CHAPTER 11: MONITORING

"It is imperative that California, which is well behind other states in the Pacific Northwest, begin conducting monitoring at spatial scales relevant to recovery planning if we are to have any hope of accurately evaluating status and progress towards recovery."

Spence et al. 2008

INTRODUCTION

The purpose of this chapter is to describe coho recovery monitoring necessary to evaluate all viable salmonid population (VSP) criteria (McElhany *et al.* 2000) and associated listing factors and threats (Crawford and Rumsey 2009) in relation to recovery criteria for the CCC coho salmon ESU described in Chapter 9. Implementation of this recovery plan will require monitoring to determine with scientific certainty that recovery actions identified herein are working to improve coho salmon populations, their habitats, and that limiting factors and threats to survival are diminishing. Because of the length and complexity of the coho salmon's life cycle and the diversity of environments they occupy, there are many uncertainties regarding the effectiveness of management prescriptions for improving production, survival, and habitat and reducing threats. Identifying relationships between management actions and salmonid responses are challenging scientific questions. It is important monitoring is directed at answering basic questions regarding assessment methods, responses, progress, success, failure, additional data needs, and evaluation methods. Including an adaptive management component will allow NMFS, as well as others, to learn from past experiences through experimentation via altering actions based on measured effectiveness, a basic tenant of science. Finally, all monitoring data must be coordinated in a regional set of databases or distributed data system using a common set of metadata and data dictionaries that fits within an integrated master sample program (Crawford and Rumsey 2009).

> "Given the imperiled nature of coho…in California it is critical that coastwide instream monitoring programs be implemented and maintained to allow warning of impending problems to these valuable resources. Without the existing minimal monitoring effort, since coho are not commercially fished or regulated, there would be little notice of their decline."
>
> *MacFarlane et al. 2008, in draft*

Existing adult coho salmon escapement monitoring programs in the CCC coho salmon ESU are currently inadequate to estimate VSP criteria with any statistical certainty for the management purposes of: (1) providing a sound basis for assessing recovery of listed populations; and (2) monitoring the success of restoration programs. Similarly, spatial pattern, diversity, and limiting factor and threat (including habitat status and trend) monitoring efforts are either inadequate or nonexistent. Recently, NMFS published the draft "Guidelines for Monitoring Recovery of Pacific Northwest Salmon and Steelhead" in Idaho, Oregon, and Washington (Crawford and Rumsey 2009). The authors make recommendations for data collection and reporting, monitoring VSP status and trends, and monitoring

listing factors and threats (including habitat status and trends, hatchery, harvest, and regulatory actions). In this chapter these guidelines are incorporated with ongoing efforts to develop and implement a coast wide salmonid monitoring program in California (Boydstun and McDonald 2005, Adams *et al.* in review) to identify high priority monitoring needs specific to the CCC coho salmon ESU.

MONITORING CCC COHO SALMON ESU VSP STATUS AND TRENDS

VSP Adult Spawner Abundance

The most important metric for population viability criteria is spawner abundance over multiple generations. Systematic and comprehensive long-term monitoring of adult CCC coho salmon is critical and immediate initiation of monitoring consistently across the ESU is imperative for recovery. Currently there is not a coordinated statewide long-term monitoring program and this has significant adverse ramifications to our ability to evaluate the status and trends of populations within the ESU. Only a few organizations are conducting some level of adult monitoring and, while it provides valuable information for specific watersheds, these efforts are insufficient to track the status of populations and recovery goals across the ESU. These efforts need integration with a cohesive master sample design. Boydstun and McDonald (2005) and Adams *et al.* (in review) recommend a two-stage sampling approach for monitoring the status and trends of California's coastal salmonids at evolutionarily significant regional spatial scales that can also be decomposed to provide population level estimates. First stage sampling is comprised of extensive regional spawning surveys to estimate escapement from redd counts collected in stream reaches selected under a Generalized Random Tessellation Sampling (GRTS, Larsen *et al*. 2008) rotating panel design at a survey level of 10 percent of available habitat each year. Second stage sampling consists of producing escapement estimates in intensively monitored census streams (also called Life Cycle Monitoring stations) through either total fish counts of returning adults or capture-recapture studies. The second stage estimates are considered to represent true adult escapement and resulting spawner to redd ratios are used to calibrate first stage estimates of regional adult abundance (Gallagher and Wright 2008). The Life Cycle Monitoring stations are places where smolt and summer rearing abundance are monitored to estimate freshwater and marine survival and to evaluate life histories which help with interpreting regional status and trend information (the stage one data). These streams are also intended to be focal points for evaluating restoration and encouraging further research. The NMFS monitoring guidelines (Crawford and Rumsey 2009) recommend using a robust unbiased spawner abundance sampling scheme that has known precision and accuracy. Similar to Adams *et al.* (in review) they offer probabilistic sampling of all accessible spawning areas using unbiased randomized sites (GRTS) with rotating panels as an option that will produce statistically valid estimates of spawner abundance with known certainty. Monitoring needs and recommendations presented below draw heavily on NMFS's "Guidelines for Monitoring Recovery of Pacific Northwest Salmon and Steelhead" (Crawford and Rumsey 2009).

