Workshop Proceedings California Monitoring Program (CMP) Workshop Series

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Executive Summary

The California Monitoring Program (CMP)[1], developed by the California Department of Fish and Wildlife (CDFW) and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries), informs agency species status reviews, state and federal recovery plans, and management activities such as hatchery operations and fisheries management. The CMP strategy, design, and methods were established by Adams et al. (2011), and the program has operated for over a decade. A five-session virtual workshop series was held in May 2021 to explore lessons learned from CMP implementation, review questions the monitoring program seeks to answer about viable salmonid population (VSP) parameters and identify next steps and updates to methodologies to make the program more effective, efficient, flexible, and adaptive. VSP parameters are used to assess the extinction risk of state and federally listed salmon and steelhead populations (salmonids) in California. Abundance, productivity, diversity, and spatial structure are the key parameters of VSP. Over 80 participants attended the workshop including scientists from multiple organizations collecting and evaluating data, from state and federal agencies, and from non-governmental organizations engaged in salmon and steelhead population management. In Session 1 we reviewed the history and context of CMP development, program structure, and use of CMP data in federal species viability assessments. In Session 2 summaries were provided by those conducting CMP monitoring, highlighting areas of successes and remaining challenges. In Session 3 we explored other salmonid monitoring approaches in California to determine if there are aspects of these programs that can inform CMP. In Session 4 we sought to identify next steps and updates to methodologies and sampling designs to make CMP more effective, efficient, flexible, and adaptive. The last session was attended by only CDFW and NOAA Fisheries representatives and was intended to synthesize workshop outcomes and next steps for the CMP. Key findings of the workshop include the following:

- A decade of CMP implementation has significantly advanced our understanding of salmonid abundance, productivity, diversity, and spatial structure, as well as needed technical and programmatic advances.
- Some datasets are approaching or exceeding the 12–16 years of uninterrupted monitoring needed to evaluate federal recovery plan criteria.

[1] The California Monitoring Program (CMP) has evolved through time and has been referred to historically as the California Coastal Monitoring Plan based on the title of Fish Bulletin 180

- As these time series of data become longer and sampling designs are refined, the information will increase greatly in its value for species status assessments, management and state and federal recovery planning.
- The original CMP sampling design did not explicitly describe populations as the building blocks of Evolutionarily Significant Units or Distinct Population Segments viability. Thus, recognition of populations or groups of populations as the explicit targets of monitoring will help guide future updates to sampling strategies.
- The CMP strategy should be updated to be flexible enough to accommodate new methodological and technological advances and funding levels, while maintaining comparability across datasets.
- The CMP Science Team will look to enhance collaboration and communication among agencies and collaborating scientists, and provide opportunities for technical assistance, guidance, and collective problem solving.
- The CMP would benefit from a re-established joint state and federal CMP management structure that is empowered to make decisions regarding CMP implementation.
- The CMP would benefit from the identification of additional stable, long-term funding sources to supplement the Pacific Salmon Recovery Fund (PCSRF), which is currently the dominant source of CMP implementation funds.

This document provides a synthesis of the workshop proceedings including session objectives, abstracts of presentations[2], and a summary of major themes identified from discussions and break out groups.

[2] Abstracts were submitted by authors and have not been altered by the authors of this document.

Foundations of CMP and 2021 CMP Workshop Series

Introduction and Background

The California Monitoring Program (CMP) is a comprehensive approach to collecting data on coastal and inland salmon and steelhead populations, groups of populations (Diversity Groups/Strata), and their Evolutionary Significant Units (ESU) or Distinct Population Segments (DPS). The CMP uses the Viable Salmonid Population (VSP) concept (McElhany et al. 2000) as the framework to assess salmonid viability in terms of four key population characteristics: abundance, productivity, spatial structure, and diversity.

CMP was developed by the California Department of Fish and Wildlife (CDFW) and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) and informs agency species status reviews, state and federal recovery plans, and management activities such as hatchery operations and fisheries management. The CMP strategy, design, and methods were established by Adams et al. (2011), and the program has operated for over a decade. The design of CMP, however, came before the final publication of federal recovery plans for coastal salmonids. These asynchronous publications suggested a need to review potential mismatches between data needed and data generated, as well as any relevant technical advances or lessons learned in the past 10 years.

Notwithstanding, some datasets are approaching or exceeding the 12–16 years of uninterrupted monitoring needed to evaluate populations relative to federal recovery plan criteria. As these time series of data become longer and sampling designs are refined, the information will increase greatly in its value for species status assessments, species management and implementation of recovery actions. Furthermore, our ability to assess the status of smaller populations, which were poorly understood prior to development of the CMP, has vastly improved. In order to explore lessons learned from CMP implementation and identify areas for program improvements, CDFW and NOAA Fisheries hosted a workshop series in 2021.

Objectives

The comprehensive goal for the CMP workshop series was to explore lessons learned from the last decade of CMP implementation, review VSP questions we seek to answer with CMP, and identify next steps and updates to field and analytical methods to make the program more effective, efficient, flexible, and adaptive.

Planning Committee

A CDFW and NOAA Fisheries workshop planning committee was formed, and monthly meetings were held from April 2020 to April 2021. The planning

committee set workshop objectives, formulated breakout discussion questions, invited presenters, gave presentations, and participated as breakout discussion facilitators. A representative from Trout Unlimited moderated the workshop. The information technology (IT) subteam from NOAA Fisheries and CDFW managed the virtual platform and calendar invitations.

Workshop Series Timeline

Session 1 - History and Context of CMP and CMP in Practice: May 3, 2021
Session 2 - From the Field: May 7, 2021
Session 3 - From the Field Continued: May 17, 2021
Session 4 - Revisiting the CMP Toolbox: May 21, 2021
Session 5 - Exploring Outcomes and Next Steps: May 24, 2021

Sessions were conducted from 9:00am to 4:00pm on a virtual platform and included Q/A, discussion rooms, panel conversations, breaks, and lunch. The workshop was invitation-only to bring together technical experts from across California to discuss the foundations and purposes of CMP, as well as emerging ideas and new technologies.

Workshop Series, Session 1 & Themes: Workshop Kick-Off, History and Context of CMP, and CMP in Practice

Objectives

Provide a high-level overview on CMP history and context, accomplishments and lessons learned from a decade of CMP implementation, and how data are being used by CDFW and NOAA Fisheries.

Presentations

The topics presented were intended to describe why and how the CMP was established, to summarize the timeline of its conception relative to criteria established to assess salmonid population viability, and to reflect on CMP achievements to date. The afternoon was used to describe the CMP Science Team's structure and its work on technical aspects of CMP implementation. The last presentations highlighted what has been accomplished through the implementation of CMP and how data are being used in federal status reviews.

Group Discussion

Open-ended discussion was guided by the facilitator and initiated with the following set of questions.

- What is it we're trying to accomplish with CMP?
- Is the CMP framework built to tell us when populations achieve recovery?
- What key information gaps exist for status reviews, recovery planning, and/or management of coastal salmonid populations? What types of monitoring are needed to address those gaps?
- What is the biggest gap (spatial and/or inferential) in our understanding of VSP (abundance, population growth rate, spatial structure, and diversity) so far?
- How can the CMP Science Team best support CMP implementation moving forward?
- How can we support/include external partners?

