



Salmonid Monitoring Protocol for the San Francisco Bay Area Network

Narrative and Appendices - Version 4.0

Natural Resource Report NPS/SFAN/NRR—2010/202



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).

Salmonid Monitoring Protocol for the San Francisco Bay Area Network

Narrative and Appendices -Version 4.0

Natural Resource Report NPS/SFAN/NRR—2010/202

Michael L. Reichmuth (Fishery Biologist)¹
Brannon J. Ketcham (Hydrologist)¹
Darren Fong (Aquatic Ecologist)²
Sarah Carlisle (Fishery Technician)³
Erin Brown (Water Resources Intern)³
Marcus Koenen (I&M Program Manager)²

¹Point Reyes National Seashore
Point Reyes Station, CA 94956

²Golden Gate National Recreation Area
Fort Mason, Building 201
San Francisco, CA 94123-0022

³Point Reyes National Seashore Association
Point Reyes Station, CA 94956

May 2010

National Park Service
Natural Resource Program Center
1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

The Natural Resource Publication series addresses natural resource topics that are of interest and applicability to a broad readership in the National Park Service and to others in the management of natural resources, including the scientific community, the public, and the NPS conservation and environmental constituencies. Manuscripts are peer-reviewed to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and is designed and published in a professional manner.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received formal, high-level peer review based on the importance of its content, or its potentially controversial or precedent-setting nature. Peer review was conducted by highly qualified individuals with subject area technical expertise and was overseen by a peer review manager.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from the San Francisco Bay Area I&M Network website (<http://www.nature.nps.gov/im/units/SFAN>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/NRPM>).

Please cite this publication as:

Reichmuth, M., B.J. Ketcham, D. Fong, S. Carlisle, E. Brown, and M. Koenen. 2010. Salmonid monitoring protocol for the San Francisco Bay Area Network: narrative and appendices - version 4.0. Natural Resource Report NPS/SFAN/NRR—2010/202. National Park Service, Fort Collins, Colorado.

NPS 963/102568, May 2010

Revision History Log

Prev. Verersion	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	4/05	Brannon Ketcham, Michael Reichmuth	Multiple revisions while undergoing internal reviews.	Development and addition to protocol.	3.1
3.1	1/07	Marcus Koenen	Revised format, clarified content, revised objectives, moved details to SOP and moved overview information from SOP to this protocol narrative	Address, peer review comments	3.2
3.3	5/08	Sarah Carlisle	Making changes as suggested by MR		3.4
3.4	5/08 7/08	Erin Brown Sarah Carlisle, Michael Reichmuth	Mikes changes Table of Figures, Tables, Glossary, Appendixes, power analysis, updated formatting	Permits, glossary	3.5
3.5	8/08	Brannon Ketcham, Michael Reichmuth, Marcus Koenen, Leigh Ann Starceovich	Revisions to draft, Substantial changes to some sections	Update based on feedback from Statisticians	3.6
3.6	8/08	Brannon Ketcham	Minor revisions	Additional review following MK incorporation of LAS comments	3.61
3.61	8/08	Dawn Adams	NRTR formatting, minor edits	Finalizing	3.62
3.62	9/08	Michael Reichmuth	Minor edits	clarification	3.63
3.63	11/08	Michael Reichmuth	Minor Edits	Incorporate Darren Fong comments	3.64
3.64	11/08	Michael Reichmuth	Removed presence/non-detect from protocol	Clarification	3.65
3.65	11/08	D. Adams	Formatting	Finalizing for peer review	3.66
3.66	12/08	Michael Reichmuth	Minor Edits	For peer review	3.67
3.67	2/10	Michael Reichmuth,	Final edits for final submittal	Technical editing and response to	4.0

Kris Freeman

internal review
comments

Contents

	Page
Revision History Log.....	iv
Figures.....	xi
Tables.....	xiii
Appendixes	xv
List of Acronyms	xvii
Executive Summary	xix
Acknowledgements.....	xxi
1 - Background and Objectives.....	1
1.1 Introduction and Purpose	1
1.2 Life History	2
1.3 Rationale for Selecting Resource for Monitoring	3
1.4 Measurable Criteria and Desired Status.....	5
1.5 History of Monitoring.....	5
1.5.1 Monitoring in Marin County.....	5
1.5.2 Other Regional Monitoring Programs.....	7
1.6 Monitoring Questions	7
1.7 Monitoring Objectives	8
1.8 Conceptual Model	9
1.9 Rationale for Objectives	11
1.9.1 Juvenile Surveys (Basinwide GSS Method)	11
1.9.2 Index Reach Method (Legacy Dataset).....	11
1.9.3 Spawner Surveys.....	11
1.9.4 Smolt Surveys	11

1.10 Link to Management	12
1.10.1 NPS Management Objectives	13
1.11 Measurable Results and Deliverables	13
2 - Sampling Design.....	15
2.1 Study Area	15
2.1.1 Overview of High Priority Streams	17
2.2 Sampling Design Overview	18
2.2.1 Individual Level	18
2.2.2 Population Level	18
2.2.3 Community Level	18
2.3 Seasonal Sampling Design.....	19
2.3.1 Summer/Fall Sampling	19
2.3.2 Winter Season	21
2.3.3 Spring Season.....	25
3 - Field Methods	27
3.1 Basinwide GSS Juvenile Coho Surveys	27
3.2 Basinwide GSS Habitat Typing	27
3.3 Basinwide GSS Surveys	27
3.4 Index Reach Surveys (Legacy dataset)	28
3.5 Spring Surveys	28
3.6 Winter Surveys.....	28
4 - Data Management.....	31
4.1 Database Designs	31
4.1.1 Smolt Monitoring Database	31
4.1.2 Spawner Monitoring Database.....	31

4.1.3 Summer Monitoring Database	32
4.2 Annual Data Work Flow	33
4.3 Quality Assurance and Quality Control	33
4.4 Version Control Guidelines and Database History	33
4.5 Metadata Procedures	34
4.6 Data Storage and Archival Procedures	35
4.7 Data Distribution	35
5 - Data Analysis and Reporting	37
5.1 Seasonal Updates	37
5.2 Seasonal Progress Reports	37
5.3 Annual Summary Reports	37
5.3.1 Routine Data Analyses	37
5.4 Analysis and Synthesis Reports	38
5.5 Reporting Format	38
6 - Personnel	39
6.1 Personnel Requirements	39
6.1.1 Project Lead (Network)	39
6.1.2 Hydrologist (PORE)	39
6.1.3 Aquatic Ecologist (GOGA)	39
6.1.4 Data Manager (Network)	39
6.1.5 Supporting Field Staff	39
6.1.6 Community Volunteers	40
6.2 Annual Workload and Field Schedule	40
6.2.1 Summer Surveys	40
6.3 Qualifications	41

6.4 Training.....	41
6.4.1 Snorkeling	41
6.4.2 Electrofishing	42
7 - Operational Requirements	43
7.1 Budget	43
7.2 Budget Shortfalls	43
7.3 Facility and Equipment Needs	45
7.4 Permitting Requirements	45
8 - Glossary	47
9 - Literature Cited.....	51

Figures

	Page
Figure 1. San Francisco Bay Area Inventory and Monitoring Network.....	1
Figure 2. The life cycle of coho salmon (<i>Oncorhynchus kisutch</i>).	2
Figure 3. Key stressors to life cycle of coho salmon.	6
Figure 4. Life cycle monitoring conceptual model.....	10
Figure 5. High and medium priority salmonid monitoring watersheds in Golden Gate National Recreation Area and Point Reyes National Seashore.....	16
Figure 6. Power test of trend for Peak Live Dead.....	22
Figure 7. Power test of trend for redds per km	23
Figure 8. Power test of trend for PLD for a single cohort.	24
Figure 9. Power test of trend for PLD for a single cohort.	24
Figure 10. Example of a three-year 10% decline for cohort 1 at all three creeks.....	26

Tables

	Page
Table 1. Other regional salmonid monitoring efforts, including watershed, life stage, and methods used in monitoring.	7
Table 2. Summary of survey type and metrics that contribute to individual, population, and community level metrics.	18
Table 3. Power estimates based on number of sampling years (number of observations) and percent declines.	25
Table 4. Summary of metrics and sampling sites for each sampling season.	29
Table 5. Annual field and reporting schedule.	41
Table 6. Salmonid monitoring program budget: Annual estimated costs (FY2010).	44
Table 7. Priority monitoring efforts for salmonid monitoring protocol if match funding is reduced.	45

Appendixes

	Page
Appendix A. Fish and Stream Aquatic Assemblages	57
Appendix B. CDFG Habitat Unit Types.....	59
Appendix C. Basinwide Habitat Survey Datasheet	61
Appendix D. Dive Datasheet	63
Appendix E. Index Reach Habitat Datasheets	65
Appendix F. Electrofishing Data Datasheet.....	69
Appendix G. Basinwide Electrofishing Log.....	71
Appendix H. Index Reach Electrofishing Log.....	75
Appendix I. Pipe Trap Datasheet.....	77
Appendix J. Spawner Survey Datasheet	81
Appendix K. Redd Survey Datasheet	85
Appendix L. Monument Tag Locations.....	87
Appendix M. Landowner Access Agreement.....	97

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
EUON	Eugene O’Neil National Historic Site
FGDC	Federal Geographic Data Committee
FOPO	Fort Point National Historic Site
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
PRSF	Presidio of San Francisco
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 Bay 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

Executive Summary

Within aquatic environments, biodiversity is being lost at rates greater than within terrestrial environments (Moyle et al. 1998). Through the San Francisco Bay Area Network (SFAN) Inventory and Monitoring planning process, the Threatened and Endangered Aquatic Species and Stream Fish Assemblages were identified as high priority indicators of ecological health of freshwater stream systems (Adams et al. 2006). In particular, steep declines of coho salmon (*Oncorhynchus kisutch*) in central California are a significant concern to park managers.

This protocol documents the methodology used to monitor salmonids in freshwater streams annually at Golden Gate National Recreation Area and Point Reyes National Seashore. Although the sampling is designed to focus on the federally and state endangered coho salmon, data are also collected on federally threatened steelhead trout (*O. mykiss*) and any other species incidentally encountered during sampling.

The protocol is divided into two parts. Part I is the protocol narrative and Appendixes. This provides the background information, justification, monitoring objectives, an overview of the sampling design, expected analyses and reports, and the operational budget. Part II covers the Standard Operating Procedures for all field work, data management, data analyses and reporting, and training and safety.

The monitoring objectives addressed by this protocol include the following:

1. Determine long-term trends in distribution and abundance, size (length) of spawning coho salmon by counting numbers of spawners, carcasses, and redds along reaches at Olema, Pine Gulch, Redwood, and Cheda Creeks.
2. Determine long-term trends in abundance and condition of smolt coho salmon by conducting spring smolt trapping near mouths of Olema, Pine Gulch, and Redwood Creeks.
3. Determine long-term trends in distribution and abundance and condition of juvenile coho salmon by conducting summer basinwide surveys (general systematic surveys [GSS]) at Olema, Pine Gulch, and Redwood Creeks.
4. Determine long term trends in summer density, size, and age composition of coho salmon at preexisting index reaches at Olema, Pine Gulch, and Redwood Creeks.
5. Identify gross changes in habitat (pool:riffle) in Olema, Pine Gulch, and Redwood Creeks during basinwide GSS surveys.

Multiple life stage monitoring is conducted during: a. the winter to sample coho spawners and redds, b. the spring to sample smolt outmigration, and c. summer to sample juvenile population abundance. This approach has provided data for regional interpretation of coho trends in survivorship and is intended for use in further regional comparisons.

This protocol builds on historic monitoring efforts that have focused on spawners at Redwood Creek since the 1940s. Much of the smolt and juvenile sampling has been conducted since the

early to mid 1990s. Despite these long-term data sets, one of the challenges of sampling coho sampling is their 3-year life cycle. Adult coho generally do not return to a stream to spawn until their third year. As a result, there are three distinct year-classes. Although nine years of sampling exists for some creeks, it reflects only three data points for each coho year class.

Preliminary analyses presented in SOP 10: Data Summaries and Analyses demonstrate that between 1994 and 2007, spawner populations of two year classes have remained relatively stable and one year class has shown an increase. Sampling during the last three years, however, indicate very few returning spawners across the Central California region (Miller 2010).

The state of California has strong interest in both the coho salmon and steelhead trout populations. Recent returns have been very low and both commercial and recreational salmon fishing along the California Coast was closed in 2008 and 2009. As a result of this concern, approximately half of the funding to conduct this monitoring program has come from the state through grants submitted to the Point Reyes National Seashore Association.

Acknowledgements

We wish to thank the two anonymous reviewers who provided comments on previous drafts of this protocol. Jay Glase also provided comments to help improve this manuscript. Kirk Steinhorst, Leigh Ann Starcevich, and Kathy Irvine contributed greatly by conducting power analyses and augmenting the sampling design and analyses sections of the protocol. Kris Freeman provided editorial assistance including reformatting both the protocol narrative and associated SOPs to meet NRTR standards. Funding for this monitoring program is provided through the San Francisco Bay Area Network Inventory and Monitoring Program and has been augmented through grants by the Point Reyes National Seashore Association and the California Department of Fish and Game. The Marin Conservation Corps (now Conservation Corps North Bay) has also supported the program through staff assistance. We also thank the many volunteers who provide hundreds of hours of field assistance each year.

1 - Background and Objectives

1.1 Introduction and Purpose

The primary focus of this protocol is on tracking population trends, reproductive health, body condition, and habitat changes of anadromous salmon, with an emphasis on coho salmon (*Oncorhynchus kisutch*) found in the watersheds of the San Francisco Bay Area Network (SFAN) of national parks. These parks include: Golden Gate National Recreation Area (GOGA) including Muir Woods National Monument (MUWO) and Point Reyes National Seashore (PORE; figure 1). In addition, data are collected through the program will also help evaluate changes in the overall fish assemblages present in the streams of the San Francisco Bay Area Network. To complement this protocol, Inventory & Monitoring (I&M) water quality monitoring was initiated in fall 2006 (Coopriider and Carson 2006) and a streamflow monitoring program is under development (Fong et al. in prep.).



Figure 1. San Francisco Bay Area Inventory and Monitoring Network.

1.2 Life History

Monitoring salmonid populations is challenging because they maintain a certain amount of time in the freshwater and parts of their adult life in salt-water systems. Salmonids have five major life stages including egg, fry, juvenile, smolt, and adult (figure 2). Egg, fry, and juvenile life stages are restricted to freshwater systems. During the smolt and adult stages, salmonids spend time in both freshwater and ocean systems. Effective monitoring would have to focus on the species' ability to survive in both of these areas.

Coho salmon have a complex life history where an individual spends 14-16 months in their natal stream before leaving to the estuary and ocean. The individual typically does not return to its natal stream to spawn until 18 months after leaving it (PFMC 2000). As a result, in the SFAN streams there are three cohorts that have little influence on one another. In general, only one cohort will return to spawn during any given year and their offspring will return 3 years later to spawn, thus completing the coho life cycle.

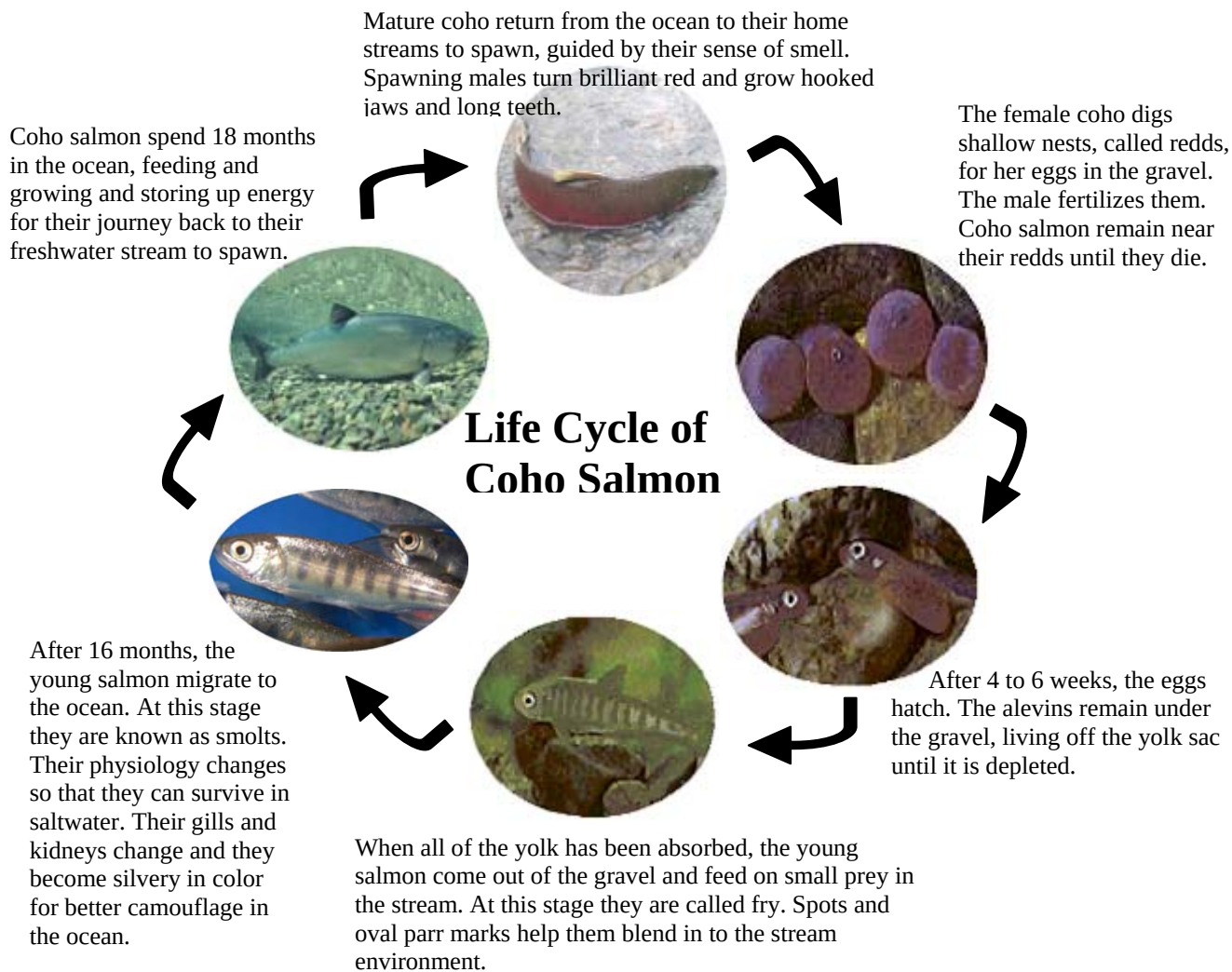


Figure 2. The life cycle of coho salmon (*Oncorhynchus kisutch*).

The life history of winter run steelhead follows the same general life cycle pattern as coho salmon in that they hatch in freshwater, migrate to the ocean to mature, and return to freshwater to spawn. What varies between the two species life history is the variation in timing spent in each life stage for steelhead when compared to coho. Steelhead life strategies are far more variable than coho, including a wider spawning window (December to May) and freshwater residence time (1-3 years). In addition steelhead are iteroparous and may spawn multiple times before dying.

1.3 Rationale for Selecting Resource for Monitoring

Fisheries have long been of human concern mainly as a food supply and economic driver. Salmonids are a prime species that have come to represent the impacts that man can have on aquatic species and systems. Even within the National Park Service (NPS), records at MUWO document an interest and fascination with salmonids returning to spawn as early as the 1940s. Unfortunately, even into the 1980s, management activities that impaired the ability of these fish to thrive continued because of a lack of understanding with regard to salmonid habitat needs.

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (PL 104-267), established new requirements for Essential Fish Habitat (EFH) for coho salmon and chinook salmon. Soon after, coho salmon (Federal Register 1996) and steelhead trout (*O. mykiss*; Federal Register 1997) were listed as federally threatened. In response to continued depressed numbers in coho populations north of the San Francisco Bay, the California Department of Fish and Game (CDFG) completed listing of coho salmon as endangered through the California Endangered Species Act (CESA) in August 2004. Subsequently, the federal Endangered Species Act (ESA) status of coho salmon was downgraded to endangered in June 2005 (Federal Register 2005). Major causes for the decline include loss of habitat due to damming of streams, erosion and siltation of redd habitat, changes in stream temperature due to loss of canopy, nutrient influx as a result of agriculture and urbanization, overfishing, and channelization (figure 3).

The National Marine Fisheries Service (NMFS) designated critical habitat for coho salmon to include all accessible reaches of rivers, including estuarine areas and their tributaries (Federal Register 1999). Through this designation, NMFS identified ten essential features of critical habitat including: substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions.

The original federal listing criteria stated that the Lagunitas/Olema Creek population accounted for more than 10% of the wild coho population (Brown et al. 1994) in the Central California Coast Evolutionarily Significant Unit (CCCESU). Recent research conducted by the NPS, Marin Municipal Water District (MMWD), and Salmon Protection and Watershed Network (SPAWN) has shown that the Lagunitas population likely represents up to 20% of the CCCESU population (Ketcham et al. 2004b).

