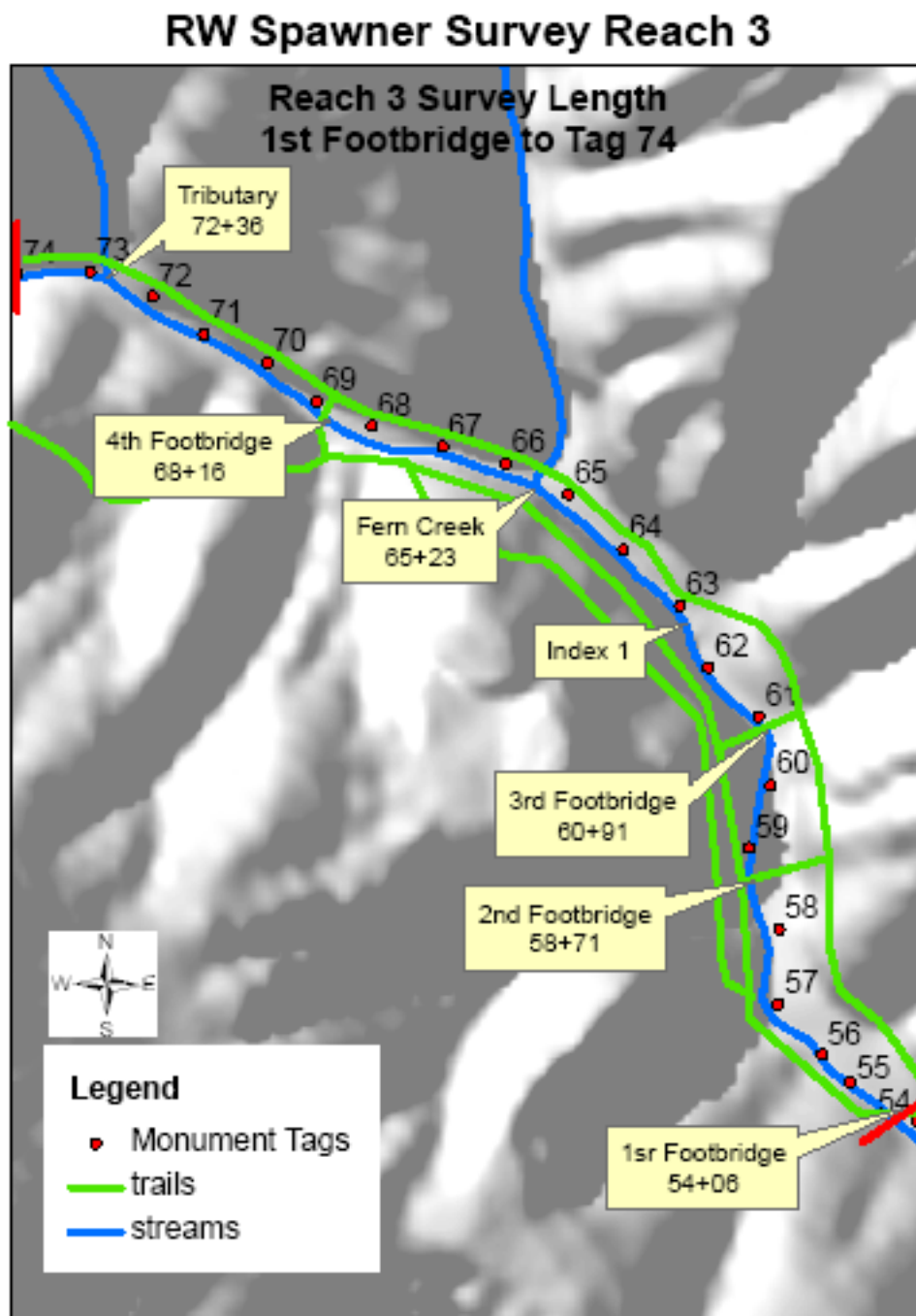


Figure SOP 9.9. Redwood Creek mainstem spawner reach 3 with monument tags and index reaches included.

Cheda Creek: Cheda Creek (figure SOP 9.10), a Lagunitas Creek tributary, has been surveyed since 1996–1997 to detect the presence or absence of coho. The NPS completed a fish passage project in the fall of 2000, coho salmon spawning in the upper part of the creek above the fish passage project site was detected for the first time during the 2004–2005 spawning season. A total of about 1.2 km is typically surveyed, including a 0.8 km reach below the fish passage improvement and 0.4 km above.

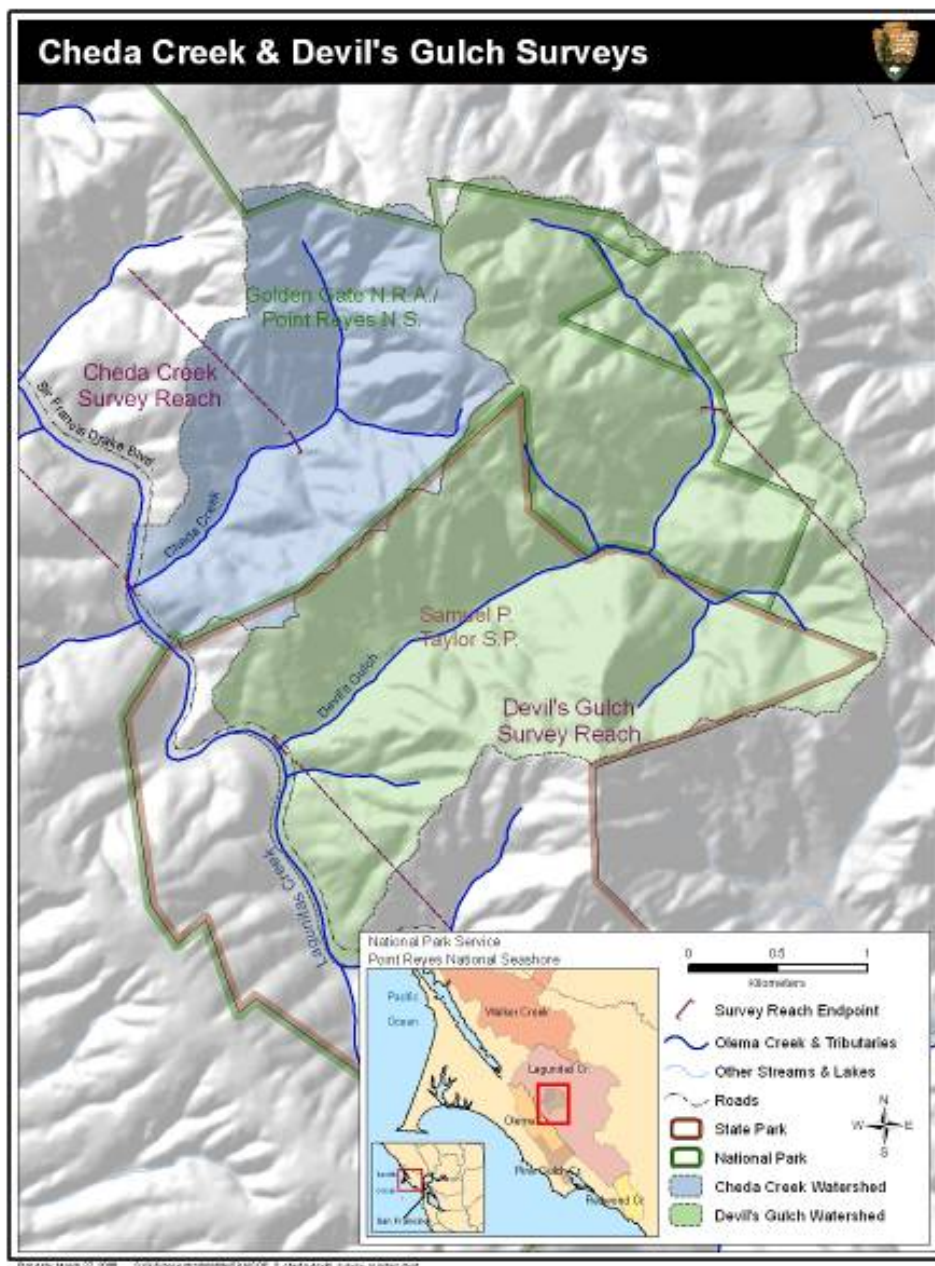


Figure SOP 9.10. Cheda Creek and Devil's Gulch (no longer surveyed) spawner survey reaches.

Smolt Trapping Sites

Smolt trapping is conducted by placing traps at the downstream end of the watershed to gain an accurate smolt productivity index for the entire watershed upstream of the trap. Smolt trapping is conducted at Olema, Pine Gulch, and Redwood Creek. Both Pine Gulch and Redwood Creeks are first order streams and thus an accurate production estimate can be obtained through downstream migrant trapping. Although Olema Creek is not a first order stream, the proximity of its confluence with Lagunitas Creek is relatively close to Tomales Bay and is thus an acceptable trapping location.

The location of the trap and watershed size plays a role in the equipment used to conduct smolt trapping. Smolt traps are located as far downstream as possible on the sampled watersheds or sub-watersheds, preferably near the mouth of the stream. Sites are selected based upon channel character, accessibility, and protection. Sites should also be reasonably accessible to facilitate equipment transport, and stream channel gradient should be suitable for type of trap being used. Sites must have adequate vertical gradient to push water through the pipe. This is easier in smaller and steeper watersheds. We have found with operation of traps at the lower end of mainstream systems, that performance is closely linked to spring runoff conditions. The trap operations may be washed over, and consideration should be taken to construct traps that readily open for high flow conditions.

Procedures for selecting smolt sample locations: Sites are selected based upon channel character, accessibility, and protection. The sites have adequate vertical gradient to push water through the pipe. At the existing Pine Gulch Creek site and other low gradient sites, the trap requires significant sand bagging around the weir as hydraulic head is necessary to push water into the trap. Inadequate head in the system results in very low flow through the pipe and inefficient trapping.

Accessibility and security are also important aspects of the trapping site. The structure should be located in an area where equipment can be easily carried to the site. In addition, it is important that the trap be located in a place where vandalism is not likely to occur. Trap locations should be assessed on an annual basis prior to trap construction. If the channel morphology changes to a state that is no longer conducive smolt trapping, a new location should be located as close to the previous trapping location as possible. New trapping locations will be spatially located using UTM coordinates.

Location of Traps: See figure SOP 9.11.

- Olema Creek: The Olema Creek smolt trap is located on NPS lands approximately 1.9 km upstream of the mouth of the creek, approximately 60 m upstream of tag 15. Due to high flow failure and the capture of California red-legged frog tadpoles in the trap box, we relocated the site to an area upstream of the potential red legged frog breeding habitat. To access the site, enter the Olema pasture on the right side of Bear Valley Road at the top of the hill above the park administration offices. Follow the ranch road along the ridge. Take the right hand fork and follow it down the hill. Turn right again at the pond and follow the road to the creep feeder at the bottom of the hill and park there. The smolt trap site is on the other side of the cattle fence.
- Pine Gulch: The location of the Pine Gulch trap site is determined in large part by access,

since the lower 4.5 km of the mainstem is on mostly private lands. The current location is about 2 km above the mouth and was chosen with the cooperation of the landowner in Paradise Valley (see Appendix M: Landowner access agreement). The original trap location in 1999, on public lands 300 m upstream of the mouth, was subject to high public access and vandalism. In order to reach the trap site, take Bolinas Road towards Bolinas. After passing a long stand of cypress trees, take the dirt road to the right that follows the line of cypress. Follow this road until it forks, and stay to the left. Go past two houses and pull in beneath the fruit tree next to the intern housing (a collection of small travel trailers). The trap site is slightly downstream of this pull out.

- Redwood Creek: The Redwood Creek mainstem site is situated approximately 400 m upstream of the mouth of the creek adjacent to the Muir Beach picnic area. The trap is downstream of all tributaries to Redwood Creek thus providing an accurate estimate of the watershed production. To access the site, drive down to the Muir Beach Parking Lot and park alongside the picnic tables. Cross the cable fence and walk across the restoration area to the creek. The smolt trap site starts below the end of the willows on the upstream side of the restoration area.



Figure SOP 9.11. Location of smolt traps on SFAN streams in Marin County, California.

Basinwide GSS Surveys

Basinwide GSS surveys are conducted along the mainstems of Olema, Redwood, and Pine Gulch Creeks. Survey reaches were delineated to capture the majority of the summer juvenile coho habitat found within each of the three creeks. Survey reaches may be adjusted on each creek on an annual basis to reflect the current water year.

- Olema Creek: A large section (11.5 km) of the mainstem of Olema Creek has been surveyed since 2003. The section currently starts 3.5 km above the confluence with Lagunitas Creek at the Vedanta Bridge and ending at the confluence of Randal Gulch with Olema Creek (figure SOP 9.12).
- Pine Gulch: Since 2001, the NPS has conducted surveys along a 10-km section of the mainstem of Pine Gulch Creek. Coho salmon were first spotted during surveys in the winter of 2000–2001. The section currently starts approximately 1.0 km above the confluence with Bolinas Lagoon at the Bolinas Road bridge and ending 2.5 km above the Teixeira ranch (figure SOP 9.13).
- Redwood Creek: Since 2004, the NPS has conducted continuous annual surveys along a 7.4 km section of the mainstem of Redwood Creek (SOP 9.14) between the Pacific Way Bridge and a small waterfall within Mt Tamalpais state park just upstream of monument tag #74. The section encompasses most of the stream length used by coho salmon.

Index Reaches

Index reaches are located in the Olema, Pine Gulch, and Redwood Creeks. Index reaches were selected based upon general conditions including Rosgen channel type (Rosgen 1994), land use patterns, other habitat characteristics, and professional judgment and knowledge of the watersheds to encompass appropriate fish habitats including a combination of pools, riffle, and runs (Beamish 2000). Because habitats change dynamically, the index reach boundaries may be adjusted slightly from year to year to incorporate this variability. The lengths of individual index sites will range from over 100 m for the lower reaches of the mainstems to 70–100 m on the upper mainstem reaches. Each index reach is designed to include at least two meander lengths (roughly 35–40 mean stream widths) so that at least three riffle-pool sequences are included (Simonson et al. 1994). Within the high priority streams in the network there are 23 index reaches (tables SOP 9.1–3 and figures SOP 9.15–17) of which 21 index reaches are currently being sampled on an annual basis.

Several steps are taken to facilitate the relocation of each index reach. The upstream and downstream ends of each site are marked with flagging and labeled aluminum tree tags. The location of the nearest permanent 100-m monument tag is recorded, and digital photos are taken and archived electronically. UTM coordinates will be recorded for the downstream and upstream ends of all index reaches for inclusion in a GIS database.

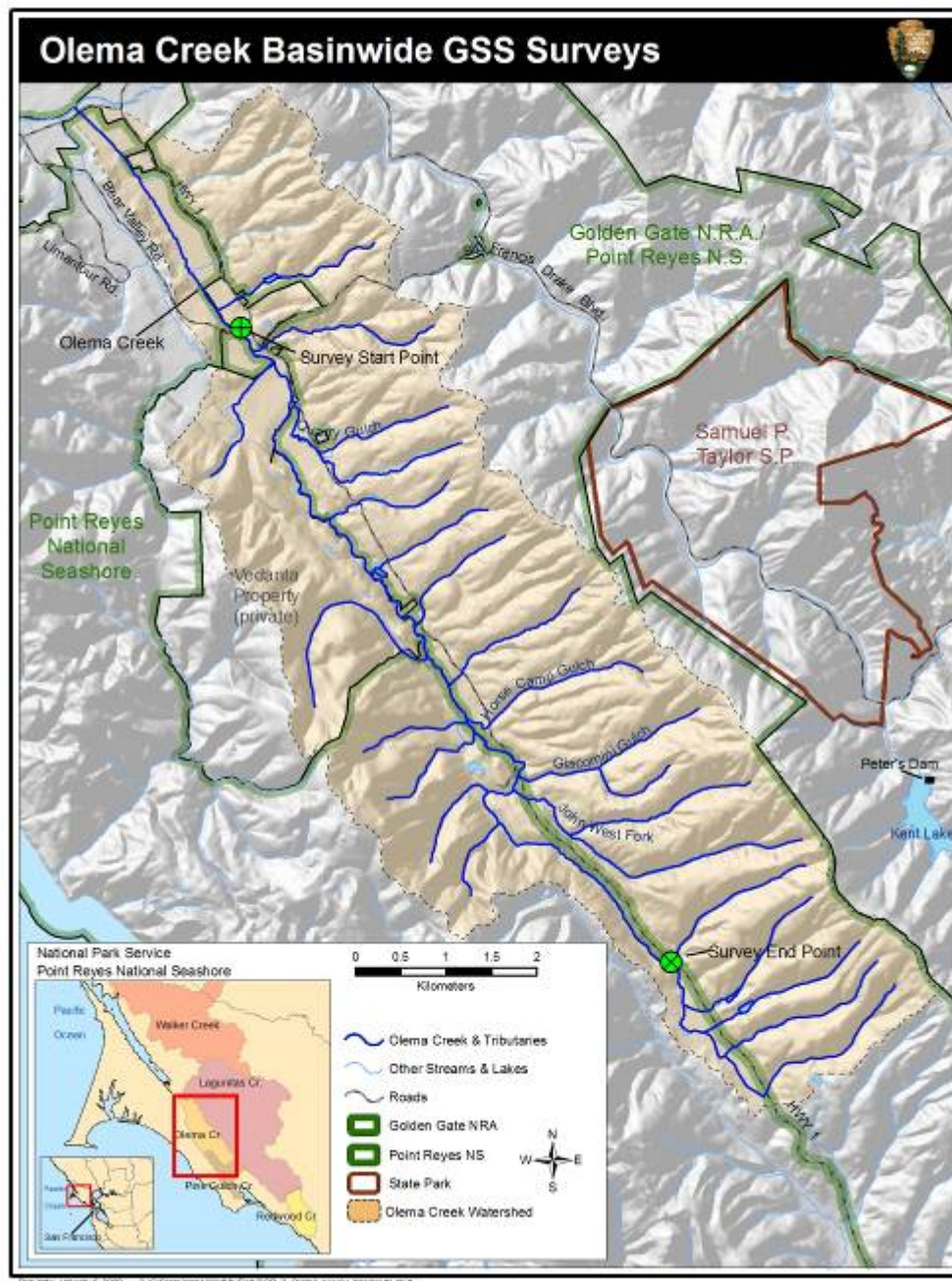


Figure SOP 9.12. Basinwide GSS Survey reach for Olema Creek.

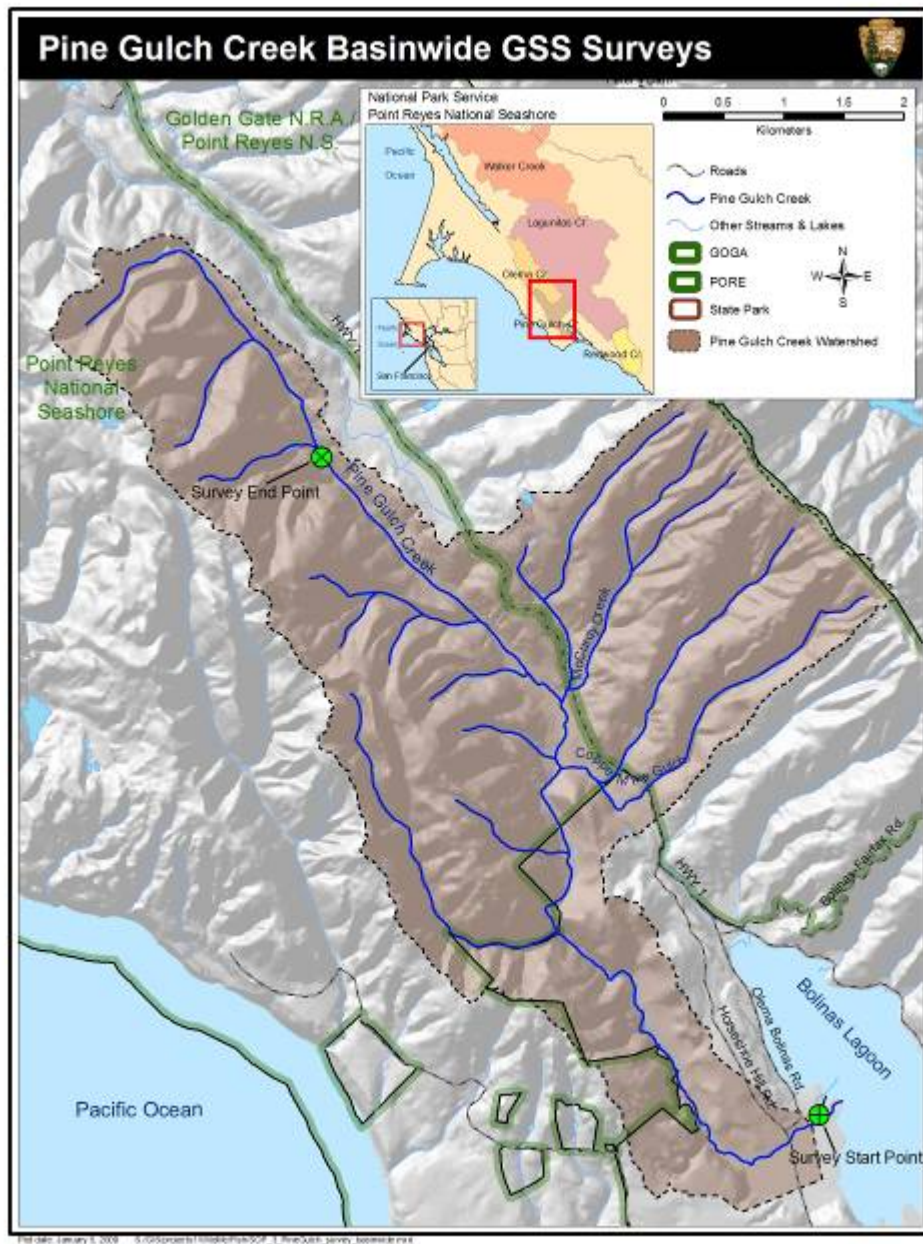


Figure SOP 9.13. Basinwide GSS Survey reach for Pine Gulch.