Notes were taken during the open and free-flow conversation, and the major discussion themes captured included;

1. The Adams et al. (2011) Fish Bulletin 180 described a coast-wide, design-based sampling plan. Limitations on implementation, status of coast-wide sample frames, and program structure (e.g. funding, staffing, partnerships) could not support an immediate coast-wide implementation. Instead, monitoring was initiated in specific areas for

specific species, with implementation gradually expanding as capacity allowed.
2. Sampling of adult abundance was and continues to be technically challenging. Getting started in adult sampling was necessary to learn what would work, but the initial desire to have uniform methods everywhere may be unrealistic due to diverse site conditions. This workshop's intent is to review this progress and review what is working and what might be adapted to better meet data needs.
3. The NMFS framework of viability assessments has better informed the scope and scale of adult sampling. CMP has a good understanding of logistical constraints, cost, and limitations of implementing adult monitoring. The future success of CMP implementation will need to match adequate baseline level program resources with the scale of monitoring needed to inform recovery criteria.

Session 1 Presentation Abstracts

Foundations of the California Coastal Salmonid Monitoring Plan

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Abstract: In the 1990's, in response to declines of anadromous salmonid populations, the National Marine Fisheries Service received petitions to list Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*Oncorhynchus tshawytscha*), and steelhead (*Oncorhynchus mykiss*) under the Federal Endangered Species Act. The Act allows the listing of "distinct population segments" as well as named species and subspecies. Pacific salmonid populations are considered "distinct" if they represent an Evolutionarily Significant Unit of the species as a whole (Waples 1991). Evolutionarily Significant Units of all three species were found to warrant listing under the Act in California. McElhany et al. (2000) defined four attributes of populations, known as Viable Salmonid Population parameters, that are considered for recovery. Parameters include abundance, productivity, spatial structure, and diversity. A viable Evolutionarily Significant Unit is buffered from localized catastrophic events, resilient to long-term demographic processes, and maintains long-term evolutionary potential. The California Coastal Salmonid Monitoring Plan began pilot efforts in 2002 to provide information on viability parameters. Concurrent with the development of the

monitoring strategy, the National Marine Fisheries Service delineated historical population structures and established objective, measurable criteria that when met, would define when Evolutionarily Significant Units are naturally self-sustaining with a low extinction risk. These criteria incorporate population abundance targets and the distribution of connected viable populations across the landscape. The parallel development of the landscape-level sampling envisioned by the monitoring program, and the criteria for viability assessment has resulted in a spatial mismatch. Viability assessments are made from building population-level information whereas the sampling design of the monitoring program envisioned decomposing large-scale sampling down to population levels. As the California Coastal Monitoring Plan moves forward, we should look to refine sampling designs and information types that efficiently and directly inform recovery criteria.

Key words: Viable Salmonid Populations, California Monitoring Plan, population viability framework

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California Monitoring Plan Science Team and sub-team development, efforts, and next steps

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Abstract: The California Monitoring Plan Science Team was established in 2011 to help ensure that all aspects of the plan are implemented in an efficient, effective, scientifically based, and technically sound manner. Over the last decade, the Science Team developed a series of sub-teams to focus on technical issues related to a particular topic. These sub-teams included the following groups: Sample Frame, Methods, Conceptual Analysis, Data Management, Southern Steelhead, Habitat, and Estuary. The Sample Frame sub-team objectives included the development of a process to create

population and regional sample frames. Through time, protocols were drafted, and watershed-scale sample frames were developed as resources became available. Next steps include continued development of sample frames along the south coast and the utilization of existing frames to address broader population questions. The Southern Steelhead sub-team objective was to draft a plan that provided detailed strategies, designs, and methodologies to monitor steelhead throughout the southern portion of California. After extensive review and input by practitioners, managers, and peers, the plan is nearly finalized and will be published in 2022. Over the last decade, the Data Management sub-team has developed a mature database with a robust schema, protocols for using the database, and a comprehensive strategy for collecting, maintaining, and sharing monitoring data. Moving forward, the sub-team seeks support to develop a statewide enterprise solution. The Methods and Conceptual Analysis sub-teams have developed written protocols for spawning ground surveys, juvenile snorkel surveys, and developed an analytical framework to generate regional redd abundance. Next steps include the incorporation of new methodologies into the monitoring plan. The Estuary sub-team made some progress in 2012 towards their goal of developing a sampling protocol that will categorize and quantify estuarine habitats, and estimate the relative abundance, distribution, and productivity of juvenile salmonids in estuaries. To continue this effort, the Estuary sub-team will need to be reestablished. The goal of the Habitat sub-team was to develop a monitoring plan to determine trends in habitat quantity and quality at regional and watershed scales. The sub-team is currently summarizing habitat monitoring techniques, metrics, and definitions used regionally, and plans to draft recommendations for implementing stream habitat monitoring.

Key words: analysis, California Monitoring Plan, data management, estuary, habitat, methods, sample frame, Science Team, southern steelhead

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California Monitoring Plan implementation through time and space: Part 1

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Abstract: A synthesis of annual salmonid monitoring efforts is explored to understand how the implementation of the California Monitoring Plan (CMP) impacts salmonid population data collected through time and space. The data set evaluated is focused on listed salmonid populations along the California coast, however some data from Klamath River and Trinity River basins are included. Annual metrics that summarize population abundance, productivity, and spatial structure are considered. Most of the data collected are focused on adult population monitoring and the three target species monitored are Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), and steelhead (*O. mykiss*). Monitoring coverage generally follows the distribution of all three species along the coast, although there are some gaps along the Central and Southern California coast. The diversity of monitoring methods used have expanded through time, likely due to advances in technology and the implementation of CMP. The spatial extent of monitoring expanded for all three species with the implementation of CMP, however most of the monitoring and reporting is abundance focused. The geographic extent of monitoring coverage within an evolutionarily significant unit or distinct population segment relies on a series of independent monitoring projects. In some cases, adult abundance estimates are spatially and/or temporally limited and not considered a full population estimate, particularly for steelhead. As CMP continues, resources for monitoring are likely to fluctuate and it will be important to maximize monitoring efficiencies when possible. New and existing CMP monitoring efforts where Coho Salmon and steelhead are present should consider extending the monitoring time frame and spatial extent to include both species. It will also be necessary to maximize sampling efficiency and identify the most important data needed for assessing species status and trends, as well as fisheries management.