The NMFS Genetics Laboratory reports that the coho salmon from Redwood Creek (GOGA) represent a genetic outlier in the CCCESU with extreme genetic distance from all other samples collected within the CCCESU and the Southern Oregon-Northern California Coast ESU (Bjorkstedt et al. 2005). Genetic tests also indicate that coho which have returned to Pine Gulch

Creek after a thirty year absence were likely strays from Redwood Creek, representing a natural expansion of this genetically distinct and significant stock to a new watershed within PORE (Garza and Gilbert-Horvath 2003). Olema Creek was determined to be part of the Lagunitas Creek population, an independent population found within the coastal diversity strata of the CCCESU (Bjorkstedt et al. 2005).

Threatened and endangered species are not generally considered effective indicators of habitat or environmental condition. This is not the case, however, for coho salmon and steelhead trout. 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. They demand year-round, high quality cold water, and complex instream and riparian habitat and structure to accommodate development from egg to smolt stage. Both coho and steelhead require these habitat conditions throughout the stream continuum and are thus important indicators of the aquatic ecosystem health throughout the watershed.

The State of California Coho Recovery Strategy (CDFG 2004) stresses the need for monitoring of coho populations as well as the development of data/information system for compiling, analyzing, and distributing information on the status and trend of coho salmon and the status of coho salmon recovery (CA Recovery Strategy items RW-AM-03, RW-AM-05, RW-AM-06, RW-AM-07, BM-LA-05, and BM-LA-06).

SFAN parks are actively initiating projects to improve habitat conditions for federally listed salmonids within park watersheds. It is vital for assuring taxpayer accountability, as well as assessing effectiveness of actions, to determine whether these habitat restoration actions measurably improved conditions for listed salmonids. The state also recognizes the importance of accountability and assessment in their recommendation for development, funding and implementation of effectiveness monitoring of restoration activities (CA Recovery Strategy items RW-AM-05, 09).

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 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 Coho and Steelhead Monitoring Program (CSMP) will be expanded to increase coverage in non-coho bearing streams.

In addition to freshwater conditions, coho salmon populations are highly responsive to ocean conditions. Research shows that salmonid populations observed in the freshwater systems are highly responsive to productivity of nearshore currents, El Niño Southern Oscillation (ENSO) events, and the Pacific Decadal Oscillation (PDO) events along the Pacific Coast (Pearcy 1997). Monitoring of these species at multiple life stages is valuable to the understanding of aquatic conditions and health of the watershed and of the sea.

1.4 Measurable Criteria and Desired Status

Development of measurable criteria and desired status for coho bearing streams within NPS lands may occur in the future but is not currently part of this SFAN monitoring protocol. The State of California is in the process of drafting a Coastal Salmonid Monitoring Program, which would assign criteria and desired status for salmonids. In addition, NMFS anticipates release of the draft Recovery Plan for Central California Coast coho salmon in 2010 (Miller 2010). Recovery criteria will include numeric targets for adult returns and smolt outmigration at the watershed scale, including Lagunitas/Olema Creek, Pine Gulch Creek and Redwood Creek (NMFS, C. Ambrose, coho recovery coordinator, personal communication, 1 February 2010). This recovery plan will also include the maintenance of a coho salmon life-cycle monitoring station within the SFAN monitoring watersheds. Examples of potential Coastal Salmonid Program criteria or desired status may be based on criteria set forth by Oregon Department of Fish and Wildlife (ODFW) in their statewide coho conservation plan (ODFW 2007). The conservation plan outlines the following criteria:

1. Abundance – the number of spawners.
2. Persistence – the forecast likelihood that the population will persist in the future.
3. Productivity – the number of recruits (progeny) produced per spawner (parent).
4. Distribution – the distribution of spawners among habitats within a population's home range.
5. Habitat – the amount of available high quality habitat across all freshwater life stages.

A sixth criterion, diversity, although not supported by current NPS activities will likely be measured by the NMFS genetics lab. Diversity is an index of genetic variability which is related to the population's ability to respond to unpredictable natural variation in the environment.

1.5 History of Monitoring

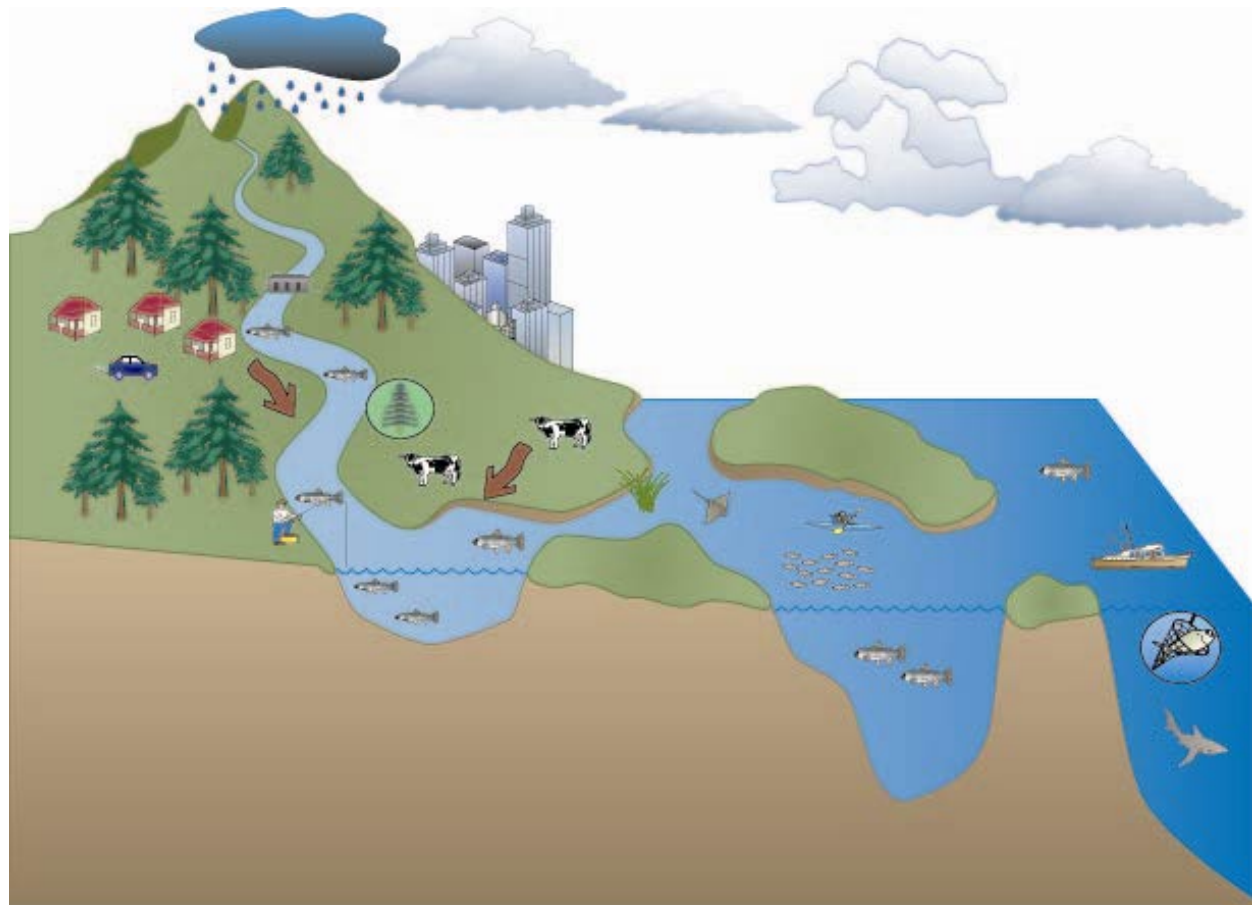
1.5.1 Monitoring in Marin County

Because adult salmon returning to the watersheds to spawn pique the interest of people, there is a long history of coho observations in the area. MUWO staff (within GOGA) staff began recording spawning in Redwood Creek in 1944. In the mid-1980s, local citizen groups began informally documenting wild coho spawning in Lagunitas and Olema Creeks. In 1994, GOGA and PORE biologists initiated more detailed surveys of Redwood Creek and assisted citizen groups with surveys on Olema Creek.

The first complete surveys of Olema Creek were undertaken in the winter of 1995–1996 by the Tomales Bay Association and PORE. These surveys were expanded to Redwood Creek, Devil's Gulch (a Lagunitas tributary) in 1997 through the NPS Coho and Steelhead Restoration Project (CSRP). These surveys have been conducted annually since 1997 by NPS staff and cooperators through funding from both the NPS and the CDFG.

To increase the value of the information collected during spawning surveys and enable comparison of data from year to year, the NPS began efforts to standardize methods and test different survey methodologies. The NPS, in conjunction with MMWD and SPAWN have reported redd survey results to represent overall spawning densities and total coho smolt

production in the coastal Marin County watersheds. Additional monitoring results related to salmonid habitat use and distribution is well documented within PORE and GOGA watersheds (Ketcham et al. 2004a, 2004b, 2004c; Reichmuth et al. 2005, 2006a, 2006b). Through this protocol, the NPS will continue to advocate standardization of data collection techniques to improve countywide reporting practices.



Focal Species



Coho Salmon/Steelhead Trout

System Drivers



Weather and climate

Stressors



Urbanization



Agriculture/Livestock

Stressors (Cont.)



Erosion/Nutrient Influx



Dam

Management



Fishery Management



Reforestation/stream restoration

Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.

Figure 3. Key stressors to life cycle of coho salmon.

1.5.2 Other Regional Monitoring Programs

Long-term monitoring programs for juvenile and adult salmonids have been established on Waddell and Scott Creeks in San Mateo County (Dr. Jerry Smith, San Jose State University [SJSU]), the Russian River drainage (Robert Coey, CDFG; David Manning, Sonoma County Water Agency [SCWA]; and University of California Cooperative Extension Program), the Lagunitas Creek watershed (MMWD and SPAWN), and the Noyo River drainage (Sean Gallagher and Scott Harris, CDFG; see table 1). The ability to use data from these sources for comparison depends on similarity in sampling techniques and coincidence of survey activities. Each of these programs is focused on answering somewhat different management questions. The proposed NPS protocol is most similar and comparable to the monitoring program described in the CDFG Interim Restoration Effectiveness and Validation Monitoring Protocols (Duffy 2005).

Table 1. Other regional salmonid monitoring efforts, including watershed, life stage, and methods used in monitoring.

Agency/ Group	Watershed	Life Stage (Season)	Methods Used
SJSU (Dr. Jerry Smith)/ NMFS	Redwood Creek (Marin County)	Juvenile (summer/fall)	index reach electrofishing and snorkel counts
	Gazos Creek (San Mateo County)		
	Waddell/Scott Creeks (Santa Cruz County)		
MMWD/ SPAWN	Lagunitas Creek	Juvenile (summer/fall)	index reach electrofishing, snorkel counts
		Adult spawner (winter)	visual spawner/carcass/redd counts
		Smolt (summer-fall)	fyke/pipe downstream migrant traps
SCWA/ CDFG	Russian River	Juvenile (summer/fall) Adult spawner (winter) Smolt (spring)	various
CDFG	Noyo River	Adult spawner (winter) Smolt (spring)	visual spawner/carcass/redd counts fyke/pipe downstream migrant traps

1.6 Monitoring Questions

This protocol was developed to answer the following questions:

- What habitat constraints exist in the parks that currently impede or limit salmon recovery efforts?
- Are parks meeting resource protection mandates relative to salmonid habitat protection?
- Is the condition (e.g., length, weight, presence of abnormalities) of coho salmon changing over time?

- What is the annual production of juvenile coho salmon outmigrants in Redwood, Olema, and Pine Gulch Creeks?
- What is the annual escapement of returning adult coho salmon in Redwood, Olema, Pine Gulch, and Cheda Creeks?
- What is the annual abundance of juvenile coho salmon rearing within Redwood, Olema, and Pine Gulch Creeks at summer base flow conditions?
- What are the changes in salmonid densities at preexisting index reach locations on Redwood, Olema, and Pine Gulch Creeks?

The following questions may be answered in part by this monitoring protocol but additional information will need to be gathered through park or partner efforts.

- Where do non-native aquatic species (fish or crayfish) occur, and how do they affect native populations?
- What are the fish populations and community assemblages within SFAN stream systems?
- What are the distribution, condition, and health of non-salmonid fish within SFAN stream systems?
- What is the population genetic structure and age-size relationship for salmonids?
- What is the survivorship between life stages for each coho cohort within Redwood, Olema, and Pine Gulch Creeks?
- How do population trends at GOGA and PORE compare with other watersheds in the region?
- What are the changes in timing and distribution of salmonid spawning, adult sex ratios, and escapement estimates in select streams at PORE and GOGA?
- What are the overall population trends of each coho salmon cohort within GOGA and PORE watersheds?

1.7 Monitoring Objectives

1. Determine long-term trends in distribution and abundance, size (length) of spawning coho salmon by counting numbers of spawners, carcasses, and redds along reaches at Olema, Pine Gulch, Redwood, and Cheda Creeks.
2. Determine long-term trends in abundance and condition of smolt coho salmon by conducting spring smolt trapping near mouths of Olema, Pine Gulch, and Redwood Creeks.
3. Determine long-term trends in distribution and abundance and condition of juvenile coho salmon by conducting summer basinwide surveys (general systematic surveys [GSS]) at Olema, Pine Gulch, and Redwood Creeks.
4. Determine long term trends in summer density, size, and age composition of coho salmon at preexisting index reaches at Olema, Pine Gulch, and Redwood Creeks.

5. Identify gross changes in habitat (pool:riffle) in Olema, Pine Gulch, and Redwood Creeks during basinwide GSS surveys.

1.8 Conceptual Model

The purpose of the conceptual model (figure 4) is to provide an understanding of the causal relationships between coho salmon ecology, monitoring techniques, and management actions. While the measurable criterion stated previously will allow park staff to describe the state of the current coho populations, the conceptual model focuses on the habitat parameters associated with a healthy watershed. The model should be used to guide changes in survey techniques used, types of indicators to be measured, and support restoration activity initiatives.

The flow of the model relates key life stages in the coho salmon life cycle to the related impacts known to impair watersheds and hamper species recovery. Each survey type will be used to measure key indicators. Although each indicator in itself may not be useful for making inferences on habitat constraints, the combined use of these indicators acquired through multiple life stage sampling will provide information on key population components. The population inferences can then be used to provide insight on critical habitat limitations such as food and refugia availability. The affected habitat is directly related to both natural and anthropogenic disturbances. Natural impacts may include such features as waterfalls, excessive rainfall, landslides, drought, and coastal upwelling. Human caused impacts may include diversions, culverts, armoring and other forms of stream degradation that are possible to rectify through well-informed management decisions.

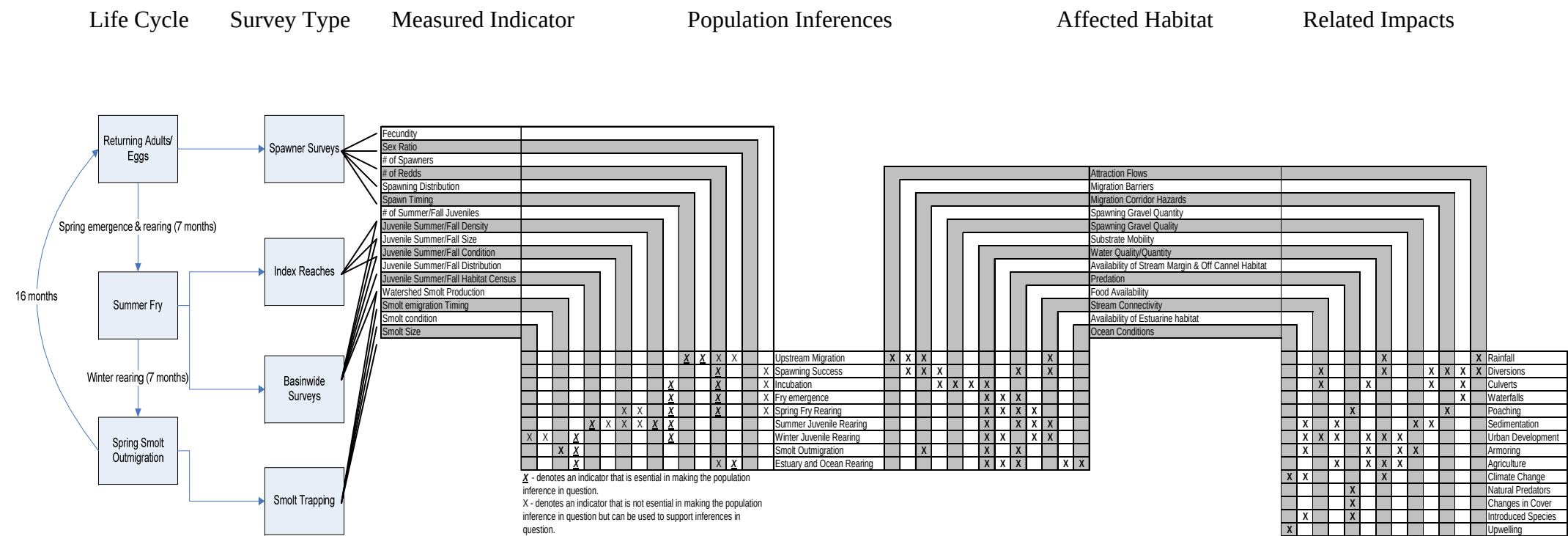


Figure 4. Life cycle monitoring conceptual model.

1.9 Rationale for Objectives

To ensure that population estimates are accurate and that management is appropriate and effective, monitoring needs to focus on multiple life stages. The multi-life stage monitoring include spawner surveys (winter), and smolt surveys (spring), juvenile basinwide (GSS) estimates (summer/fall), and continue monitoring legacy index reach monitoring (summer/fall). Each survey provides a snapshot of a major life stage within the salmon life cycle. These combined efforts will allow the NPS to explain the variability within the coho salmon population over time.

1.9.1 Juvenile Surveys (Basinwide GSS Method)

Monitoring juvenile salmonids during their freshwater residence phase provides useful information on overall population trends, particularly when combined with adult spawning data and smolt emigration data (Collins 2003), which are also part of our monitoring program. Sampling is most effective during summer and fall base flow conditions, when water clarity is greatest and conditions are more conducive to observation and capture of juvenile salmonids and other stream fish.

Implementation of juvenile basinwide surveys (Dolloff et al. 1993) employs a variety of methods which are also conducive to monitoring other species of stream fish. While snorkeling is conducted on the target salmonid species (coho salmon), electrofishing on randomly selected calibration units will allow for the sampling of steelhead, as well as most other aquatic vertebrate species, as well as larger invertebrates (e.g., crustaceans).

1.9.2 Index Reach Method (Legacy Dataset)

Index reaches are maintained in the CSMP as legacy datasets. Because index reaches were not established using a probabilistic method, they cannot be used to make watershed statements. Index reach sampling contains the longest data set with over 9 years of continuous monitoring (more than 12 years in Redwood Creek). Juvenile salmonid index reach datasets have been used along with other indices, to determine the status of coho within California by regulatory agencies (CDFG 2002). Many of the longest salmonid datasets in the region are density estimates from established index reaches. Index reaches provide a snapshot of each individual index reach, which can be compared over time. These datasets have been used at the state and federal level for listing determinations of either endangered or threatened status. Time permitting SFAN plans to maintain monitoring index reaches at a reduced scale.

1.9.3 Spawner Surveys

Winter spawner surveys provide a measure of the overall spawning success and run size of each returning year class. When smolt survey data are available, escapement estimates may also be utilized to determine ocean survival. Coho redd counts are the only consistent metric used in all regional watersheds and are therefore an important indicator for regional comparisons of spawning success.

1.9.4 Smolt Surveys

Smolt surveys performed in conjunction with winter spawner surveys and summer juvenile surveys permit an evaluation of abundance during three of five distinct freshwater salmonid life history stages (egg, emergent fry, juvenile, smolt, adult). A significant body of literature has documented life stage bottlenecks and survival rates for salmonid populations. Many of these studies describe

how alterations to watershed connectivity and condition affect these species at these different freshwater life stages. At the time they smolt, most coho have spent one to two years in the watershed, while steelhead can be up to three years old (Pollard et al. 1997). Smolt production, therefore, is the best aggregate measure of watershed condition and productivity. The response of coho and steelhead populations to changes in habitat quality can not be properly assessed without a measure of smolt production.

When evaluated as part of a comprehensive monitoring program, the smolt trap information can be compared with adult spawner indices to describe potential ocean productivity and survival, and with summer juvenile population estimates to assess rates of survival through the winter season. This type of comprehensive monitoring information is rare in the central California coast region, as most of this research has been focused in the Pacific Northwest. The habitat and climate supporting salmonids in this region have not been well studied, meaning that local adaptations by these species are not well understood. Smolt trap monitoring, in conjunction with other life stage monitoring activities allows the NPS to characterize aggregate watershed productivity for salmonids, and is a valuable resource for directing long-term management and restoration actions. Although smolt trapping is focused on salmonids, it also provides additional presence and size measurement data for other aquatic species during periods not covered by summer/fall monitoring activities.