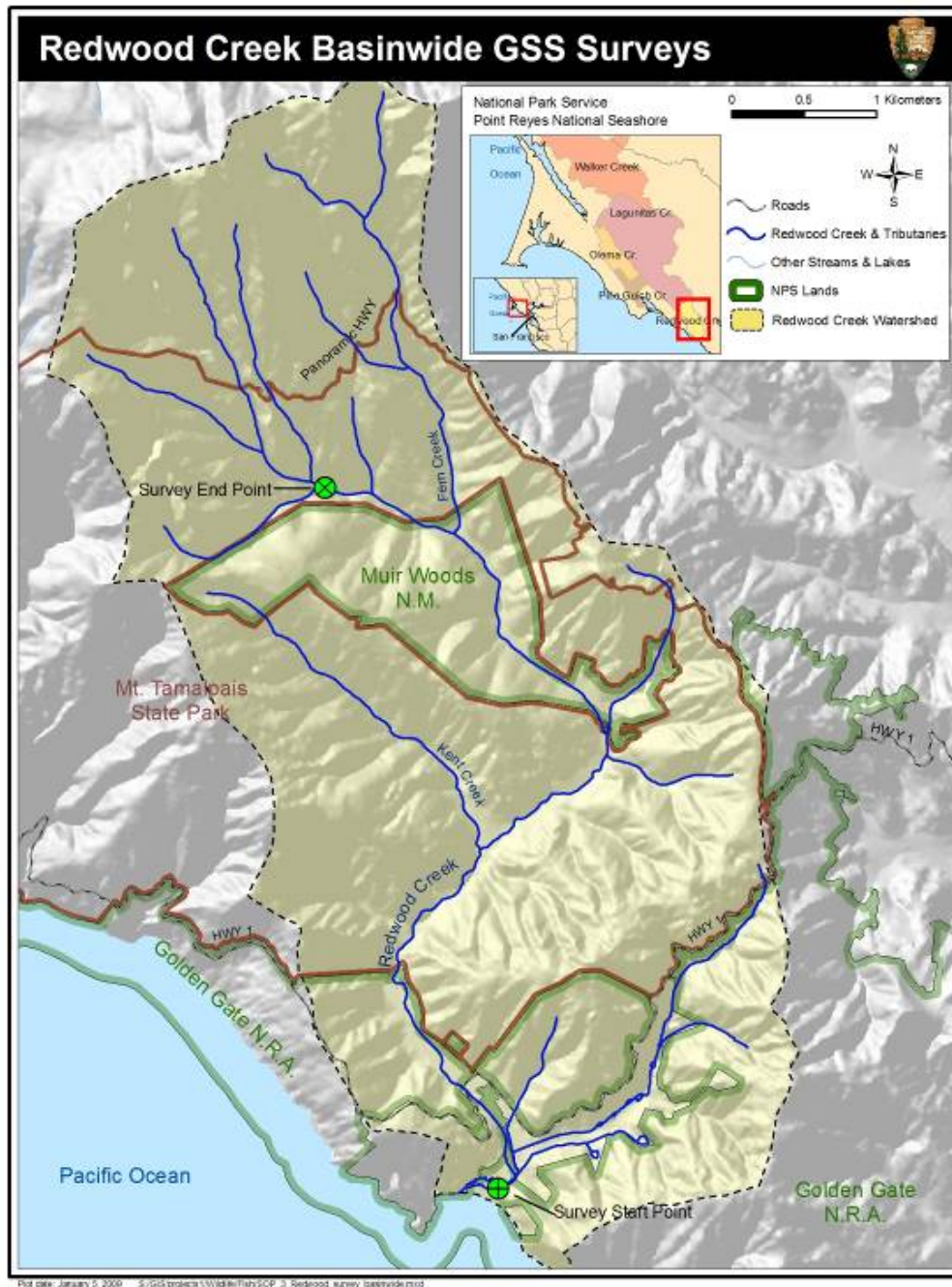


Figure SOP 9.14. Basinwide GSS Survey reach for Redwood Creek.

Table SOP 9.1. Index reach locations for Olema Creek (coordinates from Garmin backpack unit, *= no differential correction).

#	Name/ Location	Reach ID (stream km)	Description	Dec deg downstream		Dec deg upstream	
				lat	long	lat	long
1	Olema Flat	1.2	Downstream of riparian gap in Olema Flat				
2	Vedanta	3.7	~30 m upstream of Vedanta vehicle bridge	38.02170	-122.471	38.02146	-122.471
3	Cemetery Pond	4.9	~100 m downstream of Cemetery Pond in Stewart's pasture	38.01477	-122.471	38.01461	-122.470
4	Truttman	6.3	At Truttman Gulch confluence w/ Olema mainstem				
5	Bldg 168/Shook's house	7.6	~70 m downstream of Park Quarters # 168	38.00599	-122.462	38.00587	-122.462
6	Horse Camp	9.4	~200 m downstream of Stewart's Horse Camp	38.00195	-122.455	38.00173	-122.455
7	5 Brooks	10.8	At Giacomini Gulch confluence w/ Olema mainstem	*37.59491	-122.452	*37.59479	-122.452
8	Lime Kilns/Upper Olema	13.0	~200 m downstream of Lime Kilns	*37.59249	-122.450	*37.59234	-122.446

Table SOP 9.2. Index reach locations for Pine Gulch (coordinates from Garmin backpack unit, *= no differential correction).

#	Name/ Location	Reach ID (stream km)	Description	Dec deg downstream		Dec deg upstream	
				lat	long	lat	long
1a	MCOSD (Open Space)	0.3	Downstream of dredge pool in Open Space	37.55150	-122.412	37.55152	-122.412
1b	Murch's	0.4	By stream gauge @ Murch's footbridge	37.55107	-122.413	37.55110	-122.413
1c	Weber's	0.7	~50 m upstream of Bolinas Rd. bridge	37.55061	-122.414	37.55055	-122.414
2	Paradise Valley	2.8	By lone redwood at entrance road to Paradise Valley	37.55340	-122.422	37.55353	-122.422
3	Gorge	3.9	Downstream end of gorge at end of Martinelli's road	37.55517	-122.424	37.55520	-122.424
4	BPUD pasture	5.1	Downstream end of (former) BPUD pasture				
5	lower Teixeira	6.8	~50 m downstream of Olema Valley Trail lower xing	37.56545	-122.425	37.56566	-122.425
6	upper Teixeira	7.8	~20 m upstream of Olema Valley Trail upper xing	37.57160	-122.430	37.57166	-122.431

Table SOP 9.3. Index reach locations for Redwood Creek (coordinates from Garmin backpack unit, *= no differential correction).

#	Name/ Location	Reach ID (stream km)	Description	Dec deg downstream		Dec deg upstream	
				lat	long	lat	long
7	Pacific Way Bridge	0.1	J. Smith site #7, below Pacific Way bridge			4190845.6 20	537306.03 0
6	Banducci	0.8	J. Smith site #6, sampled by NPS	4191377.3 30	536859.00 0	4191434.6 50	536795.39 0
5	Frank Valley Road Bridge	1.9	J. Smith site #5, above Frank Valley Road bridge in Mt. Tam State Park	4192072.7 80	536751.22 0	4192148.1 90	536749.56 0
4	Kent Creek	2.9	J. Smith site #4, above Kent Creek confluence in Mt. Tam State Park	4192688.6 90	537271.22 0	4192777.5 10	537349.11 0
3	Miwok Trail Crossing	3.8	J. Smith site #3, below Miwok Trail Crossing	4193098.5 10	537770.52 0	4193143.2 00	537834.86 0
2	MUWO restroom	5.2	J. Smith site #2, sampled by NPS	4193946.3 40	537612.89 0	4194030.3 70	537540.09 0
1	MUWO boardwalk	6.3	by boardwalk above MUWO bridge 3	4194790.4 10	537150.14 0	4194863.8 30	537076.62 0

Olema Creek: There are 8 reaches on Olema Creek (figure SOP 9.15).

- Index reach 1: is no longer sampled on Olema Creek, due to impossible access.
- Index reach 2: is located immediately upstream of the Vedanta vehicle bridge. After turning off of Highway 1 at the Vedanta Retreat road, field crews should cross the bridge and pull out alongside the road on the left. A trail leads down to the stream channel.
- Index reach 3: is located near Cemetery Pond on Stewart Ranch. Access is through the gate on the right side of Highway 1, after passing the cemetery and crossing Quarry Gulch. Follow the ranch road through the gate and into the second pasture to the right. Continue on the ranch road until you pass the wetland area, and then turn to the left and drive across the pasture until coming to the fence. The index is across the fence and downstream approximately 50 m, below the large woody debris jam.
- Index reach 4: is located at the Truttman Creek confluence with the Olema Creek mainstem. Turn off of Highway 1 into the Truttman House complex and park near the old dairy barn. Follow the path that starts downhill from the barn, down to Olema Creek. The path is marked with flagging, and intersects with the creek approximately 50 m downstream from the bottom of the index reach. The index reach's upstream end is covered by an extremely large woody debris jam.
- Index reach 5: is located downstream of one of the park residences. Turn off of Highway 1 into the driveway of Building 168 and pull off to the side of the driveway. The path starts at the gate below the house and continues down to the creek, letting out into the middle of the index reach. The index reach's bottom is approximately 30 m downstream.
- Index reach 6: is located near the Stewart Horse Camp. Pull off of Highway 1 at the Stewart Horse Camp entrance and park close to the Rift Zone Trail entrance. Follow the Rift Zone Trail up to the top of the hill and continue down the trail for approximately 75 m. A small deer trail will split off to the right, heading downhill to the creek. Follow this trail downhill until reaching the creek. Index reach 6 is located approximately 200 m downstream of the Horse Camp.
- Index reach 7: is located near the Giacomini Gulch confluence with the Olema Creek mainstem. Pull into the pullout area upstream of the Giacomini Gulch Highway 1 crossing, across from the Giacomini Ranch house. Cross the open area, heading back towards Giacomini Gulch, and go down to the creek. Index reach 7 is located approximately 30 m upstream of the confluence with Giacomini Gulch.
- Index reach 8: is located downstream of the old Lime Kilns along Olema Creek. Go up the hill beyond John West Fork and pull off of Highway 1 at the pullout between mile markers 22.22 and 22.07. Head down the hill towards the creek. The index is approximately 30 m upstream of tag 129.



Pine Gulch Creek: There are 8 reaches on Pine Gulch Creek (figure SOP 9.16).

- Index reach 1a: is located within the Marin County Open Space property. Pull out and park at the Murch's farm and head downstream. It is downstream of the dredge pool, and located at about tag 1.
- Index reach 1b: is located by the stream gauge placed just downstream of the Murch's footbridge. As with index 1a, park at the Murch's farm and walk down to the footbridge. Access is to the side of the footbridge. The index starts just downstream of the footbridge, close to the stream gauge.
- Index reach 1c: is located approximately 50 m upstream of the creek crossing at the Bolinas Road Bridge. Pull off of the road at the pull out just beyond the bridge. Access this site by walking up the Star Route Farms driveway to the right and walk towards the creek and go past the farm house. A small path will lead toward the creek behind the farm house. Once you reach the creek the downstream end of the index reach will start immediately upstream of the trail entrance. The index starts at approximately 20 m below tag 6.
- Index reach 2: is located in Paradise Valley. Take Bolinas Road towards Bolinas. After passing a long stand of cypress trees, take the dirt road to the right that follows the line of cypress. Follow this road until it forks, and stay to the right. After crossing a cattle guard, continue around the first bend in the road and pull off in the large grassy area on the left side of the road. Move down into the creek. The index is below the only redwood in the line of trees along the creek. The index starts at approximately 30 m upstream of tag 24.
- Index reach 3: is located at the downstream end of the gorge at the end of the Martinelli's road. Follow the road past the pullout for index 2 and continue past the Martinelli farms. Follow the road up the hill, staying to the right whenever roads branch off. Pass through the gate and turn to the left. Go past the pond and turn left again, going through the gate; park at the end of that ranch road. Follow the creek upstream until reaching the downstream end of the gorge. The index starts just past the large woody debris jam, approximately 20 m upstream of tag 35.
- Index reach 4: This index reach is currently not sampled due to private property access issues.
- Index reach 5: is located near the Olema Valley Trail lower crossing. Follow Olema Valley Trail from Hwy 1 towards the lower crossing. Follow the deer trail to the left approximately 30 m upstream of the stream crossing. Index reach is approximately 15 m downstream of tag 64.
- Index reach 6: is located near the Olema Valley Trail upper crossing. Follow the trail to the upper crossing and head upstream. The index reach is approximately 20 m upstream of the crossing and 80 m upstream of tag 72.

Figure SOP 9.16. Locations of six site index reaches in the Pine Gulch Creek Watershed.

Redwood Creek: There are 7 reaches on Redwood Creek (figure SOP 9.17). Unlike Olema and Pine Gulch Creeks, Redwood Creek's index reaches start in the upper portion of the watershed with reach 1 and move downstream.

- Index reach 1: is located within MUWO, above Bridge 3. Park in the parking lot and follow the boardwalk upstream until reaching the third bridge. The index starts approximately 12 m above tag 63.
- Index reach 2: is located within MUWO, by the visitor restrooms next to the first parking lot. The index starts approximately 50 m below tag 54.
- Index reach 3: is located below the Miwok Trail Crossing. Use the pullout closest to the bridge and follow the creek downstream from the bridge. Index 3 starts approximately 40 m below tag 38.
- Index reach 4: is located just upstream of the Kent Creek confluence with Redwood Creek mainstem. Use the pullout closest to Kent Creek, near the footbridge where Redwood Creek Trail crosses the stream. Move upstream of the footbridge. The index is at tag 29.
- Index reach 5: is located above the Frank Valley Road Bridge. Pull out at the Frank Valley camping area and go across the road to the creek. The index reach starts at approximately 30 m upstream of tag 18 and approximately 100 m upstream of the road bridge.
- Index reach 6: is located near the Banducci restoration site. Park in the pull out beneath the eucalyptus trees approximately 250 m up Muir Woods Road from the Highway 1 turn-off. Access the creek by the path that leads from the pull out down to the creek.
- Index reach 7: is located below the Pacific Way Bridge. The index reach starts approximately 120 m below the bridge. To reach it, park at the Muir Beach Parking lot, and walk up the road until reaching the index, which is directly alongside the road.

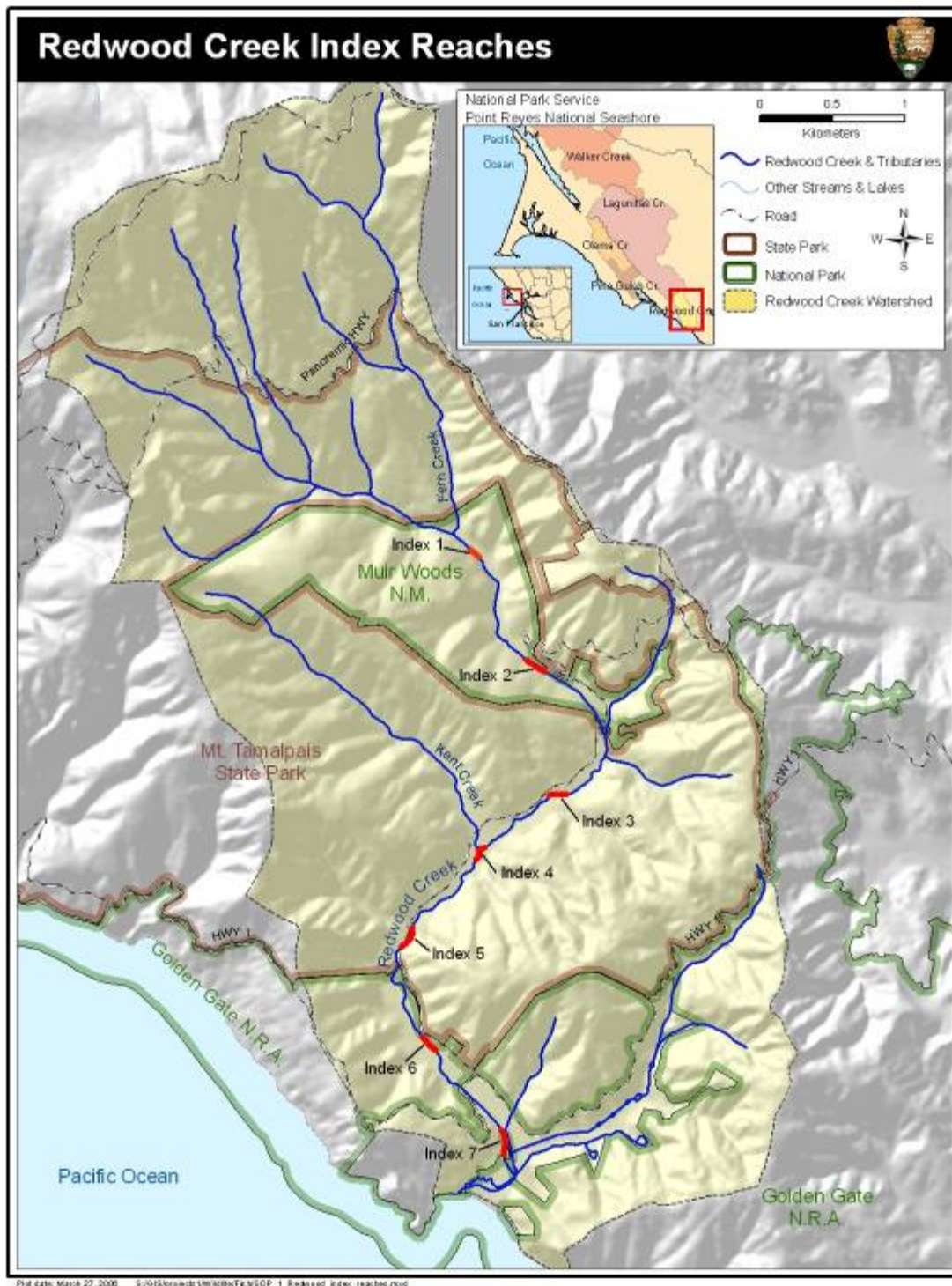


Figure SOP 9.17. Locations of seven index reaches in the Redwood Creek Watershed.

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SOP 10. Data Summaries and Analysis

Version 3.9

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	January 2007	Marcus Koenen	Created this SOP to focus on Data Analysis only.	Reduce redundancy among protocols and SOP	3.2
3.2	March 2007	Michael Reichmuth	Review of new SOP	Update protocol to current methodology	3.2 MR
3.2MR	May 2008	Erin Brown			3.3
3.3	June 2008	Sarah Carlisle	Added in smolt power analysis		3.31
3.31	June 2008	Sarah Carlisle	Linked data analysis and summaries with objectives and questions		3.32
3.32	June 2008	Sarah Carlisle	Updated all figures and graphs		3.33
3.33	June 2008	Sarah Carlisle	Added Escapement and Juvenile power analyses		3.34
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3.5	August 2008	Brannon Ketcham		Document Review for final draft	3.6
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3.6	September 2008	Michael Reichmuth	Address Leigh Ann's comments	Clarification	3.7
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3.83	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	3.9

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Overview

This SOP provides guidance for a variety of reports, publications, and outreach material generated through the salmonid monitoring program (table SOP 10.1). To increase efficiency, reports are designed to build on previous reports, starting with smaller seasonal summaries and building to comprehensive annual and long term trend reports (figure SOP 10.1). At the end of each field season, brief one- to two-page summaries are generated for park managers and project volunteers. After the completion of the seasonal update, each season's data will be validated and finalized following the procedures in SOP 8 (Data Management). Once the database has been finalized it can be used to generate the information needed for the seasonal summary reports. These reports focus solely on each individual field season (winter spawner surveys, spring smolt trapping, and summer/fall basinwide GSS surveys and index reach surveys) and provide a more extensive summation of the season's results.

The next reporting step involves compiling the information from each progress report into one annual report. The annual monitoring report is generated to summarize the results of a full year of monitoring efforts. In addition, annual permitting reports documenting monitoring-associated take are produced for National Marine Fisheries Service (NMFS; Section 10 permit 1046) and the California Department of Fish and Game (CDFG) Scientific Collection Permit. Both of these reports have specific guidelines and information these agencies desire which is extracted from the seasonal summary reports and compiled into a single report (SOP 6).

Every nine years, a Synthesis and Analysis Report will be developed that builds on the annual reports by including statistical analyses to detect trends. Scientific publications will also be pursued to focus on key findings and other topics of interest to the scientific community.

Table SOP 10.1. Summary of reporting and communication products.

Communication Product	Lead	Audience	Schedule	Summary
Coho Spawner Survey Update	Fishery Biologist	NPS Staff, Program Volunteers, Interested Parties	December – February (Weekly)	Highlight raw results of field work. Document important field incidents. Increase communication within the park and network
Coho Smolt Trapping Update	Fishery Biologist	NPS Staff, Program Volunteers, Interested Parties	April–June (Weekly)	Highlight raw results of field work. Document important field incidents. Increase communication within the park and network.

Table SOP 10.1. Summary of reporting and communication products (continued).

Communication Product	Lead	Audience	Schedule	Summary
Coho Juvenile Survey Update	Fishery Biologist	NPS Staff, Program Volunteers, Interested Parties	July–October (Monthly)	Highlight raw results of field work Document important field incidents. Increase communication within the park and network
Coho Spawner Report	Fishery Biologist/Field Staff	CDFG, NPS Resource Management	March	Highlight finalized results of field work. Document important field incidents, technical problems Increase communication within the park and network. Examples: Manning 1999, Ketcham et al. 2004, Del Real et al. 2007.
Coho Smolt Report	Fishery Biologist/Field Staff	CDFG, NPS Resource Management	October	Highlight results of field work. Document important field incidents, technical problems Increase communication within the park and network. Examples: Ketcham et al. 2004 Del Real et al. 2007.
Coho Juvenile Report	Fishery Biologist/Field Staff	CDFG, NPS Resource Management	December	Highlight results of field work. Document important field incidents, technical problems Increase communication within the park and network. Example: Del Real et al. 2008.
Annual Reports (Olema, Redwood, Pine Gulch)	Fishery Biologist/Field Staff	CDFG, NPS Resource Management	June	Summarize and compare results on all three watershed. Example: Carlisle et al. 2008.
Annual Section 10 permit reports	Fishery Biologist	NMFS	May	Meet permit requirements. Example: Brown et al. 2004.
Bi-annual CDFG scientific collection permit report	Each Principal Investigator	CDFG	2 years	Summarize take of species by principal investigator. Reports vary depending on permit limitations for each permitted principal investigator.

Table SOP 10.1. Summary of reporting and communication products (continued).

Communication Product	Lead	Audience	Schedule	Summary
Analysis and Synthesis Report	PORE Hydrologist	Park Resource Managers	9 years	Determine patterns and trends. Discover correlations among resources being monitored. Analyze data to determine the level of change that can be detected using the existing sampling scheme. Provide context, interpret data for the park within a multi-park, regional, or national context. Recommend changes to management practices.
Program and Protocol Reviews	I&M Program Manager	Program Lead, Water Quality Steering Committee, I&M Technical Steering Committee, Water Resource Division	5 years	Periodic formal reviews of operations and results. Review of protocol design and product to determine if changes are needed. Part of the quality assurance – peer- review process.
Executive Briefing	Fishery Biologist + I&M Program Manager	Program Managers, Superintendents, Front line interpretation staff	Annually (upon completion of annual report)	Two-page summary that lists monitoring objectives and questions, discusses annual results, and provides a regional context.
Vital Sign Report Card	I&M Program Manager	Program Managers, Superintendents, Front line interpretation staff	9 years (upon completion of Analysis and Synthesis Report)	Two-page summary that aggregates trend data into an index.
Web Site Intranet	Network Website Manager	Park Staff	Annually or as needed	Post all completed reports.
Web Site Internet	Network Website Manager	Park Staff, General Public	Annually or as needed	Post all Executive Briefings.

Table SOP 10.1. Summary of reporting and communication products (continued).

Communication Product	Lead	Audience	Schedule	Summary
Park Presentations	Fishery Biologist	Park Staff, Volunteers, General Public	as needed	Provide presentations to park staff during senior staff, all employee meetings, division meetings, and/or outreach events at each park upon request. Gives staff, volunteers, and general public an opportunity to ask questions about the program.
IM Update	Fishery Biologist	Park Staff	Quarterly	This one-page monthly e-mail provides park staff with a short update on vital signs projects. Text should be no more than one paragraph.
Photos	Fishery Biologist	For all reports and publication	Continuous	High quality publication quality photo are needed to support all communication products. For digital photos: 300 pixels per inch resolution in a plain or compressed TIF format. Specialists should make every effort to document ongoing work, special incidents, site visits for communication purposes.