Key words: abundance, California Monitoring Plan, implementation, population, productivity, salmonids, spatial structure

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Coastal California Monitoring Plan implementation through time and space: Part 2

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Abstract: The Northern Monitoring area of the California Coastal Salmonid Monitoring Plan includes all coastal watersheds from Aptos Creek in Monterey Bay to the Oregon border. Adams et al. (2011) envisioned design-based Generalized Random Tessellation Stratified sampling of stream reaches to estimate status and trend of adult salmonids via spawning ground surveys. The sampling design describes drawing a single sample of all reaches from a large sample frame then based upon the spatially balanced reverse hierarchical ordered list of reaches, specifying a membership design which relates reaches to panels, and finally a revisit design that relates panels to sampling schedule over a 30 year time horizon. The area could be partitioned into smaller sub-domains (e.g., populations) with augmented sampling as needed to achieve sub-domain estimates. The implementation of the plan over the past 10 years, however, has been piecewise, building from smaller scales up to achieve eventual larger scale coverage. Sample draws have been taken independently at the smaller scales, panels and membership designs independently and asymmetrically applied across, oftentimes, small sample frames. Sampling has haphazardly shifted between sub-regions, resulting in an incomplete patchwork of spatial coverage. The design elements of Adams et al. (2011) were well considered for a large landscape monitoring strategy but have been implemented differently than envisioned. The last 10 years of plan implementation has, however, positioned the program well to evaluate sampling design choices moving forward. The Northern monitoring area sample frame has now been nearly entirely constructed, and between reach variability in abundance well understood to guide sampling intensity at sub-domain scales. It is recommended that target sub-domains of estimation be identified, and sampling designs be considered that connect the sampling scheme across space and time to better achieve objectives of status and trend estimation.

Key words: California Monitoring Plan, monitoring design, sub-domain estimation

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Use of Coastal Monitoring Plan data in National Marine Fisheries Service viability assessment: North-Central California Coast Recovery Domain

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Abstract: The Federal Endangered Species Act (ESA) requires NOAA Fisheries to reassess the status of ESA-listed species every five years. Criteria have been developed at spatial scales ranging from individual populations to diversity strata (groups of populations inhabiting similar environments) for the purpose of assessing viability and progress toward recovery. Application of these criteria depends on availability of estimates of adult abundance for populations across each listed ESU/DPS. Implementation of California's Coastal Monitoring Plan (CMP) in the North-Central California Coast Recovery Domain has dramatically improved population information available for these assessments. Population-level estimates of adult abundance for independent populations of steelhead, Coho Salmon, and Chinook Salmon increased from just three populations in 2005 to as many as 55 for the 2020 viability assessment, an increase almost entirely due to CMP efforts.

Despite these significant gains, viability assessments remain hampered by several issues. First, significant spatial data gaps remain for certain diversity strata, particularly for steelhead populations in the interior Eel River basin and San Francisco Bay region. Second, several CMP programs have focused on Coho Salmon, such that the full spatial and temporal extent of spawning for other species is not encompassed. Consequently, data produced for steelhead are unsuitable for evaluating status or trends. Third, funding for several monitoring efforts has been intermittent, producing data gaps that preclude calculation of important viability metrics. Fourth, reliable methods for expanding redd estimates to population abundance have been elusive in certain areas, hindering direct comparison of these population indices with viability and recovery targets. Lastly, assignment of redds to species has proved difficult, leading to high uncertainty of Coho Salmon and steelhead estimates in certain regions (e.g., Santa Cruz Mountains). Finite resources prevent expanding programs to address all of these issues; nevertheless, reallocating existing monitoring effort could potentially produce more useful data without sacrificing key information.

Key words: California, Coastal Monitoring Plan, Endangered Species Act, population monitoring, status reviews, viability assessments

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CMP and viability assessments in southern and south-central California

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Abstract: Recent CMP data on adult abundances and low-flow juvenile densities both indicate the recent drought had large impacts, with generally negative trends observed in all indicators, most with statistical significance. Since the end of the drought in 2017 all indicators have ticked upward in the South-Central DPS but not in the southern DPS. This is probably because the drought lasted longer in southern California, and because *O. mykiss* populations persisted as resident trout in drought refugia, but all drought refugia in the southern DPS are above impassable migration barriers. In the southern DPS prior to the drought, adult counts were either zero or in the single digits; during the drought, expression of the adult steelhead life-history has nearly disappeared. A positive finding is that we now have a better understanding of the underlying genetic architecture that allows runs of steelhead to decline to zero during adverse conditions for anadromy, and then be reconstituted by populations of rainbow trout when conditions improve. This new information indicates that the precautionary-based viability criteria developed during recovery planning can be modified, but additional synthesis work is needed to develop new risk-based viability criteria. Populations will need periods when individuals homozygous for the anadromous "supergene" are frequent enough that evolutionary processes can allow the species to adapt to changing conditions, which is not currently the case. Moreover, in subpopulations isolated above impassable dams, the anadromous supergene appears to be adapting to reservoir conditions. With respect to monitoring, the relative frequency of the anadromous supergene in populations uninfluenced by reservoirs can be used as a lagging indicator for sustained past expression of the steelhead phenotype and thus to identify populations where it is being favored by natural selection. Unfortunately, monitoring of status and trends continues to be unsatisfactory in this DPS.

Key words: California, endangered species, extinction risk, anadromy, salmonids, supergene, streams

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Workshop Series, Session 2 & Themes: From the Field - CMP Implementation Across the California Coast

Objectives

The Session 2 objectives were to gain perspective from practitioners on CMP implementation, successes, and challenges from a regional and project-level view. The CMP technical subteam provided a presentation outline to presenters to ensure coverage of the following topics: focal species, monitoring landscape, timeline of monitoring efforts, partners, sampling strategy, findings, key successes, and areas for refinements and improvements.

Presentations

Practitioners from across the state provided 15-minute presentations summarizing CMP implementation efforts, successes, and challenges. Monitoring efforts were summarized in the Northern monitoring area, Mendocino Coastal region, Russian River watershed, Lagunitas Creek watershed, San Mateo-Big Basin region, Scott Creek watershed, Big Sur River watershed, San Luis Obispo Creek watershed, and the Ventura River watershed. The Session 2 presentation titles, authors, and abstracts (if provided) are given in the presentation details and abstracts section.

Breakout and Discussion

The following questions were provided to session breakout groups to help facilitate discussion:

- What are the biggest challenges of CMP application and suggested solutions?
- What are the important technical aspects of CMP (e.g., data uncertainties, parameter estimation, VSP inference)?
- What are the most important ways Life Cycle Monitoring (LCM) stations can support CMP objectives?
- What methods are being used for DIDSON data analysis to develop adult salmonid population abundances? If the data are being validated, how is that accomplished?
- How does landowner access impact CMP implementation on small or large spatial scales?
- How do we address variable spawner:redd ratios among sub-watersheds in the same year?
- How do we update protocols to better monitor populations at extremely low levels?

Breakout groups recorded their discussions for the planning team and reported back to the workshop participants. Major discussion themes included the following:

1. There should be flexibility in the methodology taking into account species and life stages monitored to fit site and environmental conditions and data needs. Detecting and assigning species to unidentified redds remains challenging in low abundance areas. Redd surveys are also impractical in some areas due to high sediment bedloads that obscure redds, or areas that are consistently inaccessible. To account for these difficulties, juvenile surveys can be standardized across regions and provide valuable information to assess Coho Salmon and steelhead distribution while providing information relevant for restoration and recovery planning.
2. Funding stability across ESUs and DPSs should remain a high priority for CMP because it ensures the continuity of geographic coverage, long term data sets, project personnel, site access and infrastructure.
3. Members of the CMP Science Team should work to improve technical communication between practitioners and statewide CMP teams. Contributing practitioners should be recognized and included in data synthesis and statewide reporting.
4. Leverage surveys to collect biological samples that inform life history diversity (e.g., differentiate between residents/anadromous forms of *O. mykiss*, run-type, and identification of juvenile rearing areas).
5. A major challenge with CMP implementation includes site access, which creates spatial data gaps at a recovery domain scale.