1.10 Link to Management

In 1996, the NPS initiated a watershed restoration and monitoring project in Marin County in conjunction with the ESA listing of coho salmon and steelhead trout along the central California coast. The CSRP was a five-year NPS-funded cooperative effort between PORE, GOGA, and MUWO. The primary objective was to restore habitat. Monitoring juvenile fish abundance and habitat availability in Redwood Creek, Pine Gulch, Olema Creek, and Lagunitas Creek was used to evaluate the effectiveness of restoration activities.

As a result of these initial efforts, and coordination among the region, the NPS monitoring program, now called the Coho and Steelhead Monitoring Program (CSMP), was recognized as a valuable resource and has subsequently been supported through CDFG matching funds since 2002. The results of our monitoring efforts, have contributed greatly to the development of successful riparian, floodplain, and estuarine restoration projects to enhance habitat for coho salmon and steelhead at both GOGA and PORE. Program staff members have advised engineers on design to maximize habitat restoration value based upon information gathered through the monitoring efforts described in this protocol.

Furthermore, park data are provided to non-governmental organizations as well as regulatory agencies responsible for coho salmon management and protection. These organizations and agencies have used park data to evaluate proposed management actions through Section 7 consultations, status and review assessments, listing determinations, and recovery plan criteria.

It is the intent of this monitoring program to use “early warning” signals about the yearly status of coho to trigger management discussions with regulatory agencies. Based on power analysis results, the long-term trend analyses approach described in this protocol would not provide parks and applicable agencies sufficient time to initiate management actions in response to catastrophic changes in the abundance of coho. At this time, NPS proposes that the absence or near absence

of coho from any life cycle monitoring station (basinwide GSS, smolt, and spawner) result in immediate discussions with NMFS and CDFG. Absence or near absence would be defined as a 90% or greater reduction in abundance of any life stage from the prior cohort.

This approach has already been tested with coho salmon in SFAN. In November 2007, an oil spill in the San Francisco Estuary resulted in bunker fuel oil reaching the outer coast shorelines of the parks. Winter spawner surveys indicated the absence of redds or coho adults from Redwood Creek, which drained to an oiled shoreline and lagoon. Presuming a cause-effect relationship, NPS contacted NMFS and CDFG staff for management advice. NMFS quickly initiated a region-wide assessment to determine the significance of this association. Their researchers concluded that poor oceanographic conditions likely caused catastrophic reductions of coho spawners region-wide, including Redwood Creek (MacFarlane et al. 2008). In this instance, “early warning data” from this program quickly relayed from the I&M program to Park managers and to regulatory agencies resulted in a timely assessment.

1.10.1 NPS Management Objectives

- Prevent the extinction of coho salmon from SFAN NPS managed lands.
- Restore and maintain a healthy network of coho bearing watersheds within the SFAN NPS-managed lands.
- Develop a coho population in Olema, Redwood, and Pine Gulch Creeks that is large enough to survive environmental variations and catastrophes.
- Develop and maintain an integrated long term monitoring program.

1.11 Measurable Results and Deliverables

At the end of each monitoring season (summer, winter, and spring) data will be summarized into a progress report compiled by the fishery biologist and technicians. These reports will compile data that pertain to that individual monitoring season only. All three monitoring seasons will be compiled into a more comprehensive data summary annually by the fishery biologist and technicians. This annual report will include a summary of past data collected and estimated survival between life stages. Any annual dramatic decline in the coho population will also be provided in the annual report along with management recommendations. A trend report will be provided every nine to twelve years to conduct more intensive data analysis including comparison of data to relevant benchmarks (criteria, desired status, objectives, and questions). These reports will be provided to each park unit and the SFAN I&M Coordinator. In addition to the production of monitoring reports, a completed database will be provided to the I&M Coordinator after each monitoring season.

2 - Sampling Design

2.1 Study Area

The SFAN encompasses eight park units: (GOGA, FOPO, PRSF, MUWO, JOMU, EUON, PINN, and PORE). MUWO, FOPO, and PRSF are administered by GOGA (figure 5). Within the four parks are seven watersheds and 43 creeks (see SOP 9: Sampling Site Descriptions). However of these 43 creeks only 5 creeks have been documented to support coho salmon.

Streams documented to support coho salmon habitat include Redwood Creek, Pine Gulch Creek, Olema Creek, Easkoot Creek, and Lagunitas Creek. Steelhead have been documented in many of the smaller GOGA, PORE and JOMU watersheds. Chalone Creek at PINN is a tributary of the Salinas River, and is the second largest drainage area in the Network, but the water regime and stream system are more directly linked to desert systems rather than coastal salmonid streams, and is not included in this monitoring protocol. The I&M program is developing an amphibian monitoring program to address PINN aquatic habitat.

Since steelhead are more widespread than coho, surveys focus on streams where both species occur. As part of the summer monitoring efforts, the sampled population will include all fish species present in the sampling sites.

High priority streams will be intensely monitored during all life stages using winter spawner surveys, spring smolt trapping, summer basinwide (GSS) surveys, and summer index reach surveys. Inferences will be limited to high priority streams.

High priority streams are known to have coho and steelhead populations (Olema, Pine Gulch, Cheda, and Redwood Creeks; figure 5). Lagunitas Creek and Devils Gulch, high priority streams, are monitored through the MMWD. NPS staff members participate in monitoring plan development and efforts to coordinate data collection and quality.

Medium priority streams will not be sampled as part of these monitoring protocols. It is anticipated that future monitoring of medium priority streams will occur as personnel and funding become available. Protocols for medium priority streams that will receive occasional site visits using low intensity monitoring techniques which will include presence/non-detect surveys only will be developed for peer review as staff and funding become available. Medium priority streams may contain salmonids (based on habitat) but populations have not been confirmed. These streams include all stream segments that are at least 500 m long that are contained within the SFAN NPS managed lands excluding PINN. Medium priority streams include watersheds that lie within GOGA, PORE and JOMU.

Low priority streams will not be sampled as part of these monitoring protocols. Low priority streams are streams where coho and steelhead are not likely to occur or stream segments less than 500 m in length.

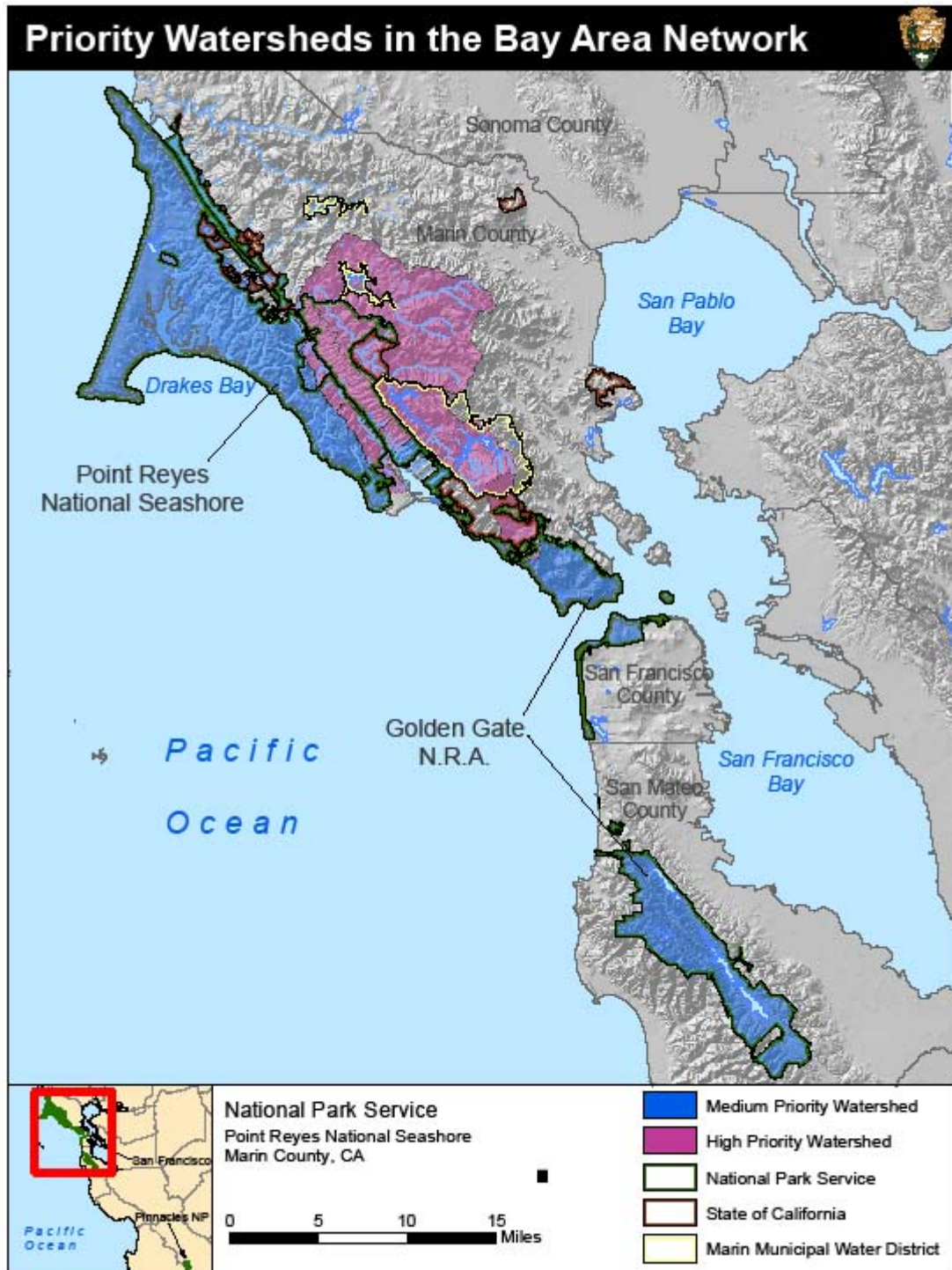


Figure 5. High and medium priority salmonid monitoring watersheds in Golden Gate National Recreation Area and Point Reyes National Seashore.

2.1.1 Overview of High Priority Streams

2.1.1.1 Olema Creek: Olema Creek is the largest watershed in coastal Marin County, California and an important stream for coho salmon and steelhead within the CCCESU. The 15.9-km stream flows northwest through the Olema Valley, the landward expression of the San Andreas Fault Zone. Its confluence with Lagunitas Creek lies at the head of the ecologically significant Tomales Bay. Protected from development, the 37.6 km² (14.5 mi²) watershed is primarily contained within the boundaries of PORE and the GOGA North District. The watershed provides habitat to four federally protected aquatic species (California freshwater shrimp [*Syncaris pacifica*], endangered; coho salmon, endangered; steelhead, threatened; California red-legged frog [*Rana aurora draytonii*], threatened). Water quality and streamflow monitoring are also conducted in Olema Creek as part of the SFAN I&M Program.

2.1.1.2 Cheda Creek: Cheda Creek is a small perennial tributary of the Lagunitas Creek watershed and provides critical habitat for steelhead trout and coho salmon. Past land-use within the Cheda Creek drainage has resulted in serious alterations to the natural hydrologic and riparian condition of the creek. These factors have negatively impacted salmonid populations, water quality, and the ability of the aquatic ecosystem to function properly. The construction of a fish passage structure in the fall of 2000 was part of an overall watershed restoration project initiated by the NPS to restore the system to a more natural and sustainable condition. The watershed provides habitat to coho salmon (endangered), steelhead (threatened), and the California red-legged frog (threatened), and California freshwater shrimp (endangered).

2.1.1.3 Redwood Creek: Redwood Creek is an 23.1 km² (8.9 mi²) coastal watershed in southern Marin County, California . Redwood Creek flows southwest from the flanks of Mt. Tamalpais, through MUWO, discharging to the Pacific Ocean through Big Lagoon at Muir Beach, CA. Protected from development, the watershed is primarily contained within the boundaries of Mt. Tamalpais State Park, GOGA and MUWO. The watershed provides habitat to coho salmon (endangered), steelhead (threatened), and the California red-legged frog (threatened). Water quality and streamflow monitoring are also conducted in Redwood Creek as part of the SFAN I&M Program.

2.1.1.4 Pine Gulch Creek: Pine Gulch Creek drains a 19.4 km² (7.5 mi²) watershed in coastal Marin County, California, and is the primary freshwater input to Bolinas Lagoon. Pine Gulch Creek is located within the CCCESU where coho salmon and steelhead occur. The watershed supports a population of steelhead and it is generally accepted that it supported a native self-sustaining population of coho salmon into the 1970s. It is likely that the drought of the late 1970s coupled with in-stream damming during the same period severely depleted multiple year classes and led to unsuitable conditions for continued survival of the species within the Pine Gulch watershed. In 2001, NPS documented the return of coho salmon to the watershed beginning with the recovery of a coho carcass, and subsequent documentation of coho juveniles in the watershed the following summer (Brown and Ketcham 2002). The watershed provides habitat to coho salmon (endangered), steelhead (threatened), and the California red-legged frog (threatened). Water quality and streamflow monitoring are also conducted in Pine Gulch Creek as part of the SFAN I&M Program.

2.2 Sampling Design Overview

This protocol presents a three tiered approach developed by Moyle et al. (1998) to monitor coho populations along with their habitat. This method includes analysis of fish at the individual level, population level and community level. This three tiered approach will use a combination of census, probabilistic, and judgmental study designs in order to gain information at all three levels of metrics. This sampling design is conducted year-round to assess population of all life stages including juvenile (summer/fall), spawners (winter), and smolt (spring); see Table 2.

2.2.1 Individual Level

Assessment at the individual level tracks changes in the condition and health of each fish encountered. Measurements of weight and length are used to evaluate for comparative metrics including individual condition factors (e.g., Fulton's K) and weight-length relationships for all fish species. Fish are also observed for abnormalities including obvious stunted growth, lesions, parasites, etc.

2.2.2 Population Level

Evaluation at the population level is limited to the high priority streams and includes distribution and overall abundance of each species encountered. Metrics of evaluation include length histograms to determine presence of multiple age or size classes as well as estimates of density and/or population size. Evaluation of fish size and condition is also used for evaluation of health at the population level, by looking at the overall range in weight-length relationships within species and age-class.

2.2.3 Community Level

Information collected on non-target species may be used in the future to evaluate community level changes and to provide data to regional efforts on status and trends. Inferences, however, will be strictly limited without adding sampling methods to target other species across monitoring locations.

Table 2. Summary of survey type and metrics that contribute to individual, population, and community level metrics.

Level	Juvenile Salmonid Data	Winter: Spawner Data	Spring: Smolt Trapping Data
Individual Level	- length-weight; - condition factors/ - abnormalities	- sex - length-weight condition factors/abnormalities - genetic samples (carcasses)	- length-weight - condition factors/ abnormalities
Population Level	- size distribution - size/age-classes - population size and relative abundance	- spatial distribution - spawner population size and relative abundance - sex ratio - spawning timing	- size distribution - size/age-class - number of smolt
Community Level	species diversity		species diversity

2.3 Seasonal Sampling Design

Because of the varying behavior of coho salmon throughout the year, a separate sample design is required to assess each life stage. During the summer, basinwide surveys are conducted to assess the abundance of juvenile populations. During the winter, spawner surveys are conducted along reaches. During the spring, smolts are trapped at the mouths of creeks. A power analysis was conducted using data from each sampling scheme to determine duration of effort in order to detect change. The 3-year life cycle of coho salmon results in the necessity to conduct analysis on cohort year, rather than calendar year. Therefore, true replication on a specific cohort occurs every three years rather than annually within a stream. Power to detect trend will require longer monitoring periods to account for this life cycle characteristic.

Annual trend represents the change in each three-year cohort cycle. Therefore, a net trend over 12 years represents the total trend from 4 cohort-cycle measurements. The NPS expects power of at least 77% to detect a net change of 75% using the updated basinwide survey design during at least three cohort cycles. Power to detect trend in escapement PLD estimates is uniformly less than 60% regardless of survey length or annual decrease for the examined ranges. Power for trend tests of redds per km is less than 40% unless the population declines drastically. Power to detect trend in PLD and redds per km may be improved if trends of single cohorts are examined, thus eliminating variation among cohorts. By implementing the current smolt trapping design, the NPS expects to exceed 80% power to detect an overall net change of 76% with six observations per cohort and a three year change of 25%.

2.3.1 Summer/Fall Sampling

The current survey design for juvenile coho salmon uses a basinwide estimate based on a GSS of snorkeled pools. The basinwide surveys will be the primary survey type for juvenile coho sampling. In addition, long-term index reach density surveys are conducted to maintain this established legacy dataset.

2.3.1.1 Basinwide General Systematic Surveys: Basinwide GSS surveys based on Dolloff et al. (1993) are conducted in each of the three core watersheds (Olema, Pine Gulch, and Redwood Creeks) to determine juvenile population abundance during each summer/fall sampling period. As part of the basinwide GSS surveys, a random start pool is chosen and every fifth pool is surveyed by snorkeling the pool in a single pass. 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 (Carlisle et al. 2009).

Habitat data are collected annually during these basinwide GSS surveys to describe the physical attributes of individual habitat units (e.g., pools) within each creek. Surveys start at the bottom of the survey area and move upstream. Every fifth pool unit is flagged for basinwide GSS snorkeling and several measured widths are taken for the purpose of calibrating the estimated width. In addition several measured widths are taken for every 10th flatwater and riffle for the purpose of calibrating the estimated width. Side channel and backwater features are also recorded.

For each creek, one of the first five pools inventoried on the downstream end is randomly selected for sampling. From there, every fifth pool upstream is sampled by snorkeling. Because the basinwide survey sites focus on pool habitats, inferences are limited to populations of coho in pool units throughout each watershed. Locations and details for the basinwide survey sites are found in SOP 9.

Basinwide estimates of juvenile population in pools for all three watersheds are needed for monitoring. However, single-pass snorkel surveys have been shown to be biased low, accounting for only 40% of the true number of fish present (Rodgers et al. 1992). The methods of Hankin and Reeves (1988) use a ratio estimator that exploits a more accurate method of detection as the basis for calibration. In past basinwide monitoring efforts, the Hankin and Reeves (1988) method was applied by using the electrofishing results from index reaches to adjust single-pass snorkel survey counts of the systematically chosen sites. However, the use of index sites as the calibration data set does not meet the requirement of sampling independence.

Based on additional review of our methods, the protocol will implement standard calibration methods where 20% of dive pools will be electrofished for calibration, as described in Dolloff et al. (1993).

2.3.1.2 Power Analysis: Starcevich and Irvine (2008) conducted a power analysis using the basinwide abundance estimates. The basinwide estimates were computed from an untested calibration method used with a non-random subset of pools. Starcevich and Irvine (2008) recommend that basinwide GSS data be collected using a true subsample of the systematic sites for calibration. Based on this feedback, the protocols now include calibration techniques consistent with Dolloff et al. (1993). Given the basinwide sampling design the NPS expects to detect three year change of 75% with a power of over 75%. The number of years required to reach this level of power depends on the three year rate of return. Once data are available, the power analysis should be conducted again and the sampling design refined as appropriate.

2.3.1.3 Index Reaches: Index reaches are approximately 100 m in length (roughly 30 wetted widths). Index reaches are located in Olema, Redwood, and Pine Gulch Creeks. Sampling along the reaches provides estimates of juvenile salmonid density, species diversity data, and individual fish biotics for the index reaches. The reaches were established in the 1990s, have been monitored annually and have been the only means of providing consistent data on the entire fish community. The index reach electrofishing efforts will be maintained as a legacy dataset.

Because stream habitat conditions change dramatically year to year due to differing flow conditions and habitat adjustments to sediment and woody debris influences, habitat units within the index reaches are variable. The start and stop points of the index reaches are fixed stream lengths and may only be adjusted slightly to capture entire habitat units, and not cut them off in the middle. Survey length was determined based on the number of sample units that could be adequately sampled by a five-person crew in one day. There are 16 index reaches in the network (tables 23–25 and figs. 49–51 in SOP 9: Sampling Site Descriptions). The number of index reaches sampled each year and the level of data collected may be reduced depending on budget constraints. Monitoring along the same index reaches provide detailed information on that stream segment in a particular portion of the stream.

The limitations of index reach surveys are well known. Sample site selection is not systematic, sample size is small relative to the overall number of habitat units, and distribution of fish throughout stream reaches is not necessarily consistent. The fish and habitat parameters collected via index reach surveys can be very accurate for the sampled area, but are not necessarily applicable to the rest of the stream or watershed. Index reach population results are no longer used for any other watershed level population estimates.

2.3.2 Winter Season

2.3.2.1 Spawner Reaches: Spawner reaches are used to estimate escapement for a variety of salmonids throughout the Pacific Northwest (Johnston et al. 1987; Irvine et al. 1992; Anderson and McGuire 1994; Downie and Peterson – undated). The surveys focus on coho salmon because their spawning behavior is more predictable than steelhead, and individual and redd counts can be conducted more accurately. Field crews will identify 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).