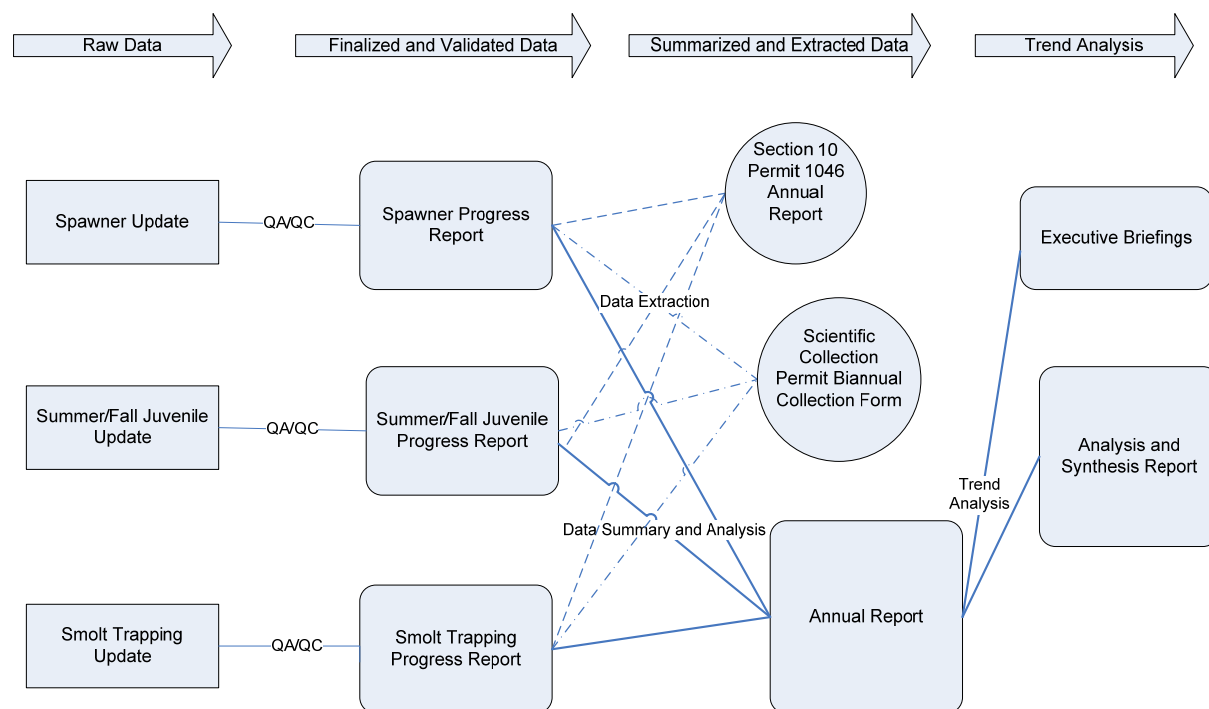


Figure SOP 10.1. A conceptual model used to represent the flow of information through the monitoring programs reporting process. Dashed lines represent information contributing to non-programatic reports.

Seasonal Updates

At the end of each monitoring season (summer, winter, and spring), seasonal updates will be provided to all park staff, program volunteers, and other interested parties. These reports are brief two page summaries which provide a subjective overview of each field season using only raw data sources. The focus of the updates is on field conditions and incidents, as well as, the observed trends. These updates are intended to provide real-time information to park interpretive staff, program volunteers, and resource managers. Providing real time information not only allows managers to be proactive on major resource issues that may be impacting NPS fisheries, but it also increases public awareness and keeps program volunteers involved in the program.

The most recent example of a seasonal update can be viewed at

http://science.nature.nps.gov/im/units/sfan/vital_signs/fish/fish.cfm

Summary Progress Reports

Summary progress reports are designed as a summary of finalized (QA/QC) data for each field season. Summary reports are intended for both park resource managers and the CDFG as a final synopsis of each field season. At the end of each monitoring season (summer, winter, and spring) data will be summarized into a progress report by the fishery biologist and technicians. These reports will compile data that pertains only to each individual monitoring season. Formats follow the same general outline including standard sections briefly describing background and introduction, study area, methods, results, and discussion. The reports follow the Natural

Resource Publications Management format

(<http://www.nature.nps.gov/publications/nrpm/finalreport.cfm>).

Examples of the most recent reports (Ketcham et al. 2005; Reichmuth et al. 2005, 2006) can be viewed at the following website:

http://www1.nature.nps.gov/im/units/sfan/vital_signs/stream_fish.cfm.

An explanation of the content which is covered in each of the seasonal summaries is presented below.

Summary Report–Juvenile Report

The Summer Juvenile Summary Report provides information about coho juvenile population changes along with stream habitat changes, as well as population distribution. Data are collected through Basinwide GSS surveys and stream index reach surveys.

Summer Juvenile Summary Reports address the following monitoring objectives:

- Conduct summer surveys at Olema, Pine Gulch, and Redwood Creeks by conducting basinwide snorkel surveys (general systematic surveys [GSS]) to determine long-term trends in distribution and abundance of juvenile coho salmon.
- Conduct summer surveys at Olema, Pine Gulch, and Redwood Creeks at preexisting index reaches to determine long term trends in density, size, and age composition of coho salmon at preexisting index reaches.
- Identify gross changes in habitat (pool:riffle) in Olema, Pine Gulch, and Redwood Creeks during summer/fall surveys.

Basinwide General Systematic Survey: Analyses provided in the summary Basinwide GSS report section are generated completely within the Salmonid Summer Database Module (See SOP 8). The summary results are dependent on the results of correlation analyses which compare visual estimates with measured results, to develop a calibration factor (raw count to calibrated count). The reported results are calibrated using the correlation factor before population estimates are determined using a ratio estimator. The following summary tables are developed within the database and reported in the summary progress report.

- summary of habitat metrics (table SOP 10.2)
- summary of snorkel counts (table SOP 10.3)
- summary of density and population estimates for target species (table SOP 10.4)
- analysis of fish condition (length and length-weight) to indicate fitness (table SOP 10.5, figures SOP 10.3–4)

Also see Del Real et al. (2008) for recent examples of summary tables and graphs.

Habitat Metrics: Habitat summaries will focus on the habitat composition of the watersheds surveyed. The metrics will be used to answer questions that relate to habitat composition and constraints that might influence salmonid populations and recovery efforts. It should be noted in

some cases that the habitat survey length exceeds the snorkel survey length due to water quality conditions. Results in table SOP 10.2 represent habitat survey length. Habitat unit numbers and survey length in table SOP 10.3 represent the habitat conditions within the actual area snorkeled.

Table SOP 10.2. Habitat composition of Olema Creek coho survey area, 2007.

Unit type	# of units	2007	
		Length of units (m)	%
Pool	406	8,217	65
Flatwater	217	2,184	17
Riffle	307	2,297	18
Total	930	12,698	100
Survey length*		12.7 km	

*Survey lengths are based on established monument tags for comparison between years.

Snorkel Survey Habitat Units and Pools: Refer to table SOP 10.3 below for a detailed example of how data will be reported for basinwide juvenile coho estimates. Although stream length is provided for comparison of length of stream surveyed between years, it is not used for calculating the actual population estimate. The number of pools snorkeled are provided with the number that contain coho as an indicator of distribution between pool habitats. A raw snorkel count for all sampled units is provided as minimum count for each creek (Dolloff et al. 1993).

All subsequent basinwide population estimate formulas were extracted directly from Dolloff et al. (1993).

Calibrated Coho per Pool: A ratio is created using the estimated number of juvenile coho observed while snorkeling and the actual number of juvenile coho calculated by multiple pass electrofishing (figure SOP 10.2). The calibration ratio ($\hat{R}$) is calculated by dividing the total number of fish estimated by multiple pass removal electrofishing (y_i) by the total number of fish counted by the diver in the habitat unit (x_i ; Dolloff et al. 1993).

$$\hat{R} = \sum_{i=1}^{n'} y_i / \sum_{i=1}^{n'} x_i = \bar{y}' / \bar{x}'$$

where

$$\bar{y}' = \sum_{i=1}^{n'} y_i / n',$$

$$\bar{x}' = \sum_{i=1}^{n'} x_i / n',$$

n' = number of units sampled both by the diver and by electrofishing.

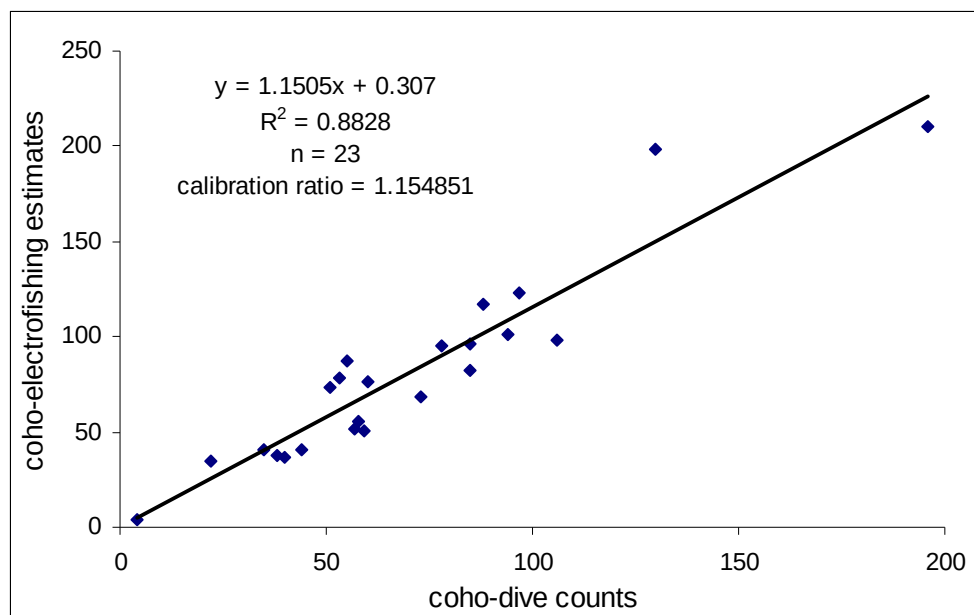


Figure SOP 10.2. Correlation between electrofishing estimates and snorkel counts for 23 pools: Olema Creek, 2007.

Table SOP 10.3. Summary of coho snorkel counts in Olema Creek, 2007.

Year	Total snorkel survey stream length (km)	Total number of habitat units	Number of Pools			Coho Counted	
			Total	Snorkeled	w/ Coho	Raw	Calibration Ratio
2007	11.8	917	368	89	86	6,688	1.155

Juvenile Coho Density per Pool: The raw juvenile coho density per pool (table SOP 10.4) is calculated by dividing the total raw snorkel count ($\bar{x}$; table SOP 10.3) by the number of pool units snorkeled (n ; table SOP 10.3). The calibrated juvenile coho density per pool ($\bar{y}_{dr}$; table SOP 10.4) is calculated by multiplying the calibration ratio ($\hat{R}$; table SOP 10.3) by raw snorkel count ($\bar{x}$; table SOP 10.3) and dividing the product by the number of pool units snorkeled (n ; table SOP 10.3; Dollof et al. 1993).

$$\bar{y}_{d,r} = \hat{R}\bar{x}.$$

where

$$\bar{x} = \sum_{i=1}^n x_i / n, \text{ and}$$

Juvenile Coho Density (coho/m and coho/m²): Juvenile coho density per meter (SOP 10.4) is derived from the total calibrated coho count, calculated above, divided by the total length of pool

habitat sampled (derived from macro in MS Access database). Juvenile coho density per square meter (SOP 10.4) is derived from the total calibrated coho count, calculated above, divided by the total surface area of pool habitat sampled (derived in MS Access database). Juvenile density by meter or square meter is a common density metric to compare salmonid production between watersheds.

Juvenile Coho Population Estimate and 95% Confidence Interval: The juvenile coho population estimate (SOP 10.4) is a ratio estimation derived from the product of the calibrated average coho per pool ($\bar{y}_{dr}^-$; table SOP 10.4) by the total number of pools in the survey area (N; SOP 10.3).

$$\hat{Y} = N\bar{y}_{d,r}.$$

A more complicated estimator of variance ($V(\hat{y}_{dr}^-)$) is used to determine a 95% confidence interval. A sample based estimator of uncertainty is provided from Dollof et al. 1993 to determine the 95% confidence interval for the calculated juvenile coho population estimate (table SOP 10.4).

$$\hat{V}(\bar{y}_{d,r}) \approx \frac{s_y^2 - 2\hat{R}s_{xy} + \hat{R}^2 s_x^2}{n'} + \frac{2\hat{R}s_{xy} - \hat{R}^2 s_x^2}{n} - \frac{s_y^2}{N}$$

where

$$s_y^2 = \frac{\sum_{i=1}^{n'} (y_i - \bar{y}')^2}{n' - 1},$$

$$s_x^2 = \frac{\sum_{i=1}^{n'} (x_i - \bar{x}')^2}{n' - 1},$$

$$s_{xy} = \frac{\sum_{i=1}^{n'} (x_i - \bar{x}')(y_i - \bar{y}')}{n' - 1}.$$

Once an estimator of variance is determined for the sample habitat type an estimator of variance for the total number of fish in all pool habitat units can be determined and a 95% confidence interval can be constructed.

$$\hat{V}(\hat{Y}) = N^2 \hat{V}(\bar{y}_{d,r}).$$

$$\hat{Y} \pm t_{0.05; n-1} \sqrt{\hat{V}(\hat{Y})}.$$

Table SOP 10.4. Coho density and population estimates: Olema Creek coho survey area, 2007.

Year	Avg. Coho per pool		Juvenile Coho Density		Juvenile Coho Population Estimate	95% confidence Interval
	Raw	Calibrated	coho/m	Coho/m ²		
2007	75.15	86.78	4.247	1.295	31,936	± 4,122

Fish Condition: Fish condition will be calculated from weight-length data that will be collected at each systematically selected calibration unit. All provided examples for fish condition are displayed using index reach data as systematic calibration unit data will not be available until the 2009 field season. Although future tables and figures will use systematic calibration unit data, the provided information will remain the same in both format and content.

Fish condition can be assessed using Fulton's condition factor and weight-length power function (Anderson and Gutreuter 1983). Fulton's condition factor (K) is represented by:

$$K = \frac{\text{Weight (g)}}{\text{Length (mm)}^3} \times 100,000$$

Mean K can then be calculated for each species/age class within a reach or habitat type. Table SOP 10.5 shows an example of the mean length, weight, and K factor for all coho and steelhead measured during the electrofishing surveys. Typically, "plumper" fish have higher K values than "skinny" fish.

Table SOP 10.5. Mean length, weight, and K factor calculated for coho, steelhead young of year (SH YOY), and steelhead 1+ (SH 1+) measured and weighed in the seven Redwood Creek index reaches, 2007.

Year	Species	Sample Size	Mean Length (mm)	Length Standard Deviation	Mean Weight (g)	Weight Standard Deviation	Mean K-Factor	K-Factor Standard Deviation
2007	coho	294	73.73	8.38	4.15	1.49	1.00	0.08
2007	SH YOY	548	63.56	9.66	2.76	1.31	1.00	0.11
2007	SH 1+	78	122.15	26.21	19.54	13.13	0.95	0.11

In addition to fish condition, fish measurement data can be further summarized graphically to represent the condition or size distribution (figure SOP 10.3). A bimodal distribution indicates the presence of multiple age classes and shows the approximate size break between classes. Figure SOP 10.4 shows fish length plotted against weight, and the power function curve from which the equation $W = aL^b$ (where W=weight, L=length, and a and b are parameters) is calculated (Anderson and Gutreuter 1983). This equation provides an idea of the fitness of the sample of measured fish, with higher b values indicating plumper fish, and can also be used to calculate weights of individual fish from their measured length. These data are used to answer larger questions about long-term trends within fish condition. Long-term trends in fish condition will be assessed using a mixed linear model of VanLeeuwen et al. (1996) and Piepho and Ogutu (2002) which is modified to reflect the cohort structure of coho salmon. Refer to Trend Model section below for an example of the trend model to be used to analyze fish condition.

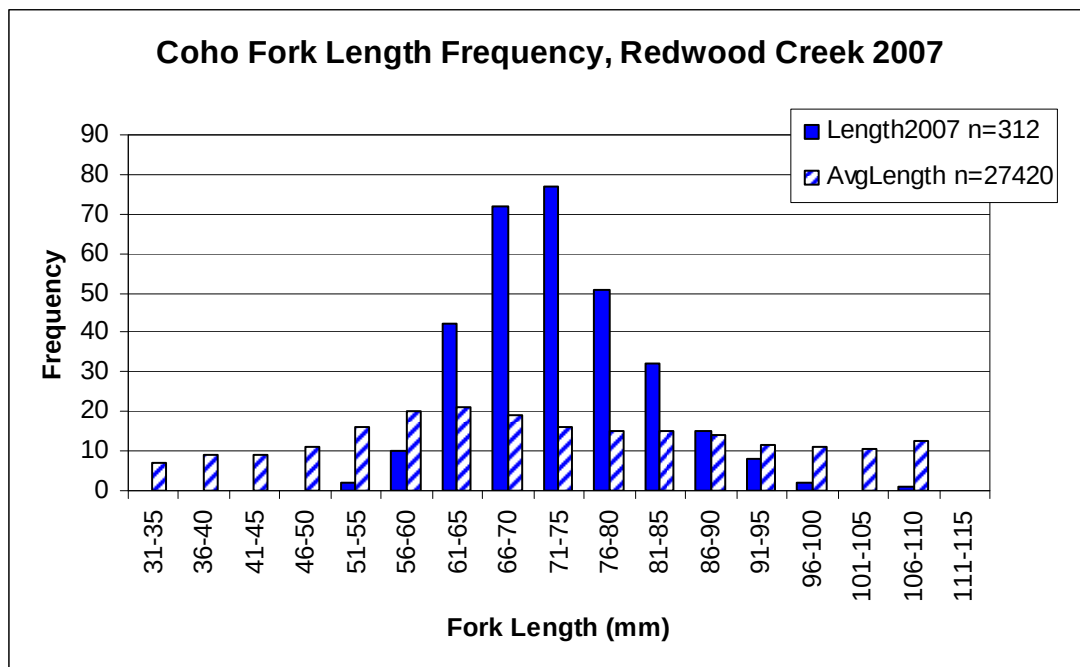


Figure SOP 10.3. Coho histogram for fish measured in the seven Redwood Creek index reaches, 2007. Historical averages (1998–2006) are shown for comparison. Fork length is represented in 5 mm bins.

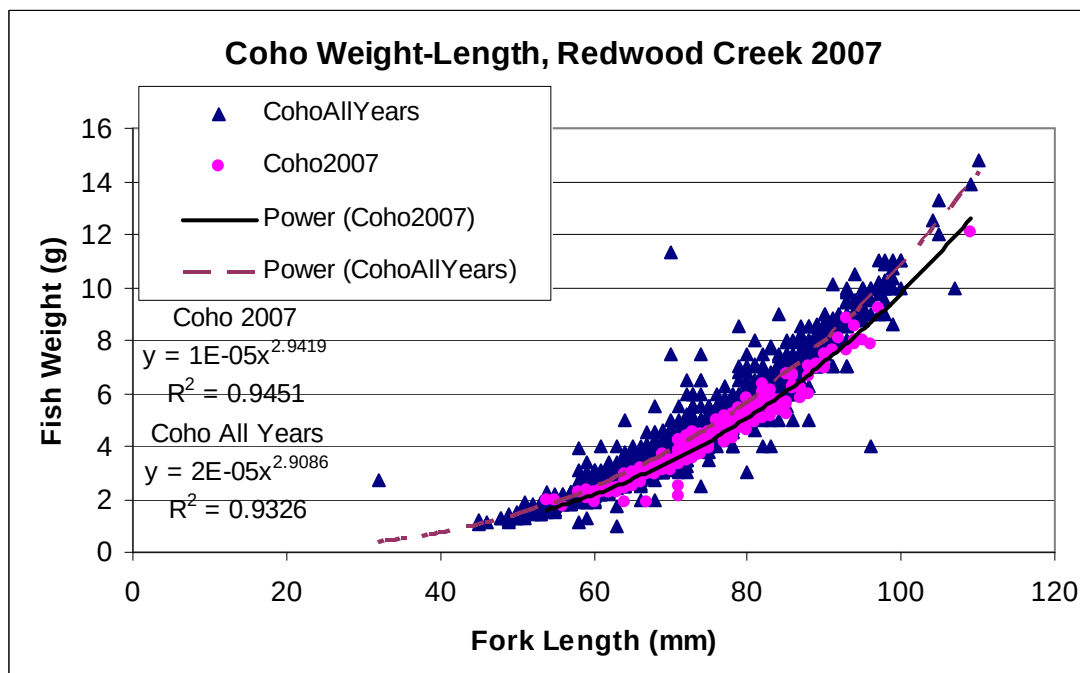


Figure SOP 10.4. Coho weight-length relationships for fish measured in the seven Redwood Creek index reaches, 2007. Historical relationships added for comparison (1998–2006).

Index Reach Survey

Index reach monitoring will be maintained as a legacy dataset. Many other monitoring programs in the region conduct similar index reach monitoring, and our dataset would be available for comparative purposes. Data summaries of index reach surveys will include the following:

- Summary of the habitat area sampled and characteristics of each index reach (SOP 10.6)
- Summary of total number of fish captured during index reach sampling (table SOP 10.7)
- Summary of population estimates and associated densities for each species by index reach and habitat type (tables SOP 10.8–9)
- Analysis of temporal changes in fish densities (fish/meter) per habitat type (tables SOP 10.8–9)
- Analysis of fish densities (fish/meter) per index reach and per year (tables SOP 10.8–9)

Habitat Characteristics: Summaries of habitat characteristics will be used to detect major stream alterations and help explain changes in fish densities (table SOP 10.6)

Habitat Summaries: These summaries will be used to answer questions that relate to habitat composition and constraints that might influence salmonid populations and recovery efforts.

Total Number of Fish: For habitat units sampled by multiple pass electrofishing, MicroFish software is used to analyze data. The software is based on removal-depletion methods to account for detection error. The program calculates a maximum likelihood estimate of the population total for each unit sampled and provides a variance estimate for the model adjustment of raw counts. This Microfish abundance estimate applies to the population within each index reach unit within a basin.

From Starceovich and Irvine (2008):

Total abundance and the associated variance estimate for each index reach will be calculated as follows:

$$\hat{T}_b = \sum_{i=1}^n \hat{t}_i,$$

where $\hat{t}_i$ is the estimate of total juveniles in habitat unit i , n is the number of habitat units within the index reach, and $\hat{T}_b$ is the estimate of juvenile abundance within an index reach. Assuming independence among habitat unit counts within a reach, the variance of $\hat{T}_b$ is then:

$$Var(\hat{T}_b) = Var\left(\sum_{i=1}^n \hat{t}_i\right) = \sum_{i=1}^n Var(\hat{t}_i) = \sum_{i=1}^n \hat{\sigma}_i^2,$$

where $\hat{\sigma}_i^2$ is the estimated variance of estimated juvenile abundance at habitat unit i . The assumption of independence among habitat unit counts within an index reach is likely tenuous, and estimated variances may underestimate the true variance if pool counts are positively correlated in space.

Fish population estimates and confidence intervals by species/age class will be calculated for each index reach unit sampled. Table SOP 10.7 shows the total number of fish captured during index reach sampling and can be quickly compiled from the raw data for an initial summary of sampling results. It provides a general sense of the annual variation in fish numbers within and distribution between index reaches monitored since 1999 (e.g., higher coho numbers in 2001 and 2002). These data can be used to answer questions relating to densities and population trends along index reaches over time. Total catch will also be used as the population estimate for species with poor multiple pass depletions or no captures after the first pass, and in units sampled with a single pass.

Fish Density: The database automatically calculates density estimates of each species by stream length (fish/m) and surface area (fish/m²) for each habitat unit (See SOP 8 for calculation details). Fish densities are calculated from the length and surface area of the habitat units that are actually sampled. See tables SOP 10.6–8. Such data can be used for answering questions related to fish densities within index reaches over time.

Density Among Habitat Types: Densities based on habitat unit type can be used to answer questions related to both density trends and habitat constraints on salmonid populations.

Table SOP 10.6. Summary of habitat composition; shows extent of area sampled and variation between reaches; Redwood Creek 2007.