Session 2 Presentation Abstracts

From the field: Northern California Coastal Monitoring Plan implementation and lessons learned

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Abstract: Over ten years of implementation of the California Monitoring Plan (CMP) in Northern California is reviewed with an eye toward successes and potential improvements to the program moving forward. Two complementary tasks are considered high priority in the Northern Monitoring Area and form the foundation of the CMP approach. The first task consists of probabilistic sampling of stream reaches within a defined region using Spawning Ground Surveys (SGS) to establish the regional status and trends

of adult salmonid abundance. The second task develops intensively monitored Life Cycle Monitoring (LCM) stations nested within the regional sample frames of the SGS. Estimates of total redd construction from SGS surveys correlate strongly with mark-recapture estimates of total escapement of Coho Salmon (*Oncorhynchus kisutch*) in Freshwater Creek LCM station. The outstanding variability is largely explained as a function of stream discharge timing and magnitude affecting the SGS intra-annual site return interval. SONAR estimates of Chinook Salmon (*Oncorhynchus tshawytscha*) abundance, however, track poorly with SGS estimates of redd construction in Redwood Creek LCM. Fewer surveys were able to be conducted within spawning seasons and redds remained available for observation for shorter periods. A meta-analysis of redd observations across CMP projects and years indicate 60-85% of redds observed are of unknown species origin. Redd species prediction model validation indicates an 85% accuracy when data is aggregated across all projects and years with little species bias. In low-abundance, mixed-stock spawning ground settings, however, observations of known species can be rare, and provide ambiguous inference into both abundance and site occupancy. Summer season juvenile snorkel surveys have been developed to define the regional spatial structure of Coho Salmon and steelhead (*Oncorhynchus mykiss*). Because detection of juveniles is high relative to adult spawning, this survey technique is well suited for sparsely occupied habitats. Multiple LCM stations have developed study designs using tagging and mark-recapture designs to investigate life history-specific survival rates for Coho Salmon. Projected future stock abundances from population dynamics models incorporating multiple life history pathways based on life cycle monitoring are used to evaluate the potential effect of targeted restoration scenarios. These tools can formally link monitoring programs to targeted recovery planning. Monitoring partnerships including State and Federal Agencies, Non-Government Organizations, Tribes, and academia have been successful in advancing CMP objectives.

Key words: California Monitoring Plan, spawning ground surveys, life cycle monitoring, salmonid spatial structure, recovery planning, monitoring partnerships

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From the field: Mendocino Coast

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Coastal Monitoring Program implementation in the Russian River

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Abstract: The Russian River watershed area is 3,846 km^2 draining over 2,500 km of stream length in more than 2,800 tributaries to the 177 km long mainstem. It provides habitat for Central California Coast Coho Salmon, Central California Coast Steelhead, and California Coastal Chinook Salmon. Beginning in 2013, the California Coastal Salmonid Monitoring Plan (CMP) was implemented for all three species; however, California Sea Grant and Sonoma Water have been conducting life cycle monitoring for one or more of these species since 2000. To develop the sample frame, a desktop exercise relying on a variety of data including NOAA's Intrinsic potential model, CDFW's Passage Assessment Database and habitat reports, as well as expert opinion was followed-up with extensive ground-truthing resulting in a sample frame consisting of 472, 2-4 km long reaches that provide habitat for one or more of the three species. Reaches in the sample frame are stratified to reflect species- and life stage- specific habitat requirements, and basinwide, Generalized Random Tessellation Stratified sampling is employed along with rotating panels to balance the dual goals of status estimation and trend detection. Life cycle monitoring in the basin has evolved. Initially, coho and steelhead monitoring occurred in the Dry Creek sub-watershed; however, several factors led us to move life cycle monitoring to four sub-watersheds that provide habitat for both species. The Chinook life cycle monitoring station is located at Sonoma Water's seasonal dam on the mainstem of the Russian River near Forestville. Although we have overcome some of the challenges of CMP implementation in the Russian through approaches that include PIT-tagging, effects on sampling for juvenile spatial distribution remain. Issues such as redd species estimation and spatiotemporal variability in spawner: redd ratios common to other CMP programs in California are also problematic in the Russian.

Key words: Coastal Monitoring Program, life cycle monitoring, Russian River, salmon, sample frame, steelhead

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Coho and steelhead monitoring in Lagunitas Creek watershed

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Abstract: The Lagunitas Creek watershed, located in Marin County, California, is home to the most southern stable population of coho salmon (*Oncorhynchus kisutch*) in the species native range. This watershed is described as a stronghold for the recovery of coho salmon populations within the Central California Coast Evolutionarily Significant Unit. Both state and local agencies have undertaken various monitoring activities within the watershed since the 1970's to inform management decisions. Long-term coho salmon monitoring was initiated by Marin Water in 1995 as a mitigation measure for the expansion of Kent Lake, a major reservoir in the watershed. In 2006, Marin Water increased monitoring efforts to include outmigrant smolt trapping along with adult and juvenile coho surveys to inform resource managers on limitations to coho survival in the mainstem of Lagunitas Creek. Lying mostly within National Park Service lands, Olema Creek is the largest tributary to Lagunitas Creek and provides the most unimpaired habitat for coho salmon within the watershed. Since 2004, the National Park Service has used a coho life cycle monitoring program in Olema Creek to document population changes. The National Park Service's monitoring program uses spawning ground surveys, outmigrant smolt trapping, and summer systematic juvenile coho surveys to describe long-term trends and population limitations. The Salmon Protection and Watershed Network is a nonprofit organization in Marin County that has performed independent spawner ground surveys since 2002 and, more recently, smolt trapping in tributaries to Lagunitas Creek located mainly on private lands. Combined, the information collected by these three organizations has helped describe temporal and spatial changes at the adult spawner, outmigrant smolt, and summer juvenile life stages for the Lagunitas Creek coho salmon population. In addition to showing population trends, this data is used to determine limiting factors to coho salmon survival. Continued life cycle monitoring, along with focused studies for particular management questions, will further direct restoration activities in the Lagunitas Creek watershed and hopefully result in the recovery of this species region-wide.