Escapement surveys are usually conducted between November and January and depend on environmental conditions conducive to spawning. Monitoring is conducted on mainstem habitat within Olema, Pine Gulch, Redwood, and Cheda Creeks. The length of the creek is broken into 2- to 4-km survey reaches to allow multiple survey crews to complete surveys in a single day (typically 10–14 km of stream habitat are surveyed in a single day). Reaches within these watersheds represent nearly the entire documented spawning habitat within each watershed. The results of escapement and redd surveys are restricted to the survey area completed in a single day. The scope of inference for estimated trends is restricted to the entirety of the survey reach within each watershed.

SFAN personnel census creek main stems and some selected tributaries. Watersheds are visited once a week or less if water is high or turbid. Observer efficiency (ability to see fish and redds) is affected by streamflow conditions and visibility into the water. Surveys are timed with flow patterns to maximize visibility into the water. Teams of two to four observers walk upstream and count live fish, carcasses, and redds. Live fish are measured visually and sex and species is recorded. Carcasses are measured, sex identified, and a clip is taken to mark the carcass to prevent double counting. The clip is preserved for submittal to the NMFS genetics lab per the NPS research and collection permit #1046. Redds are flagged and length and width measurements are recorded. From these data, estimates of Area Under the Curve (AUC), Peak Live Cumulative Dead (PLD), and redd counts and density may be obtained (See SOP 10).

As with many biological resources, detection error can affect an observer's ability to census a population. In streams in northern California, more accurate counts of adult coho salmon using weir counts have been used to estimate the bias in adult escapement estimates from visual surveys such as ours. Where possible, SFAN would solicit assistance by universities or other agencies (e.g., CDFG, NMFS) to help determine bias in total adult coho escapement. If detection probabilities do not differ dramatically over time, then the ability to detect trend over time for these four watersheds may not be compromised by detection error.

2.3.2.2 Power Analysis: A power analysis was conducted by Starcevich (2008) using pilot data from escapement surveys conducted from the 1997–1998 to the 2006–2007 spawner season in Olema, Pine Gulch, and Redwood Creeks. Reaches were visited between one and ten times within a season. Since redds are flagged and are unlikely to be double-counted, observed redds were totaled to watershed level and density estimates were calculated using the total stream length surveyed annually within a watershed. Redds recorded as “definite” redds were used for coho only.

The Olema Creek watershed is extensive and has typically not been surveyed in a single day. PLD estimates are time-dependent, so these estimates were calculated for tributaries surveyed during the same day. Olema Creek mainstem, John West Fork, and a group of four tributaries (Boundary Gulch, Giacomini Creek, Horse Camp Creek, and Quarry Gulch) each have separate PLD measurements. A weighted average of Olema Creek mainstem, John West Fork, and the four smaller tributaries was computed to summarize PLD at the watershed level and to avoid double-counting errors. The weighted mean is a conservative summary of PLD because it is always less than the maximum PLD measurement.

The results of the power for tests of trend for PLD and redds per km (figures 6 and 7, respectively) indicate that both outcomes are highly variable and require drastic population declines before obtaining the power to detect change with any reliability. For example, the monitoring program has a less than 50% power for detecting a 75% decline of PLD over 10 years (3 cohort returns, figure 6). Similarly, there is a less than 30% power for detecting a 50% decline of number of redds over 10 years (3 cohort returns, figure 7). Additional environmental covariates may explain some of the variation in cohorts or watersheds or the random unexplained variation.

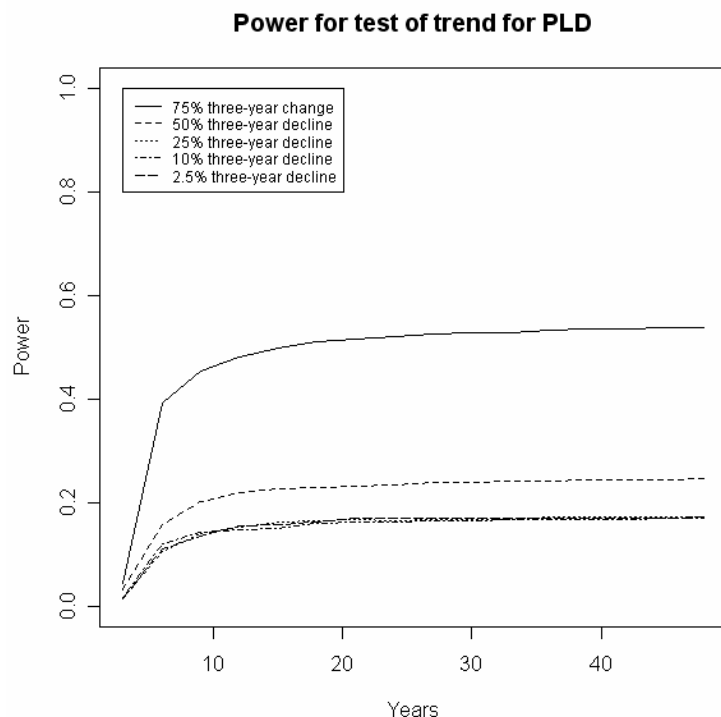


Figure 6. Power test of trend for Peak Live Dead (PLD; from Starcevich 2008).

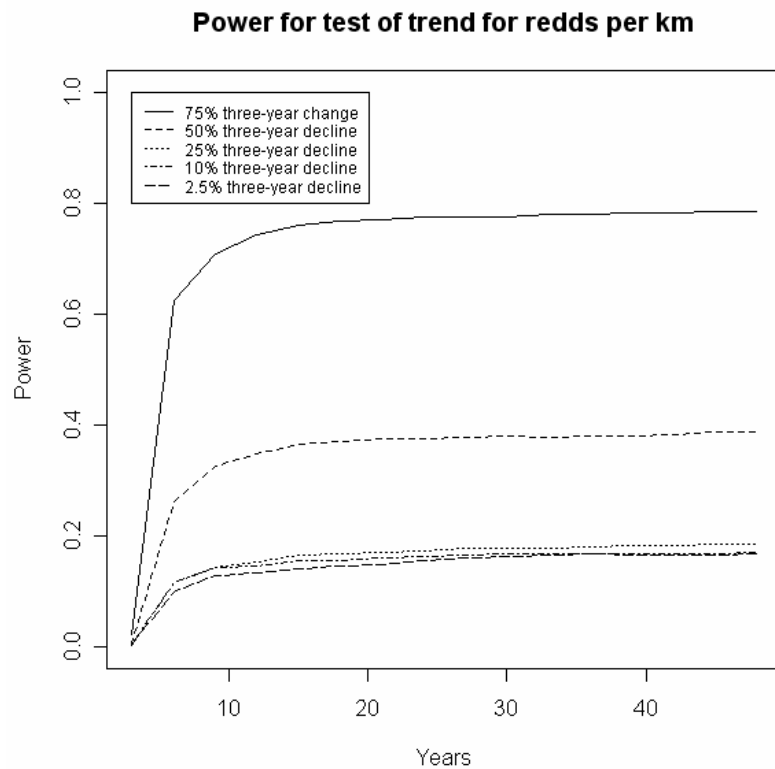


Figure 7. Power test of trend for redds per km (from Starcevich 2008).

A power analysis that focused on just one cohort was used to determine if the power to detect linear trends in escapement parameters would be greater without the additional sources of variation among cohorts and cohort-watershed interactions. The results of the cohort power analyses for PLD and redds per km are provided in figures 8 and 9, respectively. The power to detect linear trend in escapement parameters is improved by examining a single cohort, especially for redds per km. The analysis demonstrates that the monitoring program has 60% power for detecting a 75% decline of PLD over 10 years (3 cohort returns) when analyzing data for a single cohort (figure 8). Likewise, there is 60% power for detecting a 50% decline in the number of redds (figure 9).

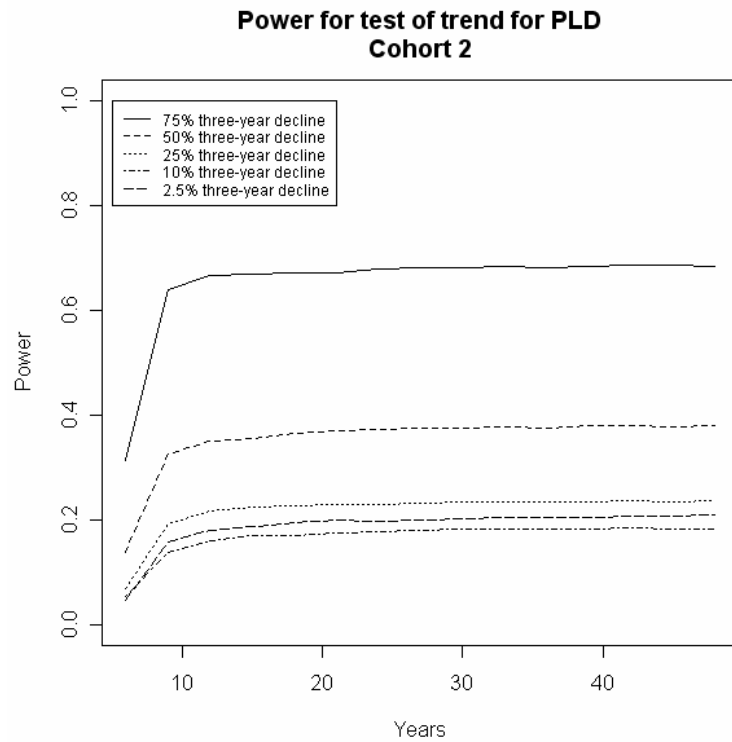


Figure 8. Power test of trend for PLD for a single cohort.

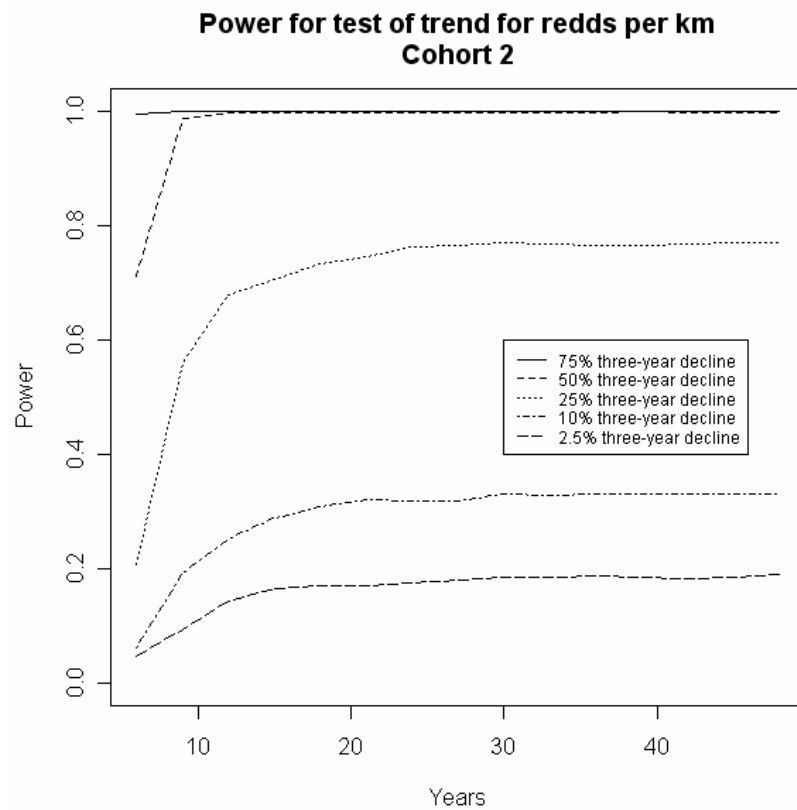


Figure 9. Power test of trend for PLD for a single cohort.

2.3.3 Spring Season

2.3.3.1 Smolt Traps: Smolt traps document the abundance of juvenile coho salmon migrating from their natal streams to the ocean. Although targeted at salmonids, smolt trapping also provides information on other fish and aquatic species. Smolt traps are placed at the downstream ends of Olema, Pine Gulch, and Redwood Creeks. Trap site locations are chosen based on accessibility, stream gradient, and location within the watershed. In general the site should be located in a relatively straight section of stream channel that contains a pool unit at the top of the site that leads to a straight relatively straight riffle unit. Cheda Creek is not included in smolt trapping because it is a tributary to Lagunitas Creek. Traps would not be able to differentiate between smolt originating in Cheda Creek from those originating in other areas of the Lagunitas watershed.

2.3.3.2 Power Analysis: A power analysis using pilot smolt data was conducted by Irvine (2008) using DARR estimates (figure 10; Bjorkstedt 2000). At the time of the analysis, however, only one cohort at Olema and Pine Gulch Creeks had two observations (2004 and 2007). Based on the power analysis, for the proposed sampling design of smolts (Olema, Redwood, and Pine Gulch Creeks) to achieve 80% power would require greater than 12 observations for each cohort at all three creeks in order to detect a 10% three-year decline. Because of the three-year return cycle for smolts this would mean greater than 35 years of annual sampling. Table 3 displays an example of a three-year 10% decline for cohort 1 at all three creeks. Because of limited data available, these models should be reproduced as more data become available.

Table 3. Power estimates based on number of sampling years (number of observations) and percent declines.

Power	Years Sampled (number of observations)	% Decline Every 3 Years
0.102	2005–2016 (4 per cohort)	2.5
0.114	2005–2028 (8 per cohort)	2.5
0.146	2005–2040 (12 per cohort)	2.5
0.454	2005–2052 (16 per cohort)	2.5
0.127	2005–2016 (4 per cohort)	10.0
0.322	2005–2028 (8 per cohort)	10.0
0.703	2005–2040 (12 per cohort)	10.0
0.957	2005–2052 (16 per cohort)	10.0

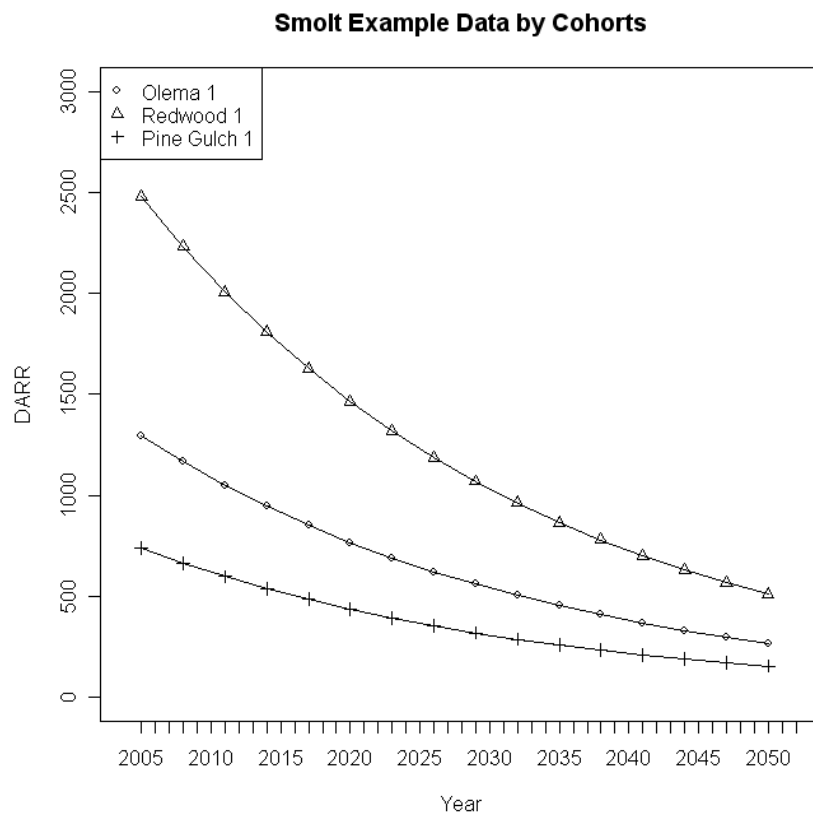


Figure 10. Example of a three-year 10% decline for cohort 1 at all three creeks.

3 - Field Methods

The field component includes three major monitoring components conducted at different times of the year: summer/fall surveys for juvenile salmonids and other fish and aquatic species; winter surveys for spawning adult salmonids; and spring salmonid smolt trapping (see table 4). Field techniques are largely consistent with the CDFG Interim Restoration Effectiveness and Validation Monitoring Protocols (Duffy 2005) and the Coho Broodstock Recovery Program in the Russian River basin. All aspects related to field methods and implementation are discussed in the Standard Operating Procedures:

SOP 1: Basinwide GSS Juvenile Coho and Habitat Surveys

SOP 2: Index Reach Surveys

SOP 3: Specialized Field Methods

SOP 4: Spring Outmigrant Smolt Trapping

SOP 5: Winter Adult Spawner Surveys

3.1 Basinwide GSS Juvenile Coho Surveys

Summer surveys will provide data about:

- a. fish habitat including geomorphic features on specific areas within each watershed,
- b. fish abundance and distribution data, and
- c. individual and population condition within each watershed.

3.2 Basinwide GSS Habitat Typing

For each survey area, the field crew classifies the habitat, measures the length, depth, and estimates the average width of each habitat unit. Units are classified as pool (scour pool, backwater pool, plunge pool, or mid-channel pool), flatwater, or riffle. The width of each habitat unit is estimated visually (see SOP 1).

3.3 Basinwide GSS Surveys

Field crews collect fish abundance and distribution data by snorkeling, seining, and electrofishing. The sampling can be performed in relatively short periods of time and is preferred over other approaches that rely on electrofishing or trapping techniques alone (Dolloff et al. 1993, Williams et al. 2004).

Snorkel counts are conducted in each of the pools identified for sampling during the habitat surveys. Divers use a dive light to search under vegetation, woody debris, and undercut banks. Multiple snorkel passes may be necessary depending on the size and complexity of the unit. All target species (coho) are counted. Presence of non-target species is documented, as well as cover, habitat complexity, and general survey conditions are noted. Snorkelers record or call out (to an on-shore assistant) their observations and transfer the information immediately to field sheets once they complete a pool unit. A subsample of the snorkeled pool units are calibrated using multiple pass electrofishing as described in Dolloff et al. (1993). Field methods are detailed in SOPs 1 and 3.

3.4 Index Reach Surveys (Legacy dataset)

Index reach surveys are performed during the fall following the completion of Basinwide GSS surveys. Index reaches are separated into a series of sampling units, which are used collectively to describe each index reach. Index reach units are determined each season by delineating each habitat type contained within the index reach. Each unit within the reach is isolated using block nets upstream and downstream. The units are then sampled individually with an electrofisher or seine net, using a multiple pass depletion technique. A subsample of fish is measured for individual and population purposes (length and weight). After the fish sampling is completed, habitat measurements and assessments will be made by the field crew for the purposes of historic site description in case a drastic change in stream condition occurs. Field methods are detailed in SOPs 2 and 3.

3.5 Spring Surveys

Spring smolt surveys include capture and handling of juvenile salmonids and other fish with downstream migrant traps. Smolts are captured using pipe/fyke net traps. Traps are designed to minimize impingement under high flows and in-trap predation of fry by larger juvenile salmonids and other fish. A subsample of fish is measured for individual and population purposes (length and weight). Mark and recapture techniques are used on smolt to determine trapping efficiency, which is necessary to estimate outmigration rates. Field methods are detailed in SOP 4.

3.6 Winter Surveys

Coho salmon spawner surveys involve observation of live fish and measurement of carcasses and redds. The surveys are conducted annually between November and February in the Olema, Pine Gulch, Cheda and Redwood Creek watersheds. Surveys are conducted by trained volunteers and PORE/GOGA staff approximately every 1–2 weeks during favorable weather and stream flow conditions, with less frequent surveys during less favorable conditions.

Typically, teams of 2 to 3 people survey reaches of 2- to 4-km in length, walking upstream along creek margins and banks where possible and looking for redds, carcasses, and live fish. Start and end locations for reaches are based on known access points. Occasional steelhead adults and redds are observed and counted incidental to coho observations. Locations of all live fish, carcasses and redds are recorded in reference to permanent tags that mark every 100 m of stream length. Redds are targeted as they are stationary and can be monitored over time to determine spawning success. Field methods are detailed in SOP 5.

Table 4. Summary of metrics and sampling sites for each sampling season.

Sampling Season	Summer/Fall (July–Oct)	Winter (Early Nov–Feb)	Spring (Late March–May)
Life Stage Sampled	Juvenile	Spawner	Smolt
Sampling Design Used	1. Basinwide GSS 2. Index reach	Spawner survey	Smolt trap
Field Methods	Snorkeling, seining, electrofishing in basinwide survey units and 100-m index reaches	Count live and dead fish, and redds along 2- to 4-km reaches	Pipe/fyke net traps placed near mouth of streams
Data Gathered	1. Habitat typing 2. Coho salmon abundance 3. Species diversity	1. Abundance 2. Carcass sex and length 3. Redd count	1. Abundance 2. Fish weight and length 3. Species diversity
Sampling Sites	High priority streams (Olema, Pine Gulch, Redwood, and Cheda Creeks)	High priority streams	High priority streams (Cheda Creek not included)
Sampling Frequency	Sampling is performed on one creek at a time with each creek taking approx. one month to complete	If stream conditions allow, each stream is surveyed weekly	Smolt traps are checked one to two times per day

4 - Data Management

This chapter briefly describes how the salmonid monitoring protocol meets established I&M data management objectives through data entry specifications, database design, quality assurance and control measures, metadata development, data maintenance, data storage, and data archiving. SOP 8: Data Management describes in more detail the data management procedures for all the components of the protocol.