Index Reach	Habitat Type	# of Units	Length		Surface Area	
			Sampled (m)	% of total	Sampled (m ²)	% of total
1	Pool	3	39.9	36.2%	145.3	40.4%
	Riffle	3	46.2	42.0%	144.3	40.1%
	Flatwater	2	24.0	21.8%	69.9	19.5%
	Total	8	110.1	100.0%	359.6	100.0%
2	Pool	3	42.1	40.0%	209.9	52.5%
	Riffle	2	25.1	23.8%	65.7	16.5%
	Flatwater	2	38.1	36.2%	124.1	31.0%
	Total	7	105.3	100.0%	399.7	100.0%
3	Pool	4	59.2	79.4%	224.2	86.6%
	Riffle	2	15.4	20.6%	34.7	13.4%
	Flatwater	0	0	0.0%	0	0.0%
	Total	6	74.6	100.0%	258.9	100.0%
4	Pool	4	57.9	69.9%	211.2	81.7%
	Riffle	2	9.7	11.7%	11.8	4.6%
	Flatwater	2	15.2	18.4%	35.6	13.8%
	Total	8	82.8	100.0%	258.6	100.0%
5	Pool	3	74.2	68.9%	323.8	72.3%
	Riffle	1	4.2	3.9%	5.3	1.2%
	Flatwater	1	29.3	27.2%	119.0	26.6%
	Total	5	107.7	100.0%	448.0	100.0%
6	Pool	3	78.1	92.1%	273.3	95.7%
	Riffle	1	6.7	7.9%	12.4	4.3%
	Flatwater	0	0	0.0%	0	0.0%
	Total	4	84.8	100.0%	285.7	100.0%
7	Pool	2	32.4	41.0%	84.5	46.9%
	Riffle	2	3.8	4.8%	4.1	4.4%
	Flatwater	3	42.9	54.2%	91.6	50.9%
	Total	7	79.1	100.0%	180.2	102.2%
Total	Pool	18	383.8	59.6%	1472.1	67.2%
	Riffle	13	111.1	17.2%	278.3	12.7%
	Flatwater	10	149.5	23.2%	440.2	20.1%
	Total	41	644.4	100.0%	2190.6	100.0%

Table SOP 10.7. Summary of total catch for coho salmon (CO) and steelhead (SH) along with steelhead young of the year (YOY) by reach within Redwood Creek mainstem index reach sample locations, 2004–2007.

Year	Species	Index Reach							Total
		1	2	3	4	5	6	7	
2004	CO		42	95	74	159	71		441
	SH YOY	Not sampled	6	22	19	24	4	not sampled	75
	SH 1+		19	8	17	15	13		72
2005	CO	23	59	77	93	164	236	338	990
	SH YOY	44	38	41	70	77	178	81	529
	SH 1+	5	12	12	10	14	9	4	66
2006	CO	6	21	21	38	3	9	0	98
	SH YOY	38	78	26	20	5	17	4	188
	SH 1+	2	24	21	20	11	20	1	99
2007	CO	54	138	215	120	146	89	8	770
	SH YOY	90	161	305	170	212	392	144	1474
	SH 1+	8	43	10	11	7	11	7	97

Table SOP 10.8. Summary of population and density estimates for each coho salmon (CO), steelhead young of the year (SH YOY) and steelhead >1 year old (SH 1+) by index reach on Redwood Creek, summer 2007.

Index Reach	Species (age)	Population Estimate		Density		Fish/m ²	95% CI
		# of Fish	95% CI	Fish/m	95% CI		
1	CO	54	±38	0.49	±0.35	0.15	±0.11
	SH YOY	98	±83	1.57	±0.15	0.41	±0.04
	SH1+	8	±65	0.07	±0.59	0.02	±0.18
2	CO	138	±35	1.31	±0.33	0.35	±0.09
	SH YOY	165	±15	1.57	±0.15	0.41	±0.04
	SH1+	43	±47	0.41	±0.44	0.11	±0.12
3	CO	215	±18	2.88	±0.25	0.83	±0.07
	SH YOY	305	±8	4.09	±0.10	1.18	±0.03
	SH1+	10	±44	0.13	±0.59	0.04	±0.17
4	SH YOY	125	±56	1.51	±0.68	0.48	±0.22
	SH1+	179	±43	2.16	±0.52	0.69	±0.16
	SH (1+)	11	±63	0.13	±0.76	0.04	±0.04
5	CO	146	±22	1.36	±0.21	0.33	±0.05
	SH YOY	215	±18	2.00	±0.17	0.48	±0.04
	SH (1+)	7	±38	0.06	±0.35	0.02	±0.08
6	CO	89	±15	1.05	±0.18	0.31	±0.05
	SH YOY	396	±10	4.67	±0.12	1.39	±0.04
	SH (1+)	11	±34	0.13	±0.40	0.04	±0.12
7	CO	8	±52	0.10	±0.65	0.04	±0.29
	SH YOY	155	±42	1.96	±0.53	0.86	±0.23
	SH (1+)	7	±61	0.09	±0.78	0.04	±0.34
Average Densities			CO	1.20	±0.36	0.35	±0.10
			SH (0+)	2.35	±0.34	0.69	±0.10
			SH (1+)	0.15	±0.55	0.04	±0.16

Table SOP 10.9. Summary of population and density estimates from electrofishing surveys for coho salmon by index reach habitat unit on Redwood Creek, 2004–2007.

Year	Habitat Type	# of Habitat Units	Population Estimate		Density			
			# of Fish	95% CI	Fish/m	95% CI	Fish/m ²	95% CI
2004	Pool	13	428	±38	1.81	±0.16	0.46	±0.04
	Riffle				*Not Surveyed			
	Flatwater	4	23	±5	0.40	±0.08	0.16	±0.03
2005	Pool	19	977	±362	2.02	±0.75	0.48	±0.18
	Riffle	5	22	±80	0.24	±0.88	0.12	±0.44
	Flatwater	3	12	±27	0.24	±0.55	0.11	±0.25
2006	Pool	22	103	±149	0.25	±0.37	0.07	±0.10
	Riffle	13	0	N/A	0	N/A	0	N/A
	Flatwater	6	0	N/A	0	N/A	0	N/A
2007	Pool	16	761	±51	1.98	±0.13	0.52	±0.03
	Riffle	6	2	±109	0.02	±0.98	0.01	±0.39
	Flatwater	3	12	±69	0.08	±0.46	0.03	±0.16

*Riffles were not surveyed in 2004 due to low flow conditions.

The Spawner Summary Report

The Spawner Summary Report provides information about the adult coho population changes. The main objective to be addressed in this report is:

- Conduct winter survey at Olema, Pine Gulch, Redwood, and Cheda Creeks by counting numbers of spawners, carcasses, and redds along spawner reaches to determine long-term trends in distribution and abundance, size (length and weight) of spawning coho salmon within reaches.

For each stream, the report should clearly describe the:

- Total number of live fish, redds, and carcasses observed during each survey (table SOP 10.10);
- Population estimates based on Peak Live Dead (PLD) Index (tables SOP 10.11–12, figures SOP 10.5–6) and Area Under the Curve (AUC) Index estimates (tables SOP 10.13–14);
- Spawner population density (table SOP 10.14);
- Sex ratios of live fish and carcasses with total numbers of jacks; (table SOP 10.15)
- Total number and spatial distribution of redds (figures SOP 10.7–9)
- Environmental conditions during each survey including flow or gage data, weather, and water clarity (table SOP 10.16, figure SOP 10.10)

Numbers of Spawners: The analysis of spawner survey data is complicated by annual variability in environmental conditions and run characteristics. Table SOP 10.10 presents data collected during the spawner surveys. Accurate abundance estimates are difficult to generate without counting weirs or other intensive sampling techniques (Irvine et al. 1992). The NPS monitoring program is, nonetheless, interested in developing precise indices of abundance. Two techniques, Peak Live plus cumulative Dead (PLD) and Area Under the Curve (AUC) are used to compute index values (Beidler and Nickelson 1980; Johnston et al. 1987). In addition to calculating the indices, we summarized the live fish, redd, carcass, and environmental data for each stream.

Table SOP 10.10. Summary of live adults, carcasses, and redds found on Olema Creek mainstem, winter sampling season 2006–2007.

Survey Date	# of Adult Coho								
	# of Coho Redds		# of Live Adult Coho			# of Coho Carcasses			Total Adults
	Definite	Possible	Male	Female	Unknown	Male	Female	Unknown	
11/22/06	0	0	0	0	0	0	0	0	0
12/18/06	34	1	21	36	1	4	1	0	63
12/31/06	21	1	18	24	2	1	8	2	55
1/10/07	10	0	6	11	0	2	3	1	23
1/24/07	5	0	2	1	0	2	2	3	1
2/16/07	0	0	0	0	0	0	0	0	0

The PLD and AUC estimates provide different types of information. While the PLD index produces a minimum instantaneous estimate, the AUC method is used to calculate a total population estimate.

Peak Live Dead (PLD): The PLD index is computed using the sum of live fish observed during a single day of the spawning season and the cumulative number of unmarked carcasses observed prior to that date. Live numbers may only be added from separate survey dates when the survey interval is greater than 20 days between peak live fish counts and the residence time of spawning coho are assumed to be less than 20 days long (Irvine et al. 1992). Redd count and location is used to describe spawning density, spawner success, and spatial distribution. Data collected during the spawner surveys are used to detect any changes in timing, distribution of salmon spawning, adult sex ratios, and escapement in estimates in the streams surveyed. Tables SOP 10.11–12 show PLD indices along with other survey results, run timing, and survey information. Figure SOP 10.5 provides a summary of the PLD indices for coho in the Redwood Creek watershed. The three year classes are represented as different patterns to show relationships between spawning runs. Other creeks are presented in figure SOP 10.6.

Table SOP 10.11. Coho salmon run timing, total monthly rainfall (Bear Valley rain gage, PORE), and Redwood Creek Peak Live plus Cumulative Dead (PLD), total carcasses and redds documented in the surveys for spawner years 1998–1999 through 2006–2007 within Redwood Creek mainstem.

Spawner Year (SY)	Run Timing				Total Monthly Rainfall (in)				Redwood Creek PLD			
	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb	Survey Area (km)	PLD Index	Total Carcasses	Total New Redds
1998–1999					3.28	1.49	5.27	8.47	9.4	39	10	58
1999–2000					2.72	0.59	5.95	0.00	8.4	10	1	7
2000–2001					0.00	0.00	4.39	6.07	9.4	49	13	35
2001–2002					0.00	0.00	0.83	3.56	9.4	105	63	47
2002–2003					2.18	13.04	1.23	1.83	9.4	24	3	7
2003–2004					2.62	3.45	7.21	6.38	9.4	67	25	43
2004–2005					0.8	7.59	3.66	3.09	9.4	171	76	93
2005–2006					2.19	12.57	0.00	3.48	9.4	27	5	12
2006–2007					2.58	4.27	0.63	3.63	9.4	28	6	21

Table SOP 10.12. Coho salmon spawning survey including Peak Live plus Cumulative Dead (PLD) Index tally of total carcasses, and total redds for Redwood Creek.

Year	Number of Surveys	Survey Area (km)	PLD Index	Total Carcasses	Total Redds
1969**	1	3.2	24	4	--
1977–1978***	1	3.2	36	3	--
1985–1986**	1	7.2	50	--	--
1994–1995	5	8.4 ^a	58	22	--
1995–1996	5	8.4 ^a	27	18	--
1996–1997	6	8.4 ^a	57	15	--
1997–1998	7	9.4 ^b	65	30	80
1998–1999	11	9.4 ^b	3 ^c	10	58
1999–2000	6	8.4 ^a	10	1	7*
2000–2001	5	9.4 ^a	49	13	35
2001–2002	5	9.4 ^b	105 ^d	63	47
2002–2003	5	9.4 ^b	24 ^e	3	7*
2003–2004	6	9.4 ^b	67	25	43
2004–2005	7	9.4 ^b	171 ^f	76	93
2005–2006	5	9.4 ^b	27 ^e	5	12
2006–2007	9	9.4 ^b	28 ^g	6	21

^aIncludes the main stem of Redwood Creek and Fern Creek^bIncludes the main stem of Redwood Creek, Fern Creek, and Kent Creek^cIncludes two peaks, 7 weeks apart^dIncludes two peaks, 22 days apart^eIncludes two peaks, 33 days apart^fIncludes two peaks, 25 days apart^gIncludes three peaks, 26 and 24 days apart

*Poor survey conditions resulted in low observer efficiency

**CDFG 1986

***CDFG 1978

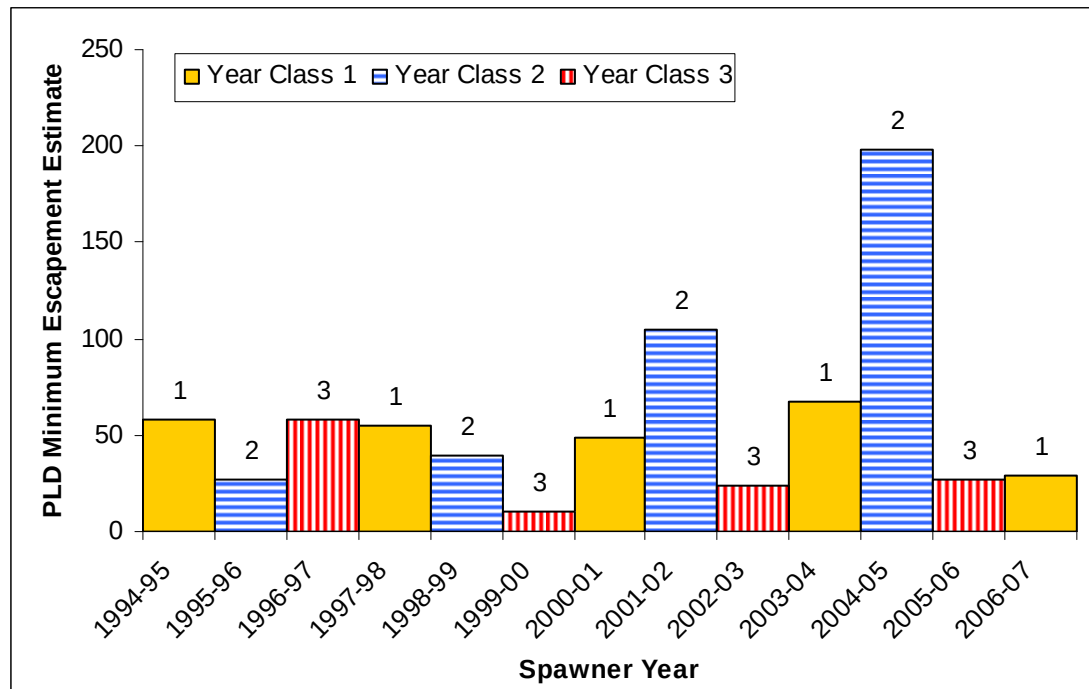


Figure SOP 10.5. Redwood Creek watershed, coho salmon PLD Index Escapement results winter 1994–1995 through winter 2006–2007.

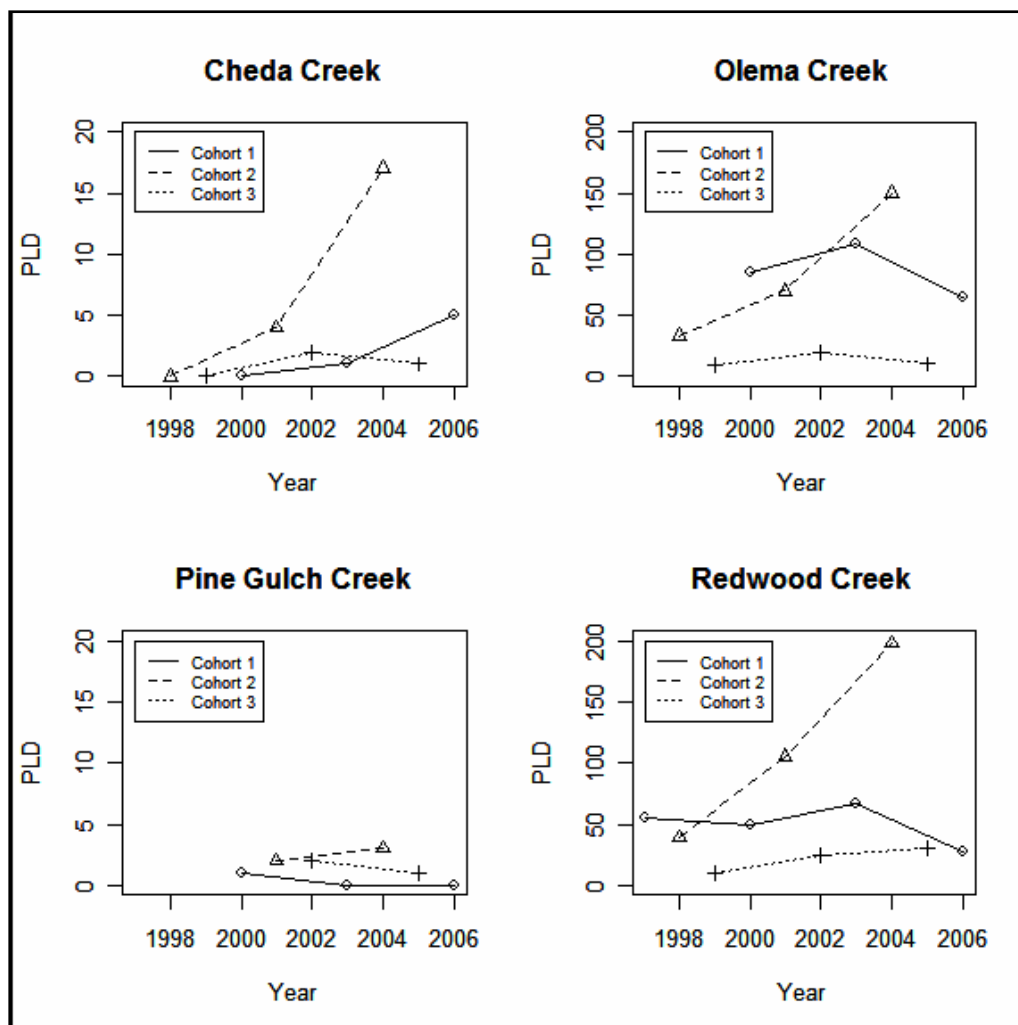


Figure SOP 10.6. PLD measures by cohort for Cheda, Olema, Pine Gulch, and Redwood Creeks.

Area Under Curve

The AUC estimate (table SOP 10.3) is calculated using the total number of live fish observed during each survey and the average life of fish on the spawning grounds (residence time). Calculating the area under the curve created by plotting the live fish observations for each survey, produces a quantity termed total fish-days. The area under the escapement curve was given by:

$$\text{AUC} = 0.5 \left\{ \sum (t_i - t_{i-1}) (p_i + p_{i-1}) \right\}$$

where t_i is the number of days since the first fish entered the survey area and p_i is the total number of fish observed on the i^{th} day (Irvine et al. 1992). Dividing the total number of fish days by the residence time gives the population estimate. Because we did not estimate residence time, separate AUC estimates were computed using the range of values, 8 to 17 days, presented in the literature (Moring and Lantz 1975; Johnston et al. 1987; Irvine et al. 1992). Data collection typically stops after repeated surveys no longer indicate the presence of live coho. High flows prevented us from conducting surveys during significant portions of some spawner seasons. If

fish were observed during the last survey of the season, the last date used for calculating the AUC estimate was arbitrarily set at 10 days after the final survey date. AUC estimates are provided as a more liberal estimate of coho escapement but are not used for trend analysis at this time due to the inconsistency in the ability to make an AUC estimate in any given year.

Table SOP 10.13. Coho salmon spawning survey Area Under the Curve (AUC) estimates for Redwood Creek, 1997–1998 through 2006–2007.

Year	Number of Surveys	Date of Entry	Mean Survey interval (days)	Survey Length (km)	AUC Range 100% OE RT 8–17 days	AUC Range 50% OE RT 8–17 days	AUC Range 70–80% OE RT 11–13 days	Redwood Creek PLD
1997–1998	7	23 Nov 97	7.5	9.4	89–188	177–376	145–195	65
1998–1999	11	29 Nov 98	8.6	9.4	39–83	78–167	64–87	39
1999–2000	6	01 Jan 00	11.8	8.4	8–17	16–35	13–18	10
2000–2001	5	15 Dec 00	13.0	9.4	74–157	148–314	121–163	49
2001–2002	5	07 Dec 01	11.3	9.4	116–247	233–494	190–257	105
2002–2003	5	10 Dec 02	14.0	9.4	22–46	43–92	35–48	24
2003–2004	6	11 Dec 03	6.3	9.4	43–91	86–182	70–94	67
2004–2005	7	06 Dec 04	8.3	9.4	169–359	338–718	276–373	171
2005–2006	5	01 Dec 05	9.6	9.4	28–59	55–117	45–61	27
2006–2007	9	13 Nov 06	10.4	9.4	24–50	46–98	39–51	29

Spawner Density: To facilitate comparisons between years and with other watersheds where survey areas may be considerably different, survey results will be also be expressed as # per kilometer. Table SOP 10.14 shows an example of # of live fish (based on PLD and AUC estimates), carcasses, and redds per km for multiple years.

Table SOP 10.14. Density information (per kilometer) for parameters measured or estimated during spawner surveys for Olema Creek, winters 1997–1998 through 2003–2004. Survey areas used to calculate PLD, carcass and redd densities may be different from the survey area used to calculate the AUC estimate.

Year	Density (# / km)				
	PLD Index	AUC OE=80% RT=13 days	AUC OE=70% RT= 11 days	Total Carcasses	Total Redds
1997–1998	7	20	27	2.9	9.4
1998–1999	4	5	7	1.1	3.6
1999–2000*	1*			1.3	1.4
2000–2001	9	11	14	5.6	7.4
2001–2002	8	15	20	2.4	5.0
2002–2003*	2*			1.5	0.4
2003–2004	12	20	26	2.9	7.6

*Survey data for mainstem not adequate to develop AUC estimate

Sex Ratio: Sex ratios are reported for both live coho and carcasses (table SOP 10.15). Mean fork lengths are also provided on the relative number of two year old spawners and female fecundity. Males less than 50 cm fork length are considered jacks (2-year-old males; Shapovalov and Taft 1954), and their relative numbers can indicate the amount of exchange between year classes. Sizes are summarized for both carcasses and live fish lengths. Live fish lengths represent visual estimates only while carcass lengths are measured to the nearest centimeter.

Redd Density and Distribution: Figure SOP 10.7 shows a GIS map of coho redd density (# redds per 100 m). Figure SOP 10.8 shows a graph with similar information at a lower resolution (per km instead of per 100 m) but with live coho and carcasses observed in addition to redds. Because power analysis indicated that results are most meaningful expressed by cohort and watershed data are presented as in figure SOP 10.9.

Table SOP 10.15. Sex ratios and size of live coho (visually estimated) and carcasses (measured) within Redwood Creek, 1997–2007.