Key words: coho, Lagunitas Creek, Marin Water, National Park Service, Olema Creek, salmon, Salmon Protection and Watershed Network

California Coastal Monitoring Plan in Santa Cruz and San Mateo counties

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Abstract: The California Coastal Monitoring Plan (CMP) was implemented in the San Mateo-Big Basin region beginning in 2011 with a focus on endangered Central California Coast (CCC) Coho Salmon (Oncorhynchus kitsuch) and threatened CCC steelhead trout (Oncorhynchus mykiss). Regional sample frame development continued until 2013 when a Generalized Random Tessellation Stratified design was implemented for the Coho salmon sample frame, resulting in a three-year rotating panel of survey reaches. The rotating panel was updated in 2016 to a six-year rotation with 30 survey reaches per season, which was 23% of the 131 total reaches in the sample frame. Adult salmonid spawning surveys were conducted annually, and juvenile coho snorkel surveys began in 2017. Due to the extreme low population levels present in the San Mateo-Big Basin region, only one adult escapement estimate greater than zero was produced over the course of the project. For similar reasons, no juvenile Coho salmon occupancy estimates were possible following snorkel surveys. Several challenges to CMP implementation exist in the San Mateo-Big Basin region. Each season 13-20% of targeted survey reaches were rejected due to a lack of consent from private landowners, which may have created a sampling bias in favor of more accessible locations. Additionally, CMP methodology was created in northern California rivers and was difficult to adapt to the stream conditions and low population levels present in the region. Lastly, the San Mateo-Big Basin project was hindered by a lack of consistent funding, which impacted the ability to complete long term population status and trend reviews.

Key words: California Coastal Monitoring Plan; Coho salmon; Santa Cruz; San Mateo; steelhead trout

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Implementing the California Monitoring Plan in the Santa Cruz Mountains: Scott Creek life cycle monitoring station.

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Abstract: The Scott Creek salmonid life cycle monitoring (LCM) station in Santa Cruz County is the only fixed counting station in the Santa Cruz Mountains Diversity Stratum. Operated by NOAA Fisheries and the University of California Santa Cruz since 2003, the Scott Creek LCM station has generated an important time series of key viability metrics for both Central California Coast Coho Salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*). While the methods outlined in the California Monitoring Plan have yielded robust annual estimates of adult and juvenile abundance and survival, a number of methodological challenges have emerged during implementation of spawning ground surveys in Scott Creek. The assignment of redds to species is a vexing problem due to high spatial and temporal overlap of adult Coho Salmon and steelhead during winter, and because live fish and (or) carcasses are rarely encountered near redds. In general, the use of the *k*-nearest neighbors algorithm outperforms logistic regression methods for redd assignment; however, the low abundance of Coho Salmon in Scott Creek—and elsewhere in the diversity stratum—routinely biases redd assignment towards steelhead. There is also considerable uncertainty surrounding inter-annual variability in the spawner to redd ratios derived at the Scott Creek LCM station, and the applicability of these ratios to other watersheds in the region. Summer/fall juvenile snorkel surveys have proven to be an effective method for monitoring the status of Coho Salmon in Scott Creek, particularly when fish are in very low abundance. Consequently, snorkel surveys may warrant consideration as an alternative to spawning ground surveys to assess the status and trends of Coho Salmon populations in the Santa Cruz Mountains Diversity Stratum.

Key words: California, conservation, endangered species, life cycle, population monitoring, salmonids, status and trend, viability

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Status of the California Coastal Monitoring Program in Monterey County, California

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Abstract: The primary goal of the Department of Fish and Wildlife's California Monitoring Program in Monterey County is to determine the population status and trends of steelhead trout (Oncorhynchus mykiss) on the Big Sur River. Staff produced the first ever adult steelhead population estimates for the 2017 water-year and has continued to calculate yearly estimates for the Big Sur River. This standardized monitoring study is used to determine steelhead population status, the spatial distribution of spawning adults and to potentially inform effectiveness of riverine restoration on the local population of steelhead trout. To accomplish this goal, two methods are used to determine population status including spawning ground surveys and a Dual-frequency identification sonar camera which records images of adult steelhead trout. The escapement estimate for the 2017 water-year is 228 adult steelhead trout. For the 2018 water-year, staff estimated an escapement of 112 adult steelhead trout and 324 for the 2019 water-year. Population estimates from the Dual-frequency identification sonar data are compared to results from spawning ground surveys and serve as a quality control for the sonar data. Lastly, staff have been developing a survey sample-frame for the entire South-Central California Coast Steelhead Distinct Population Segment Federal management area. When completed, this sample-frame will allow for spatially and statistically surveys of both adult and juvenile steelhead using individual small unit reaches and derive population estimates for the entire management area.

Key words: population estimate, South-Central California Coast Steelhead Distinct Population Segment, sonar camera, steelhead trout, water-year

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San Luis Obispo Creek Watershed

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The San Luis Obispo Terrace Biogeographical Population Groups South-Central California Coast Steelhead (Oncorhynchus mykiss) population status and trends are unknown. Components of the Coastal Monitoring Program efforts began in 2017 when staff began using a dual-frequency identification sonar unit in lower San Luis Obispo Creek to assess adult Steelhead abundance status and trends. Staff continued these efforts for four

consecutive seasons but without designated staff and funding, the data has not been reviewed and analyzed to enumerate and measure size of adult Steelhead. Technical constraints of operating a dual-frequency identification sonar unit in lower San Luis Obispo Creek include the ability to operate dual-frequency identification sonar (DIDSON) during high flow events when Steelhead may be moving upstream, the availability of a reliable power source to power equipment without failure, and the ability to distinguish identities of Steelhead and Common Carp. Technical constraints of of implementing spawning ground surveys in the San Luis Obispo Creek watershed include lack of public land and difficulties in obtaining landowner access. In the development of a Sample Frame, staff are finding there are technical difficulties in the identification of limits of anadromy within the mainstem and tributary waters. These systems don't have easily identifiable physical barriers, and typically become small, shallow streams before drying completely. Future strategies for implementing the Coastal Monitoring Program in San Luis Obispo Creek watershed will be to establish a Life Cycle Monitoring station using the dual-frequency identification sonar for status and trends of adult Steelhead and operate an outmigrant trap to assess status and trends of out-migrating Steelhead; finalize sample frame, identify available landowner access, evaluate available habitat, and assess juvenile spatial structure. Because the San Luis Obispo Terrace Biogeographical Population Group was not part of the initial Coastal Monitoring Program statewide funding priorities (due to lack of statewide funds) there currently is no dedicated funding or staffing. CDFW is ready to implement once dedicated funding becomes available for this important geographic area.

Key words: Biogeographical Population Group, Coastal Monitoring Program, South-Central California Coast Steelhead, dual-frequency identification sonar, San Luis Obispo Creek, watershed, life cycle monitoring

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Ventura River and Topanga Creek Watersheds

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Workshop Series, Session 3 & Themes: From the Field Continued - Monitoring Approaches from Southern California, Klamath/Trinity, and the Central Valley

Objectives

Session 3 focused on learning from other salmonid monitoring approaches in California with a focus on determining if there are aspects of these programs that can inform CMP.

Presentations

Practitioners from Southern California, the Klamath and Trinity basins, and the Central Valley presented monitoring approaches for these geographies including advancements in life cycle monitoring and monitoring to support reintroduction. The Session 3 presentation titles, authors, and abstracts (if provided) are given in the presentation abstracts section at the end of the Session summary.

Breakout Spatial Chat

A virtual spatial chat was used to allow participants to 'wander' between open discussions about broad subject areas. The 'rooms' of the virtual chat sessions included;

1. Life Stage Monitoring: Adult and juveniles (Methods and metrics for data collection, what information is valuable, and why is the information valuable)
2. VSP Parameters: Abundance, spatial structure, diversity, and productivity (How do VSP parameters fit broadly into recovery?)