4.1 Database Designs

4.1.1 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 represents each day and each smolt trap that is checked by the field staff. The survey or event data are 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. A table within the database stores UTM coordinates and a descriptive location of each smolt trap installed during the course of the monitoring project. Linking the survey records to the correct trap location provides a spatial reference to the smolt data.

4.1.2 Spawner Monitoring Database

The SFAN staff has continued to use a relational Microsoft Access database for the smolt 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 are related to the observations of spawning coho salmon or steelhead trout and the measurements of redds encountered during the survey.

The location of each fish or redd observed during a spawner survey is referenced to the nearest downstream 100-m section tag. Each tag, usually placed on a tree along the stream bank, represents the beginning of a 100-m stream section. Within the spawner database, stream tag locations are stored in a separate locations table with corresponding UTM coordinates. Linking

the fish and redd observation records to the correct stream tag location records provides a spatial reference to the data.

4.1.3 Summer Monitoring Database

The SFAN staff has continued to use a relational Microsoft Access database for summer salmonid monitoring activities (Basinwide GSS and Index Reach) 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 represents 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.

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, usually placed on a tree along the stream bank, represents the beginning of a 100-m stream section. Within the summer database, stream tag locations are stored in a separate locations table with corresponding UTM coordinates. Linking the summer monitoring surveys to the correct stream tag location records provides a spatial reference to the data.

During habitat typing surveys, each stream habitat unit is assigned a sequential basinwide habitat unit code representing the stream location, unit number, and year. The basinwide unit code is again recorded if and when the unit is revisited 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 between snorkel surveys and electrofish surveys or compare unit measurements (length, width, depth) recorded during separate field events.

A series of queries have been developed within the summer database that follows the guidelines developed by Dolloff 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. Correct documentation of basinwide unit codes between corresponding habitat typing, electrofish, and snorkeling records is essential to calculating the basinwide estimates.

4.2 Annual Data Work Flow

The master monitoring databases contain or will 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 PORE. The satellite data tables are blank in each of the databases, but the look-up tables are populated and ready for use. The databases are provided in MS Access XP format.

At the end of each season, the salmonid 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. Once certified, the Data Manager imports the satellite data into the master database, appends the data to the appropriate tables, and archives the satellite.

4.3 Quality Assurance and Quality Control

The success of the salmonid 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 salmonid 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. SOP 8: Data Management outlines specific QA/QC guidelines and procedures to be followed during data entry, data collection, data verification, and data validation.

4.4 Version Control Guidelines and Database History

Version control guidelines for the salmonid 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, etc.). Significant database re-design may require approval by the project manager, review by other data management staff, and revisions to the 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 salmonid 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*.

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 are 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.

4.5 Metadata Procedures

The NPS GIS Committee requires all NPS GIS data layers to 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 salmonid 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 salmonid 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.

When completed, metadata records, but not the data, 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).

4.6 Data Storage and Archival Procedures

All master data files for the salmonid monitoring project are housed at GOGA. The SFAN I&M Program office and the SFAN Data Manager are stationed at GOGA. The master databases, reside in a separate folder directory from archived seasonal satellite databases and previous master database versions. The database directory is located at:

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

The salmonid 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 salmonid 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

Within this directory, separate folders store active satellite databases and copies of the master databases.

4.7 Data Distribution

Guidance documents, reports, and data must be easily discoverable and obtainable for the salmonid monitoring program to inform park management and to enable sharing program information with other organizations and the general public. 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/>

As previously mentioned, the salmonid monitoring database will not be posted for public download, but 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 on-line 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.

5 - Data Analysis and Reporting

Reporting results is a critical component of long-term vital signs monitoring to ensure that information generated through the program is available to all levels of park management including planning, interpretation, maintenance, and law enforcement. The overall strategy includes development of 1) seasonal updates 2) seasonal progress reports 3) annual summary reports and 4) analysis and synthesis reports.

5.1 Seasonal Updates

Seasonal updates will be provided to all park staff, program volunteers, and all interested parties at the end of each field season. Seasonal updates will provide a subjective summary of each field season using raw data sources only. These updates are produced with the intent of providing 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.

5.2 Seasonal Progress Reports

Seasonal progress reports are designed as a summary of finalized (QA/QC) data for each field season. Population estimates will be calculated and provided in each progress report. Seasonal progress reports will also provide an account of the events that occurred throughout each season. Summary reports are provided for both park resource managers and the CDFG as a final synopsis of each field season.

5.3 Annual Summary Reports

Annual summary reports are provided as a more comprehensive report including regional comparisons, life stage comparisons, and multiyear summaries that will be prepared annually. Salmonid annual reports will also include summaries of winter adult escapement surveys, spring smolt out migration studies, and summer juvenile fish density and population estimates for each watershed, as well as comparisons between years. Annual summary reports are designed as a compilation of the three seasonal reports placed in context with historic and regional data. The intent of the annual report is to provide summarized data with a comparative analysis for each year compared to the historic average and regional trend to resource managers. Annual reports may allow resource managers to observe trends or anomalies before a synthesis report is produced.

5.3.1 Routine Data Analyses

Detailed description and documentation of routine analyses are included in SOP 10. Refer to Carlisle et al. (2009) for an example of the types of analyses that will be conducted. Results will be presented separately for each watershed and each of the three year classes.

5.3.1.1 Juvenile Population Estimates: Calibrated snorkel counts are used for basinwide population estimates, using survey techniques developed by Hankin and Reeves (Dolloff et al. 1993). Fish densities, fork length frequencies, fish condition, and habitat composition are calculated from the collected juvenile data.

5.3.1.2 Winter Spawner Data: Because coho return to spawn over a one- to three-month period November through January (weather dependent) and residence time on the spawning grounds is variable, live fish may be double counted during repeated surveys. Reported spawning estimates are made using the PLD (Peak Live + Cumulative Dead) index. This index is derived by adding the peak number of live fish observed during a single survey to the number of carcasses recovered on or prior to that date and is considered a minimum estimate of the population. Carcass information is also used to calibrate observer length and sex estimates. Redd counts are used to describe spawning density and spatial distribution. Where survey frequency is adequate, reporting will include escapement estimates using the AUC method (Irvine et al. 1992).

5.3.1.3 Smolt Population Estimates: Trapping results can be compared with previous annual results. Results will also be examined temporally to determine when the bulk of smolt and fry migration occurs; and environmental conditions such as rainfall and temperature are gathered to detect influences on migratory timeframes. The collection of weight and length allows analysis of individual and population condition metrics. Fish population estimates and standard error are calculated using the computer software program DARR for stratified mark/recapture data.

5.4 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 and current status of coho salmon relative to the desired status. Analysis and synthesis reports are intended to provide a benchmark for park management in the mission to preserve and protect the stream resources for future generations. Methods for long-term trend analysis are described in SOP 10. In general, the salmonid monitoring protocol will report results by year, and synthesize long-term regional results within these documents. This report will differ from the annual report by providing statistics to describe trends over the long-term.

Due to the cohort structure of coho salmon, a modified mixed linear model of VanLeeuwen et al. (1996) and Piepho and Ogutu (2002) will be used to determine population trends. 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).

5.5 Reporting Format

Formats of the seasonal, annual, and long-term trend reports will follow the templates of the Natural Resource Publications Management (<http://www.nature.nps.gov/publications/nrpm/index.cfm>).

6 - Personnel

The salmonid monitoring program is a full-time commitment for a minimum crew of three to four staff, including the project leader and two to three field staff. Volunteers will be necessary during specific times when additional personnel are required, particularly for winter spawner surveys and summer index reach electrofishing surveys. Volunteers will be utilized for non-sensitive tasks such as recording data, dip netting for fish, and as additional observers during spawner surveys. All staff should review the fisheries job hazard analysis before starting field monitoring. It is the responsibility of the field crew leader to review critical field safety points with volunteers prior to starting each survey.

6.1 Personnel Requirements

6.1.1 Project Lead (Network)

Implementation of year-round surveys and reporting is conducted by a GS-9 Fishery Biologist. The Fishery Biologist is required to have extensive experience in fishery science. Approximately 50% of their time is for fieldwork and 50% for data management, data analysis and reporting working closely with the Network Data Manager. The Fishery Biologist schedules, oversees, provides training to, and works closely with cooperators and volunteers.

6.1.2 Hydrologist (PORE)

The Hydrologist at PORE supervises the Fishery Biologist/Project Lead, hires new staff, provides programmatic and budget oversight, handles contracts or cooperative agreements, and reviews all documents produced by the Biologist. The Hydrologist is also responsible for submitting grant requests and ensuring that permit requirements are met. The Hydrologist represents the NPS at a variety of local and regional salmonid-related forums.

6.1.3 Aquatic Ecologist (GOGA)

The GOGA Aquatic Ecologist provides technical assistance, guidance, and permit compliance throughout the project. The Ecologist may also represent the NPS at a variety of local and regional salmonid-related forums.

6.1.4 Data Manager (Network)

The Network Data Manager provides support for managing the project database including the development of queries, analyses, and reports. The Data Manager is ultimately responsible for building proper QA/QC procedures into the database management system and that appropriate data handling procedures are followed. The Data Manager is also responsible for archiving electronic data, data security, and facilitating software upgrades as necessary. The Data Manager, in collaboration with the Project Lead/Fishery Biologist, will develop and modify data entry forms, queries, and reports as necessary.

6.1.5 Supporting Field Staff

Supporting field staff members have been funded through the CDFG grants with staff hired through Point Reyes National Seashore Association and/or Conservation Corps North Bay (CCNB). One full-time and two seasonal assistants are needed to implement the program. The full-time staff member will serve as the crew leader in the field. Field staff may include

volunteers, interns, seasonal staff, or cooperators. The field staff should expect to be conducting field work 75% of the time, with approximately 25% of their time in the office to transfer and manage field collected data during the months when field operations are being performed (table 5). In late fall (October–November) and late winter (February), field staff commits 80% of their time to data entry, data summaries, data analysis and reporting (table 5). Field staff may also help coordinate community volunteers.

6.1.6 Community Volunteers

Community volunteers provide more than 1,200 hours per year in volunteer support to the program annually. Over the years, a core group of well-trained volunteers has been established. New volunteer participants are solicited as needed. Hands-on training is provided by assisting in the field with experienced field staff.

6.2 Annual Workload and Field Schedule

Surveys are conducted year round as presented in table 5.

6.2.1 Summer Surveys

6.2.1.1 Basinwide Surveys: Basinwide surveys are conducted from July to mid October and require a crew of four staff members. Snorkel surveys require two trained and qualified staff to perform coho dive counts. All staff members must have at least one full season of snorkeling experience before they can be utilized for snorkel surveys. Basinwide habitat censuses are performed using two trained and qualified staff members. Staff members will be trained by the program lead (I&M Fishery Biologist) prior to each field season.

6.2.1.2 Index Reach Surveys: Index reach monitoring is conducted annually after the completion of Basinwide GSS surveys. Index reach monitoring requires at minimum a crew of three, though five is preferable. The crew should include at least two trained and qualified staff, one to operate the electrofishing unit and the other to process (weigh and measure) captured fish. Other park staff or volunteers may be recruited as needed.

6.2.1.3 Winter Spawner Surveys: Spawner surveys are conducted between late November and early February. The surveys require 5–10 volunteers. Each team is led by a trained program staff member or an experienced volunteer team leader. Volunteer team leaders will be determined by the Program Lead (I&M Fishery Biologist), but in general the volunteer should have at least 2 years of experience. Volunteer team leaders must be able to properly identify adult salmonids and redds without the aid of a program staff member. The program lead must ensure that both program staff and volunteer leaders are proficient at both data collection and fish processing techniques prior to each field season.

6.2.1.4 Spring Smolt Surveys: Spring smolt surveys occur between March and early June. Traps must be checked on a daily basis (including weekends and holidays) and requires the availability of two to three experienced people to conduct the work. Because this involves handling of threatened and endangered species, only qualified personnel can operate the traps. Volunteers may only be used for transcribing data onto datasheets, assisting in trap construction, and assisting in trap maintenance.

Table 5. Annual field and reporting schedule.

Field Task (# of staff)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Summer Habitat Surveys (2)						X	X	X	X	X		
Summer Basinwide Survey (4)						X	X	X	X	X		
Summer Index Reach Surveys (3-5)									X	X		
Summer Progress Report										X	X	
Winter Spawner Surveys (2–3)	X	X									X	X
Winter Progress Report			X	X								
Spring Smolt Trapping (2–3)			X	X	X	X						
Spring Progress Report					X	X						
Annual Report			X	X								
Permit Report			X	X	X							

6.3 Qualifications

The program requires observation and handling of threatened and endangered species. Appropriate handling and care associated with these species is developed through training and field experience. The aquatic species list is short enough that field staff, without local experience, may learn the identification skills quickly (within a week of field experience). What is most important is an interest in and respect for the fish species that are handled through this program. The project leader should have a strong background in fisheries monitoring and analysis techniques, and should be an effective teacher of field skills. The project leader will also oversee field staff to insure that they are capable of safely handling the fish species. All I&M Fisheries staff are included in the federal and state ESA research and collection permits.

6.4 Training

Personnel should review Training and Safety SOP #11 and associated protocols, supporting documents, and field datasheets for each survey type.

Other specific tasks such as operating a backpack electrofisher will also require specialized training.

6.4.1 Snorkeling

Snorkel surveys require highly skilled observers with at least one field season or 300 hours of snorkeling experience (Hillman et al. 1992).

6.4.2 Electrofishing

If new personnel are being trained, several days should be scheduled to practice electrofishing. All field staff operating electrofishing units must possess a valid CPR training certification card. Only staff should operate electrofishing equipment. Pregnant women or any individual with a surgically implanted electronic device such as a pacemaker must not participate in electrofishing activities but may assist in fish processing.

7 - Operational Requirements

7.1 Budget

This protocol assumes a project staffing level of three to four staff, including the project leader, field crew leader, AmeriCorps member, and field technician. The fieldwork is accomplished with the assistance of volunteers, particularly during winter surveys and summer electrofishing surveys. Program funding currently comes from the SFAN I&M Program and is supplemented by grants from CDFG Competitive Grant Program through FY2013 (table 6).

7.2 Budget Shortfalls

The current budget is augmented by grants through FY2013. The CSMP has received funding from the CDFG competitive grants program since 2002. Given the past and current level of funding, combined with the current status of the CCC ESU coho populations, CDFG will likely continue their support of the CSMP. 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. Some expenses such as equipment costs may vary per year. In addition, the number of monitored watersheds and/or sites would be reduced to a manageable level based on existing staff and volunteer availability. Field support for monitoring is currently augmented, but may be achieved with student interns and volunteers. The minimum cost for each survey type proposed in table 7 assumes the maximum use of volunteer effort. It should also be noted that minimum costs in table 7 were developed separate from the combined budget presented in table 6 since some costs such as vehicle and equipment are reduced when annually performing multiple survey types. Qualified student interns from the Pacific Coast Learning Center have provided additional summer field assistance since 2004 and it is anticipated that this program will continue in FY2011 and beyond.

Table 6. Salmonid monitoring program budget: Annual estimated costs (FY2010).

Funding Source/ Expense Categories	Description	Amount
I&M Program		\$90,700
CDFG (through FY2013)		\$102,000
Total Available Funds		\$192,700
Expenses		
	Spawner Surveys – I&M Project Leader (8 pp)	\$25,000
	Smolt Trapping – I&M Project Leader (5 pp)	\$15,000
	Basinwide Surveys – I&M Project Leader (8 pp)	\$25,000
	Index Reach Surveys – I&M Project Leader (2 pp)	\$ 6,000
I&M Project Leader Total	GS-9 – Subject-to-furlough (23 pp)	\$71,000
I&M Data Manager	GS-11 (approx. 2 pp)	\$ 7,500
NPS Labor Total		\$78,500
Network Travel & Training		\$ 700
	Spawner Surveys – DFG Grant Field Crew Leader (8 pp)	\$18,000
	Smolt Trapping – DFG Grant Field Crew Leader (5 pp)	\$13,000
	Basinwide Surveys – DFG Grant Field Crew Leader (9 pp)	\$20,000
	Index Reach Surveys – DFG Grant Field Crew Leader (2 pp)	\$ 4,500
DFG Grant Crew Leader Total	Cooperative Agreement or GS-7 equivalent (25 pp)	\$55,500
	Smolt Trapping - DFG Grant Field Technician (5 pp)	\$ 9,000
	Basinwide Surveys - DFG Grant Field Technician (8 pp)	\$14,500
	Index Reach Surveys - DFG Grant Field Technician (2 pp)	\$ 3,500
DFG Grant Field Technician Total	Cooperative Agreement or GS-5 (15pp)	\$27,000
Field Crew	CCNB/AmeriCorps (20 pp fixed per year)	\$18,000
DFG Grant Labor		\$100,500
	Spawner Survey Equipment Maintenance & Replacement	\$ 500
	Smolt Trapping Equipment Maintenance & Replacement	\$ 4,000
	Summer Index Reach & Basinwide Equipment Maintenance & Replacement (Both surveys require similar equipment)	\$ 3,000
Equipment Total	Cooperative Agreement (\$1,500) and I&M Program (\$6,000)	\$ 7,500
Vehicle	Fixed cost per year	\$ 5,000
Total Expenses		\$192,700
Balance		-0-

Table 7. Priority monitoring efforts for salmonid monitoring protocol if match funding is reduced.

Rank/ Priority	Monitoring Component	Min. Cost	# Sites/Time Commitment	Min. Staff	Min. Volunteer	Pros/Cons
1	Spawner surveys	\$50,000	3 watersheds (Olema, Pine Gulch, Redwood) (3 months total)	2–3	2–5	Specific to salmonids; existing dataset since 1997; can involve many volunteers; valuable to regional salmonid recovery; CCCESU Recovery Goal
2	Smolt trapping	\$62,000	3 sites (3 months total)	3–4	1–4	Focused on salmonids but also yield info for some other spp; existing dataset since 1998; requires 7 day/week commitment; CCCESU Recovery Goal
3	Basinwide surveys	\$70,000	3 watersheds x 3–4 weeks per watershed (3 months total)	3–4	0–4	Best for salmonids but can be used for some other spp; yields population estimate for target spp; existing datasets since 2001 (Pine Gulch Creek), 2003 (Olema Creek) & 2004 (Redwood Creek)
4	Index reach surveys	\$16,000	5–6 sites (1–2 weeks) per watershed x 3 watersheds (1.5 months total)	2–3	2–3	Focused on specific stream reaches; samples stream habitat and entire vertebrate community; existing dataset since 1999

7.3 Facility and Equipment Needs

The fish monitoring program is housed at PORE, where appropriate office space and equipment storage is available. Complete equipment lists specific to each of the monitoring components are given in the respective SOPs. Most of the equipment required to implement this monitoring protocol has been acquired although there is a continuing need for equipment maintenance and replacement. The equipment and materials (dry suits, wet suits, electrofisher, nets, scales and other equipment) required for monitoring are subject to extensive wear and tear, and require repair or replacement on a regular basis.

7.4 Permitting Requirements

All of the proposed monitoring will be conducted under research and collection permits from the CDFG and NMFS. Various reporting requirements are associated with the permits and are outlined in SOP 6.

NPS is authorized under NMFS permit #1046 modification #2 until February 2012 to take adult and juvenile federally endangered coho salmon, threatened steelhead, 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/Distinct Population Segment (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.

Field work also falls within the scope of CDFG Scientific Collection Permit 2081 (b). This permit applies 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.

8 - Glossary

Adipose fin: A small fleshy fin with no rays, located between the dorsal and caudal fins.

Age: The number of years of life completed, here indicated by an Arabic numeral, followed by a plus sign if there is any possibility of ambiguity (age 5, age 5+).

Age class: A group of individuals of a certain species that have the same age.

Alevin: The developmental life stage of young salmonids and trout that are between the egg and fry stage. The alevin has not absorbed its yolk sac and has not emerged from the spawning gravels.

Anadromous: Fish that hatch rear in fresh water, migrate to the ocean (salt water) to grow and mature, and migrate back to fresh water to spawn and reproduce.

Anal fin: The fin located on the ventral median line and behind the anus.

Assemblage: a group or aggregate of things gathered or collected.

Basinwide survey: A survey which provides a statistically accurate estimate of stream habitat and/or a population of a particular fish species for a broad area or entire stream.

Evolutionarily Significant Unit (ESU): A population of organisms that is considered distinct for purposes of conservation.

California Central Coast Evolutionarily Significant Unit (CCCESU): The distinct population of all naturally spawning populations of coho salmon from Punta Gorda in northern California south to and including the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento–San Joaquin River system.

Caudal fin: The tail fin.

Cohort: See year class.

Community: An assemblage of interacting populations occupying a particular area.

Condition factor: A ratio relating fish length to fish weight and measuring the relative plumpness of a fish.

Critical size: The average size of the fish in a year-class at the time when the instantaneous rate of natural mortality equals the instantaneous rate of growth in weight for the year-class as a whole. Also called optimum size.