Year	Month	Live Coho				Carcasses			
		#	%	Mean FL	FL SD	#	%	Mean FL	FL SD
1997–1998	M	12	26%	57.9(n=12)	5.42	6	25%	56.0(n=3)	6.56
	F	24	52%	56.9(n=24)	4.85	7	29%	54.8(n=6)	4.07
	J	4	9%	40.0(n=4)	0.00	4	17%	39.7(n=7)	1.25
	Unk	6	13%	53.3(n=6)	4.08	7	29%	60(n=2)	7.07
	All	46	100%			24	100%		
1998–1999	M	8	22%	61.3(n=8)	3.54	2	14%	62.0(n=2)	2.83
	F	16	44%	53.8(n=16)	3.87	6	43%	52.3(n=6)	2.58
	J	6	17%	36.7(n=6)	5.16	5	36%	42.2(n=5)	2.59
	Unk	6	17%	55.0(n=6)	4.47	1	7%		
	All	36	100%			14	100%		
1999–2000	M	3	33%	56.7(n=3)	11.55	0	0		
	F	4	44%	62.5(n=5)	11.90	1	100%	55.0(n=1)	
	J	0	0			0	0		
	Unk	2	22%	67.5(n=2)	3.54	0	0		
	All	9	100%			1	100%		
2000–2001	M	4	9%	60.0(n=4)	7.07	3	23%	62.5(n=2)	3.54
	F	14	30%	55.0(n=14)	4.39	6	46%	66.8(n=5)	2.94
	J	28	61%	39.1(n=28)	4.31	3	23%	42.7(n=3)	4.62
	Unk	0	0			1	8%	55.0(n=1)	
	All	46	100%			13	100%		
2001–2002	M	52	56%	59.2(n=51)	8.25	19	37%	70.1(n=19)	6.31
	F	31	33%	56.7(n=30)	6.34	20	38%	65.4(n=20)	5.28
	J	1	1%	45.0(n=1)		0	0		
	Unk	9	10%	57.1(n=7)	6.99	13	25%	64.9(n=7)	4.6
	All	93	100%			52	100%		
2002–2003	M	2	13%	65.0(n=2)	7.07	0	0		
	F	10	67%	53.6(n=7)	3.78	1	20%	50.0(n=1)	
	J	2	13%	42.5(n=2)	3.54	4	80%	36.5(n=4)	8.19
	Unk	1	7%	55.0(n=1)		0	0		
	All	15	100%			5	100%		
2003–2004	M	19	32%	62.0(n=19)	6.96	10	36%	63.8(n=8)	7.32
	F	26	43%	59.6(n=25)	4.55	13	46%	64.2(n=12)	5.39
	J	13	22%	35.4(n=13)	6.91	2	7%	40.5(n=2)	0.71
	Unk	1	2%	55.0(n=1)		3	11%	64.0(n=2)	1.41
	All	59	99%			28	100%		
2004–2005	M	69	40%	65.1(n=68)	5.50	18	26%	67.2(n=15)	4.68
	F	82	48%	60.1(n=78)	5.13	40	58%	63.3(n=40)	4.78
	J	9	5%	38.3(n=9)	2.50	1	1%	70.0(n=1)	
	Unk	11	6%	60.6(n=8)	6.23	10	14%	49.0(n=1)	
	All	171	100%			69	100%		
2005–2006	M	8	21%	69.4 (n= 8)	14.7	2	40%	57 (n=2)	1.4
	F	13	34%	60.4 (n=12)	5.8	3	60%	62 (n=3)	1.7
	J	12	32%	38.7 (n=12)	4.8	0			
	Unk	5	13%	57 (n=5)	2.7	0			
	All	38	100%			5	100%		
2006–2007	M	13	30%	63.4 (n=13)	4.7	0			
	F	26	59%	60.4 (n=26)	3.7	4	66%	66 (n=4)	5.8
	J	1	2%	45 (n=1)		1	17%	44 (n=1)	
	Unk	4	9%	57.5 (n=4)	2.89	1	17%	62 (n=1)	
	All	44	100%			6	100%		

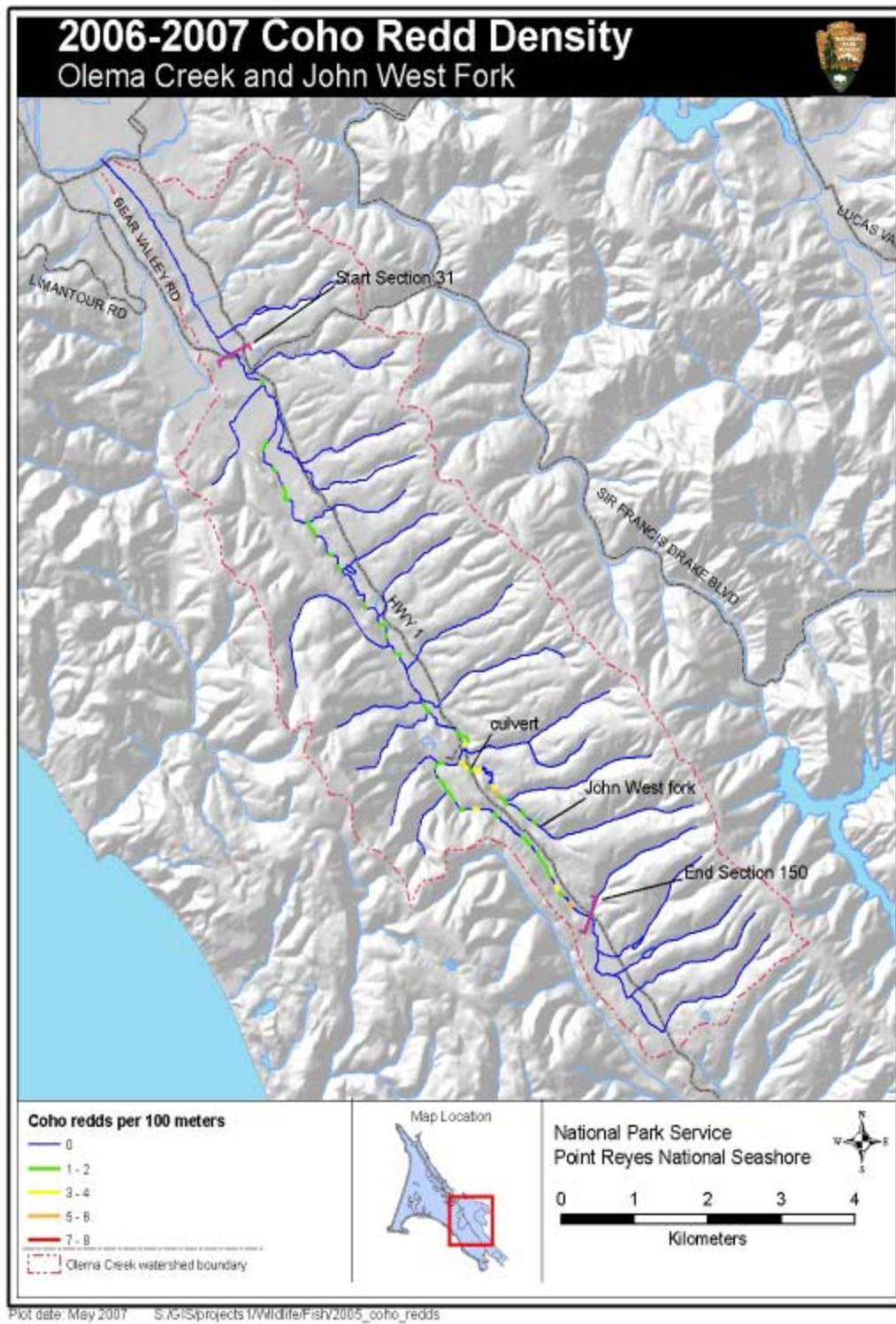


Figure SOP 10.7. Coho redd density per 100 m within Olema Creek and John West Fork.

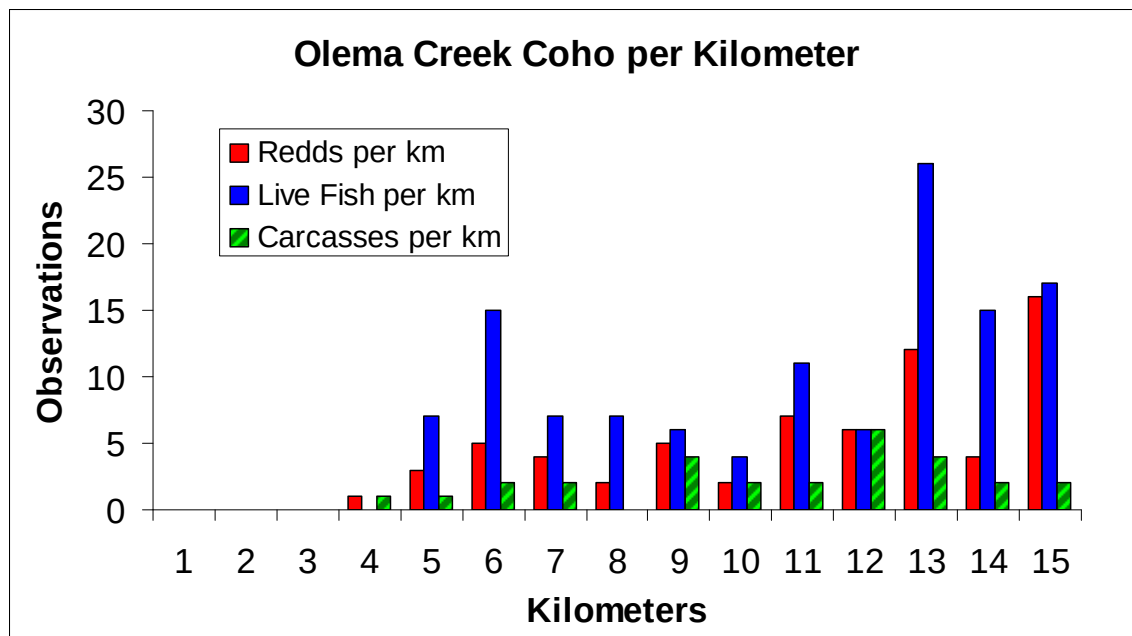


Figure SOP 10.8. Live coho fish, carcass, and redd observations by kilometer during spawner year 2006–2007 on the Olema Creek mainstem.

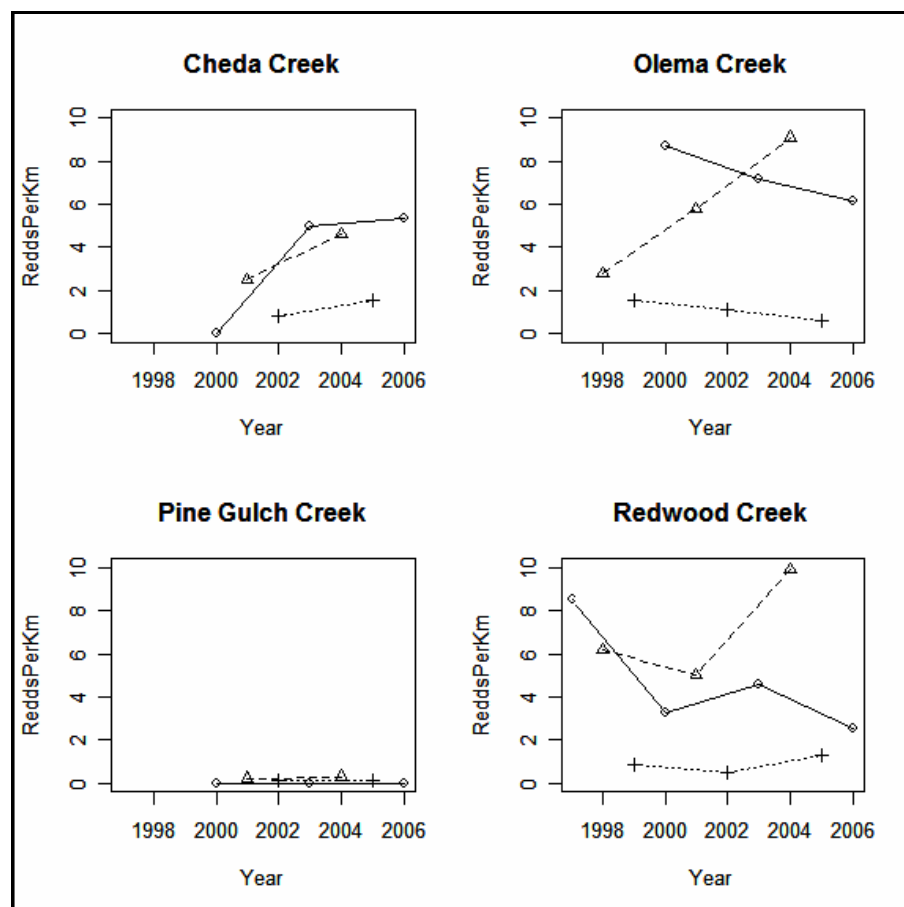


Figure SOP 10.9. Redds per km measures by cohort for all four watersheds.

Ancillary Data: Weather and Water Clarity: Table SOP 10.16 shows the weekly rainfall and water clarity during the winter surveys, as well as the raw results for those surveys. During the winter months stream conditions can change rapidly with increased stream flows caused by winter storm events. Winter storm events with subsequent increased stream flows may lower water clarity which in turn lowers observer efficiency. Figure SOP 10.10 shows the results of each survey in graphical format. These data, while ancillary, are useful in answering possible questions about environmental conditions, spawner timing, and data confidence. For example during the 2006–2007 spawner season on Olema Creek, spawning activity was observed following rain events. However, rain events also reduce water clarity which can decrease the detection of spawning by the surveyor. If water clarity remains low throughout the spawner season, then the reported PLD and total redd count are likely to be lower than the actual escapement size.

Table SOP 10.16. Seven day total rainfall per Julian week, average water clarity, and the number of coho redds, carcasses, and live adults observed in 2006–2007 on Olema Creek mainstem.

Julian Week	Survey Date	Survey Reaches	Calendar Day	7 Day Rainfall during Julian Week (in)	Average Survey Water Clarity (cm)	Coho Redds	Coho Carcass	Live Coho
46	13 Nov 06			1.65				
47	21 Nov 06	1–3	325	0.14	70	0	0	0
48				1.16				
49				1.86				
50				2.65				
51	18 Dec 06	2–6	352	0.84	95	34	5	58
52				2.28				
53	31 Dec 06	2–6	365	0	88	20	12	43
1				0.67				
2	10 Jan 07	2–6	10	0.02	100	9	5	17
3				0.03				
4	24 Jan 07	2–6	24	0.37	100	3	4	3
5				0				
6				5.54				
7	16 Feb 07	2–6	47	0.68	52	0	1	0
8				2.59				

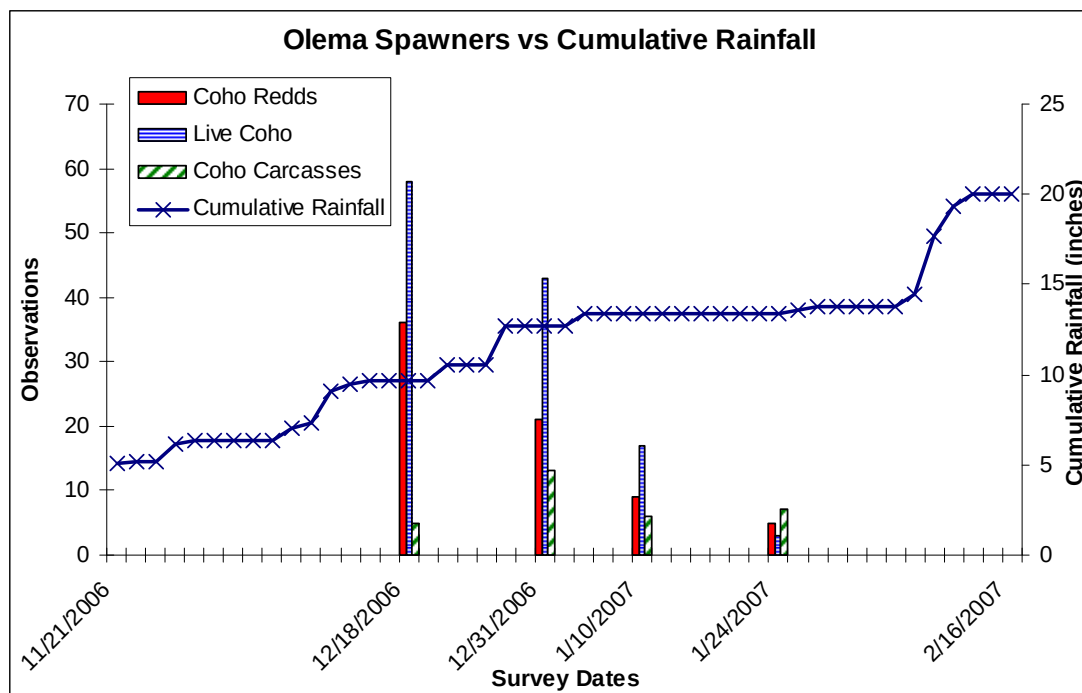


Figure SOP 10.10. Representation of rainfall totals and coho adult escapement survey results on Olema Creek mainstem, including live fish, carcasses, and redds, observed during surveys in 2006–2007.

Summary Report: Spring Smolt

The Spring Smolt Report provides information about the adult coho population changes. The main objective to be addressed in this report is:

- Conduct spring surveys at Olema, Pine Gulch, and Redwood Creeks by smolt trapping near creek mouths of Olema, Pine Gulch, and Redwood creeks to determine long-term trends in abundance of smolt coho salmon.

For each stream, the report should clearly describe the:

- Summary of trap operation dates (table SOP 10.17)
- Summary of total number of smolts captured, population estimates during smolt trapping (table SOP 10.17, figures SOP 10.11–12)
- Summary of outmigration timing and peaks (figures SOP 10.11–12)
- Analysis of fish condition (length and weight-length) to indicate fitness (table SOP 10.18, figures SOP 10.13–15)

For an example of a Spring Smolt Report see Del Real (2007).

Because the spring monitoring period is subject to high flow events, there are some periods where the traps are not operable or are blown out. In such cases traps are reinstalled as soon as feasible. Because of the highly variable response observed in outmigration patterns, we have not attempted to estimate fish numbers for the period of time when the trap is out. Evaluation of

multiple years of data may allow us to develop estimates based on flow and smolt emigration rates for each year.

Operation Period: Smolt trapping dates and locations are presented in table SOP 10.17.

Number of Smolt Captured: Coho smolt and fry along with steelhead juvenile and adult captured are presented in table SOP 10.17 and figure SOP 10.11.

Table SOP 10.17. Summary of salmonid information for Olema, Redwood, and Pine Gulch Creeks trap operations, 1999–2006

Watershed	Year	Trap Operation Dates		Steelhead					Coho		Coho Production Estimate	
		from	to	Juvenile smolt	Juvenile parr	Juvenile fry	Adult resident	Adult ocean-run	smolt	fry	estimate	SD
Olema Creek	2004	30 Mar	28 May	13	5	140	0	0	229	32	831	± 167
	2005*	1 Apr	9 May	9	8	1,218	0	1	87	14	1,296	± 724
	2006	10 Apr	9 Jun	6	19	497	0	0	368	51	10,544	± 8,399
Redwood Creek	2005	27 Mar	31 May	1	1	344	0	0	301	535	2,481	± 616
	2006	18 Apr	9 Jun	18	0	24	0	0	1,048	27	3,253	± 542
Pine Gulch	1999	16 Apr	24 May	62	42	65	1	0	0	0	N/A	N/A
	2002	28 Mar	29 May	27	27	240	0	5	249	0	N/A	N/A
	2003	28 Mar	30 May	282	120	235	1	1	576	1	N/A	N/A
	2004	25 Mar	28 May	49	50	57	0	0	149	0	737	± 144
	2005	31 Mar	31 May	28	10	200	0	0	8	0	N/A	N/A
	2006	26 Apr	9 Jun	11	7	2	0	0	93	1	368	± 76

Coho and steelhead presmolts are included in the coho smolt totals.

*Trapping discontinued May 9 due to high flows. Trap was not reinstalled.

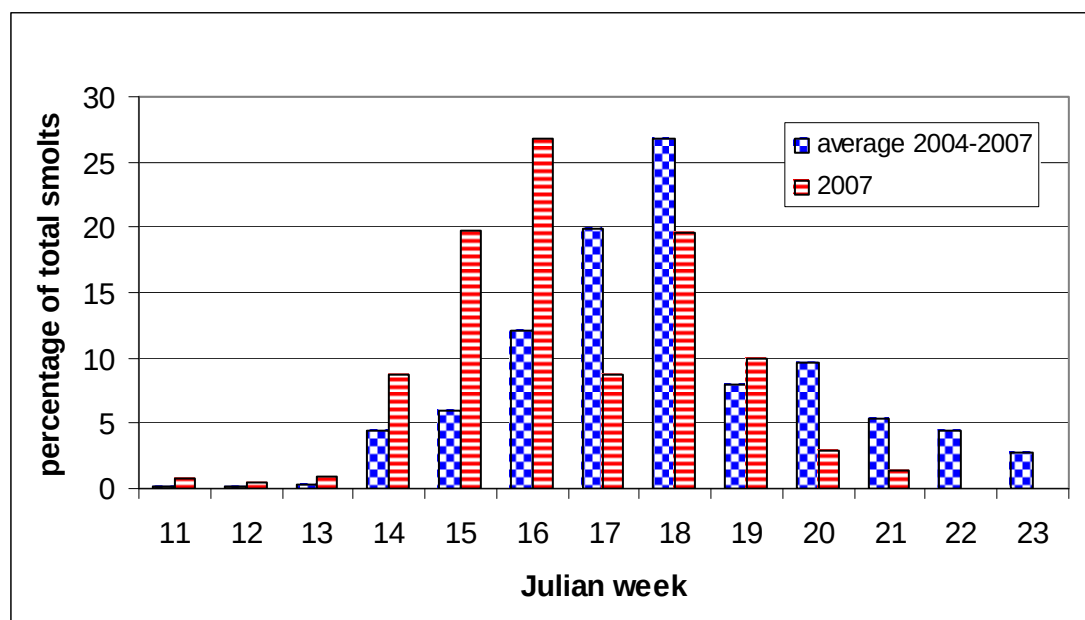


Figure SOP 10.11. Percent of total coho smolts captured by Julian week for Olema Creek in 2007 compared to the running average 2004–2007.

The result of the Darroch Analysis with Rank Reduction (DARR) modeling exercise (figure SOP 10.12) is an estimate of smolt production and confidence interval for the watershed. DARR modeling uses the stratified mark/recapture data from each survey week to determine capture efficiencies for each survey period. Using a stratified Peterson estimator, a series of algorithms are performed on the stratified mark/recapture data set to aggregate the survey periods to produce a reasonable estimate of smolt abundance and subsequent confidence intervals (Bjorkstedt 2005).

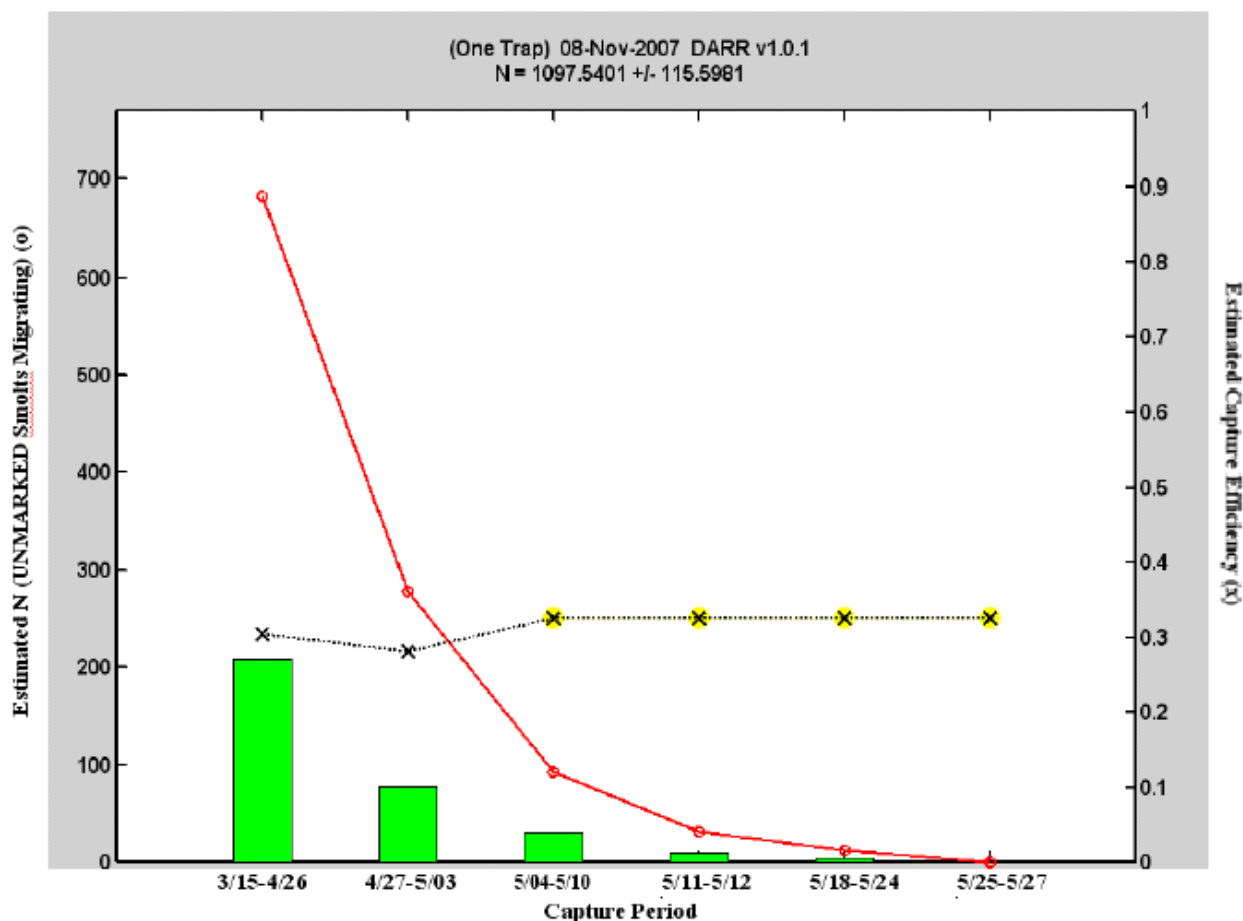


Figure SOP 10.12. DARR output graph of smolt outmigration by week for traps requiring mark/recapture operation. Shows # of fish captured (bars), estimated total # of fish (solid line with o's), and estimated capture efficiency (dotted line with x's) for each week, Olema Creek, 2007.