Adult CCC coho salmon males collected at the Pudding Creek weir Life Cycle Monitoring station, Fort Bragg, California. Pudding Creek maintains one of the stronger remaining runs of coho salmon in the ESU. The lifecycle station is a cooperative effort between Hawthorne Timber Company (HTC) and DFG (partially funded by the Fisheries Restoration Grants Program) and is an important source of information regarding adult coho salmon returns. (Photos courtesy of David Wright – HTC)

1. Implement, as soon as possible, an unbiased two stage GRTS based ESU-wide monitoring program of adult CCC coho salmon that has known precision and accuracy. Monitoring should include:

    a. Yearly adult spawner abundance estimates for the entire ESU, for each diversity stratum, and where possibly for each population identified in Table 8 and 9 of Chapter 5 that incorporates existing monitoring into a master sample GRTS design;

    b. Establish (at a minimum one or preferably two) Life Cycle Monitoring streams in each diversity stratum, and maintain current lifecycle stations in Lagunitas Creek in Marin County, Pudding Creek in Mendocino County, and Scott Creek in Santa Cruz County to estimate spawner: redd ratios for calibrating regional redd counts and adults in/smolts out for estimating survival- these streams may also serve as intensively monitored watersheds for evaluating restoration actions;

    c. Strive to have ESU level adult spawner data with a coefficient of variation (CV) on average of 15% or less;

    d. Regional spawner data should have the statistical power to detect a change of ± 30% with 80% certainty within 10 years;

    e. Strive to have abundance estimates at the Life Cycle Monitoring stations with CV on average of 15% or less;

f. Estimate migration rates between basins and tributaries of larger basins to validate assumptions that underlie population delineations and to assess potential role of interbasin exchange on extinction probabilities;

g. Evaluate hatchery impacts and hatchery wild ratios (this should cover a range of issues from genetic changes to brood stock mining) and implement hatchery recommendations per Spence *et al.* 2008; and

h. Monitoring should utilize the protocols published in the American Fisheries Society Salmonid Field Protocols Handbook (Johnson et al. 2007).

VSP Productivity

1. Develop a 12 year or greater data set of accurate spawner information to estimate geometric mean recruits per spawner and evaluate population trends.

2. Implement yearly smolt abundance monitoring in at least one significant population in each diversity strata. The Life Cycle Monitoring stations should cover this requirement.

    a. Juvenile monitoring should strive to have data with a CV on average of 15 percent or less;

    b. Power analysis for each monitored juvenile population should be conducted to determine the statistical power of the data to detect significant changes in abundance; and

    c. Estimate apparent marine and fresh water survival (couple adult data with the smolt abundance estimates).

VSP Spatial Distribution

1. Determine the spatial distribution of coho salmon in the CCC ESU with the ability to detect a change of ≥ 15 percent with 80 percent certainty. Follow Boydstun and McDonald (2005) and Adams *et al.* (in review) to develop and implement, as soon as possible, randomized probabilistic (GRTS) summer and fall snorkel survey sampling of juvenile coho salmon within the ESU.

2. Evaluate changes in adult spawning areas using probabilistic sampling.

VSP Diversity

1. Monitor status and trends of spawn timing, sex ratio, age distribution, fecundity, and etc. (see Adams *et al.* in review) at one Life Cycling Monitoring Stream per diversity strata and within and among diversity strata.