Egg-to-smolt survival: The numerical difference between the number of fertilized eggs produced by a group of fish and the number of smolts resulting from those eggs.

Electrofishing: The use of electricity to capture fish

Emergence: The process during which fry leave their gravel spawning nest and enter the water column.

Emigration: Referring to the movement of organisms out of an area. See immigration and migrating.

Escapement: The quantity of sexually mature adult salmon (typically measured by number or biomass) that successfully passes through a fishery to reach the spawning grounds.

Falcate: Hooked or curved like a sickle.

Fecundity: The reproductive capacity of an individual, usually measured as the total number of eggs produced by a female fish.

Fin ray: A soft or hard cartilaginous rod in fins.

Fingerling: Refers to a young fish in its first or second year of life.

Fork length: The length of a fish from the most anterior part of the body to the tip of the medial caudal fin ray.

Fry: A stage of development in young salmon or trout. During this stage the fry is usually less than one year old, has absorbed its yolk sac, is rearing in the stream, and is between the alevin and parr stage of development.

Habitat unit: Stream morphology classification unit, such as a pool (scour pool, backwater pool, plunge pool, or mid-channel pool), flatwater, or riffle.

Immigration: Referring to the movement of organisms into an area. See emigration and migrating.

Index reach survey: Established stream reaches approximately 100 m in length, sampled during summer/fall base flow periods to assess fish abundance and distribution.

Iteroparous: The ability to reproduce more than once in a lifetime.

Jack salmon: A young male salmon that matures precociously (earlier than other fish in its age-class).

Juvenile: Fish from one year of age until sexual maturity.

Krill: Small abundant crustaceans that form an important part of the food chain in Antarctic waters.

Kype: The distinctive hooked jaw that male salmon develop during spawning.

Lateral line: A series of sensory pores opening to the exterior and along the side of fish.

Length frequency: An arrangement of recorded lengths which indicates the number of times each length or length interval occurs.

Live box: A container filled with water and often equipped with accessories such as aeration equipment that is used to hold and transport live fish.

Milt: The sperm of fishes.

Natal stream: Stream of birth.

Naturally spawning populations: Populations of fish that have completed their entire life cycle in the natural environment without human intervention.

Outmigration: The migration of fish down the river system to the ocean.

Parr: The developmental life stage of salmon and trout between alevin and smolt, when the young have developed parr marks and are actively feeding in fresh water.

Parr marks: Distinctive vertical bars on the sides of young salmonids

Pre-smolt: A juvenile salmon or steelhead that has not yet reached the physiological state known as a smolt.

Pre-spawning mortality: Generally refers to non-fishery mortality of adult salmon and steelhead between the time the fish enter the stream and the completion of spawning.

Precocious: Fish that have matured more quickly, or faster than the remaining fish of the age-class.

Ray: One of the supports of a fin.

Rearing: Refers to the amount of time that juvenile fish spend feeding in nursery areas of rivers, lakes, streams and estuaries before migration.

Redd: A nest of fish eggs consisting of gravel, typically formed by digging motion performed by an adult female salmon.

Relative abundance: An estimate of actual or absolute abundance; usually stated as an index; for example, as bottom trawl survey stratified mean catch per tow.

Reproduce: To produce offspring.

Resident species: Species of fish which spend their entire lives in freshwater.

Roe: The eggs of fishes.

Salmonid: Fish of the family Salmonidae that includes salmon and steelhead.

Seine: A length of netting with weights at the bottom and floats at the top that is pulled from the ends through the water to sample fishes.

Semelparous: Species that reproduce only once during their lifetime.

Smolt: Refers to the salmonid or trout developmental life stage between parr and adult, when the juvenile is at least one year old and has adapted to the marine environment.

Smoltification: Refers to the physiological changes anadromous salmonids and trouts undergo in freshwater while migrating toward saltwater that allow them to live in the ocean.

Spawn: The act of reproduction of fishes. The mixing of the sperm of a male fish and the eggs of a female fish.

Stock: A specific population of fish spawning in a particular stream during a particular season.

Straying: A natural phenomena of adult spawners not returning to their natal stream, but entering and spawning in some other stream.

Thalweg: The line defining the lowest points along the length of a river bed or valley.

Upwelling: The movement of nutrient rich waters from the bottom of the ocean to the surface.

Year class: Fish in a stock born in the same year. Synonymous with cohort.

Yearling: A one-year old fish.

9 - Literature Cited

- Adams, D., S. Allen, J. Bjork, M. Coopridge, A. Fesnock, M. Koenen, T. Leatherman, S. O'Neil, D. Press, D. Schirokauer, B. Welch, and B. Witcher. 2006. San Francisco Bay Area Network vital signs monitoring plan. NPS/SFAN/NRR—2006/017 National Park Service, Fort Collins, CO.
- Anderson, D. and H. McGuire. 1994. Redwood Creek basin 1991–1992 spawning and carcass survey, annual report. Unpublished report. National Park Service, Redwood National Park. Arcata, California.
- Bjorkstedt, E. P. 2000. DARR (Darroch Analysis with Rank-Reduction): A method for analysis of stratified mark-recapture data from small populations, with application to estimating abundance of smolts from outmigrant trap data. Contribution 116. Administrative Report SC-00-02. 28 PP. DARR software. NOAA National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, California. Online. (<http://swfsc.noaa.gov/textblock.aspx?Division=FED&id=3346>). Accessed on 10 November 2009.
- Bjorkstedt, E.P., B.C. Spence, J.C. Garza, D.G. Hankin, D. Fuller, W.E. Jones, J.J. Smith, and R. Marcedo. 2005. An analysis of historic population structure for evolutionary significant units of chinook salmon, coho salmon, and steelhead in the North-Central California Coast recovery domain. NOAA Technical Memorandum NMFS NOAA-TM-NMFS-SWFSC-382. NOAA National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, California.
- Brown, G. G., and B. J. Ketcham. 2002. Documentation of coho salmon in Pine Gulch Creek, Marin County, CA. Coho Salmon and Steelhead Trout Restoration Project. PORE-NRWR-02/02. Point Reyes National Seashore, Point Reyes, California.
- Brown, L. R., P. B. Moyle, and R. M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. *North American Journal of Fisheries Management* 14:237–261.
- California Department of Fish and Game (CDFG). 2002. Status review of California coho salmon north of San Francisco. Report to the California Fish and Game Commission. California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, Sacramento, California.
- California Department of Fish and Game (CDFG). 2004. Recovery strategy for California coho salmon. Report to the California Fish and Game Commission. California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, Sacramento, California.
- 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.

- 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.
- Coopridge, M. A., and R. G. Carson. 2006. San Francisco Bay Area Network freshwater quality monitoring protocol, version 2.11. NPS/SFAN/NRR – 2006/016. National Park Service, Fort Collins, Colorado.
- Dolloff, C. A., D. G. Hankin, and G. H. Reeves. 1993. Basinwide estimation of habitat and fish populations in streams. General Technical Report SE-83. USDA Forest Service Southeastern Forest Experiment Station, Asheville, North Carolina. Online. (http://www.srs.fs.usda.gov/pubs/gtr/gtr_se083.pdf). Accessed 10 November 2009.
- Downie, S. and G. Petersen. Undated. Spawning inventory. California Department of Fish and Game Unpublished Report [instructions for conducting spawner surveys]. Sacramento, California.
- 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.
- Federal Register. 1996. Final rule. Endangered and threatened species: Threatened status for Central California Coast coho salmon evolutionarily significant unit (ESU). Federal Register 61 (212):56,138–56,149.
- Federal Register. 1997. Final rule. Endangered and threatened species: Listing of several evolutionary significant units (ESUs) of west coast steelhead. Federal Register 62(159):43,937–43,954.
- Federal Register. 1999. Final rule and correction. Endangered and threatened species: Designation of critical habitat; central California coast and southern Oregon/northern California coasts coho salmon. Federal Register 64(86):24,049–24,062.
- Federal Register. June 28, 2005. Final rule. Endangered and threatened species: Final listing determinations for 16 ESUs of west coast salmon and final 4(d) protective regulations for threatened salmonid ESUs. Federal Register 70(123):37,160–37,204.
- 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.
- Fong, D., D. Press, and M. Koenen. In prep. San Francisco Bay Area Network (SFAN) streamflow monitoring protocol v2.91. Natural Resource Report NPS/SFAN/NRR—2009/XXX. National Park Service, Fort Collins, Colorado

- Garza, C., and E. Gilbert-Horvath. 2003. Report on the genetics of coho salmon (*Oncorhynchus kisutch*) held at the Warm Springs (Don Clausen) Hatchery for recovery efforts in the Russian River. National Marine Fisheries Service, Southwest Fisheries Science Center. Santa Cruz Laboratory, Santa Cruz, California.
- Gurka, M. J. 2006. Selecting the best linear mixed model under REML. *The American Statistician* 60(1):19–26.
- Hankin, D. G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. *Canadian Journal Fisheries Aquatic Sciences* 45:834–844.
- Hillman, T. W., J. W. Mullan, and J. S. Griffith. 1992. Accuracy of underwater counts of juvenile chinook salmon, coho salmon, and steelhead. *North American Journal of Fisheries Management* 12:598–603.
- Irvine, K. 2008. Smolt power analysis. San Francisco Bay Area Inventory and Monitoring Program Unpublished Report, Sausalito, California.
- Irvine, J. R., R. C. Bocking, and K. K. English, and M. Labelle. 1992. Estimating coho salmon (*Oncorhynchus kisutch*) escapements by conducting visual surveys in areas selected using stratified random and stratified index sampling designs. *Canadian Journal of Fisheries and Aquatic Sciences* 49: 1972–1981.
- Johnston, N. T., J. R. Irvine, and C. J. Perrin. 1987. Instream indexing of coho salmon (*Oncorhynchus kisutch*) escapement in French Creek, British Columbia. *Canadian Technical Report of Fisheries and Aquatic*, No. 1573.
- Ketcham, B. J., G. G. Brown, and O. G. Wolff. 2004a. Coho salmon (*Oncorhynchus kisutch*) in Pine Gulch Creek, Marin County, CA. 2003 monitoring report. Point Reyes National Seashore, California.
- Ketcham, B. J., G. G. Brown, and O. G. Wolff. 2004b. Olema Creek watershed summary monitoring report, Marin County, CA. 1997–2003. PORE/NR/WR/04-02. Point Reyes National Seashore, Point Reyes, California.
- Ketcham, B. J., G. G. Brown, and O. G. Wolff, 2004c. Long-term coho salmon and steelhead trout monitoring program in coastal Marin County – summer 2003 monitoring progress report. Report to California Department of Fish and Game, contract #P0130434, Point Reyes National Seashore, California.
- MacFarlane, R. B., B. Wells, and S. A. Hayes. 2008. Coho and Chinook salmon decline in California during the spawning seasons of 2007/08. NOAA National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, California.

- Miller, G. 2010. In central California, coho salmon are on the brink. *Science* 237: 512-513.
- Moyle, P. B., M. P. Marchetti, J. Balrige, and T. L. Taylor. 1998. Fish health and diversity: Justifying flows for a California stream. *Fisheries* 23(7):6–16.
- Oregon Department of Fish and Wildlife (ODFW). 2007. Oregon coast coho conservation plan for the state of Oregon. Oregon Department of Fish and Wildlife, Salem, Oregon.
- Palmer, C. J. 2003. Approaches to quality assurance and information management for regional ecological monitoring programs. Pages 211–225 *in* D. E. Busch, and J. C. Trexler, editors. *Monitoring ecosystems: Interdisciplinary approaches for evaluating ecoregional initiatives*. Island Press, Washington, D.C.
- Pacific Fishery Management Council (PFMC). 2000. Pacific coast salmon management plan, appendix 14. Pacific Fishery Management Council, Portland, Oregon. Online. (www.pcouncil.org/salmon/salfmp/a14/99efh2.pdf). Accessed August 2004.
- Pearcy, W. G. 1997. Salmon production in changing ocean domains. Pages 331–352 *in* D. J. Stouder, P. A. Bisson, and R. J. Naiman, editors. *Pacific salmon and their ecosystems*. Chapman & Hall, New York.
- Piepho, H.-P. and J. O. Ogutu. 2002. A simple mixed model for trend analysis in wildlife populations. *Journal of Agricultural, Biological, and Environmental Statistics* 7(3):350–360.
- Pollard, W. R., C. Groot, and G. F. Hartman. 1997. Field identification of coastal juvenile salmonids. Harbour Publishing Company, Madeira Park, British Columbia.
- Press, D. T. 2005. Data management plan for the San Francisco Bay Area Network Inventory and Monitoring Program. USDI National Park Service, San Francisco, CA.
- Reichmuth, M., B. J. Ketcham, D. Fong. 2005. Adult escapement monitoring program summary 2004–2005. PORE/NR/WR/06-01. Point Reyes National Seashore, Point Reyes, CA.–
- Reichmuth, M., C. Del Real, and B. J. Ketcham. 2006a. Smolt trapping program summary – Olema Creek, Pine Gulch, and Redwood Creek, Marin County, CA. 2006. Report to Pacific States Marine Fisheries Commission – California Adaptive Watershed Improvement Grant # ADWI-CE-15. PORE/NR/WR/07-01. Point Reyes National Seashore, Point Reyes, CA.
- Reichmuth, M., B. J. Ketcham, K. Leising, and B. Craig. 2006b. Olema Creek watershed summary monitoring report, Marin County, CA. 1997–2005. PORE/NR/WR/06-02. Point Reyes National Seashore, Point Reyes, CA.
- Rodgers, J. D., M. F. Solazzi, S. L. Johnso, and M. A. Buckman. 1992. Comparison of three techniques to estimate juvenile Coho salmon populations in small streams. *North American Journal of Fisheries Management* 12:79–86.

- Schwarz, G. 1978. Estimating the dimension of a model. *The Annals of Statistics* 6: 461–464.
- Starcevich, L. A. 2008. Power analysis of escapement trends for the Coho salmon protocol. San Francisco Bay Area Inventory and Monitoring Program Unpublished Report, Sausalito, CA.
- Starcevich, L. A., and K. Irvine. 2008. Estimates of status and trend for the SFAN juvenile Coho salmon. San Francisco Bay Area Inventory and Monitoring Program Unpublished Report, Sausalito, CA.
- VanLeeuwen, D. M., L. W. Murray, and N. S. Urquhart. 1996. A mixed model with both fixed and random trend components across time. *Journal of Agricultural, Biological, and Environmental Statistics* 1(4):435–453.
- Williams, L. R., M. L. Warren, Jr., S. B. Adams, J. L. Arvai, and C. M. Taylor. 2004. Basin visual estimation technique (BVET) and representative reach approaches to wadeable stream surveys: methodological limitations and future directions. *American Fisheries Society: Fisheries* 29(8):12–22.

Appendix A. Fish and Stream Aquatic Assemblages

While juvenile coho and steelhead are likely to be the most frequently captured aquatic species, there are several others that may be encountered. Because salmonid surveys will likely be the primary long-term stream fish monitoring program supported by the parks, collected data will be important for not only documenting the status and trends of juvenile salmonids, but other species as well. Equal care in field sampling and consistency in identification is required.

Common name	Scientific name	Life stage	Code
Coho salmon	<i>Oncorhynchus kisutch</i>	young of year	CO
Steelhead/Rainbow trout	<i>Oncorhynchus mykiss</i>	young of year	SH
Unknown salmonid			Salmonid
Sculpin spp.	<i>Cottus spp.</i>		SCU
Prickly sculpin	<i>Cottus asper</i>		PS
Coastrange sculpin	<i>Cottus aleuticus</i>		CRS
Riffle sculpin**	<i>Cottus gulosus</i>		RS
Pacific staghorn sculpin	<i>Leptocottus armatus</i>		PSS
Threespine stickleback	<i>Gasterosteus aculeatus</i>		STK
California roach	<i>Hesperoleucus symmetricus</i>		RO
Sacramento sucker	<i>Catostomus occidentalis</i>		SUC
*Golden Shiner	<i>Notemigonus crysoleucas</i>		
Lamprey spp.	<i>Lampetra spp.</i>	ammocete	LAM
Pacific lamprey	<i>Lampetra tridentata</i>	smolt/adult	PL
Pacific brook lamprey	<i>Lampetra pacifica</i>	adult	PBL
River lamprey	<i>Lampetra ayresi</i>	adult	RL
*Green sunfish	<i>Lepomis cyanellus</i>		GSF
Other Aquatic Vertebrates			
California giant salamander	<i>Dicamptodon ensatus</i>	larva	CGS
California newt	<i>Taricha torosa</i>	adult	CAN
Rough-skinned newt	<i>Taricha granulosa</i>	adult	RSN
California red-legged frog	<i>Rana aurora draytonii</i>	adult	RLF
*Bullfrog	<i>Rana catesbeiana</i>	adult	BF
Foothill yellow-legged frog	<i>Rana boylei</i>		YLF
Pacific treefrog	<i>Hyla regilla</i>	adult	PTF
Western pond turtle	<i>Clemmys marmorata</i>		WPT
*Red-eared slider	<i>Pseudemys scripta elegans</i>		RES
Invertebrates			
California freshwater shrimp	<i>Syncaris pacifica</i>		CFS
*Signal crayfish	<i>Pacifastacus leniusculus</i>		Cray
*Swamp crayfish	<i>Procambarus clarkii</i>		SWC

*non-native

Appendix B. CDFG Habitat Unit Types.

From Flosi et al. 1998.

Level III		Level IV	
Type	Code	Type	Code
Riffle	R	Low Gradient Riffle	LGR
		High Gradient Riffle	HGR
Cascade	C	Cascade	CAS
		Bedrock Sheet	BRS
		Pocket Water	POW
		Glide	GLD
Flatwater	FW	Run	RUN
		Step Run	SRN
		Edgewater	EDW
		Trench Pool	TRP
Main Channel Pool	MC	Mid-Channel Pool	MCP
		Channel Confluence Pool	CCP
		Step Pool	STP
		Corner Pool	CRP
		Lateral Scour Pool - Log Enhanced	LSL
Scour Pool	SC	L. Scour Pool - Root Wad Enhanced	LSR
		L. Scour Pool - Bedrock Formed	LSBk
		L. Scour Pool - Boulder Formed	LSBo
		Plunge Pool	PLP
		Secondary Channel Pool	SCP
Backwater Pools	BW	Backwater Pool - Boulder Formed	BPB
		Backwater Pool - Root Wad Formed	BPR
		Backwater Pool - Log Formed	BPL
		Dammed Pool	DPL
Dry	DR	Dry	DRY
Culvert	CU	Culvert	CUL
Not Surveyed	NS	Not Surveyed	NS
		Not Surveyed due to a marsh	MAR

61

Spent ____ at ____

Habitat Type Data

Unit Types							
(P)Pit	(C)Cove	(F)Flatwater	(SC)Scour Pool	(PL)Plunge Pool	(MC)Main Channel Pool	(BW)Backwater Pool	(CR)Cr.
Note: Pools must have a max depth > 0.3 meters. The length of all habitat units must be > than the wet width.							
Habitat Transverse: 2 transverse for units 0-8 m, 3 transverse for units 9-15 m, 4 transverse for units 16-25 m, 5 transverse for units 26-35 m, 6 transverse > 35 m.							

Instructions for Basinwide Habitat Survey Datasheet

Stream:	Stream name.
Watershed:	Watershed name.
Date:	mm/dd/yy.
Location:	Name of reach covered by that page or description of location on stream.
Crew:	Names of all personnel. (First, Last)
BW Unit #:	Numbered sequentially moving upstream, starting with 1 at beginning (downstream end) of survey area.
Section Number:	Record the nearest downstream monument tag to be used as a reference point and approximate distance from tag. Not applicable for side channel and basinwide habitats.
Unit Type:	Using CDFG level III classification system. Note primary and secondary types if unit consists of more than one type.
Side Channel:	Check box if the habitat unit lies within a side channel.
Len. (m):	Length of habitat unit, measured along thalweg, to the nearest 0.1 m
Est. Width (m):	Visually estimated average width of habitat unit.
Measured Widths:	Up to five widths measured to the nearest 0.1 m for predetermined calibration units.
Tran Length (m):	Record distance between transects to the nearest meter.
Max Depth (m):	Record the maximum depth of all pools and flatwater unit types to the nearest 0.1 m.
Crest Depth (m):	Record crest depth to nearest 0.01 m for all pool and flatwater units.
Comments :	Record monument tag #'s and locations, split channels, and other notable landmarks in comments section. If split channel indicate left bank (LB) or right bank (RB) unit.