Fish Condition: Trends in fish condition can be tracked using fork length frequencies (figures SOP 10.13–14) and weight-length relationships (figure SOP 10.15), as well as Fulton's condition factor (K factor), as shown in table SOP 10.18.

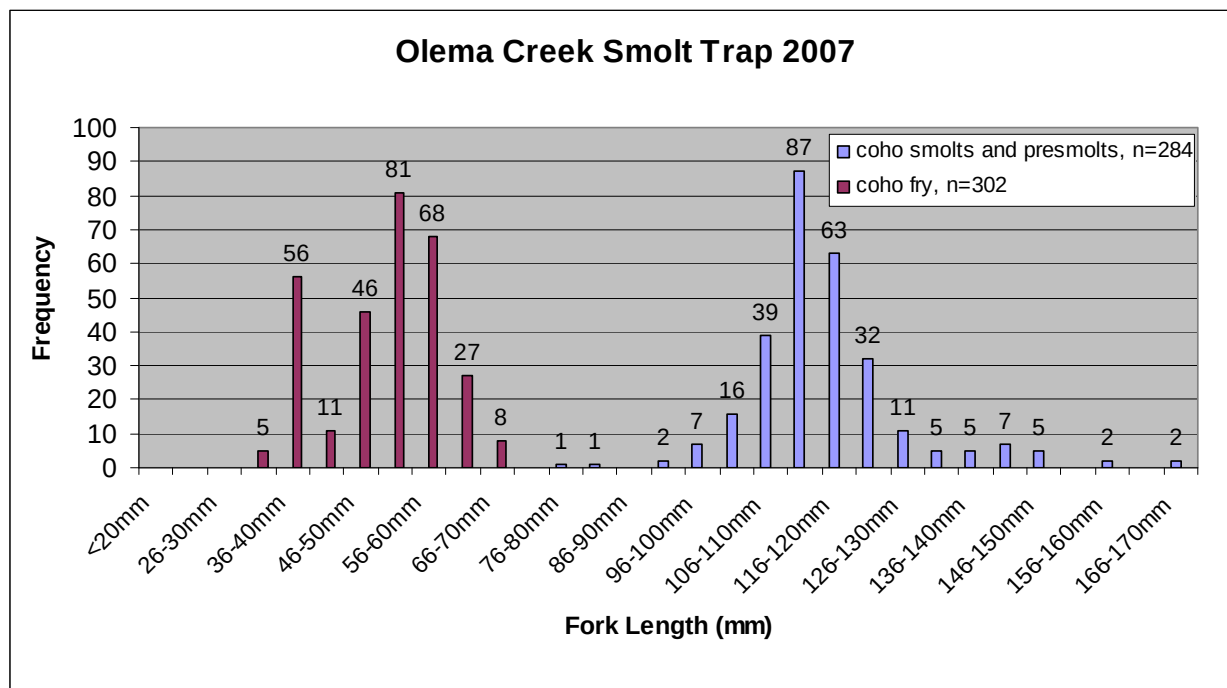


Figure SOP 10.13. Coho smolt and fry fork lengths in 10 mm increments for Olema Creek, 2007

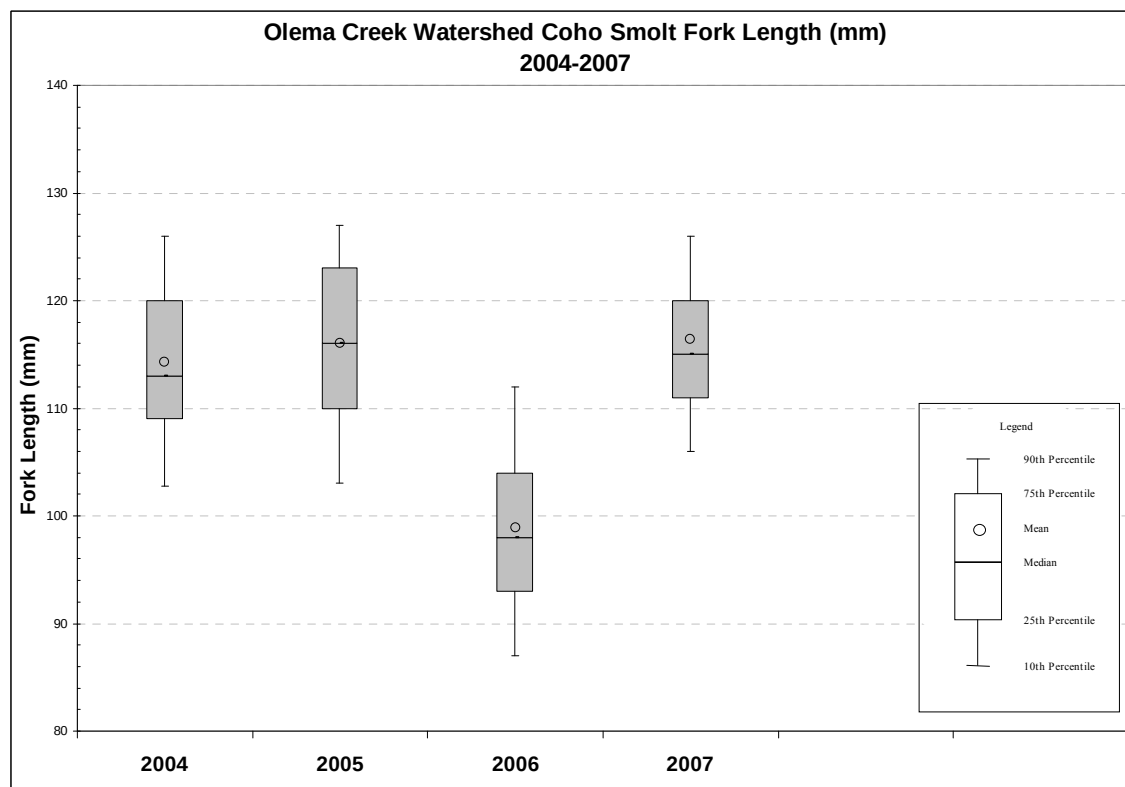


Figure SOP 10.14. Fork length of coho salmon smolts in Olema Creek, 2004–2007.

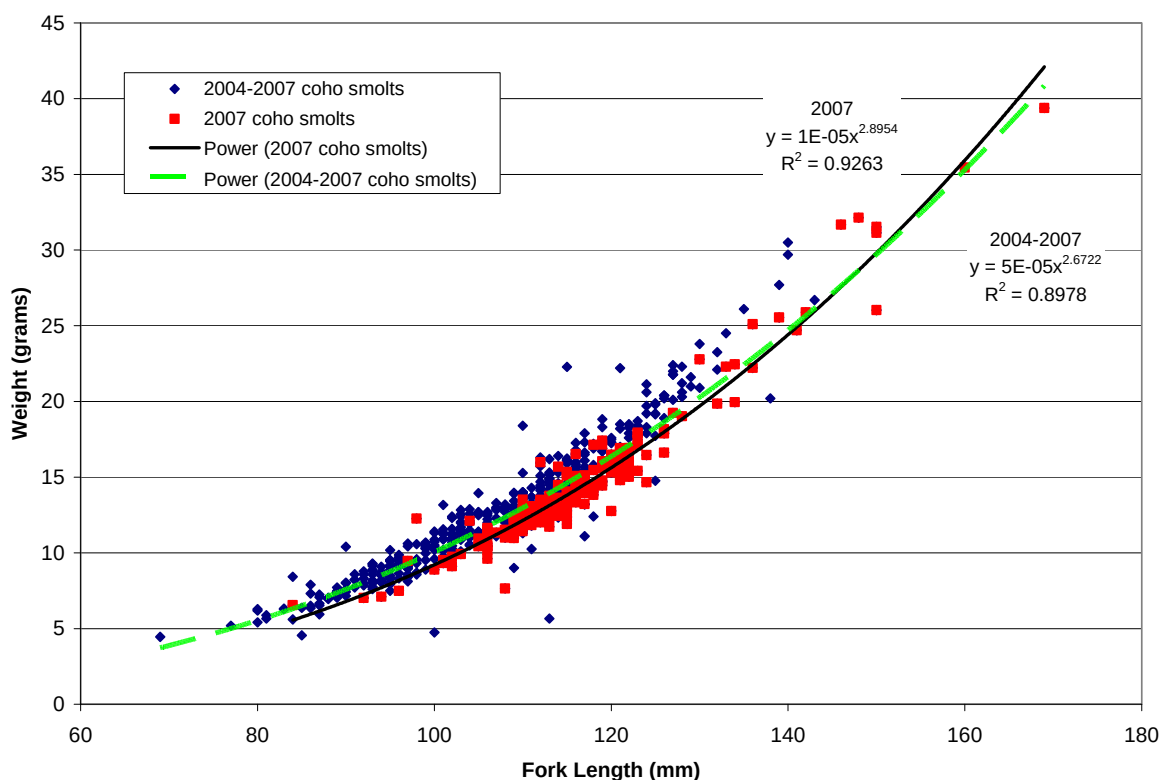


Figure SOP 10.15. Weight-length comparison between coho smolts of Olema Creek in 2007 compared to the average from years 2004–2007.

Table SOP 10.18. Mean and median coho smolt length, weight, and K factor calculated for the trapping location at Olema Creek 2004–2007.

Year	Sample Size	Mean Length (mm)	Length Standard Deviation	Median Length (mm)	Mean Weight (g)	Weight Standard Deviation	Median Weight (g)	Mean K-Factor	K-Factor Standard Deviation
2004	169	114.31	9.30	113	15.11	4.02	14.5	0.99	0.08
2005	37	116.05	9.53	116	15.95	3.89	14.98	1.01	0.13
2006	203	98.94	9.56	98	10.28	3.06	9.56	1.04	0.11
2007	191	116.43	10.99	115	14.72	4.73	13.64	0.91	0.07
Total Average	750	109.89	12.69		13.40	4.56		0.98	0.10

Annual Reports

Annual summary reports are designed as a compilation of the three seasonal reports that include standard sections such as an introduction, study area, methods, results, and discussion. The intent of the annual report is to provide resource managers with a status review of goals met, comparison of trends observed between watersheds, and the current recovery stage for salmonids. Data presented in annual reports are the same as those discussed in the summary reports (above). The annual reports provide more meaningful discussion of unique findings for

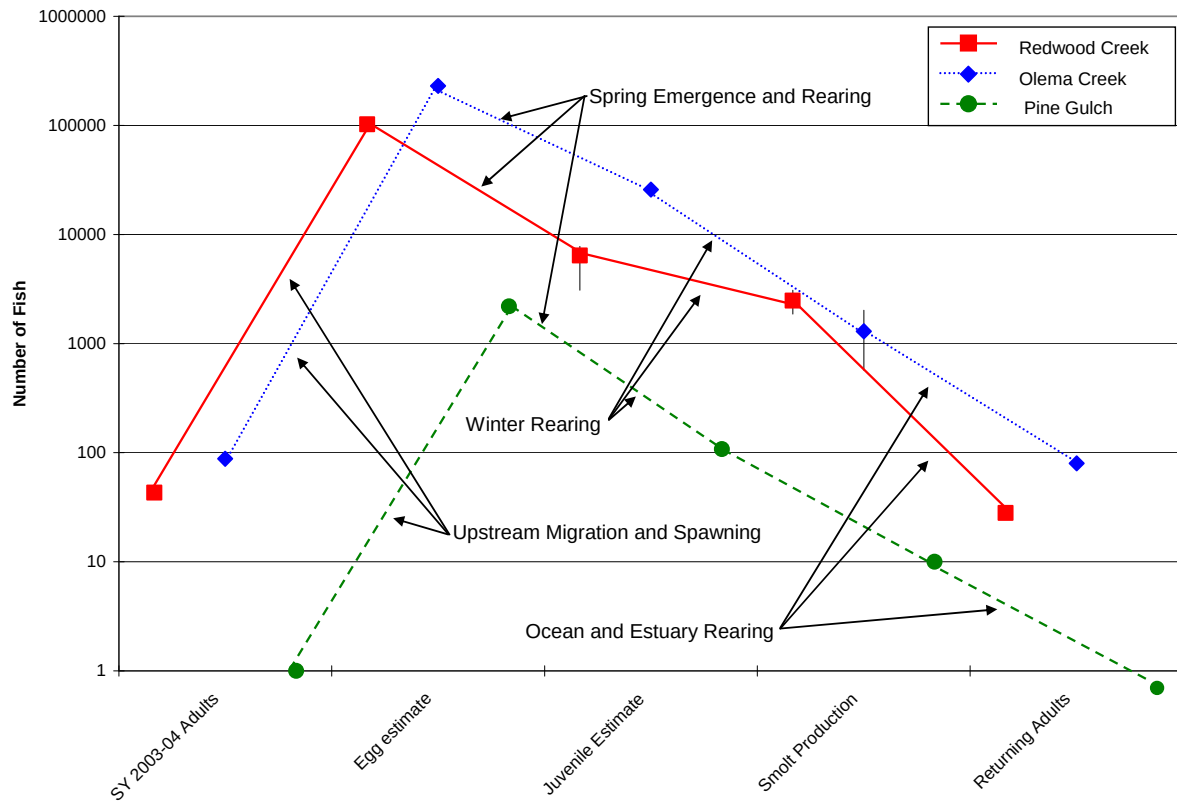
the year and interpret their significance to managers. Annual reports will also interpret annual findings relative to other years and relative to the other year classes. These reports will focus on presenting multi year and creek summaries for key metrics including:

- Abundance of coho salmon (juvenile, spawning, and smolt) (tables SOP 10.4, 10.11–14, figures SOP 10.10–11)
- Distribution of coho salmon (juvenile, spawning) (tables SOP 10.3, figures SOP 10.7–8)
- Condition (length) and sex ratio of spawning coho salmon (table SOP 10.5)
- Juvenile and smolt coho condition (length, weight) and age composition. (tables SOP 10.5 and 10.8, figures SOP 10.3–4, 10.13–15)
- Juvenile coho salmon density along index reaches (tables SOP 10.7–9)
- Juvenile steelhead trout density, condition (length, weight), age composition along index reaches (tables SOP 10.7–8)
- Changes in ratios of habitat types (pool:riffle) (table SOP 10.2)
- Analysis of multiple life-stages (table SOP 10.9, figure SOP 10.16)

Carlisle et al. (2008) provide the most recent example available and was the basis of the graphs shown above in the summary reports. Annual reports are peer reviewed by other NPS staff and follow the Natural Resource Technical Report (NRTR) format (see: <http://www.nature.nps.gov/publications/nrpm/>). Annual reports are generally completed between the smolt sampling season and the summer sampling season.

Analysis of Multiple Life Stages

Data from coho spawner surveys can be combined with juvenile coho data from summer surveys and spring smolt trapping to allow for comparison of trends within a cohort, as well as between cohorts in the same or different year classes. Figure SOP 10.16 shows the survival rate between life stages between watersheds while table SOP 10.19 tracks each cohort across multiple, life stages and gives a rough idea of survivorship between life stages within the individual watershed. By tracking survivorship between life stages the NPS will be able to determine potential limiting factors that currently inhibit the recovery of coho salmon in each watershed.



*It should be noted that the Olema Creek smolt trap was removed approximately one month early during the spring of 2005 and therefore the 2005 smolt production estimate is likely much smaller than the true production.

Figure SOP 10.16. Survival rate between monitored life stages in Olema, Pine Gulch, and Redwood Creeks for spawner year 2003–2004.

Table SOP 10.19. A comparison of multiple life stage observations of coho salmon within the Olema Creek mainstem from the SY 2002–2003 to SY 2006–2007.

Olema Creek mainstem (watershed)*	Spawner Year (SY)				
	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007
PLD Index	20	138	184	12	80
Redds	10 ^a	88	92	6 ^a	66
(Watershed Redd total)*	(22)	(109)	(137)	(10)	(95)
Average Female Fork Length	64 ^b	66.3	65.7	58.7	65.3
Estimated Number of Eggs	23,580 ^c	230,202 ^c	234,317 ^c	10,973 ^c	165,106 ^c
Basinwide Juvenile Estimate	11,926 ±3,244	25,857 ±1,499	27,423 ±7,772	1,793±869	31,936 ±4,122
Estimated Survival Rate Egg to Juvenile	50.6%	11.2%	11.7%	16.3%	19.3%
Watershed Smolt Production Estimate	831±167	1,296±724 ^d	10,544 ±8,399	1,098±116	-
Mean Smolt Length (mm)	114.31	116.05	98.94	116.43	
Mean Smolt Weight (g)	15.11	15.95	10.28	14.72	
Estimated Survival Rate Juvenile to Smolt	7.0%	5.0%	38.4%	61.2%	-
Estimated Survival Rate Egg to Smolt	3.5%	0.6%	4.5%	30.0%	-
Estimated Survival Rate Smolt to Adult ^e	2.40%	14.66% ^d	SY2007–2008	SY2008–2009	SY2009–2010

*Includes John West Fork redd count

^aDue to poor observer efficiency, the PLD index was used to estimate the Olema mainstem redd count based on two spawners per redd.

^bAverage female length based on female carcass lengths on Olema Creek for spawner years 2003–2004 thru 2006–2007.

^cEstimated number of eggs using Shapovalov and Taft (1954) formula based on average female fork length.

^dThe Spawner Year 2003–2004 watershed production estimate is artificially low since trapping operations were suspended early due to the capture of Red-legged frog tadpoles. The actual watershed production estimate was likely four to five times higher based on regional smolt production estimates. For these reasons, the smolt to adult survival rate is likely artificially high.

^e Estimated smolt to adult calculated by dividing number of adult spawners (estimated based on 2 times the total watershed redd count (in parentheses)) divided by the estimated number of outmigrating smolts for previous cohort

Other Annual Reports

NMFS Section 10 Permit Reports

The Endangered Species Act Section 10 permit reports are required annually by NMFS, as well as a final report which is to be submitted at the end of each Section 10 permitting period. All reports are due to the NMFS on the first of May. For complete details provided by the NMFS for final, annual and special reporting requirements please refer to SOP 6 (Permit Requirements).

The most recent Section 10 annual report can be viewed online

(http://science.nature.nps.gov/im/units/sfan/vital_signs/fish/fish.cfm).

Annual USFWS Section 10 Permit Report

An annual report of activities shall be submitted to the Recovery Permit Coordinator at the Sacramento U.S. Fish and Wildlife Service (USFWS) office by January 31 of each year. The report should include: 1) an introduction addressing the reasons and objectives for taking the species; 2) methodologies used for data collection and analysis; 3) a results section that summarizes the data collected on any federally listed species while conducting monitoring efforts under this permit; and 4) a conclusion that provides recommendations for the recovery of the species.

Other Reporting Documents and Components

Bi-annual CDFG Scientific Collection Permit Report

The CDFG requires that a Report of Specimens Collected or Salvaged (RSCS) be submitted within 30 days of the expiration of the scientific collection permit (SCP). Permits are valid for 2 years; therefore, reports will be submitted on a bi-annual basis. Each individual to whom a SCP is issued must provide their own RSCS. Even if the SCP holder is not renewing a permit, CDFG still requires a final report to be submitted within 30 days of the expiration of the SCP. For detailed directions on how to fill out a RSCS refer to the CDFG website:

http://www.dfg.ca.gov/licensing/pdffiles/SC_REPT.xls. The CDFG also requires that a record of field observations of Threatened, Endangered, or Special Concern species is submitted to the California Natural Diversity Data Base. The California Native Species Survey Form and instructions for completing it are posted on our web page at www.dfg.ca.gov/whdab/html/animals.html.

Executive Briefing

The executive briefing is submitted to the park superintendent, program management, and park interpretation staff after the completion of the annual report. This is a two-page summary that lists monitoring objectives and questions and discusses annual results. It is intended to provide a regional context for the information that is collected through the fisheries monitoring programs

Web Sites

Websites are used to provide information to both park staff and the general public. Information will be updated both annually and as new reports and updates are completed. Posted items include all seasonal and annual reports, Executive Briefings, and the Vital Signs Report Card.

Park Presentations

Presentations may be preformed for NPS staff, volunteers, and the general public at different times for a variety of different purposes. Presentation may be preformed at senior staff meetings, all employee meetings, and division meetings. This opportunity gives staff a chance to hear about the monitoring program and ask questions. Other outreach presentations may be performed for volunteers and the general public at different times upon request at any of the SFAN network parks.

I&M Update

The I&M Program Manager will prepare a one-page monthly e-mail to park staff with a short update on vital signs projects in order to keep park staff informed about the program.

Photos

High quality publication photos are needed to support all of the program's communication products. For digital photos this means 300 pixels per inch resolution in a plain or compressed TIF format. Program participants should make every effort to document ongoing work, special incidents, site visits for communication purposes.

Outreach Materials

A variety of products are developed or updated regularly that are directed at lay audiences but include park staff. These include 2-page Executive Briefings, Vital Sign Report Cards, I&M Updates. Content on existing websites including internet and intranet will also be updated to ensure that the most recent information is available to the public.

Analysis and Synthesis Reports

Analysis and synthesis reports are produced on a nine year cycle with the intent of evaluating the success in answering the key monitoring questions. Analysis and synthesis reports are intended to provide a benchmark for park management in their mission to preserve and protect our stream resources for future generations. These reports will focus on presenting trend analyses on key metrics including:

- Abundance of coho salmon (juvenile, spawning, and smolt)
- Distribution of coho salmon (juvenile, spawning)
- Condition (length) and sex ratio of spawning coho salmon
- Juvenile and smolt coho condition (length, weight) and age composition.
- Juvenile coho salmon density along index reaches
- Juvenile steelhead trout density, condition (length, weight), age composition along index reaches
- Changes in ration of habitat types (pool:riffle)
- Analysis of multiple life-stages

Along with comparing trends between watersheds and year-classes, trend and synthesis reports will compare trends reported by other research programs or agencies. The analyses include a synthetic look at multiple life stages. Discussions will include recommendations for changes in management practices that will help increase coho salmon populations to their optimal sustainable population. General content and format will follow the annual reports with the addition of a population trend analysis.

Population Trend Analysis

The following trend analysis will be performed on abundance data for juvenile, smolt, and adult coho salmon data sets. Distribution, condition, and habitat data will be used as covariate information and will therefore be after an initial trend analysis is performed. Methods for analyzing covariate information will be determined following trend analysis results.

Trend Model Selection: Piepho and Ogutu (2002) parameterize year as both a fixed effect for testing linear trend and as a random effect to account for annual variation in the outcome. The

fixed effect of year, referred to as *WYear* in their paper, is defined as an integer starting at 0 and increasing each year by one. Because SFAN personnel want to interpret three-year multiplicative changes in outcomes, the fixed effect for year is parameterized as 0, 0, 0, 3, 3, 3, 6, 6, 6, ... to account for the coho return schedule. This fixed effect for year is referred to here as *CCYear*, for creek-cohort year.