Session 3 Presentation Abstracts

Monitoring southern steelhead: Thinking it through

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Abstract: California's coastal monitoring plan for salmonids is intended to be both statistically sound and comprehensive with respect to geography and viability indicators. But uniform, sound design that can be applied

everywhere to all indicators has proven elusive, especially given available budgets. In an update to the monitoring plan for steelhead (*Oncorhynchus mykiss*) in the southern monitoring area, we worked through these issues and came to a variety of conclusions with potentially broader relevance. First, for many indicators—but especially adult abundance—different methods may be necessary in different watersheds due to a great diversity of site conditions and the fact that no method is ideal. We should also expect methodological improvement over time, and so the plan should have formal mechanisms for periodically rolling out new or updated methods. A key issue is how to find the right balance between methodological consistency and methodological flexibility. Second, the plan's original emphasis on random sampling of reaches is one of its greatest strengths, but in practice it will seldom be feasible to implement such designs across the entire sampling frame during the wet season. Thus, indicators tied to this method—notably certain aspects of spatial structure and diversity—can only be monitored comprehensively in the low flow season. In our case, this included distribution of drought refugia, abundance of resident rainbow trout, juvenile densities, and genetic composition. Third, although the original plan avoided statistical stratification, we find that operational efficiency (and thus cost) can be greatly improved by stratifying low-flow surveys by targets of estimation—in our case, groups of biogeographically similar populations. Strategies for double-sampling and two-phase sampling can also provide efficiency gains under some conditions. Finally, monitoring adult steelhead abundance remains a difficult challenge but there are a variety of promising point-based counting methods that warrant further development.

Key words: Southern steelhead, rainbow trout, monitoring

Klamath basin fishery monitoring overview

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Abstract: The Klamath Basin is a large coastal watershed and has been the focus of rigorous long term adult Fall Chinook Salmon monitoring since 1978. Monitoring originally focused on Klamath River Fall Chinook to meet fishery management objectives but in recent years has included Coho salmon. Due to the size of the watershed and inclusion of multiple state, Tribal and federal jurisdictions, cooperation and data sharing among

responsible parties has been a requirement for effective fishery management in the basin. Natural area monitoring strategies vary based on specific watershed requirements and include adult fish counting stations, boat based and foot-based surveys. Annual estimates of in-river Tribal and recreational harvest are calculated. Additionally, there is a need to account for hatchery origin fish in all areas. Annual Klamath River Fall Chinook management requires a total run size estimate by age and associated natural origin and hatchery origin composition.
Juvenile trapping for salmonids has expanded in recent years and most major tributaries produce juvenile estimates through the use of rotary screw traps or fyke traps. In areas where both adult and juvenile monitoring exists in-river production and out of basin survival estimates can be generated. Multiple projects in the basin are focused on monitoring juvenile Coho Salmon life history using PIT tags and an expanding network of antennas. While a coordinated basin wide *o.mykiss* monitoring program is currently not in place, valuable juvenile and adult *o.mykiss* data is being collected in many areas of the watershed. Spring Chinook monitoring has relied heavily on coordinated summertime refugia dives.

Key words: Klamath River, salmon, monitoring, fishery management

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Klamath River anadromous fishery repopulation and restoration monitoring plan after four hydroelectric dam structures are removed

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Abstract: The Klamath River is one of several major river systems on the U.S. West Coast. The decline in natural salmon and steelhead abundance in the Klamath River system has been attributed in part to the construction of four hydroelectric dams on the mainstem Klamath River in Siskiyou County, California and Klamath County, Oregon. Volitional fish passage to the upper Klamath Basin is expected to be restored through the removal of those dams. Once fish passage is restored, anadromous species are, with a high degree of confidence, expected to volitionally move upstream and spawn in suitable historical upstream habitats. Monitoring the repopulation of anadromous fishes will be critical for their conservation as well as informing management of Klamath River salmon and steelhead fisheries populations for Tribal, commercial, and recreational harvests, as well as non-consumptive uses.

The draft *Klamath River Anadromous Fishery Repopulation and Restoration Monitoring Plan* is being prepared by the California Department of Fish and Wildlife (CDFW) with support from the Oregon Department of Fish and Wildlife (ODFW) and other key partners including several Klamath Basin Tribes, NOAA Fisheries, and the U.S. Fish and Wildlife Service. The monitoring plan describes the environmental setting, provides a brief history of mainstem Klamath River dams with fish passage constraints, and discusses the fish species of the Klamath River Basin with a focus on anadromous species. It identifies the spatial and temporal extent of monitoring, provides the purpose, and need for repopulation and monitoring, describes the regulatory setting, and identifies key issues and uncertainties that will affect successful repopulation and monitoring. Lastly, it describes a conceptual monitoring approach to evaluate and assess recolonization of anadromous fishes to historical habitats and describes Klamath River restoration monitoring activities and potential funding sources in a post dam removal world.

Key words: funding hydroelectric dams, Klamath River, monitoring, repopulation, salmon and steelhead, tribal, volitional

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Salmonid monitoring in the Central Valley

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Advancements in life cycle monitoring to support modeling and management decisions

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Abstract: Effective species management required a robust monitoring network that provides quantitative information about the status of imperiled species at key life stages and geographic locations. For example, quantitative metrics such as adult salmon abundance over time is used to assess extinction risk and long-term trends in population viability. However, additional quantitative information is required to support life cycle models used to assess how management actions such as hatchery supplementation, harvest, reservoir releases, and habitat restoration influence population dynamics. The existing monitoring network for endangered Sacramento River winter-run Chinook Salmon (SRWRC, *Oncorhynchus tshawytscha*) in California's Central Valley was compared to conceptual models developed for each life stage and geographic region of the life cycle to identify relevant SRWRC metrics. We concluded in Johnson et al. 2017 that the current monitoring network was insufficient to diagnose when (life stage) and where (geographic domain) chronic or episodic reductions in SRWRC cohorts occur, limiting our ability to track changes within and among years. The strongest quantitative data exist in the Upper Sacramento River, where abundance estimates are generated for adult spawners and emigrating juveniles. However, once SRWRC leave the upper river, our knowledge of their identity, abundance, and condition diminishes, despite significant monitoring. In Johnson et al. 2017, we identified six system-wide recommended actions to strengthen the value of data generated from the existing monitoring network to assess resource management actions: (1) incorporate genetic run identification; (2) develop juvenile abundance estimates; (3) collect data for life history diversity metrics at multiple life stages; (4) expand and enhance real-time fish survival and movement monitoring; (5) collect fish condition data; and (6) provide timely public access to monitoring data in open data formats. I will provide key examples to illustrate how updated technologies can enhance the existing monitoring to provide quantitative data on SRWRC and how each recommendation, if adopted, would improve management decisions.

Key words: Sacramento River winter-run Chinook Salmon, life cycle, monitoring recommendations

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Workshop Series, Session 4 & Themes: Revisiting the CMP Toolbox, Participant Feedback, and Closing Remarks

Objectives

In Session 4 we discussed gaps in VSP monitoring, incorporating habitat inventory surveys into CMP, sampling redesign and efficiencies and solicited feedback on next steps from the workshop participants.

Presentations

Presentations centered on how collection of data to inform VSP parameters could be redesigned. Several presentations described the sequencing and alignment of monitoring efforts to better inform conservation needs and progress towards population viability. Sampling redesign, spatial and temporal survey improvements, cost efficiencies, and inclusion of habitat metrics and habitat restoration effectiveness were the focus of other presentations. The Session 4 presentation titles, authors, and abstracts (if provided) are given in the presentation abstracts section at the end of the Session summary.

Breakout and Discussion

The following questions were provided to session breakout groups to address:

- What are the three most important considerations for CDFW and NOAA Fisheries to consider for CMP and to discuss in Session 5?
- What data are most valuable for which stage of recovery: endangered species, threatened species, and fisheries management?
- Assuming the CMP will experience periods of expansion and contraction over time, are there ways we can plan ahead for fluctuations in resources in a more organized way (e.g. design considerations, spatial scale manipulation, distribution of effort between LCM stations, regional surveys, and methodology)?
- How do we integrate measurement of habitat variables into CMP?
- How can we relate habitat values to VSP parameters (abundance, productivity, diversity, and spatial structure)?
- Does it make sense to include habitat in randomized stream habitat surveys? What would we learn and how might we use that information?

Breakout groups recorded their notes for the planning team and reported back to the workshop participants. The major discussion themes captured included;

1. CMP should be organized to efficiently utilize the resources available to answer the most important questions and leverage existing efforts. Low flow juvenile surveys are relatively cost effective, can incorporate habitat metrics, and can be integrated with adult monitoring. Distribution of species and occupancy patterns are of high value, especially in areas and periods of low adult abundance levels.
2. CDFW and NOAA Fisheries should identify the most useful monitoring information and ensure temporal and geographic continuity of data sets under variable levels of funding. The CMP should review and adapt the toolbox of methodologies and sampling designs applied (e.g. juvenile surveys, adult surveys, eDNA, biological samples, two-phase sampling, stratification) while ensuring consistency and design-based sampling principles.
3. Incorporating randomized, design-based habitat inventories would be useful for determining change across the landscape. Simultaneous sampling of fish and habitat in the same sample reaches could be incorporated to understand the response of fish to changes in habitat. Remote sensing (e.g. LiDAR, Landsat imagery, UAV-based imagery) could be incorporated at a landscape level to make inference on watershed processes and habitats, and improve the efficiency of sampling designs. A habitat monitoring component should be incorporated into the CMP.
4. Improve collaboration and communication (external & internal) on technical issues, methods, analysis. Institute practices to facilitate collaboration among CMP practitioners and partners, provide for a timely and coordinated reporting of CMP data.

Session 4 Presentation Abstracts

Realigning CMP to better inform conservation needs and progress toward viability: Sequencing monitoring efforts to better inform conservation and recovery actions along the path to recovery.

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Abstract: California's Coastal Monitoring Plan (CMP) and federal viability criteria were developed to provide and use data to assess extinction risk and progress toward recovery of Pacific salmonids. The National Marine Fisheries Service (NMFS) developed criteria to assess extinction risk (i.e., viability) of Evolutionarily Significant Units (or Distinct Population Segments for steelhead), the approach recognizing the hierarchical structure of Pacific salmonids that ranges from individuals to an Evolutionarily Significant Unit. Viability assessments conducted by NMFS rely on metrics intended to address four Viable Salmon Population parameters, including abundance, productivity, spatial structure, and diversity. These criteria require population-level estimates of abundance for key "independent populations" deemed essential for recovery, and propose additional goals at the level of diversity strata (groups of populations inhabiting similar environments) to ensure an interconnected network of viable populations across the landscape within each ESU. CMP implementation has focused on collecting data to inform the viability criteria, principally adult abundance. In some regions, current adult-focused monitoring efforts produce data for, at best, only a few populations in each ESU; with such sparse data, assessing overall trends in abundance or distribution at the ESU level remains difficult. Further, many populations are very far from viability/recovery targets; thus, the value of getting precise estimates of adult abundance versus collecting data for other life stages needs consideration. A phased, sequential monitoring strategy, where the targeted life stage, frequency, and spatial extent of sampling changes through time based on (1) existing information gaps, and (2) current status of populations (i.e., distance from recovery targets), could provide stronger information for assessing ESU viability through time. Such a phased monitoring approach, using appropriate VSP performance indicators, could inform fisheries management and restoration activities through successive restoration and monitoring phases.

Key words: California, Coastal Monitoring Plan, Endangered Species Act, population monitoring, juvenile monitoring, status reviews, viability assessments, recovery actions

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Realigning CMP to better inform conservation needs and progress toward viability: Could reallocation of effort provide better data for viability assessments?

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Abstract: California's Coastal Monitoring Plan (CMP) and federal viability criteria and recovery plans developed on parallel but separate tracks. Consequently, the goals of the CMP and the data needs for federal viability and status assessments are not entirely aligned. The CMP's original goal was to produce region-wide estimates of adult salmonid abundance, with the ability to produce population-level estimates where sampling intensity was sufficient. This is achieved through a spatially balanced sampling scheme with rotating panel design that encompasses species-specific spawning habitats within each region. Federal viability criteria developed by Technical Recovery Teams require population-level estimates of abundance for key "independent populations" deemed essential for recovery, and propose additional goals at the level of diversity strata (groups of populations inhabiting similar environments) to ensure an interconnected network of viable populations across the landscape within each ESU/DPS. The distinction is that federal stratum-level abundance targets are the aggregate of the contributing independent populations, rather than region-wide estimates based on sampling across all possible habitats. Federal recovery plans added complexity by proposing numeric abundance targets for selected "dependent populations."

Because of these differences in goals, some data collected by CMP programs are not especially informative for viability analyses. Smaller watersheds containing dependent populations either have too few reaches surveyed to produce robust population estimates or are not sampled annually; intensifying sampling to produce population estimates is unrealistic given current funding. Elsewhere (e.g., Santa Cruz Mountains), the current abundance of the primary target organism, Coho Salmon, is so low that the effort required to comprehensively sample adult spawners can be difficult to justify. In both cases, annual juvenile monitoring—either replacing or complementing adult surveys—could provide data that better informs status and trend assessments than do current adult data, potentially at lower cost. Reallocating effort would come with tradeoffs that need full exploration.

Key words: California, Coastal Monitoring Plan, Endangered Species Act, population monitoring, juvenile monitoring, status reviews, viability assessments

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Fisheries Restoration Grants Program effectiveness monitoring

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Abstract: The Fisheries Restoration Grants Program monitors salmonid habitat restoration projects to guide future restoration and for permit requirements issued under the Clean Water Act and Federal Endangered Species Act. One hundred percent of implementation projects receive implementation monitoring shortly after construction. Ten percent of projects receive pre-treatment and post-treatment effectiveness monitoring. Of these projects, those that focus on improving instream habitat or remedying fish passage barriers also receive pre-treatment and post-treatment biological monitoring. Since 2014, four projects have been selected for a before after control impact pilot study. Each monitoring protocol addresses specific monitoring questions. Effectiveness monitoring includes photographic monitoring, measurement of quantitative metrics, and qualitative responses regarding project objectives. Both implementation monitoring and effectiveness monitoring include assignment of qualitative ratings. Biological monitoring includes juvenile snorkel surveys and adult spawner surveys. The before after control impact pilot focuses on habitat characteristics including thalweg profile, large wood, substrate, and fish cover. Reports are generated annually for permittors. Technical reports are produced per grant cycle. The Salmonid Habitat Assessment of Restoration Effectiveness team including Department of Fish and Wildlife and National Oceanic and Atmospheric Administration scientists has been meeting to guide monitoring efforts for one year. This team seeks to evaluate Fisheries Restoration Grants Program funded projects for completeness, achievement of goals, and effects on ecosystem processes. Additionally, the team aims to improve data collection methods and inform restoration practitioners about empirically derived best practices. Monitoring protocol guiding questions were recently reviewed and prioritized. A restoration partners survey was recently released. To coordinate with the California Coastal Monitoring Plan, work is underway to conform data for inclusion in the Aquatic Surveys Program database. Coordination has begun to align habitat and monitoring data. Finally, coordination is underway to leverage status and trend biological monitoring data.

Key words: before after control impact, California Coastal Monitoring Plan, effectiveness monitoring, Fisheries Restoration Grants Program, implementation monitoring, salmonid habitat restoration

Sampling design considerations for regional coastal California salmonid monitoring

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Abstract: Adams et al. (2011) describes spatially balanced Generalized Random Tessellation Stratified equal probability sampling of stream reaches across the Northern Monitoring area to estimate status and trend of adult salmonids via redd counts. Estimation of populations could be made by expanding the subregion sample estimates to the smaller domain. We used 10 years of CMP redd count data from across the Northern Monitoring Area projects to create a realistic distribution model for Coho Salmon (*Oncorhynchus kisutch*). We used predictions from our model as a proxy for the 'true' distribution of redd abundances over all reaches, then compared the spatial coverage and sampling uncertainty of alternative sampling designs to our 'true' abundance. We evaluated the equal probability sampling design of Adams et al. (2011) against an alternative unequal probability sampling scheme that weights 90% sampling toward targeted population subregions and 10% elsewhere, and a 100% sample allocation to target populations only. All three sampling designs were simulated 100 times at three different sampling intensities to reflect levels of program funding. Results indicate tradeoffs between spatial coverage and ability to estimate subregions. Equal probability sampling provided good spatial coverage, but poor population estimates for smaller target populations at all but the highest funding level. Unequal probability sampling increased the likelihood of estimating target populations at low funding levels at the expense of spatial coverage, but still produced estimates at the larger scales. Allocation of all sampling to target populations performed best for target populations, but by design, will fail to produce estimates at the large scale. Lastly, we explore the potential of a two-phase, parent-progeny sampling design where rapid juvenile counts are made in a large first phase sample of reaches and adult redd counts made in a smaller second phase sub-sample of first phase reaches. Analysis of the optimal allocation between phases indicates approximately 50-50 split between methods would result in 2–3 times greater landscape coverage with similarly precise estimates of adult abundance.

Key words: California Monitoring Plan, sampling designs, two-phase sampling

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Large wood restoration effectiveness monitoring in a coastal Northern California stream: a Before, After, Control, Impact (BACI) design Pudding Creek, Mendocino County (2011-2020).

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Workshop Series, Session 5 & Themes: Interagency Discussion on next steps for the California Monitoring Plan.

Objectives

Session 5 was an agency-only discussion to reflect on what we learned from the CMP workshop series, discuss and develop recommendations for next steps and determine how to formalize workshop outcomes.

Discussion

To focus the Session 5 discussion, key themes from each Session, breakout group feedback, and workshop survey results were assembled into a spreadsheet. The group reviewed and discussed the Session themes, agreed on CMP next steps, and charted a process to formalize workshop proceedings. The four areas of the agency-only discussion included:

1. The reestablishment of CMP as an institutionalized and coordinated interagency program to include a governance structure. A renewed program would:
    a. Provide a unified vision for CMP articulating an appropriate balance between consistency and flexibility between different management objectives (e.g. risk assessment, fisheries management, adaptive management of habitat)
    b. Ensure efficient use of resources and provide technical guidance for developing more efficient statistical approaches
    c. Establish a shared frame of reference and resource for practitioners
    d. Formalize an adaptive management process and structure for interagency technical, management and policy dialog, and
    e. Form and convene a CMP Management Team to support CMP implementation.
2. CDFW and NOAA Fisheries review of workshop session information, action items, and development of workshop proceedings.
3. The two agencies will work with partners to prioritize areas for technical advances in CMP, and initiate a tradition of publishing peer-reviewed papers on technical advances, as a kind of "learning institution" to support the continuing refinement of CMP.
4. Identify a CDFW and NOAA Fisheries CMP review team to provide updates as needed to refine monitoring efforts for individual ESUs and DPSs or geographic regions.

Key Findings

- The CMP has made significant advances in providing information for state and federal viability assessments for coastal salmonids over the

last 10 years. While the CMP has achieved numerous successes and has greatly improved the data availability in the coastal zone, its spatial coverage, species coverage, temporal consistency, and methodological challenges continue to limit our ability to evaluate species viability.

- The original CMP sampling design did not explicitly describe populations as the building blocks of ESU or DPS viability. Thus, recognition of populations or groups of populations as the explicit targets of monitoring will help guide future updates to sampling strategies.
- Currently, there are challenges translating the landscape-level adult sampling implemented by CMP to population-level sampling needed for federal viability assessments, but these can and should be addressed by a combination of updated estimation tools and sampling plans.
- Many populations are far from the adult viability and recovery targets; thus, the value of getting precise estimates of adult abundance versus collecting data for other life stages needs consideration. We recommend an adaptive monitoring strategy. The CMP should look to refine sampling designs to inform the viable population parameters (i.e., abundance, productivity, spatial structure, and diversity) that efficiently and directly inform species status assessments, fisheries management, and state and federal recovery planning.
- Evaluate existing monitoring efforts with regard to new methods and technologies to potentially produce more useful data or operationally efficient approaches, without sacrificing key information.
- Valuable lessons have been learned regarding implementation, methodological development, program structure and cost. The CMP is in an informed position to re-evaluate the current CMP sampling design and implementation to better assess current population status and recovery processes.

Priority Actions

- Prepare workshop proceedings.
- Include CMP practitioners in Science Team technical working groups.
    - Collectively identify common technical problems and establish programmatic solutions.
- CMP agencies and practitioners should document CMP technical and scientific successes and challenges from the last decade of implementation.
    - Utilize the existing scientific peer review platforms (Fish Bulletins, California Fish and Wildlife journal, others) to document CMP technical issues and findings, and evaluate methods to keep CMP adaptive and moving forward.

- CMP Science Team and practitioners will synthesize and collate VSP data for state and federal viability assessments.
- Reactivate CMP as a formal CDFW/NOAA Fisheries program, renew the CMP governance structure (e.g., form a new CMP management team and charter), and update the CMP approach.
- CDFW and NOAA Fisheries staff will be identified and positioned by respective leaderships to provide updates as needed to Fish Bulletin 180

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