Appendix D. Dive Datasheet

Sheet # of

DIVE DATA SHEET

Stream: _____ Watershed: _____ Location: _____
Date: ____/____/____ Divers: _____ Recorder: _____

[illegible]

Instructions for Dive Datasheet

Stream:	Stream name.
Watershed:	Watershed name.
Location:	Name of reach covered by that page or description of location on stream.
Date:	mm/dd/yy.
Divers:	Names of all personnel. (First, Last)
Recorder:	Name of person recording data. (First, Last)
BW Unit # / Type:	BW Unit # and type of preselected dive unit. Should match BW Unit # and Unit Type from <i>Basinwide Habitat Survey</i> datasheet.
Section #/Location:	Nearest downstream monument tag for locational reference and approximate distance from tag. Should match Section # and Location from <i>Basinwide Habitat Survey</i> datasheet.
Index Reach #/Index Unit #:	If applicable the name or number of the index reach, and number of the unit within the index reach, starting at 1 from the downstream end.
Diver Initials:	Initial of diver or divers snorkeling each unit.
Pass #:	Fill out separate line for each snorkeling pass.
Pass Time:Start/End:	Start time and end time of snorkel pass in minutes.
Species:	CO (coho), SH (steelhead), or other species observed.
Age:	YOY (young of year) or 1+ if applicable.
Number:	Number of coho counted per pass or P (present) for all other species observed.
Visibility:	Estimate of underwater visibility distance (in meters).
Comments:	General notes including habitat unit complexity or obstructions, undercut banks, presence of non target species.

Appendix E. Index Reach Habitat Datasheets

Page ___ of ___

INDEX REACH HABITAT DATA

Stream: _____ Date: ____/____/____ Index Reach #: _____
Crew: _____ Recorder: _____

Reach-wide Habitat Data

Bank Vegetative Cover					
%OS	0	1	2	3	4
%US	0	1	2	3	4
%FG	0	1	2	3	4

(0) none (1) 1-25% (2) 26-50%
(3) 51-75% (4) 76-100%

Woody Debris Tally (bankfull channel)					
Root Wad	LWD Jam	SWD Jam	10-20 cm (4-8 in)	20-50 cm (8-20 in)	>50 cm (>20 in)

Dry Bed					
0	1	2	3	4	

(0) none (1) 1-25% (2) 26-50% (3) 51-75% (4) 76-100%

Isolated Pools:	
Y	N

Comments: _____

Bank Erosion					
Left	0	1	2	3	4
Right	0	1	2	3	4

(0) stable banks, no erosion
(1) 1-25% false, broken down, eroding
(2) 25-50% false, broken down, eroding
(3) 50-75% false, broken down, eroding
(4) 75-100% false, broken down, eroding
Comments: _____

Unit Habitat Data:

Water Quality	Unit #:	Unit #:	Unit #:	Unit #:
H ₂ O Temp				
DO %				
DO mg/l				
Conductivity				
Specific Conductance				
Salinity				

In-stream Shelter		Unit # / type				In-stream Shelter Classes (Select one class for each in-stream shelter type)
		1	2	3	4	
% perimeter	undercut bank					0 – Shelter type not present 1 – <1% present 2 – 1% to 5% present 3 – 5% to 10% present 4 – 10% to 20% present 5 – 20% to 30% present 6 – 30% to 50% present 7 – 50% to 75% present 8 – 75% to 100% present
	bedrock ledge					
% surface area	SWD (<10 cm / 4")					
	LWD (>10 cm / 4")					
	terrestrial veg.					
	aquatic veg.					
	bubble curtain					
	boulders (>25 cm / 10")					
	root mass					

Unit Habitat Data (cont.):

Page ____ of ____

Unit #: _____ unit type: _____ length: _____ max depth: _____ crest depth: _____

total width
average width

Instructions for Index Reach Habitat Datasheet

Stream:	Stream name.
Date:	mm/dd/yy.
Index Reach #:	Number of established sample site.
Location:	Description of location on stream--site name if at index reach or other established location.
Crew:	Names (First, Last) of all personnel.
Recorder:	Name of person (First, Last) recording data.
Bank Vegetative: Cover	Visually estimate cover of the overstory (%OS), understory (%US), and ground cover (%FG) for the index reach and circle the percentage category.
Dry Bed:	Visually estimate the amount of dry bed along thalweg of index reach if flow in main channel is disconnected and circle the percentage category.
Isolated Pools:	Indicate if isolated pools exist in the index reach, either backwater/side units or along thalweg.
Woody Debris: Tally	Tally each type or size class of woody debris in the index reach within the bankfull channel.
Bank Erosion:	Visually estimate the extent of bank erosion in the index reach and circle the percentage category for each bank.
water temp *C:	Water temperature in Celsius from YSI 85, YSI 30, or thermometer.
DO%:	Dissolved oxygen % from YSI 85.
mg/l:	Dissolved oxygen mg/l from YSI 85.
conductivity:	Conductivity from YSI 85 or YSI 30.
sp. cond.:	Specific conductance from YSI 85 or YSI 30.
salinity:	Salinity from YSI 85 or YSI 30.
Instream Shelter:	Visually estimate the amount and type of instream shelter for each habitat unit and record the percentage of habitat unit covered by each type.
Comments:	General notes or comments for the index reach.

(Instructions for Page 2)

Unit #: Numbered sequentially moving upstream, starting with 1 at downstream end. Should match **Unit #** from ***Index Reach Electrofishing Log.***

Unit type: Using CDFG level III classification system. Note primary and secondary types if unit consists of more than one type. Should match **Habitat Type** from ***Index Reach Electrofishing Log.***

Length: Length of habitat unit, measured along thalweg, to the nearest 0.1 m.

Max depth: Depth measured to the nearest 0.01 m at the deepest point of pool or flatwater unit (not needed for riffle units).

Crest depth: Depth measured to the nearest 0.01 m at the crest of flatwater or pool tailout (not needed for riffle units).

For each transect, measure the wetted channel width to the nearest 0.1 m and record under **Total width.**

Appendix F. Electrofishing Data Datasheet

(version updated 7/1/05)

Sheet # ____ of ____

ELECTROFISHING DATA SHEET

Stream: _____ Location: _____ Date: ____/____/____
 Crew: _____ Recorder: _____
 Gear Type: _____
 Unit Number: _____ Unit Description: _____

	Pass #	Species	Fork Length (mm)	Bag + Fish wt. (g)	Bag post wt. (g)	Fish Condition	Comments
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
Pass #	Species	Tally					

Species Abbreviations
 CO = Coho; SH = Steelhead; RO = Roach; STK = Stickleback; SCU = Sculpin; AM = Pacific Lamprey
 Ammocete; SUC = Sacramento Sucker

Instructions for Electrofishing Datasheet

Stream:	Stream name.
Location:	Description of location on stream--# and/or name of index reach or site name if at other established location.
Date:	mm/dd/yy.
Crew:	Names (First, Last) of all personnel.
Gear Type:	Model/type of electrofisher or type of seine used.
Unit #:	Basinwide habitat unit number for GSS calibration pools. For Index Reaches enter the Index Reach number followed by the unit number. Index Reach unit numbers are numbered sequentially moving upstream, starting with 1 at downstream end of index reach.
Unit Description:	Habitat type using CDFG level III classification system. Note primary and secondary types if unit consists of more than one type. Should match Habitat Type from <i>Index Reach Electrofishing Log</i> or <i>Basinwide Habitat Datasheet</i> .
Pass #:	Electrofishing pass number in which fish was captured, or “seine” if seine capture.
Species:	Species (and age class of steelhead) using codes at bottom of sheet. For steelhead young of year use SH , for age 1+ steelhead use SH 1+ .
Fork Length (mm):	Fork length measured to the nearest mm (=total length for sculpin and stickleback).
Bag+fish wt. (g):	Gross weight to the nearest 0.01 g of fish in weighing bag (rezero scale before weighing each fish).
Bag post wt. (g):	Residual weight of bag after fish is removed (can be positive or negative #).
Fish condition:	Indicate B for burn, I for other injury, or M for mortality or probable mortality.
Comments:	General notes or comments.

Appendix G. Basinwide Electrofishing Log

(version updated 12/14/05)

Page ____ of ____

ELECTROFISHING LOG

Stream: _____

Date: ____/____/____

SubProject: _____

Gear Type: _____

Recorder: _____ Crew: _____

Section #:				
Unit type:				
BW Unit #:				
Pass #	Seine or E-fish?	E-fish Time	E-fish Volts	E-fish Setting
1				DC
2				DC
3				DC
Water Quality Data				
H ₂ O Temp		Cond		
DO %		Spec Cond		
DO mg/l		Salinity		

Section #:				
Unit type:				
BW Unit #:				
Pass #	Seine or E-fish?	E-fish Time	E-fish Volts	E-fish Setting
1				DC
2				DC
3				DC
Water Quality Data				
H ₂ O Temp		Cond		
DO %		Spec Cond		
DO mg/l		Salinity		

Pass #	species	# per pass	# of mort's	Pass type
1	CO			
2	CO			
3	CO			
1	SH YOY			
2	SH YOY			
3	SH YOY			
1	SH 1+			
2	SH 1+			
3	SH 1+			
1	AM			
2	AM			
3	AM			
1	RO			
2	RO			
3	RO			
1	STK			
2	STK			
3	STK			
1	SCU			
2	SCU			
3	SCU			
1				
2				
3				

Comments: _____

Pass #	species	# per pass	# of mort's	Pass type
1	CO			
2	CO			
3	CO			
1	SH YOY			
2	SH YOY			
3	SH YOY			
1	SH 1+			
2	SH 1+			
3	SH 1+			
1	AM			
2	AM			
3	AM			
1	RO			
2	RO			
3	RO			
1	STK			
2	STK			
3	STK			
1	SCU			
2	SCU			
3	SCU			
1				
2				
3				

Comments: _____

Instructions for Basinwide Electrofishing Log

Stream:	Stream name.
Date:	mm/dd/yy.
Subproject:	Project associated with the survey (Efish Index, Efish Basin, Fish Rescue, Restoration, Other).
Gear Type:	Model/type of electrofisher or type of seine used.
Recorder:	Name (First, Last) of person recording data
Crew:	Names (First, Last) of all personnel.
Section #:	Record the nearest downstream monument tag to be used as a reference point and approximate distance from tag.
Unit Type:	Using CDFG level III classification system. Note primary and secondary types if unit consists of more than one type
BW Unit #:	Numbered sequentially moving upstream, starting with 1 at downstream end.
Seine or E-fish:	Enter either seine or E-fish (electrofishing) for the sampling type used.
Time:	Time readout (seconds) from electrofisher for each pass.
Volts:	Electrofisher volts setting for each pass (should be same for all passes on a unit).
Setting:	Electrofisher current/frequency setting for each pass; unpulsed DC is setting used most often (same setting should be used for all passes).
H₂O Temp:	Enter the water temperature in °C.
DO%:	Enter the percent of dissolved oxygen.
DO mg/l:	Enter the dissolved oxygen in milligrams per liter.
Cond:	Enter the conductivity in micromhos per centimeter.
Spec Cond:	Enter the specific conductivity in micromhos per centimeter.
Salinity:	Enter the salinity in parts per thousand.
For each species/age class, record the # captured in each pass:	
CO:	Coho
SH YOY:	Steelhead young of year
SH 1+:	Steelhead age 1+
AM:	Lamprey ammocetes (Field identification keys are not yet adequate to determine species)
RO:	California roach
STK:	Three spine stickleback
SCU:	Sculpin (Field identification keys are not yet adequate to determine species)
Other:	Other species captured or comments specific to each pass.
Total Catch:	Total catch per species for all passes.
Mortality:	Mortalities (if any) for each species/age class (include injured individuals if likely mortality)

Pass type: Enter the pass type, either E-fish or seine pass.

Comments: General comments for each unit, including any mortalities or injuries.

Appendix H. Index Reach Electrofishing Log

(version updated 12/14/05)

Page ____ of ____

INDEX REACH ELECTROFISHING LOG

Stream: _____ Index Reach #: _____ Date: ____/____/____
 SubProject: _____ Gear Type: _____
 Recorder: _____ Crew: _____

Section #:
 Index Reach Unit #:
 Unit type:
 BW Unit #:

Pass #	Seine or E-fish?	E-fish Time	E-fish Volts	E-fish Setting
1				DC
2				DC
3				DC

Section #:
 Index Reach Unit #:
 Unit type:
 BW Unit #:

Pass #	Seine or E-fish?	E-fish Time	E-fish Volts	E-fish Setting
1				DC
2				DC
3				DC

Pass #	species	# per pass	# of mort's	Pass type
1	CO			
2	CO			
3	CO			
1	SH YOY			
2	SH YOY			
3	SH YOY			
1	SH 1+			
2	SH 1+			
3	SH 1+			
1	AM			
2	AM			
3	AM			
1	RO			
2	RO			
3	RO			
1	STK			
2	STK			
3	STK			
1	SCU			
2	SCU			
3	SCU			
1				
2				
3				

Comments: _____

Pass #	species	# per pass	# of mort's	Pass type
1	CO			
2	CO			
3	CO			
1	SH YOY			
2	SH YOY			
3	SH YOY			
1	SH 1+			
2	SH 1+			
3	SH 1+			
1	AM			
2	AM			
3	AM			
1	RO			
2	RO			
3	RO			
1	STK			
2	STK			
3	STK			
1	SCU			
2	SCU			
3	SCU			
1				
2				
3				

Comments: _____

Instructions for Index Reach Electrofishing Log

Stream:	Stream name.
Index Reach #:	Number of established sample site
Date:	mm/dd/yy.
Subproject:	Project associated with the survey (Efish Index, Efish Basin, Fish Rescue, Restoration, Other).
Gear Type:	Model/type of electrofisher or type of seine used.
Recorder:	Name (First, Last) of person recording data
Crew:	Names (First, Last) of all personnel.
Section #:	Record the nearest downstream monument tag to be used as a reference point and approximate distance from tag.
Index Reach Unit #:	Numbered sequentially moving upstream, starting with 1 at downstream end of index reach.
Unit Type:	Using CDFG level III classification system. Note primary and secondary types if unit consists of more than one type
BW Unit #:	Numbered sequentially moving upstream, starting with 1 at downstream end.
Time:	Time readout (seconds) from electrofisher for each pass.
Volts:	Electrofisher volts setting for each pass (should be same for all passes on a unit).
Setting:	Electrofisher current/frequency setting for each pass; unpulsed DC is setting used most often (same setting should be used for all passes).
For each species/age class, record the # captured in each pass:	
CO:	Coho
SH YOY:	Steelhead young of year
SH 1+:	Steelhead age 1+
AM:	Lamprey ammocetes (Field identification keys are not yet adequate to determine species)
RO:	California roach
STK:	Three spine stickleback
SCU:	Sculpin (Field identification keys are not yet adequate to determine species)
Other:	Other species captured or comments specific to each pass.
Total Catch:	Total catch per species for all passes.
Mortality:	Mortalities (if any) for each species/age class (include injured individuals if likely mortality)
Comments:	General comments for each unit, including any mortalities or injuries.

Appendix I. Pipe Trap Datasheet

Sheet # ____ of ____

Date ____/____/____

NATIONAL PARK SERVICE COHO SALMON AND STEELHEAD TROUT MONITORING PROGRAM

STREAM: _____

CREW: _____

H₂O TEMP: _____

ARRIVAL TIME: _____

DEPARTURE TIME: _____

WEATHER: _____

STAGE HEIGHT: _____

CIRCLE THIS WEEKS MARK TYPE: PANJET: ANAL (A) LOWER CAUDAL (LC)
PINK (P) BLUE (B) ORANGE (O)

COMMENTS: _____

CLIP OR NOTCH TYPE:

FIN CLIP (C) FIN NOTCH (N)

ANAL (A) UPPER CAUDAL (UC)

LOWER CAUDAL (LC)

TRAP IS: WORKING PARTIALLY WORKING NOT WORKING

Fish #	Species CO, SH, etc.	Fry / Parr Presmolt / Smolt Adult	Fork Length (mm)	Fish Weight (g)	Bag Weight (g)	New Mark/Recap (NUCAN, NLCAN, NA, RUC, RLC, RA, etc.)	Mark Color	Dead	Injured	S	Tissue	Envelope ID	Comments
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													

17													
18													
19													
20													

Recap Code	UN Notch	LC Notch/A Clip	Anal Notch	LC Notch	UC Clip	LC Clip	Anal Clip	Blue Clip	Pink Lower Caudal	Orange Lower Caudal	Pink Anal
Total											

Daily Trap Summary (Recap Summary on back)

Species	Total Live	<u>TOTAL DEAD</u>	<u># NEW</u>	<u># MARKED</u>	<u># RECAP</u>	<u>COMMENTS</u>
COHO SMOLTS						
COHO PRESOLTS						
STEELHEAD SMOLTS						
SH PRESOLTS						
SH PARR						
COHO FRY						
SH FRY						
SCULPIN (SCU)						
ROACH (RO)						
STICKLEBACK (STK)						
OTHER						

RECAP TALLY:

SPECIES CODE	COMMON NAME
AMMA	spotted salamander
BF	Bullfrog
BUAM	eastern american toad
CAN	California newt
CFS	California freshwater shrimp
CGS	California giant salamander
CH	Chinook
CO	Coho salmon

CRAY	Signal crayfish
SWC	Swamp crayfish
CRS	Coastrange sculpin
GSF	Green sunfish
GSH	Golden shiner
LAM	Lamprey spp.
PBL	Pacific brook lamprey
PL	Pacific lamprey
PS	Prickly sculpin
PSS	Pacific staghorn sculpin
PTF	Pacific treefrog
RES	*Red-eared slider
RL	River lamprey
RLF	California red-legged frog
RO	California roach
RS	Riffle sculpin
RSN	Rough-skinned newt
SAL	Unknown salamander/newt
Salmonid	Unknown salmonid
SCU	Sculpin spp.
SH	Steelhead/Rainbow trout
STK	Threespine stickleback
SUC	Sacramento sucker
UNK	Species Unknown
WPT	Western pond turtle
YLF	Foothill yellow-legged frog

Appendix J. Spawner Survey Datasheet

SPAWNER SURVEY DATA SHEET

Sheet # ____ of ____

Stream: _____ Reach: _____ Date: ____/____/____ Weather: _____

Start Time: _____ End Time: _____ Observers: _____ Recorder: _____

Tel: (____) _____ Water Temp: °C ____ °F ____ Water Clarity (cm): _____ Stage (ft.): _____

	Location	Species			Live Fish		Carcasses						Comments (live fish or carcass condition, live fish spawning, etc)
		CO	SH	?	Sex (M/F/?)	Length (cm)	Sex (M/F/?)	Length (cm)	Mark Code	Recap Code	tissue	scales	
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													

Location: Nearest downstream monument tag. **Species:** coho (CO), Steelhead (SH), Unknown (?) **Live Fish:** Estimate sex and length. **Carcass:** Record Sex, Length, Mark Code (# of holes punched), Recap Code (# of holes observed on a previously marked carcass), check if a tissue or scale sample was collected.

Instructions for Spawner Survey Datasheet

The Spawner Survey Datasheet contains the following fields for recording information at the beginning and end of each survey reach. All information must be written in pencil on waterproof copies of the datasheet provided by the park staff. Please write legibly.

Stream:	Record the full name of the stream you are surveying.
Reach:	Record the reach number.
Date:	Enter the survey date in Month / Day / Year format.
Weather:	Record the weather conditions at the time of the survey.
Start Time:	Enter the time at the beginning of the survey.
End Time:	Enter the time at the end of the survey.
Observers:	Enter the first initial and last name of all crew members.
Recorder:	Enter the name (first, last) of the person who is writing the data.
Tel:	Enter the telephone number of the recorder (datasheets can become illegible).
Water Temp:	Record the water temperature in either Celsius (C) or Fahrenheit (F) using thermometers provided by the park staff.
Water Clarity:	Measure water clarity in a pool by noting the depth at which the bottom of the marked survey rod is no longer visible (to the nearest 10 cm).
Stage:	Some stream reaches have staff gauges (graduated plates) to measure water level. If you encounter a gage on your survey, record the water level to the nearest one hundredth of a foot and the time of your observation.
Location:	Record the nearest downstream monument tag and the estimated distance between the monument tag and the location of the fish sighting.
Species:	Check the box for the fish species (coho, steelhead, or unknown).
Live Fish:	For live fish, give the sex (male, female, unknown) and estimated length in cm.
Carcasses:	For any carcasses, give the sex (male, female, unknown) and the length in cm. If it is a new carcass, write down the mark code used on the fish. If it is a recaptured carcass, record the code taken from the fish. If scales and tissue are taken, mark the appropriate boxes.

Comments: Record any comments relative to the fish sighting- fish condition, fish spawning, etc.

REDD SURVEY DATA SHEET

Sheet # _____ of _____

Stream: _____ Reach: _____ Date: ____/____/____ Weather: _____

Start Time: _____ End Time: _____ Observers: _____ Recorder: _____

Tel: (____) _____ Water Temp: _____°C _____°F Water Clarity (cm): _____ Stage (ft.): _____

Specific Location: Bank is designated by looking downstream. Tag # is the nearest downstream monument tag. Tag Dist is an estimated distance from the nearest downstream tag. **New Redd:** Check if redd is new. **New Data:** Check if any previous data has been changed. **Redd Description:** Spec. Coho (CO), Steelhead(SH) Def./? is it a definite redd or a possible test redd. Len is Length of Redd. Wid is Width of Redd. **Fish on Redd:** Coho(CO), Steelhead(SH)

The Redd Survey Datasheet contains the following fields for recording information at the beginning and end of each survey reach. All information must be written in pencil on waterproof copies of the datasheet provided by the Park staff. Please write legibly.