2. Develop a genetic baseline of DNA micro satellite markers for each population in the ESU.

MONITORING CCC COHO SALMON LISTING FACTORS AND THREATS

1. Develop and implement a GRTS based habitat status and trend monitoring program which is coordinated with the juvenile spatial structure evaluations and the Life Cycle Monitoring stations.

    a. Develop a standardized survey methodology for evaluating habitat attributes;

    b. Integrate ongoing habitat assessment work into a master GRTS sample design;

    c. Incorporate consistent habitat monitoring protocols that provide comparable watershed information; and

    d. Develop and employ suitable habitat assessment criteria and models that provide high level indicators of watershed conditions.

2. Wherever possible, habitat restoration activities should have both an implementation and an effectiveness monitoring component. Work in Life Cycle Monitoring stations and intensively monitored watersheds should also incorporate validation monitoring.

    a. Restoration efforts should be reported and correlated with habitat limiting factors so cumulative impacts can be tracked within the ESU;

    b. Reach scale effectiveness monitoring should be conducted following the Before After Control Impact (BACI) design;

    c. Habitat restoration in the Life Cycle Monitoring stations should follow the BACI design, have enough of the watershed treated and monitored to effect a detectable change in fish abundance, occur in streams with all life stages of coho salmon, and occur in proximity to similar sized watersheds that can serve as controls; and

    d. Establish at least one Intensively Monitored Watershed (as detailed in Crawford and Rumsey 2009) within the ESU. Conduct power analysis early in development to determine amount of watershed required to be treated necessary to detect 30-50 percent change in fish response.

3. Currently no monitoring program exists that tracks freshwater harvest or ocean bycatch. NMFS recommends the California Fish and Game commission, in collaboration with NMFS, devise an appropriate mechanism for tracking.

4. Water quality monitoring relevant to salmonids is recommended as part of recovery monitoring.

5. To assess adequacy of regulatory actions implement a recovery plan tracking system to document if local and State agencies have implemented actions proposed in this recovery plan.

6. Climate change is a significant potential threat and monitoring the effects of this on coho salmon should include changes in stream flow and temperature and their effects on fresh water survival.

DATA MANAGEMENT AND REPORTING

1. All monitoring data must be coordinated in a regional set of databases or distributed data system using a common set of metadata and data dictionaries that fits within an integrated master sample program. This should be should be housed and maintained in one place by one entity.
2. All entities collecting habitat and fish monitoring data should coordinate their sampling and data collection to fit into a master sample program for the CCC coho salmon ESU.

COSTS ESTIMATES

Regional spawning ground surveys cost about $ 3,000 to survey one reach a sufficient number of times each season to generate reliable redd counts (Gallagher and Wright 2008). There are 339 0.1km to 3.9km reaches encompassing 834 km of spawning habitat in coastal Mendocino County from Usal Creek in the North to Schooner Gulch in the South (S. Gallagher unpublished). Tables 8 and 9 in Chapter 5 indicate there are 827 IP/km in this area and a total of 2398 IP/km in the CCC coho salmon ESU. A 10% sample of 3 km reaches in the ESU would result in a sample draw of approximately 80 reaches at an annual cost of ~$240,000, not including data storage and report preparation. Adult monitoring at the Pudding Creek Life Cycle Monitoring station in Mendocino County costs about $36,000 per year (Gallagher and Wright 2008). This estimate does not include smolt or summer rearing abundance estimates nor does it include data analysis and reporting. It costs about $15,000 per year to conduct the juvenile monitoring in Pudding Creek for an approximate grand total of $51,000 per Life Cycle Station. One Life Cycle Station per recovery domain comes out to at least $204,000 per year. Note that this estimate is based on Pudding Creek, a small stream classified as having a dependent coho salmon population. To conduct life cycle monitoring in the nearby Ten Mile River (a functionally independent population) would be more difficult and much more expensive due to the lack of infrastructure and the larger size of the river. Juvenile spatial structure and habitat monitoring likely will run about $1,000 per reach. There is a great deal more juvenile habitat than spawning habitat, perhaps twice as much, thus an annual sample of 160 reaches might cost about $160,000 per year. This estimate does not include data analysis, storage, or report preparation. Sample size and reach variance issues will have to be developed for juvenile spatial structure and habitat monitoring. Determining actual costs of this monitoring could be part of this evaluation and will need to include cost estimates for evaluating restoration actions, implementing a recovery tracking system, and for developing and maintaining a coordinated data management system. Finally, monitoring the recovery of coho salmon in the CCC ESU will require continuing evaluation of costs, dedicated funding, and a long term commitment of resources by all involved parties.