A mixed linear model of VanLeeuwen et al. (1996) and Piepho and Ogutu (2002) is modified to reflect the cohort structure of coho salmon. Covariate information (e.g., fish K factors, local rainfall, and habitat data) will be incorporated into the trend analysis to explain temporal and spatial variation and more precisely measure trend. Model selection for mixed models analyzed with restricted maximum likelihood will be selected using Bayes Information Criterion (Schwarz 1978; Gurka 2006).

Trend Model: The mixed linear model of VanLeeuwen et al. (1996) and Piepho and Ogutu (2002) is modified to reflect the cohort structure of coho salmon. Assuming one population estimate per watershed per year, the modified linear mixed model is given by:

$$\ln(y_{ijk}) = b_j + \alpha_i + w_j\beta + w_j t_i + \gamma_k + \phi_{ik} + w_j d_k + e_{ijk}$$

where $i = 1, \dots, m_a$ indexes watershed;

$j = 1, \dots, m_b$ indexes year;

$k = 1, 2, 3$ indexes the cohort;

m_a = the number of watersheds surveyed for juveniles ($m_a = 3$);

m_b = the number of years of sampling;

y_{ijk} = Basinwide population estimate for juveniles in watershed i , year j , and cohort k .

b_j = random intercept of the j^{th} year, iid as $N(0, \sigma_b^2)$;

α_i = the fixed intercept of the i^{th} watershed;

β = fixed slope of the linear time trend;

w_j = is a constant representing the j^{th} cohort-by-watershed year;

t_i = random slope of i^{th} watershed, iid as $N(0, \sigma_t^2)$;

γ_k = fixed intercept of k^{th} cohort;

ϕ_{ik} = the fixed interaction between the i^{th} watershed and k^{th} cohort;

d_k = random slope for the k^{th} cohort, iid as $N(0, \sigma_d^2)$; and

e_{ijk} = unexplained error, iid as $N(0, \sigma_e^2)$.

This linear model forms the basis of the power analysis for the test of the fixed effect for *CCYear*. Tests will be performed at the $\alpha=0.10$ level. Simulations will be conducted in R to generate random effects and assess the power to detect actual trends over time. The two-sided hypothesis test of no trend will be calculated for three-year multiplicative decreases of 2.5%, 10%, 25%, 50%, and 75%.

Program and Protocol Revision

A formal review of the monitoring program and protocols will take place on a 6-year cycle or two life cycles. The review will ensure that the most sound and up to date methodologies for collecting and analyzing fisheries data are being used. All protocols require editing as new sample collection, analysis, and data management information becomes available. Required edits

should be made as soon as they are deemed necessary and as appropriate reviews are conducted. See SOP 7 for details on protocol revisions.

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SOP 11. Personnel Training and Safety

Version 1.5

Revision History Log

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	November 2009	Allison Dedrick, Angie Rodoni	Created SOP		1.0
1.0	November 2009	Allison Dedrick, Angie Rodoni	Editing, combined training and safety sections		1.1
1.1	November 2009	Allison Dedrick	Changed format of table SOP 11.4	Previous table unreadable	1.2
1.2	November 2009	Michael Reichmuth	Final minor edits	SOP finalization	1.3
1.3	November 2009	Allison Dedrick	Fixed literature cited	Inconsistencies	1.4
1.4	February 2010	Michael Reichmuth	Final edits for final submittal	Response to editors and internal review comments	1.5

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Overview

This standard operating procedure (SOP) describes the training and safety measures required for staff and volunteers. Training and safety are handled in one SOP because they are tightly linked: thorough training must include proper safety coverage to ensure the well-being of employees and volunteers. This SOP discusses training for spawner surveys, smolt trapping, habitat typing, electrofishing, snorkeling, seining, and data management. The safety section addresses general field safety, defensive and safe driving, and CPR/AED and first aid training. Sample forms and a fisheries job hazard analysis (Appendix A) pertaining to safety protocol are also provided.

Training Requirements for Staff

Prior educational and field background is very important to implement this monitoring program. All program staff should review all pertinent reading material prior to engaging in any monitoring activities.

The Fisheries Biologist (Program Lead)

The project lead should have field experience working with smolt traps, snorkel surveys, electrofishing, and spawner surveys as well as experience leading field crews. Familiarity with statistics and report-writing is also useful. Field experience and some leadership background are required for the Field Crew Leader. Field Assistants and other technical staff should have some educational background in biology or aquatic sciences, with minimal field experience required.

Crew Leaders and Crew Members

All field staff including the Crew Leader and Crew Members should be familiar with the list of potentially occurring aquatic species either through past job experience, academic coursework, or by use of field guides for this region. The nature of the work described in the Salmonid Monitoring Protocol involves access through difficult terrain and working in potentially inclement weather. All staff should be aware of their physical limitations before conducting monitoring activities.

Volunteers

Volunteers will need less experience because they will always be going out with experienced staff. Once they are trained, however, they may take on the roles of Crew Members. All volunteers should be aware of their physical limitations before conducting monitoring activities. All volunteers are required to complete a volunteer agreement form (Appendix B) prior to participating in monitoring activities. Volunteer agreement forms will be verified and maintained by the program lead.

Spawner Survey

Crew Leader: Crew Leaders lead spawner surveys. Staff members and experienced volunteers can be trained as Crew Leaders by the Program Leader. Training will consist of reviewing identification materials and SOP 5 in the office and accompanying the Program Leader on spawner surveys in the field. Field training will continue until the Program Leader is confident in the trainee's ability to consistently identify live fish and redds correctly, process a carcass, and lead a crew in the field.

Crew Member: Crew Members accompany a Crew Leader on a spawner survey and consist of staff members and volunteers. Crew Members should review identification

information prior to the survey. In the field, Crew Leaders should review distinguishing characteristics among the fish species and should point out examples of each to the Crew Members when seen.

Smolt Trapping

Staff members should review SOP 4 prior to going out in the field. Once in the field, the Program Leader or an experienced staff member should demonstrate how to set up, maintain, and take down the smolt trap. The Program Leader should also review how to operate the trap, process fish, and should demonstrate how to tag a fish with Passive Integrated Transponder (PIT) tags. After demonstrating, the Program Leader should supervise new staff members while PIT-tagging fish until the Program Leader feels they are competent.

Volunteers need less extensive training because they will not be checking smolt traps without an accompanying staff member. In the field, the staff member can direct volunteers on how to assist with trap set-up, trap maintenance, and fish recording.

Habitat Typing

New staff members should review the section on habitat typing in SOP 1 prior to going out in the field. In the field, new staff members should be paired with an experienced staff member until the experienced staff member is confident in the new staff member's ability to characterize habitat. Volunteers will not be involved with habitat typing.

Electrofishing

Only staff members should be trained to operate the electrofisher and process fish. All field crew members, including volunteers and staff members, should be trained to net, pass, and record fish. Staff members should review the electrofishing section in SOP 3. The staff member leading the field crew should go over safety measures and procedures before starting work in the field.

Electrofisher Operator: Only staff members will be trained to operate the electrofisher. Prior to going out in the field, staff members will review the Principles and Techniques of Electrofishing handbook to learn the fundamental techniques and safety precautions. Once in the field, the Program Leader will demonstrate how to use the electrofisher, explain how to fish around challenging areas like rootwads, undercut banks, woody debris, and deep holes. The Program Leader should also supervise a recently trained staff member during the first couple of times operating the electrofisher, offering suggestions and guidance.

Netter: Netters flank the electrofisher operator and catch stunned fish. Once in the field, a staff member should demonstrate proper netting technique and how to transfer fish between nets and buckets. The staff member should remind netters to stay on either side of the electrofisher operator and not to get ahead of the operator, which could compromise visibility by stirring up sediment.

Passer: In the field, a staff member should demonstrate proper technique for transporting and handling fish. Volunteers should be reminded to wet their hands and nets before handling fish.

Processor: Only staff members should be trained to weigh and measure fish. In the office, staff should review identification techniques for the various species of fish. While in the

field, the Program Leader should point out distinguishing features of fish specimens. All staff members should review the section Handling Captured Fish in SOP 3.

Recorder: A staff member should ensure that all crew members are familiar with the data sheets, described in the section Handling Captured Fish in SOP 3.

Snorkeling

Only staff members will snorkel; accurately counting and identifying fish requires extensive experience. New staff members will be trained by the Program Leader or another staff member who is an experienced diver. Divers will be trained in the field for at least one season before becoming lead divers and leading surveys themselves. Before going out in the field, new divers should review the section on snorkeling in SOP 1 and should discuss with the lead diver techniques for counting fish and filtering them between divers. Once in the field, the lead diver should demonstrate how to dive and point out fish underwater to help the new staff member learn to identify fish underwater.

Seining

Staff members should review the section on seining in SOP 3. Once in the field, the Program Leader or other experienced staff member should demonstrate how to pull the seine net for new staff members and volunteers.

Data management

Staff members should familiarize themselves with SOP 8. An experienced staff member should lead new staff members through the process of using the database. Volunteers will not use the database.

Safety

General Field Safety

Safety Circle: Prior to beginning any activity that is new to field personnel, the crew should gather for a safety talk. Additionally, a period of stretching to prepare the crew for physical activity is highly advisable and could potentially minimize risk for injuries.

Safe Wading: Field personnel working in and near streams may encounter a number of hazards. Due to the often uneven streambeds containing slippery rocks of varying sizes, it is easy for field crew members to fall which can lead to injuries or drowning. To wade safely, enter a stream where water movement is slowest, taking short steps into the current, walk at a slight downstream angle in swifter waters and if you must turn, turn into the current. Waders should fit properly, with enough room to allow for mobility. Wading belts should also be worn with waders as they help prevent waders from filling if overtopped. Standard, rubber soled wading boots are suitable for slower-moving streams with mud, sand, or pebble beds. Using a wading staff is very helpful in maintaining balance while wading in swifter waters. If used, hold the staff on the upstream side, placing it firmly before taking a step. Personal flotation devices should always be worn when wading in large streams (Berry, Jr., 1996).

Streams in the San Francisco Bay Area Network (SFAN) tend to be “flashy” due to the Mediterranean climate in the region. Flashy streams are characterized as having water levels that rise rapidly during storm events. If multiplying a stream’s velocity by its width results in

greater than or equal to 10 ft²/s, one should not attempt wading. Other hazards to be aware of during storms include the presence of flowing logs, debris, and falling trees (Coopridge & Carson, 2006).

Electrofishing Safety: All field crew members should wear proper chest waders with no leaks. Crew members netting or operating the electrofisher should wear polarized glasses. Lineman's gloves are advised. The electrofisher operator should review electrofishing methods and safety measures prior to starting field work. When the shocker is on, crew members should not put their hands in the water even if wearing gloves (Kolz et al, 1998). Netters and other crew members should alert the electrofisher operator if they need to touch the water or feel unbalanced so that the operator can stop shocking. People who are pregnant or have heart conditions, such as a pacemaker, should not participate in electrofishing fieldwork. Anyone operating the electrofisher should be CPR and First Aid Certified. If weather conditions turn stormy with continuous rain or thunder and lightning, the electrofisher operator should stop electrofishing. No one should be out in the field electrofishing alone. More detailed safety considerations are in chapter 12 of the Principles and Techniques of Electrofishing handbook.

Fish Handling Safety: The risk for personal injury and disease from handling fish is often greatly underestimated among field personnel. Potential hazards include diseases or infections from contact with certain organisms, cuts, punctures, or abrasions from various parts of fish such as spines, gill rakers, teeth, or opercula (table SOP 11.1). The risk for contracting diseases is particularly elevated in polluted or organically enriched streams because these streams contain increased levels of pathogens and bacteria. Avoiding polluted areas as much as possible should be considered and contamination prevention by the consistent practice of wearing gloves should be emphasized. Punctures, and open wounds should of course be avoided but if they occur, prompt, thorough cleansing, disinfection, and bandaging of the wound after exposure is critical to prevent disease and infection. If wounds are sustained to bodily joints, medical care should be sought immediately as punctures to these areas of the body are more vulnerable to infection. Signs of infection include: ascending red marks, increased pain, and soreness in joint areas or above the sting area (Olmsted, 2008).

Underwater and Diving Safety: All divers must be strong swimmers able to swim in fast-moving water. Divers should work in groups of at least two and should wear full wetsuits, including hood and gloves, and a snorkel. Before going in the field, divers should look at maps and aerial photos of the survey area to find good access points and possible evacuation points. Divers should not try to swim through cascades or under large logs and should instead exit the creek and walk around potentially hazardous obstacles. While underwater, divers must stay alert to avoid hitting hidden objects or becoming tangled in debris. All divers should be CPR and First Aid Certified and should know the signs of hyperthermia and hypothermia. On especially warm days, divers should take extra care to stay hydrated and cool, especially if there are long distances to hike between dive sites. Divers should not dive in areas known to have poor water quality and should use their judgment at sites where water quality is unknown but seems questionable. When possible divers should request water quality samples from the I&M Water Quality Specialist within 48 hours of the scheduled surveys.

Plants: The most common plants throughout the SFAN that warrant hazard awareness are poison oak (*Toxicodendron diversilobum*), and stinging nettle (*Urtica dioica*). The safety briefing “Working in Poison Oak” (Brands-Maloney, 2001) provides an extensive review of poison oak identification, location, prevention, and treatment of contact dermatitis and can be consulted for details. Field personnel should review this BEFORE entering the field and should be familiar with the shape, color, and size of poison oak leaves twigs, vines, and, yes, shrubs. Stinging nettle is not a health threat but causes skin irritation which can be severe (though temporary) if in large amounts (Coopridge & Carson, 2006).

Table SOP 11.1. Examples of diseases potentially hazardous to field personnel.

Name	Other Names	Pathogen	Carrier	How transmitted	Appearance on host	Human symptoms	Prevention
Vibriosis		<i>Vibrio parahaemolyticus</i> ; <i>V. vulnificus</i> ; <i>V. alginolyticus</i>	Shellfish, crustaceans	Cuts, open wounds.	Not visible	Acute diarrhea, abdominal cramps, fever, soft tissue destruction	Protective foot and hand gear.
Erysipeloid or Erythema migrans	Fish handler's disease, fish poisoning, fish hand, sealer's finger, whale finger blubber finger, diamond skin disease	<i>Erysipelothrix rhusiopathiae</i>	Fish, shellfish, marine mammals.	Handling infected organisms or fecal waste with open wounds		Elevated lesions on skin (can be diamond-shaped), joint pain, fever, severe headaches; incubation 1-7 days.	Use gloves when handling.
Crayfish Handlers Disease	Sealer's finger	<i>Erysipelothrix insidiosa</i> , species of <i>Vibrio</i>	Fish and shellfish	Handling infected organisms with open wounds or abrasions	Not visible	Painful itching or burning; joint swelling, stiffness; lasts up to 3 weeks	Use gloves when handling, thick boots when wading
Fish TB	Fish tank granuloma, swimming pool granuloma, tuberculosis, mycobacteriosis	<i>Mycobacterium marinum</i>	Fish	Handling fish with open wounds		Skin, soft tissue destruction; small purple lesions that gradually enlarge; incubation period 2 weeks–2 years; can mimic carpal tunnel syndrome	Use gloves or other protective gear; avoid punctures or handling with open wounds
Salmonellosis	Salmonella	<i>Salmonella sandiego</i> , <i>S. java</i> , <i>S. Pomona</i> , <i>S. Miami</i>	Turtles, newts, frogs, toads, other reptiles and amphibians	Direct contact and indirect (unwashed clothes).	Not visible	Diarrhea, abdominal cramping, fever	Wash hands and clothes after handling
Swimmer's Itch		<i>Schistosoma cercarial dermatitis</i>	Waterfowl and humans-adult phase; aquatic snails – intermediate	Swimming or contact with waters infested with the flatworm		Skin rashes and bumps (papulae) within 30 min of exposure	Avoid waters with known outbreaks, prevalent waterfowl, or aquatic snail populations

Table SOP 11.1. Examples of diseases potentially hazardous to field personnel (continued).

Name	Other Names	Pathogen	Carrier	How transmitted	Appearance on host	Human symptoms	Prevention
Giardiasis		<i>Giardia intestinalis</i>	Infected soil and water; surfaces contaminated with animal or human feces	Accidental ingestion	Not visible	Diarrhea and dehydration	Avoid contaminated soil, water, food, fecal exposure
Red Plague		<i>Aeromonas salmonicida</i>	Wild and captive freshwater fish	Handling infected fish		Diarrhea, skin infections	Use gloves when handling.

Source: Adapted from Olmsted 2008

Defensive and Safe Driving

Before leaving, the driver should inspect the vehicle to make sure it is functioning properly and contains the necessary safety gear, including jumper cables, road reflectors, safety vests, a basic tool kit, a tire pressure gauge, and flashlight (Reicke, 2008). Drivers should also check that they know how to operate the vehicle, since all vehicles are slightly different.

En route to field sites, drivers and passengers should always wear seat belts. Drivers should drive at a safe speed, which may be slower than the posted speed limit. On dirt or ranch roads, drivers should be aware of the road conditions and watch for other vehicles, even when behind locked gates. Drivers should leave gates locked as found. When turning on narrow roads, drivers should use a spotter and never back toward a hazard, such as a cliff edge (Fong et al, 2003). Extra caution should be used when driving in unfamiliar areas, remote areas, and places where large animals are likely to cross the road. Drivers should also pay extra attention when driving at night or in stormy conditions. Drivers should watch for signs of fatigue and take a nap or have a field partner drive if necessary.

CPR/AED and First Aid Training

In case of emergency situations, all fisheries staff should be up-to-date in CPR/AED and First Aid Certification. This training is invaluable to personnel safety, particularly since fisheries staff often work in remote locations, outdoors for extended periods of time, and far from medical facilities. A variety of trainings are regularly offered by organizations such as the American Red Cross and American Heart Association. The nearest chapters of these organizations can be found on their websites. A combination course consisting of first aid, cardiopulmonary resuscitation (CPR), and automated external defibrillator (AED) training is often most valuable and economical. Up-to-date certification can usually be completed within one day and lasts 1-2 years for CPR/AED training and 3 years for first aid. Course options are described in table SOP 11.2, with wilderness training options in table SOP 11.3. table SOP 11.4 summarizes typical field and/or fisheries related injuries.

Table SOP 11.2. First aid, CPR, and AED training options

Course	Course Content	Est. Hours Training
Standard First Aid, CPR & AED [Often meets OSHA requirements]	Breathing and cardiac emergencies in adults; identifying and caring for bleeding, sudden illnesses, injuries; and preventing disease transmission. Includes an introduction to AEDs.	6-7
First Aid	Identifying and caring for bleeding, sudden illnesses, injuries; and preventing disease transmission.	3-4
Advanced First Aid	Breathing and cardiac emergencies; bleeding and shock, sudden illness, and injuries; special situations; natural disasters.	16-40
CPR & AED	Breathing and cardiac emergencies in adults, children and infants, heart disease prevention, scene assessment, patient assessment, CPR, AED use.	3-4
CPR & AED Refresher	Refresher course for individuals who have previously been certified in CPR and AED operation. Review of CPR, using an AED, and choking for lay rescuers.	2-4

Source: Csoboth, 2008.

The following information on training options for CPR/AED, first aid, and wilderness safety is referenced directly from Csoboth (2008) in the *Fisheries Safety Handbook*.

“A few options exist for training employees/students. Each option includes instructor observations to ensure participants acquired the requisite knowledge and skills.

- An instructor can come to your facility and train your employees at a time that works for you—daytime, evenings or weekends. Typically, class sizes are 10 individuals, but can be larger if there are multiple instructors.
- One of your employees can become an authorized instructor to provide first aid, CPR and AED training onsite. This cost-effective option allows you to schedule training at your convenience with instructors familiar with your specific emergency procedures and site-specific needs. This option tends to be feasible only for large programs or in those with a high interest level.
- When only a few employees need training, classes are available at community locations.
- The newest and most flexible option allows everyone to learn at their own pace. The Red Cross offers Blended Learning training, where the first part of the training is accessed online at the employee's convenience, followed by an instructor-led skills practice and assessment. The American Heart Association offers CPR Anytime or AED Anytime training, where CPR skills and lessons are taught using a DVD and CD-ROM, followed by an instructor-led skills test."

Wilderness Safety Training Options

"For aquatic resource professionals that regularly work in remote wilderness settings, it may be beneficial to expand the scope of their first aid and rescue skills.

Remote settings are identified based upon both the miles-from-care, as well as the accessibility of the site. Generally, areas beyond two hours from definitive care are considered remote. Wilderness safety training may also be beneficial for individuals working alone or in small groups that would require administering emergency care for an extended period before professional medical assistance could arrive. The primary hazards associated with working in remote locations are:

- Isolation from public rescue services;
- Limited means of communication;
- Exposure to adverse/severe weather

If extended period of time outside of normal cell coverage areas is expected, it may be prudent to consider purchasing a satellite phone. Wilderness first aid courses can be found throughout the country (and world), and are typically rigorous, fast-paced, with many hands-on training components. Certifications are typically three years. If you choose to go this route, it is imperative that you go with an industry-recognized training organization. The top three such organizations in the U.S. are: Wilderness Medical Associates, SOLO, and the Wilderness Medicine Institute".

Table SOP 11.3. Wilderness First Aid training options.

Course	Appropriate for...	Course Content	Est. Hours Training
Wilderness First Aid	People working or leading groups outdoors for short periods of time	Basic skills of response and assessment, musculoskeletal injuries, environmental emergencies, survival skills, soft tissue injuries (trauma), and medical emergencies (critical care, CPR)	16
Advanced Wilderness First Aid	People wanting more information, exposed for long periods, but not acting as first responders	Builds upon basic skills and subjects, emphasizes patient assessment, and presents new survival skills	32

Source: Csoboth, 2008.

Table SOP 11.4. Typical field and/or fisheries related injuries.

Type of Injury	Injury	Characteristics
Flesh Wounds	Scrapes and Abrasions	Usually does not penetrate skin, slow bleeding
	Cuts	Blood is dark red, flows at a steady pace, can be life-threatening
	Puncture Wounds	Blood is bright red, flows very rapidly. If major artery is punctured, treat immediately
Skeletal	Sprained Joints and Dislocations	Range from aching to severe pain. Dislocations show signs of deformity, swelling, discoloration, pain, inability to move injured area, and can emit a grating sound.
	Broken Bones	Deformity, swelling, discoloration, grating sound, pain, inability to move area, exposed bone in the case of compound fracture
	Head and Neck	Change in consciousness, breathing difficulty, impaired vision, inability to move body part, headache, vomiting, loss of balance, tingling in hands, fingers, feet, and/or toes
Toxins, Bites, Stings	Spider Bite (Brown Recluse)	Swollen, painful, and itchy in area of bite. Wound blisters. Wound may develop in a large ulcerated area within hours or days. Severe symptoms include fever, chills, nausea/vomiting, and body rash.
	Spider Bite (Black Widow)	Minimal to sharp pain, followed by redness and swelling at site. Bite may not be painful initially. Severe symptoms include abdominal pain, dizziness, headache, fever, severe cramps, weakness and difficulty breathing.
	Scorpion Bite	Immediate pain, itching, swelling, skin changing color, anxiety, fainting, numbness of tongue, vision problems, diarrhea.
	Tick Bite	Possible rash, tick usually visible. Risk of Lyme's disease.
	Snake Bite	Swelling around bite usually.
	Insect Sting	Never pull out stinger. Use edge of credit card or something similar to snag venom sack about skin level.

Table SOP 11.4. Typical field and/or fisheries related injuries (continued).

Type of Injury	Injury	Characteristics
Contact Allergies	Jellyfish Sting	Typically painful, red rashes limited to area of direct contact. Lesions can last days/weeks. Severe stings can cause weakness, headaches, vomiting, fever, chills, muscle spasm, difficulty breathing, possibly shock.
	Stingray Sting	Immediate, excruciating pain, bleeding, wounded area may turn red or blue, nausea, vomiting, fever, chills, muscle cramps, paralysis, fainting.
Medical Emergencies	Catfish Sting	Severe pain, inflammation at site of sting
	Poison Ivy, Oak, & Sumac	Redness, itchy skin; red bumps or large oozing blisters; often in streaks or patches
	Allergic Reactions	Skin (redness, itching, blistering, hives), lungs (wheezing, tightness, cough, shortness of breath), head (swelling of face, eyelids, lips, tongue, throat), nose (stuffy, runny, sneezing), eyes (red, itchy, swollen, watery), stomach (pain, nausea, vomiting, diarrhea)
	Diabetes	Fatigue, excessive thirst, excessive urination, irritability, blurry vision
	Stroke	Weakness, numbness of face, arm, leg, blurred vision, severe headache/dizziness/confusion
	Cardiac Arrest	No heart beat, unresponsive, not breathing
	Seizures	Person makes a sound followed by abnormal stiffening and jerking of arms and legs
Environmental Emergencies	Hypothermia	Shivering, numbness, apathy, weakness, loss of consciousness
	Hyperthermia	Heat Exhaustion: cool, moist skin, headache, nausea, weakness, heavy sweating Heat Stroke: red, hot, dry skin, vomiting, loss of consciousness
	Frostbite	Lack of feeling, waxy, cold, discolored skin
	Sunburn	Red, dry skin; blisters form when more severe
	Drowning/Near-Drowning	Coughing, choking, vomiting, shortness of breath/gasping, blue lips/tongue, clenched teeth, frothy sputum, weak pulse, slow absent breath, and coma

Source: Csoboth 2008.

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Appendix SOP 11A. Fisheries Job Hazard Analysis

Job Hazard Analysis PORE			
U.S. Department of Interior National Park Service	WORK PROJECT/ACTIVITY Aquatic surveys and projects	LOCATION Point Reyes National Seashore	UNIT Nat'l Resource Mngt and Science
JOB HAZARD ANALYSIS (JHA)	DEVELOPED BY Michael Reichmuth	JOB TITLE Fishery Biologist	DATE PREPARED 14 July 2006
APPROVED BY:		DATE:	
Required and/or Recommended Personal Protective Equipment: Sturdy work boots Warm clothing / hat Sun hat Polarized Sun glasses Sunscreen Personal water bottles First Aid Kit Park radio Technu (poison oak cleanser) Forceps / vial Safety glasses Personal Flotation Device Lug sole waders (chest, hip, neoprene) Lug sole wading boots Cotton gloves / wool gloves Linesman gloves Latex gloves Survivor kit Wetsuit/Dry Suit Maps Mask and snorkel / neoprene gloves Throw Bag			
TASKS/PROCEDURES	HAZARDS	ABATEMENT ACTIONS Engineering Controls*Substitution*Administrative Controls* Personal Protection Equipment	
All Tasks and Procedures	Unfamiliarity	All people (permanent, seasonal, VIPs) involved in any project should receive a general orientation and tailgate safety session specific to the task prior to beginning of work.	
1. Driving to and from remote field sites.	1a. Narrow, single-lane roads with bumpy or "washboard" surfaces;	WEAR SEATBELTS AT ALL TIMES WHEN VEHICLE IS MOVING 1a. Maintain a safe speed (this is often below the legal speed limit) for the road conditions;	

		stay clear to the right, especially on curves, <i>drive with headlights on at all times</i>; when turning around on mountain roads always “face the danger” (versus backing toward the cliff edge, e.g.); the passenger should get out and spot for driver when backing up;
	1b. Driving with limited visibility;	1b. Maintain windshield cleaner fluid level and clean both sides of windows regularly (remember back window); <i>slow down</i>; if blinded by sun or dust, proceed slowly or pullover and wait for hazard to pass; keep to the right hand side of the road and drive with your <i>lights on</i>;
	1c. Sharp rocks on edge or in middle of road;	1c. Get out and move sharp rocks out of the way, reduce speed substantially in places with large amounts of rockfall; make sure tires are properly inflated and check tread and walls regularly for damage; make sure tire jack fits the vehicle and all parts are in the vehicle;
	1d. Large animals crossing or standing in roads (including park bypass);	1d. Slow down where animals might be present to allow for reaction time; do not swerve abruptly to avoid hitting an animal, if necessary it's better to ride out the impact;
	1f. Fatigue at night and after a long shift in the field;	1f. Be aware of signs of fatigue- pull over and rest! Take a short catnap or eat a snack or have a partner drive; do not take chances by continuing to drive; communicate with your field partner;
	1g. Storm conditions – wind, lightning, muddy/slippery roads;	1g. Keep informed on the current weather- check www.weather.com or www.wrh.noaa.gov; if winds exceed 15 mph, or the excessive wind category on Beaufort scale (tree tops swaying, twigs and leaves falling, etc.), do not travel into the field; avoid going to the field if lightning is present and avoid using radios; drive slowly when roads are muddy and slippery or snow covered, check with geologists if you are uncertain of back road conditions; avoid wet clay roads as much as possible, these roads can fail after storms, especially in spring, <i>maintain a slow speed when driving on these roads!</i>; if you damage waterbars make sure you repair them immediately;
	1h. Fallen trees on	1h. For small trees, try and remove tree or cut with a handsaw and

		change into after coming out of field; wash field clothes separately from other laundry.
	4b. Bees/Wasps/ Hornets	4b. Determine if any field crew are allergic to bee stings. Notify other crew members and the supervisor if you know you are allergic to bee stings. Ensure that individual carries prescribed medication to prevent anaphylactic shock; Carry a bee sting kit or Benadryl or other antihistamine; Be aware of the ground where you step- some hornets build nests in the ground at the base of trees or shrubs, or in rotten logs- watch for bees buzzing in and out of holes or around ground level; if possible, flag a nest so future surveyors won't run into it;
	4c. Ticks	4c. Know how to identify and distinguish the "deer tick" that carries Lyme disease, from the "wood tick" that does not; if bitten by a tick, remove it (grasp tick with tweezers at head and pull straight out), and follow instructions for preserving it and turn it in to the county health department so they can determine if it was carrying Lyme; fill out a CA-1 (accident report) in the event that symptoms of Lyme disease appear eventually;
	4d. Scorpions	4d. Inspect items left lying on the ground, e.g., clothing, for scorpions prior to putting them on;
	4e. Rattlesnakes	4e. Avoid rattlesnakes by inspecting the ground near logs before stepping over them; avoid placing hands on rock ledges or other natural hoists without visually inspecting them first; in the unlikely event you're bitten by a rattlesnake, stay calm, sit still, and call and wait for help;
	4g. Mountain lions	4g. Avoid mountain lions; if you encounter a lion that doesn't run from you- leave the area; if attacked- fight back!
	4h. Disease (bubonic plague and Hanta Virus)	4h. Stay away from dead rodents and rodent feces, especially in closed buildings.
	4i. Encounters with strangers	4i. Report uncomfortable encounters with strangers in the park to a supervisor as soon as possible; report apparent illegal activity to a park

		ranger, do not get into a confrontation with visitors in the park.
5. Exposure to environmental variables	5a. Treatment of general injuries 5b. Hypothermia 5c. Hyperthermia 5d. Giardia 5e. Sunburn	5a. All NPS field staff and contractors will be required to have current First Aid certification. 5b. Always anticipate bad weather and dress accordingly, or carry warm clothes with you. Always travel in pairs as a minimum. Keep clothing as dry as possible. Eat high energy nutritional supplements between meals. Cover the head and neck to prevent heat loss. Keep active to maintain the body's metabolism. Drink plenty of liquids to prevent dehydration, although an individual does not "feel" thirsty. Drink warm liquids not cold. Understand the effects of cold and wind: most hypothermia cases develop between 30°F and 50°F. 5c. Hyperthermia may occur during high temperatures, monitor for dehydration, heat exhaustion, heat cramps, and heat stroke; symptoms include nausea, headache, and flushed, red skin; drink plenty of water (even when you are not thirsty); as heat increases, take frequent breaks in cool locations; wear a light shirt. 5d. Giardia is caused by drinking contaminated water- carry plenty of water on outings. Consider all streams contaminated. 5e. Much of the work takes place in full sunlight (estuary seining, snorkeling, etc.) so prevent sunburn, use 15+ or greater SFP sunscreen and lip balm; and wear a hat, sunglasses, and shirt.
6. General work in or near streams	6a. Working near unstable, steep, deep channels, swift flows. 6b. Giardia 6c. Sunburn 6d. Undergrowth	6a. Reconnoiter to familiarize yourself with stream and reach adjacent to project. Know the current and projected flow conditions from weather forecasts and stream gauge info. Familiarize yourself with work area prior to fieldwork. Review maps and aerial photos to determine access points, reference points, and potential evacuation points. Develop evacuation plans for remote stream sites and make sure you sign out (including location) on the checkout board prior to leaving for the field. 6b. Refer to 5d. 6c. Refer to 5e. 6d. Refer to 3b.

7. Aquatic surveys, Culvert Surveys, Spawning/Carcass Counts, Habitat Monitoring, Downstream Migrant Trapping, Frog Surveys, Fish Distribution Study, Habitat Improvement Design and Layout, and Project Monitoring	7a. Wading/walking in and across streams	7a. Wear proper waders, lug-soled, chest or hip boots for conditions. When using waders, wear wading belt or similar device. Purchase and use waders with lug soles or retrofitted with anti-slip devices. In cold weather, wear neoprene waders or wear warm, preferably polyester garments with standard waders. Use walking stick to improve stability in current. Walk slowly and carefully. Work in teams of two or more and within sight of one another. Cross-stream at shallow riffles, and avoid deep, swift areas. Consult weather forecast each morning or call local observer to determine stream and flow conditions. Avoid wet logs and slippery rocks. Sign out/in at board in front office each day. All people must be CPR and First Aid Certified. Carry a means of communication (e.g., cell phone or radio).
	7b. Wading/walking in and across aquatic sites	7b. Refer to 7a. When wading in aquatic sites with deep, fine sediments, test fine sediment depths with wading rod before entering. Do not enter when fine sediment depths extend above knee.
	7c. Crossing Debris Jams	7c. Determine the safest route along the creek; either climbing around on either side of the banks, or by going under and/or on top of the jam. When crossing you should be in sight of your coworkers in case anything should occur. Free both hands to assist with climbing jams. If crossing under and/or on top of the jam, be cognizant of its structural integrity. Walk or crawl on the larger key pieces/logs in the jam as smaller woody pieces are more prone to shift, break, or completely give way. Usually, the larger pieces are the most stable and structurally sound. The same is true for any handholds you may use when climbing the jam. If unsure, do not put all your weight on a piece at once, be slow and maintain your handholds if possible. Avoid slick wet logs without bark and if cold, be aware of ice that may be on their surfaces. DO NOT JUMP onto log pieces.
	7b. Hypothermia 7c. Giardia 7d. Sunburn	7b. Refer to 5b. 7c. Refer to 5d. 7d. Refer to 5e.
8. Boats (non-motorized)	9a. Drowning	9a. Wear proper boating protective/floatation gear (life vests, water-repellent clothing) at all times. Use boats ONLY if trained and knowledgeable in boat use. Work in pairs or teams. Consult flow gauge to determine stream safety level.

	9b. Capsizing	9b. Watch out for large organic debris (sweepers) in the channel. Scout unfamiliar obstacles before paddling through. Balance the weight in the boat. Be cognizant that a boat can be easily tipped by shifting your weight.
	9c. Hypothermia	9c. See 5a.
10. Electrofishing	10a. Electrocuting	10a. Wear proper chest waders, lug-soled shoes "Without Any leaks" and polarized glasses. Wear linesmen gloves "Without Any leaks". Do not put hands in water when shocker is on (even if wearing gloves). Crew should discuss field methods, safety procedures, and communication prior to beginning electrofishing. Personnel with heart condition (e.g., pacemaker) or pregnant should not participate. All people must be CPR and First Aid Certified.
11. Snorkel dive fish counts	11a. Snorkeling, swimming, negotiating rapids (Drowning and blunt force injuries)	11a. Divers must be able to swim well in swift water. Divers should work in pairs or teams. Wear wetsuits, including hood and gloves and mask and snorkel. Fins or wading boots are appropriate depending on depth and length of reach. Do not attempt to swim over rapids, falls, or cascades; or under logs, ledges, or boulders. Exit stream and walk around these hazards. On extended multi-day trips, carry adequate first aid, warm clothing, camping gear, radio, and food in float bags. Know and respond quickly to hypothermia or heat stress signs. All people must be CPR and First Aid Certified. Review maps and aerial photos to determine access points, reference points, potential evacuation points. All crewmembers should know potential evacuation points. When diving, crews should be cognizant they may be exposed to giardia. Do not dive in areas known to have water quality risks.
	11b. Hyperthermia	11b. Refer to 5b.
	11c. Giardia	11c. Refer to 5d.
	11d. Sunburn	11d. Refer to 5e.

12. Downstream Migrant Trapping	12a. Trap construction and maintenance 12b. Hyperthermia 12c. Giardia 12d. Sunburn	12a. Consult weather forecast each morning or call local observer to determine stream and flow conditions. Always be aware of woody debris or other objects floating downstream while constructing or maintaining traps. Wear Neoprene or leather gloves during trap construction and maintenance. When removing debris from the trap be aware of both the weight of the object and the force of the flow pulling downstream. Survey the area downstream of the trapping location for potential dangers or pullouts to be aware of in the event a crew member is swept downstream. Have safety lines and throw bags on hand. 12b. Refer to 5b. 12c. Refer to 5d. 12d. Refer to 5e.
JHA Instructions The JHA shall identify the location of the work project or activity, the name of		Emergency Evacuation Instructions Work supervisors and crewmembers are responsible for developing and discussing field emergency evacuation procedures (EEP) and alternatives in the event a

employee(s) involved in the process, the date(s) of acknowledgment, and the name of the appropriate supervisor approving the JHA. The supervisor acknowledges that employees have read and understand the contents, have received the required training, and are qualified to perform the work project or activity. Identify all tasks and procedures associated with the work project or activity that have potential to cause injury or illness to personnel and damage to property or material. Include emergency evacuation procedures (EEP). Identify all known or suspect hazards associated with each respective task/procedure listed. For example: a. Research past accidents/incidents. b. Research the Health and Safety Code, or other appropriate literature. c. Discuss the work project/activity with participants. d. Observe the work project/activity. e. A combination of the above. Identify appropriate actions to reduce or eliminate the hazards identified. Abatement measures listed below are in the order of the preferred abatement method: a. Engineering Controls (the most desirable method of abatement). For example, ergonomically designed tools, equipment, and Furniture. b. Substitution. For example, switching to high flash point, non-toxic solvents. c. Administrative Controls. For example, limiting exposure by reducing the work schedule; establishing appropriate procedures and practices. d. PPE (least desirable method of abatement). For example, using hearing protection when working with or close to portable machines (chain saws, rock drills, and portable water pumps). e. A combination of the above. Copy of the JHA as justification for purchase orders when procuring PPE.	person(s) becomes seriously ill or injured at the worksite. Be prepared to provide the following information: a. Nature of the accident or injury (avoid using victim's name). b. Type of assistance needed, if any (ground, air, or water evacuation). c. Location of accident or injury, best access route into the worksite (road name/number), Identifiable ground/air landmarks. d. Radio frequencies. e. Contact person. f. Local hazards to ground vehicles or aviation. g. Weather conditions (wind speed & direction, visibility, temperature). h. Topography. i. Number of individuals to be transported. j. Estimated weight of individuals for air/water evacuation. The items listed above serve only as guidelines for the development of emergency evacuation procedures. JHA and Emergency Evacuation Procedures Acknowledgment We, the undersigned work leader and crewmembers, acknowledge participation in the development of this JHA (as applicable) and accompanying emergency evacuation procedures. We have thoroughly discussed and understand the provisions of each of these documents: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; width: 30%;">SIGNATURE</th> <th style="text-align: center; width: 10%;">DATE</th> <th style="text-align: center; width: 30%;">SIGNATURE</th> <th style="text-align: center; width: 10%;">DATE</th> </tr> </thead> <tbody> <tr><td>_____</td><td></td><td>_____</td><td></td></tr> <tr><td>_____</td><td></td><td>_____</td><td></td></tr> <tr><td>_____</td><td></td><td>_____</td><td></td></tr> <tr><td>_____</td><td></td><td>_____</td><td></td></tr> <tr><td>_____</td><td></td><td>_____</td><td></td></tr> <tr><td>_____</td><td></td><td>_____</td><td></td></tr> </tbody> </table>	SIGNATURE	DATE	SIGNATURE	DATE	_____		_____		_____		_____		_____		_____		_____		_____		_____		_____		_____		_____	
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Appendix SOP 11B. Volunteer Agreement Form

OMB 0596-0080 (Expires 8/2010)

Volunteer Services Agreement for Natural Resources Agencies <i>for Individuals or Groups</i>			
<i>Please print when completing this form</i>			
Site Name	Agency		Reimbursement (if any)
Name of Volunteer or Group Leader – Last, First, Middle	Home Phone	Cell Phone	Email Address
Street Address	City	State	Zip Code

IF VOLUNTEER IS UNDER AGE 18 – Name of Parent or Guardian	Home Phone	Cell Phone	Email Address
Street Address	City	State	Zip Code
I affirm that I am the parent/guardian of the above named volunteer. I understand that the agency volunteer program does not provide compensation, except as otherwise provided by law; and that the service will not confer on the volunteer the status of a Federal employee. I have read the attached description of the work that the volunteer will perform. I give my permission for _____ to participate in the specified volunteer activity sponsored by _____ at _____ <i>(Name of Sponsoring Organization, if applicable)</i> <i>(Name of Volunteer Duty Station)</i> From _____ to _____ <i>(Date)</i> <i>(Date)</i> <i>(Parent/Guardian Signature)</i> <i>(Date)</i>			

Emergency Contact Name	Home Phone	Cell Phone	Email Address
Street Address	City	State	Zip Code

GOVERNMENT OFFICIAL COMPLETES THIS SECTION	
Brief description of work to be performed. <i>Include details such as minimum time commitment required, use of personal equipment, use of government vehicle, etc. Attach the complete job description to this form. If this is a group agreement, the leader is to provide the group name, a complete list of group participants to be attached to this form, and parental approval (above) completed for each volunteer under the age of 18.</i>	
Government Vehicle required? ☐ Yes ☐ No	☐ Valid State Driver's License ☐ International Driver's License
Personal Vehicle to be used? ☐ Yes ☐ No	Please verify that the volunteer is in possession of one of these documents. DO NOT keep a copy of the document for his/her file.

Optional Form 301A (6/2007)
USDA-USDI

I understand that I will not receive any compensation for the above work and that volunteers are NOT considered Federal employees for any purpose other than tort claims and injury compensation. I understand that volunteer service is not creditable for leave accrual or any other employee benefits. I also understand that either the government or I may cancel this agreement at any time by notifying the other party.

I understand that my volunteer position may require a background investigation in order for me to perform my duties.

I understand that all publications, films, slides, videos, artistic or similar endeavors, resulting from my volunteer services as specifically stated in the attached job description, will become the property of the United States, and as such, will be in the public domain and not subject to copyright laws.

I do hereby volunteer my services as described above, to assist in agency-authorized work.

(Signature of Volunteer)

(Date)

The above-named agency agrees, while this arrangement is in effect, to provide such materials, equipment, and facilities that are available and needed to perform the work described above, and to consider you as a Federal employee only for the purposes of tort claims and injury compensation.

(Signature of Volunteer Manager/Coordinator)

(Date)

Termination of Agreement

Volunteer requests formal evaluation ☐ Yes ☐ No

Evaluation Completed

(Date)

Agreement terminated on

(Date)

(Signature of Volunteer Manager/Coordinator)

Public Burden Statement

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To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA and USDI are equal opportunity providers and employers.

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Volunteer Position Description for
Coho and Steelhead Monitoring Program Volunteer, FY 2010

Supervisor: Michael Reichmuth

Location: Lagunitas Creek, Olema Creek, Pine Gulch Creek, Easkoot Creek, and Redwood Creek in Point Reyes National Seashore and Golden Gate National Recreation Area

Project Duration: ongoing

Time commitment: 6 hours per workday, from 9:00am to 3:00pm

Minimum age: 16

Goals/Outcome of Position:

- 1) To assist park staff in determining long-term trends in: a) distribution, abundance, and size of spawning coho salmon; b) abundance of smolt coho salmon and steelhead trout; and c) species diversity, distribution, abundance and size and age composition of juvenile coho salmon and steelhead trout
- 2) To assist park staff in identifying gross changes in stream habitat

Description of Duties

- **Collect data relating to stream habitat, water quality, fish and invertebrate populations, salmon spawning, riparian area condition and stream channel substrate composition**
- **Count numbers of spawning salmon, carcasses, and redds (nests) along Olema, Pine Gulch, Redwood, and Cheda Creeks during winter surveys**
- **Help erect, repair and check smolt traps near creek mouths of Olema, Pine Gulch, and Redwood Creeks during spring surveys**
- **Assist project staff during electrofishing operations by netting, measuring and recording data on juvenile fish during summer and fall surveys**
- **Identify and record gross changes in habitat in Olema, Pine Gulch, Redwood, and Easkoot Creeks during summer and fall surveys**

Tools and Equipment to be Used in the Performance of Duties

- Wading staff and wading boots
- Measuring tape, stadia rod, measuring board, and weighing scale
- Five gallon buckets, dip nets, block nets, and seines
- Clip board, data sheets, and writing utensil
- For downstream migrant trap installation only: shovels, sandbags, scissors, wire cutters, fencing tool, hardware cloth, erosion cloth, PVC pipe, fyke net, live box, wire, and T-posts

Training Provided and/or Required

Must receive proper training by crew leader before performing each survey technique

Knowledge/Skills/Experience Desired

- **Must be able to follow verbal and written instructions**

Special Requirements of the Position

- Must be able to walk long distances over rough, uneven terrain in streams subject to high flows while carrying 20 to 40 lbs of equipment
- May be exposed to ticks, poison oak, rain and extreme temperatures

Benefits to the Volunteer

- **Volunteer will gain knowledge on stream and fish sampling techniques.**
- **Volunteer will enjoy the satisfaction of helping to preserve salmon for current and future generations.**

Please note: Your email address will be passed on to Melanie Gunn, the park-wide Volunteer Program Manager, to keep you updated on volunteer news. If you would prefer not to have your email address on a park-wide volunteer list, please notify your supervisor, Mike Reichmuth.

Appendix SOP 11C. Checklists for Standard Safety Equipment

Checklists are helpful for ensuring that personnel have the appropriate safety equipment available during field trips. Each study team needs to consider the specific needs for their work and should customize these checklists as necessary (Coopridge & Carson, 2006).

√	Climatic and UV protection, etc.
	Boots, rubber soled or felt soled depending on substrate.
	Waders + wading belt
	Fluids (for example, water and sports drinks)
	Hat, wide-brimmed
	Insect repellent (unscented)
	Rain gear
	Sunglasses
	Sunscreen
	Antibacterial soap or hand lotion
	Temperature-modifying clothing

Items for Vehicles

√	Flotation and reflective protection
	Personal Flotation Devices
	Safety harness

√	Communications and instructions
	Field folder (including maps, emergency phone numbers for medical facilities, office contacts, family contacts)
	Cellular phone/communication equipment (check that the service is operational for the area to be traveled)

√	First aid and protective equipment
	Complete change of clothes (stored in dry area)
	Fire extinguisher (safely secured)
	First aid kit and manual (check for missing or old, expired items and replace if necessary)
	Orange reflective vest

√	Miscellaneous equipment
	Bungee cords (to secure loose articles)
	District flood plan (most current version)
	Flagging
	Flares
	Flashlight (including fresh batteries)
	Safety cones
	Tool kit
	U.S. Geological Survey TWRI Book 9 Chapter A9.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 963/102571, May 2010

National Park Service
U.S. Department of the Interior



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