Tel: Enter the telephone number of the recorder (datasheets can become illegible).

Water Temp:	Record the water temperature in either Celsius (C) or Fahrenheit (F) using thermometers provided by the park staff.	
Water Clarity:	Measure water clarity in a pool by noting the depth at which the bottom of the marked survey rod is no longer visible (to the nearest 10 cm).	
Stage:	Some stream reaches have staff gages (graduated plates) to measure water level. If you encounter a gage on your survey, record the water level to the nearest one hundredth of a foot and the time of your observation.	
Specific Location:	Tag #	Nearest downstream monument tag
	Downstream Tag Dist (m)	Estimated distance between monument tag and red location
	Bank	Redd location along bank (Left bank, Right bank, or Main Channel)
New Redd:	Check box if the redd is a new redd with no previous history recorded on it	
New Data:	Check box if the redd is a previously recorded redd but the data taken on it is new	
Redd Description:	Species	Record the species that created the redd
	Def	Record the confidence level of that ID
	Len (m)	Record the length of the redd in meters
	Wid (M)	Record the width of the redd in meters
	Fish on Redd:	
	Species	Record the species of any fish located on redd
	#	Record the number of any fish located on redd
Comments:	Record any information related to the redd such as fish located near redd, carcasses located near the redd, fish spawning near the redd, etc.	

Appendix L. Monument Tag Locations

Table L-1. Location information for monument tags on Olema Creek mainstem.

tag # 25–150	Bank side	Location information	Y Coordinate	X Coordinate
25	LB	Dead Tree		
26	LB	Dead Alder		
27	RB	Willow		
28	LB	Willow		
29	LB	Willow		
30	LB	Alder		
31	LB	Willow upstream of Bear Valley Bridge	4210474.582	518449.107
32	LB	Alder	4210415.108	518469.482
33	RB	Willow	4210313.477	518535.143
34	LB	Alder	4210248.064	518561.182
35	RB	Alder	4210216.606	518599.383
36	RB	Alder	4210209.158	518726.027
37	RB	Alder, more then 100 from tag 36, above bird coop	4210045.126	518831.850
38	RB	Alder	4209982.166	518888.955
39	LB	Alder	4209928.116	518937.568
40	LB	Alder	4209810.380	518986.799
41	RB	Alder, just upstream of Quarry Gulch	4209744.939	519000.133
42	RB	Alder	4209650.182	518948.569
43	LB	Alder, next to cemetery pasture	4209553.186	518957.739
44	LB	Alder	4209481.642	518906.120
45	RB	Alder	4209422.530	518825.283
46	RB	Alder	4209360.595	518810.361
47	RB	Bay	4209323.010	518772.314
48	RB	Alder, 10 m downstream of car wall	4209239.143	518796.988
49	RB	Alder, new tag placed in old tag spot	4209161.829	518824.002
50	LB	Alder high on bank	4209100.117	518905.592
51	LB	Alder, in clump of alders	4209034.247	518990.488
52	RB	Alder	4208920.626	519017.118
53	LB	Alder across from barb wire fence	4208851.608	519028.107
54	RB	Alder bellow large down fir in creek	4208807.133	519098.833
55	RB	Fir tree upon bank from rock face	4208691.644	519090.158
56	LB	Alder	4208680.487	519155.157
57	LB	Alder across from eroded bank, new tag inline w/ old	4208635.921	519186.336

Table L-1. Location information for monument tags on Olema Creek mainstem (continued).

tag # 25–150	Bank side	Location information	Y Coordinate	X Coordinate
58	LB	Alder	4208535.905	519177.155
59	LB	Alder	4208431.792	519197.174
60	RB	Alder	4208418.337	519296.552
61	LB	Alder across from rock wall	4208394.763	519395.013
62	RB	Alder at bottom of index #4	4208373.959	519406.833
63	RB	Alder at top of index #4	4208334.168	519443.654
64	LB	Alder	4208245.016	519497.542
65	LB	Alder	4208213.599	519551.294
66	LB	Alder across from sand stone wall	4208264.462	519664.175
67	RB	Alder	4208061.048	519723.993
68	RB	Alder just up of canyon	4208001.357	519653.037
69	RB	Alder	4207980.082	519716.184
70	RB	Alder, across from Large Woody Debris jam	4207963.606	519794.387
71	RB	Alder just above landslide	4207857.098	519807.830
72	RB	Alder, tag on root of tree	4207801.899	519871.531
73	RB	Alder just upstream of RB trib	4207752.694	519952.171
74	LB	Alder tree across from eroded wall	4207679.610	520003.675
75	LB	Alder across from eroded bank w/ fence at top, tag 20m from crk	4207664.878	520063.984
76	RB	Alder at bottom of index #5, Shook's house	4207573.824	520068.445
77	RB	Alder adjacent to Shook's house	4207484.707	520134.589
78	LB	Alder	4207460.994	520173.261
79	LB	Maple	4207325.892	520176.420
80	RB	Alder, new tag	4207309.372	520235.323
81	LB	Alder	4207334.608	520331.324
82	LB	Alder	4207238.825	520348.986
83	LB	Alder	4207159.761	520387.798
84	RB	Alder	4207088.410	520417.172
85	LB	Alder across from start of pasture on RB	4207000.446	520467.310
86	RB	Alder	4206924.344	520500.465
87	RB	Alder	4206825.017	520528.970
88	LB	Alder, just above horse crossing bath	4206752.617	520613.920
89	LB	Alder across from horse ranch, new tag at old tag loc	4206692.017	520657.870
90	LB	Alder, new tag at old tag location	4206616.512	520691.498
91	LB	Alder, across from trail to Stewart ranch barn, new tag	4206563.081	520745.321
92	LB	Bay 40 m above horse crossing, new tag	4206461.334	520757.824

Table L-1. Location information for monument tags on Olema Creek mainstem (continued).

tag # 25–150	Bank side	Location information	Y Coordinate	X Coordinate
93	RB	Alder 10m above start of index #6, new tag	4206401.330	520801.775
94	RB	alder 5m upstream of utility pole, new tag	4206308.602	520850.049
95	RB	Bay new tag old location	4206227.195	520903.004
96	LB	Buckeye, new tag	4206145.173	520947.956
97	RB	Alder	4206074.496	521007.009
98	RB	Alder, 15m bellow horse camp bridge	4206005.630	521075.949
99	RB	Alder	4205962.938	521138.699
100	RB	Alder	4205870.156	521165.314
101	LB	Bay, boulder in front of tree	4205854.933	521262.376
102	RB	Bay	4205821.858	521360.428
103	LB	Alder	4205769.025	521413.788
104	LB	Dead Alder, 20m bellow Hwy 1 bridge	4205719.208	521482.212
105	RB	Alder adjacent to white house	4205703.988	521579.277
106	RB	Alder	4205632.377	521508.346
107	LB	Alder, 5m upstream of 2 nd HWY 1 bridge	4205525.272	521519.932
108	RB	Alder, 10 m bellow Giacomini crk	4205438.151	521435.379
109	RB	Alder 10m bellow John West Fork	4205373.239	521421.890
110	RB	Alder	4205347.398	521327.284
111	RB	Willow	4205356.739	521257.550
112	RB	Dead Tree	4205364.346	521207.131
113	RB	Alder, right at horse crossing also LB trib	4205315.914	521122.003
114	RB	Bay, hangs over crk	4205239.709	521114.193
115	RB	Alder	4205169.580	521154.411
116	LB	Bay across creek	4205130.335	521169.115
117	RB	Alder across bank, tag at base of down tree	4205091.208	521229.508
118	LB	Buckeye, - fallen	4205053.354	521320.986
119	RB	Alder	4204980.758	521328.241
120	LB	Alder	4204905.298	521377.897
121	RB	Alder	4204870.346	521440.637
122	LB	Alder	4204836.437	521447.321
123	RB	Bay up on bank	4204822.952	521525.078
124	LB	Alder	4204837.694	521472.754
125	RB	Alder up high on bank	4204826.166	521615.510
126	RB	Bay	4204814.512	521709.750
127	RB	Bay	4204798.698	521805.886
128	LB	On down log	4204788.844	521904.832
129	LB	Alder	4204722.337	521962.478

Table L-1. Location information for monument tags on Olema Creek mainstem (continued).

tag # 25–150	Bank side	Location information	Y Coordinate	X Coordinate
130	LB	Alder in index 8	4204656.427	522021.066
131	RB	Bay	4204620.306	522089.938
132	RB	Buckeye, at lime kiln put in	4204560.403	522168.296
133	RB	Alder, new tag at old tag location	4204503.433	522230.630
134	LB	Alder	4204441.092	522287.328
135	LB	Bay trunk	4204413.980	522384.913
136	LB	Alder	4204367.097	522435.446
137	LB	Alder new tag	4204295.267	522503.949
138	RB	Buckeye	4204207.259	522533.399
139	LB	Alder	4204124.028	522568.488
140	LB	Bay	4204064.158	522657.218
141	RB	Bay		
142	RB	Alder		
143	LB	Alder		
144	LB	Alder, new tag at old tag location		
145	LB	Alder, new tag at old tag location		
146	LB	Alder		
147	RB	Alder at Randalls slide		
148	RB	Alder		
149	RB	Maple Tree		

Table L-2. Location information for monument tags on Pine Gulch mainstem.

tag # 01- 95	Bank side	Location information	Y coordinate	X coordinate
1 old	LB	Alder, 50 m upstream of bridge		
1 new	RB	Alder, 15m up from old tag	4197115.375	527237.999
2	RB	Alder	4197015.516	527211.856
3	RB	Alder, 10 m upstream of T post fence across crk	4196962.946	527123.077
4	RB	right before alders lean across crk, hard see walking upstream, behind a bush	4196942.591	527043.614
5	RB	Alder, just downstream of concrete bridge	4196867.253	526999.423
6	LB	Eucalyptus	4196789.117	526935.099
7	RB	Eucalyptus, damll and low down on trunk, hard to see		
8	RB	Alder	4196717.369	526810.508
9	RB	Alder just downstream of little bridge		
10	RB	Eucalyptus across from green building	4196686.399	526633.263
11	LB	Bay	4196754.944	526572.365
12	LB	Alder	4196752.623	526468.331
13	LB	Alder, 40 m upstream of low metal bridge	4196773.945	526394.507
14	RB	Alder fallen across crk	4196859.605	526352.630
15	RB	Alder across from big pulled up root mass	4196963.556	526310.763
16	RB	Alder	4196997.698	526283.607
17	RB	Alder		
18	LB	Alder	4197110.257	526218.444
19	RB	Alder, fallen tree across crk, right at our smolt stie from 2000	4197195.185	526162.902
20	LB	Alder, smaller	4197267.218	526098.361
21	LB	Alder	4197356.608	526096.038
22	LB	Alder hard to see low down up bank 5m, dwns of wood foot bridge to sunny house	4197469.632	526090.324
23	LB	Alder	4197540.372	526067.474
24	LB	Branch of fallen Bay	4197583.926	525974.199
25	LB	Alder	4197663.053	525936.551
26	RB	Alder	4197730.626	525882.681
27	LB	Alder	4197798.354	525808.281
28	LB	Alder 4m up bank	4197879.277	525820.676
29	RB	Bay	4197944.499	525735.417
30	LB	Alder near big gravel LB	4197994.087	525686.895
31	RB	Alder, near house with dogs	4198029.327	525749.323
32	RB	Alder	4198129.210	525725.185
33			4198195.000	525661.500
34			4198258.507	525615.830
35			4198184.180	525528.124
36				

Table L-2. Location information for monument tags on Pine Gulch mainstem (continued).

tag # 01- 95	Bank side	Location information	Y coordinate	X coordinate
37			4198293.698	525421.716
38			4198377.482	525356.726
39			4198411.531	525272.847
40			4198456.282	525202.427
41			4198532.737	525163.039
42			4198567.442	525073.438
43			4198658.314	525034.343
44			4198742.092	524987.572
45				
46			4198865.825	525105.046
47			4198938.265	525173.394
48			4199000.109	525137.804
49	RB	Alder		
50	LB	Alder pasture is up on LB	4199177.588	525202.130
51	LB	Alder, near where road goes up hill	4199281.644	525214.345
52	RB	Alder, broad gravel RB	4199302.187	525131.137
53	RB	Alder?	4199388.123	525118.847
54	LB	Alder	4199492.083	525084.739
55	RB	Alder just upstream of log jam	4199579.412	525027.808
56	LB	Bya, down	4199621.388	524966.263
57	RB	Alder there are redwoods in area		
58	LB	Alder		
59	LB	Redwood		
60	RB	Alder		
61	RB	Alder		
62	RB	Alder pink flagging not blue		
63	RB	Alder pink flagging not blue		
64	RB	Bay pink		
65	LB	Alder, just upstream of concrete slab, pink		
66	MC	Fallen log in middle of stream, pink	4200402.647	525132.832
67	RB	pink		
68	MC	Bay, pink		
69	LB	Alder, downstream of wooden bridge, no flagging	4200605.823	525000.228
70	LB	Alder, Pink		
71	LB	Alder, blue flag		
72				
73	LB	Alder		
74	LB	Alder blue		
75	LB	Alder blue		
76?	RB	Alder, upstream of log jam, blue	4200934.926	524574.181

Table L-2. Location information for monument tags on Pine Gulch mainstem (continued).

tag # 01- 95	Bank side	Location information	Y coordinate	X coordinate
77	RB	Bay, fallen	4201027.904	524531.199
78	MC	Dead wood, blue		
79	LB	Alder, blue flag		
80	RB	Alder, blue flag	4201207.164	524349.347
81	MC	logs fallen across crk	4201288.893	524289.929
82	RB	Alder		
83	LB	Redwood	4201422.592	524145.794
84	RB	Alder		
85	MC	Alder, on MC gravel bar	4201445.939	524025.576
86	RB	Alder, young		
87	MC	Maple, fallen tree across creek, (where old 88 was)		
88	RB	Maple	4201599.602	523895.331
89	LB	Alder, site of old tag 94	4201665.673	523818.992
90	RB	Alder	4201752.343	523771.234
91	RB	Alder	4201786.191	523746.271
92	LB	Alder	4201833.672	523686.914
93	LB	Alder	4201913.831	523641.588
94	RB	Bay	4201936.650	523575.461
95	LB	Alder	4202031.945	523500.144

Table L-3. Location Information for Monument Tags on Redwood Creek Mainstem.

tag # 00- 74	Bank side	Location information	Y coordinates	X coordinates
0	RB	bridge near pelican in	4190845.620	537306.030
1	RB	Alder, just dwnstream of RB shingle house	4190921.140	537239.550
2	LB	Alder, 5m from stream, hard to see	4190975.950	537163.560
3	RB	Buckeye	4191046.980	537090.520
4	LB	Alder, downstream of cement bridge	4191093.680	537007.160
5	LB	Alder	4191156.420	536970.390
6	LB	Alder	4191233.200	536959.780
7	LB	Alder	4191316.810	536924.210
8	RB	Alder	4191377.330	536859.000
9	RB	Alder	4191434.650	536795.390
10	LB	Alder	4191528.480	536745.680
11	LB	Alder	4191594.150	536686.600
12	LB	Alder	4191683.430	536694.820
13	RB	Alder, broken tree	4191773.200	536679.160
14	LB	Alder	4191811.340	536622.170
15	LB	Alder	4191887.430	536653.710
16	RB	Alder	4191947.550	536632.330
17	RB	Alder	4192006.620	536680.550
18	LB	Alder	4192072.780	536751.220
19	LB	Alder	4192148.190	536749.560
20	LB	Alder, 5.4m off creek	4192228.610	536800.190
21	RB	Alder	4192272.130	536841.380
22	LB	Alder, 10 m upstream of foot bridge	4192289.120	536917.130
23	RB	Alder	4192347.180	536991.710
24	RB	Alder, upstream of big WDJ	4192379.690	537058.190
25	LB	Alder	4192471.950	537099.020
26	RB	Alder	4192523.810	537133.670
27	RB	Alder	4192604.830	537184.940
28	RB	Alder	4192661.040	537205.720
29	RB	Alder	4192688.690	537271.220
30	RB	Alder	4192777.510	537349.110
31	LB	Alder	4192834.210	537436.850
32	RB	Alder	4192905.770	537454.820
33	LB	Alder, tree is leaning back, tag a little hard to see	4192932.200	537537.040
34	RB	Alder	4192961.240	537590.080
35	RB	Alder	4193026.800	537669.560
36	LB	Alder	4193077.960	537698.820
37	LB	Alder	4193098.510	537770.520
38	LB	Dead tree	4193143.200	537834.860

Table L-3. Location Information for Monument Tags on Redwood Creek Mainstem (continued).

tag # 00- 74	Bank side	Location information	Y coordinates	X coordinates
39	RB	Alder, 50m downstream of Miwok ped. bridge	4193108.900	537899.240
40	RB	Alder	4193166.850	537976.830
41	RB	Alder	4193248.120	538016.930
42	RB	Alder	4193319.420	538042.290
43	RB	Alder	4193367.850	538100.700
44	RB	Alder	4193465.980	538094.400
45	LB	Alder	4193529.590	538045.540
46	RB	Alder, just downstream of concrete bridge	4193634.610	538034.710
47	LB	Alder, 100m upstream of concrete bridge	4193692.650	537973.360
48	RB	Alder	4193773.470	537931.630
49	RB	Maple	4193809.230	537861.870
50	LB	Alder, just downstream of board bridge, from parking lot	4193872.010	537784.430
51	LB	Alder	4193898.990	537686.180
52	LB	Alder, downstream of cascade	4193946.340	537612.890
53	LB	Alder	4194030.370	537540.090
54	LB	Alder	4194082.060	537451.710
55	LB	dead tree	4194118.000	537413.720
56	RB	Bay	4194185.640	537356.250
57	RB	Bay	4194285.850	537357.340
58	LB	fence post	4194392.970	537317.260
59	RB	Maple	4194476.720	537345.240
60	LB	Bay	4194568.640	537330.200
61	LB	bay, upstream of bridge, upstreamside of tree	4194633.670	537263.340
62	LB	Redwood	4194715.430	537225.400
63	LB	Redwood, 10 m up from bottom of index 6	4194790.410	537150.140
64			4194863.830	537076.620
65			4194905.790	536993.420
66			4194927.220	536909.660
67			4194954.450	536815.490
68			4194986.950	536742.250
69			4195038.870	536676.470
70	RB	Maple, downstream of log across creek	4195076.110	536592.120
71	LB	tree root, just downstream Alice Eastwood Trail sign	4195127.020	536523.670
72	LB	Redwood	4195160.220	536440.300
73	LB	Redwood, small	4195156.520	536343.490
74	LB	Redwood	4195167.030	536280.090

Appendix M. Landowner Access Agreement

POINT REYES NATIONAL SEASHORE/PRNSA
1 BEAR VALLEY ROAD
POINT REYES STATION, CA 94956

ACCESS/ENTRY AGREEMENT Coastal Marin Long-term Coho Salmon and Steelhead Monitoring Program

PURPOSE

The following agreement details the requirements of the landowner regarding implementation of the Long-Term Coho Salmon and Steelhead Monitoring Program in Coastal Marin County. The long-term monitoring project has been conducted in these areas for the past nine years. The watershed property is contained within the following historic land grand areas: Tomales Y Baulines, Punta de los Reyes, Ranch las Baulines, Saucelito Rancho, Rancho de Nicasio.

All monitoring locations in Olema and Cheda Creek are located within National Park Service lands. Within the Redwood Creek watershed, all monitoring locations are on either National Park Service or California State Park land. The NPS and State Parks have a working agreement with regard to access, monitoring and restoration. Within private lands on Pine Gulch Creek, the National Park Service has working arrangements with landowners access to the stream and existing monitoring equipment.

The project monitoring is conducted through this monitoring program is conducted under Section 10 Permit 1046 issued through the National Marine Fisheries Service. The National Park Service is also working to develop a memorandum of understanding with regard to monitoring effects on state listed species.

Information collected through this monitoring program will be maintained and reported by the National Park Service.

REQUIREMENTS

The National Park Service agrees to:

Support and maintain the long-term fisheries monitoring program on NPS lands.

Maintain existing relationships with private landowners for access on their property. This is an issue only in Pine Gulch Creek. In this area, the NPS is facilitating development of a water operations program hat includes construction of off-stream irrigation ponds. The farmers are working with the NPS on this project and have allowed access as necessary for hydrologic and fisheries monitoring.

DURATION OF NOTICE

The term of this agreement shall extend for the duration of the project (up to five years), for maintenance, inspection, and monitoring purposes from the last date of execution shown below. This is provided that the California Department of Fish and Game shall give landowner

reasonable actual notice prior to each needed access. Reasonable and actual notice may be given by mail, in person, or by telephone.

This agreement can be amended only by prior written agreement of both parties executing this permit.

LIABILITIES

Reasonable precautions will be exercised by the National Park Service to avoid damage to persons and property.

Date _____

Don L. Neubacher, Superintendent
Point Reyes National Seashore

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 963/102568, May 2010

National Park Service
U.S. Department of the Interior



Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA™