A SUMMARY OF THE AUGUST 23-25, 2005 CENTRAL VALLEY SALMONID MONITORING WORKSHOP

By
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and the
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For
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INTRODUCTION

In this report we summarize an August 23-25, 2005 technical workshop on monitoring Chinook salmon and steelhead in California's Central Valley (CV) and adjacent coastal ocean. The CALFED Science Program and the Stockton Office of the US Fish and Wildlife Service (FWS) sponsored the workshop that attracted about 90 managers and biologists from around the CV (Attachment 1).

The specific impetus for the workshop arose from discussions between Russ Bellmer (formerly of FWS, Stockton) and Serge Birk of the Central Valley Project Water Association (CVPWA). One of Birk's main concerns was that the Central Valley Project Improvement Act's (CVPIA) Anadromous Fish Restoration Program (AFRP), the CALFED Bay-Delta Program's Ecosystem Restoration Program (ERP) and other habitat restoration programs were spending millions of dollars to restore Chinook salmon and anadromous steelhead, but current monitoring programs were not adequate to evaluate the effectiveness of their actions. Birk suggested that one or more workshops be organized to address lack of adequate monitoring and assessment programs. Bellmer requested that the CALFED Science Program co-sponsor the workshop. The Science Program agreed and appointed Randy Brown to co-chair and help organize the workshop. To ensure that we had coverage of all existing monitoring programs and all view points represented, we established an advisory committee consisting of:

- Alice Low, Department of Fish and Game (DFG)
- Brad Cavallo, Department of Water Resources (DWR)
- Serge Birk, CVPWA
- Jim Smith, Red Bluff FWS
- Tim Heyne, DFG
- Joe Miyamoto, East Bay Municipal Utility District (EBMUD)

John Conomos (US Geological Survey, retired) and Ladd Lougee (now with the CALFED Science Program) represented the Bay-Delta Science Consortium and assisted the advisory committee in workshop planning.

The advisory group agreed to focus this workshop on monitoring that increases our ability to assess population status at various life stages. We recognized that all facets of monitoring, for example, the effectiveness of individual actions or projects, could not be adequately addressed in a 2-day workshop. As Birk originally suggested, this workshop could be one of a series of workshops on related topics, perhaps sponsored by CALFED or natural resource management agencies. The advisory group pointed out that an ongoing series of salmonid monitoring related workshops is presently underway through the Interagency Ecological Program's (IEP) Salmonid Project Work Team. The work team has organized several workshops in the past few years, some in cooperation with the CALFED Science Program.

The co-chairs and the advisory committee envisioned this workshop as one step along the path towards a more comprehensive CV anadromous salmonid monitoring

program. Our overall goal was to assemble knowledgeable people to listen to and react to presentations by several people active in various aspects of the field of salmonid monitoring. The workshop and this summary are to provide a limited assessment of the salmonid population monitoring progress towards meeting natural resource management needs. For example several key environmental monitoring needs were not covered - such as climate change, ocean conditions, and other physical variables - thus this summary is not a comprehensive treatment of the subject. We believe the workshop and discussions led to a better understanding of some of the underlying issues. We also believe the discussions and presentations emphasized the importance, and complexity of collecting, storing, analyzing and reporting on the myriad data needed to determine how well salmonid populations are doing and the reasons for any observed changes in abundance and distribution.

WORKSHOP SUMMARY

The following summary is taken from the presentations, the discussion, the background material and other relevant material. Since space limited the amount of material we could include, the text is based on considerations of the points raised, our experience, knowledge of local monitoring programs, existing published and unpublished literature, and inputs from salmonid experts. The sections are grouped somewhat differently than in the workshop itself to help keep the reader focused on a particular topic. Although this summary has been reviewed and helpful comments provided by advisory committee members, we take full responsibility for the summary's contents.

The summary is followed by a digest of the major points (and questions) made during the discussion. Finally, we include some of our thoughts on where this could all be going.

Perspectives on monitoring needs

We asked four experts representing different perspectives to present their experiences and views on the needs and scope of monitoring. Some of their main points are described below.

Jim Smith (FWS, Red Bluff) – fisheries manager Jim defined monitoring as systematically collecting data to check what you have done and is an integral part of the adaptive management process. As such, a monitoring program needs to be tied to project objectives, design and implementation. Jim described three types of monitoring ranging from compliance (did we do what we said we would do?) to effectiveness (is what we did working as designed?) to validation (is the life stage responding as we had postulated?). Finally, when designing a monitoring program one must consider what is necessary (he used spatial and temporal scales as examples), what is feasible in terms of methods and dealing with uncertainty and variability and finally what is practical in terms of budget, technology and infrastructure. Jim closed with what he called the Monitoring Imperative – basically the need for resource managers to be able to document how well the vast sums of restoration funds are achieving their desired benefits. He cited Botkin et al. (2000) as

an example of how the principles of monitoring design have been applied to salmon conservation and restoration plans.

Serge Birk (CVPWA) – water user association stakeholder. Birk looks at monitoring from the federal water users perspective and their focus on the effectiveness of CVPIA restoration actions being planned, funded and implemented to restore CV salmonids. Of particular interest was collecting and analyzing information that enables managers to document progress towards achieving AFRP doubling goals (AFRP is part of the CVPIA) and delisting spring and winter Chinook and steelhead. CVPIA actions being implemented to achieve the AFRP and ESA related goals consist of habitat restoration, structural measures (e.g. fish screens), water acquisition and changes in water project operations. Potential population level indicators include population trends, population sustainability and ESA population viability. The CVPIA includes a Comprehensive Assessment and Monitoring Program (CAMP) to help collect and assess monitoring data but its funding has been severely limited in recent years. Our collective challenge is to link monitoring to restoration program goals and objectives and to integrate existing and future monitoring efforts that provide information useful to scientists, managers, stakeholders and the public.

Bruce Oppenheim (NOAA Fisheries) – regulatory agency. Oppenheim took a slightly different slant on the topic by describing some science needs in the system, including about anything to do with steelhead. Spring run on the mainstem Sacramento River (does is exist?), monitoring data from Red Bluff to Verona, through- Delta salmon survival, and in-river sports harvest are significant knowledge gaps that can be filled by an effective monitoring program. Solutions to our monitoring needs include implementing a steelhead monitoring plan being developed through a CALFED grant (more on this later) and possible use of the Anderson-Cottonwood Irrigation District fish ladders, combined with genetic assessment, to provide information on putative spring run in the Sacramento River, Bruce also advocated that new studies be initiated to look at the possibility of passing salmon and steelhead around large dams, establishing in-stream flow needs, understanding salmonid life histories, and histopathological condition. . The presentation of data needs pointed out the difficulty of separating monitoring from research – they typically must go hand in hand.

Wim Kimmerer (San Francisco State University) – research/modeling. Kimmerer used key nodes in the salmonid life cycle (as obtained from a general model of salmon survival), important population controls and critical missing information to identify areas where we should focus existing and new monitoring efforts. From the model, the key questions were:

- Is there density dependence at the variance life stages?
- Which factors vary the most?
- What causes these factors to vary?
- Which factors are dependent on location?

Key population controls appear to include density dependence in some stages and streams (e.g. superimposition of redds and limited juvenile rearing habitat), egg survival,

temperature effects, downstream migration, through-Delta survival, harvest and adult migration. We are missing important information in all these areas, as well as the role and effects of hatcheries that are superimposed on the naturally spawning fish. Key foci for monitoring included:

- hatching to emergence
- smolting and migration, including the Delta
- hatcheries
- the ocean, including the effects of changing environmental conditions and harvest.

Finally Wim emphasized that we generally can not determine cause and effect from monitoring data but need to determine the underlying mechanisms.

Existing salmonid monitoring programs

Two recent pivotal documents were posted as workshop background material and deserve special mention here. Kerrie Pipal (NOAA Fisheries) (Pipal 2005) summarized monitoring activities for CV listed salmonids, including program history and extensive data. Kerrie prepared the report for Central Valley Technical Recovery Team to help team members better understand existing data and how they were obtained. Alice Low (2005) compiled and edited a DFG report summarizing existing monitoring efforts for all CV salmonids, with the focus on monitoring adult escapement and juvenile abundance. Alice and her colleagues limited the report to program descriptions and did not include any data. Estimated total annual costs for adult escapement and juvenile monitoring were $2.6 and $5.5 million respectively.

Monitoring needs

This section includes material from presentations by Kevin Niemela, John Wickert, and John Williams.

Kevin Niemela (FWS, Red Bluff) listed what he considered to be the 10 most important monitoring needs, namely (in his order of importance, with one need occupying two slots due to its importance),

1. Emigration through the Delta
2. Emigration through the Delta
3. Differentiating hatchery and natural fish
4. Monitoring data from the entire steelhead life history
5. Developing and using new approaches to escapement monitoring
6. Accurate fish counts
7. Monitoring inland harvest
8. Acquiring more monitoring data from the lower Sacramento River
9. Chinook salmon age structure
10. Effects of flow management on redd dewatering

John Wickert (FWS, Stockton) focused on AFRP needs, and said the AFRP goal was to: Make "reasonable efforts to double natural production of anadromous fish in California's CV on a long-term, sustainable basis." Production is defined as harvest (inland and ocean) plus escapement and natural production is overall production minus the hatchery contribution.

The AFRP uses a "model" (Chinookprod) that calculates "natural production" by including harvest, hatchery proportion, and escapement. At this time the values for each of numerous factors in the model needed for reliable production estimates are not available. With regard to escapement, for example, we need not only numbers of spawners, but also age structure determined from length frequencies or scale or otolith reading. For estimating hatchery proportion in the escapement we must have the fish marked (or use natural marks such otolith sulfur microchemistry) and need to recover the marks on the spawning grounds or in the hatcheries.

Wickert stressed the need to assess the benefits of restoration projects to salmonid populations both on short and long term basis. Short term monitoring could include such things as habitat use and value, whereas long-term monitoring would include juvenile production and survival. Wickert identified the following important monitoring gaps:

- Hatchery proportion
- Age distribution
- Inland Harvest
- In river survival

Wickert stated inland harvest rates could be 5% for the San Joaquin tributaries to up to 45% for the Feather River. He provided some examples of the proportion of hatchery fish in the escapement, 0% for the Yuba, 90% for Battle Creek, and 13 to 48% for the Feather River. He also suggested determining the benefits of gravel versus riparian enhancement projects.

Wickert identified data quality and dissemination as areas in which more work is needed if we are to have a workable comprehensive salmonid monitoring program.

John Williams (Private consultant) indicated in his presentation title (*Salmonid monitoring in the Central Valley – evolution or intelligent design?*) concerns that the existing, and perhaps even new monitoring program design are based more on conventional production thinking, rather than a more ecological based population approach. He used the information in Table 1 to help make this point. For example, currently CV fall Chinook are managed to achieve an annual Sacramento Valley escapement of 122,000 to 180,000 fish. DFG has established natural and hatchery fall Chinook escapement goals for individual streams to help meet the overall goal (for example 27,000 natural spawners and 5,000 fish taken into the hatchery for the Feather River). These types of production goals take little or no consideration for the tenets of an ecosystem based a population level approach.

Table 1. A comparison of production versus population thought process when considering salmonid management and monitoring. (Bottom et al. 2005)

	Production Thinking	Population Thinking
Goals	**Efficiency, production**	**Resilience, reproduction**
Population Units	**Arbitrarily defined**	**Biologically defined**
Time Frame	**Short**	**Evolutionary**
Objectives	**Control survival and abundance**	**Conserve local populations and life-history diversity**
Estuary Function	**Corridor for a single, homogenous group of salmon**	**Nursery area for many self-sustaining populations**
Estuary Management	**Control predators, promote rapid salmon out-migration**	**Protect habitats of diverse life-history types**

According to Williams, mitigation hatcheries also typify the problems inherent in production thinking. Hatcheries produce and release literally millions of fish each year to meet harvest and escapement goals. He cited several sources that described the unwanted consequences of hatchery operations including reduced fitness through domestication and other adverse effects. From a monitoring standpoint, the ISAB (Independent Science Advisory Board) mentioned the following hatchery and naturally spawning salmonid information needs:

- natural fish spawning in the rivers and hatchery by age, with confidence intervals
- hatchery fish spawning in the rivers and hatchery by age, with confidence intervals
- such variables on both natural and hatchery fish as:
    - fecundity
    - pre-spawning mortality
    - spawning effectiveness
    - adult age structure
    - adult length and weight
    - run timing
    - spawn timing

John made some specific recommendations to analyze differences in fish size at the export salvage, review length at age data to look for relationships with ocean conditions, study salmon movement through the Delta, and reinstate the Glenn Colusa Irrigation District and Knights Landing beach seine program of 1982 – 2000.

In closing Williams again returned to Table 1 and emphasized the need for biologists and managers to rethink their approach to managing and monitoring anadromous salmonid stocks.

Where are we going with escapement monitoring?

Alice Low (DFG) gave an informative and encouraging presentation on where we are now and may be heading in monitoring the escapement of adult Chinook salmon to CV streams. DFG and others have been estimating Chinook salmon escapement since the 1950s. Currently there are 35 monitoring programs on 18 CV streams used about 44 person years with a total estimated annual cost of about $2.6 million. These programs are funded [not dedicated funds] by a variety of agencies including DFG, CALFED, FWS, the US Bureau of Reclamation (USBR), DWR, EBMUD, Yuba County Water Agency, the City and County of San Francisco, and the Turlock and Modesto irrigation districts. The surveys use many methods such as:

- Mark-recapture carcass surveys for all four runs
- Ladder or weir counts for fall, winter and springs
- Redd counts for late-fall and springs
- Snorkel surveys for springs

In addition to estimating the numbers of fish, the field samplers collect information on fork length, sex and spawning condition, recover coded wire tags and may collect scale, otolith and tissue samples, with the latter for genetic identification.

CV salmonid biologists are also evaluating new methods including Vaki Infrared Monitoring on the Lower Stanislaus, a digital video monitoring system on the Lower Mokelumne, a video system on Battle Creek and hydroacoustic monitoring on Lower Mill Creek. As shown below, in two streams the more automated system provided results comparable to carcass survey estimates.

COMPARISON OF WEIR COUNT/CARCASS SURVEY DATA

Stream	Year	Weir/Dam Estimate	Carcass Survey Estimate
Mokelumne River	2003 2004	10,240 11,416	9,921 11,943
Battle Creek	2003 2004	152,530 92,254	153,027 92,090

Low used escapement sampling rates (ESR) and CWT inspection rates to show that the existing monitoring programs are doing a reasonable job at estimating escapement and obtaining coded wire tags. For the 10 stream for which she presented data, the average ESR was 0.48 with a range from 0.36 (American River) to highs of 0.61 on Butte and Mill creeks. Tag inspection rates were around 50% for all streams except the American and Feather rivers where the large numbers of fish and tags requires a stratified sampling program and lower overall inspection rates.

The IEP's CV Salmonid Escapement Project Work Team, formed in 2001, is working to improve coordination and communications among programs, improve methods used to estimate escapement and to seek additional funding for CV programs. The team, with some help from CALFED, has sponsored three technical workshops and has more planned.

Alice also mentioned four upcoming CALFED sponsored projects that will be important monitoring components, or helping plan for better monitoring. These projects are:

- CV wide scale aging project. This project will begin in 2006. Over the years many scales have been collected but few have been read.
- In-River sports harvest monitoring. Previous DFG surveys had demonstrated that inland sports harvest was an important source of mortality for Chinook salmon that had escaped the ocean fisheries. This will restore funding to this important monitoring component. This element will also begin in 2006.
- Development of a Chinook salmon escapement monitoring plan. This plan, being developed with the help of a team (biological, statistical, and database

management experts) staffed by the Pacific States Marine Fisheries Commission (PSMFC), will make recommendations and cost estimates for:

- In-river escapement
- Inland harvest
- CWT recovery
- An integrated data management and reporting system.

Agency biologists will provide technical guidance and review. The plan is expected in by early 2008. It should be noted that this will be a plan and will require agency and stakeholder cooperation and funding to implement.

In a similar vein, CALFED is funding the development of a comprehensive CV steelhead monitoring plan. The IEP's Steelhead Project Work Team developed the proposal and will work with a PSMFC technical team (similar in constitution to the Chinook salmon team) during plan development. The steelhead is particularly important because the Steelhead PWT and NOAA Fisheries concluded that existing monitoring efforts (primarily directed towards Chinook salmon) were totally inadequate for steelhead. This plan is due about the same time as the Chinook monitoring plan – that is, in early 2008.

The Feather River – a case history of an evolving adult Chinook salmon monitoring program

Brad Cavallo (DWR) described how the adult Chinook salmon escapement and tag recovery program on the Feather River has evolved over the past decade or so. Before the early 1990s DFG staff conducted the surveys. Beginning in 1992, DWR began various studies on the Feather River in anticipation of the need for more data as part of renewing its Federal Regulatory Commission (FERC) license for the Oroville Complex. (The current FERC license expires in 2007.) The new studies and information gathering efforts included an emphasis on obtaining more reliable estimates of the numbers of Chinook spawners. DWR also began tagging significant numbers of Feather River Hatchery (FRH) juvenile Chinook, as well as the progeny of natural spawners thus needed to recover the tags quantitatively. The new information needs have resulted in more effort (money and people) than had been allocated to these programs in the past.

Although the Feather River studies include juvenile monitoring and abundance surveys (electrofishing and snorkel surveys and rotary screw traps) and juvenile steelhead survival and growth studies, Brad focused his presentation on estimating escapement and collecting coded wire tags.

Escapement surveys DWR employs standard mark-recapture carcass survey methods but Brad noted that mark-recapture techniques were originally developed for live populations and using them for dead animals violates some of the study assumptions. For example, the distribution of carcasses (large numbers of carcasses tend to collect in particular areas) and the way the carcasses are encountered by sampling crews can lead to biased estimates. The potential sampling bias can partially overcome

by using a stratified sampling approach. In the Feather River, the roughly 16 river miles of spawning habitat were divided into 25 sections to track spatial distribution of carcasses and allocate sampling effort. Effort required to conduct these surveys is considerable.

In 2000 DWR carried out a pilot study to test assumptions and assess importance of sampling design. They found that:

- A considerable increase in sampling effort was necessary, including:
  - 4 10-hr days per week
  - 8-12 people on the river
  - 2-3 jet boats
- Sampling design and implementation are critically important
- Violations of assumptions (and biased estimates) were likely with the old methods.

Simulations indicate that the new study design and execution have improved population estimates (e.g. through better recovery rates) but Brad cautioned that there are no direct methods (e.g. weir counts) that can be used for comparison. Finally Brad recommended that for best results study designers and data analysts should work closely with field crews.

Tag recovery surveys Recovering salmon heads (and the embedded tags) offers several sampling problems, including:

- tag recovery is often considered secondary to estimating escapement – especially in the CV where there is not a history of tagging hatchery fish.
- One needs to know the actual number of carcasses sampled for CWTs and this number is often uncertain.
- Adipose fin clips are easy to overlook or on the other hand the crew looks too carefully for CWTs at the expense of random sampling.
- The crews have to collect the heads and transport back to the hatchery or other location. The heads are heavy and smelly and samplers may tend to be less effective later in the day.
- The bias that occurs when crews are collecting CWTs rather than sampling for them.

Hatchery related monitoring

The five CV mitigation/production anadromous salmonid hatcheries collectively release about 30 million juvenile Chinook salmon each year. A relatively small fraction of these fish is tagged – a limitation that restricts our ability to estimate what fraction of the harvest and escapement consists of hatchery fish. Five workshop talks dealt with some aspect of monitoring that addresses the hatchery question.

Tagging hatchery fish – a constant fraction marking program There were two presentations dealing with using coded wire tags to mark a fraction of the fall Chinook released by CV hatcheries. Both efforts have been funded by CALFED.

Dave Hankin (Humboldt State University) provided a history of California's constant fractional marking efforts, beginning with his 1978-1980 work on Klamath River Chinook. The problem there, as in the CV, was that low marking rates precluded estimates of hatchery performance and status of wild fish. DFG rejected his initial suggestion to mark all hatchery fish as too expensive. The question then became how to mark less than 100% of the hatchery fish and still allow accurate estimates of the proportion of hatchery fish. Hankin (1982) recommended that one-third of the hatchery fish be marked (ad clip) and coded wire tagged. This protocol was generally followed in the '79-82 broodyears. Subsequently, the fraction tagged in the Klamath Basin has been less and variable.

The situation is more complicated in the CV due to the large number of hatcheries and stocks, the historic low marking/tagging rates, and the likely high straying caused by the off-site release strategy used in three hatcheries. As described in Newman et al. (2004), Hankin and his colleagues proposed a Constant Fractional Marking (CFM) strategy for CV Chinook that included specific assumptions, release strategies and marking at least 1/3 of the production fish. As they showed in simulation studies, this strategy would produce the most reliable estimates of hatchery and wild catches and escapement. Hankin also noted that accurate escapement estimates are critical to robust production estimates. Finally he provided an illuminating example of what happens when you mark 100% of the fish. The 2001 Trinity River study showed 1600 of 1741 adipose clipped fish were hatchery fish. (We see similar results for steelhead where all of the hatchery fish are marked, for example at the Feather River Hatchery.)

Alice Low described the recent history of the CFM in California's CV in the following timeline.

- 1998 CALFED and the CVPIA funded the Hankin et al. modeling efforts
- 2000-2001 – CALFED funded a pilot marking tagging effort at CNFH, FRH and Nimbus where an automated tagging machine was used to mark and tag a total about 5.5 million juvenile fall Chinook.
- 2004 – An implementation plan proposal was submitted to the CV Salmonid Project Work Team and thence to CALFED.
- 2005 – CFM project is included in CALFED's Ecosystem Restoration Plan budget.

In consultation with local biologist and representatives of agencies in the Northwest, the CV implementation plan includes a 25% mark rate, as opposed to the 33.3% rate recommended in Newman et al. (2004). The CALFED funded program is being implemented according to the following timeline.

- In 2005, there were coordination meetings among the state and federal fish hatchery managers.

- In 2006 the PSMFC (the contact administrator) hires a program coordinator and contracts with Northwest Marine Technology to begin constructing the three automated tagging trailers. The trailers are to be delivered in December 2006.
- In early 2007 the operators and assistants will be hired and marking tagging will begin in March or April.
- The tagging will resume in late winter/early spring 2008 with the 2007 BY
- After 2008, a longterm project will be in place. (The long-term project is not currently funded.)

Programs to develop the necessary tag recovery, reading and analyses are also underway – see for example the Chinook escapement monitoring program Alice mentioned earlier.

Alice noted that otolith themal marks are useful for river and hatchery studies but not for studying the ocean fisheries management.

Following their presentations, Alice and Dave answered questions on the planned CV Constant Fractional Marking Program. Dave stated that although his study concluded that a 1/3 marking/tagging rate would be optimum, he believes that the current program (25% rate) will provide the data needed for much improved management of CV stocks. He is pleased to see the CFM program entering the implementation phase.

Ocean and inland tag recoveries

Allen Grover (DFG) described the harvest and ocean tag recovery program coordinated by DFG's Ocean Salmon Project in Santa Rosa. The program goal is to estimate effort and catch of commercial and recreational fisheries (both skiff and charter boats) and to sample 20% of the fisheries for coded wire tags. The collected tags are sent to the Santa Rosa laboratory for extraction and decoding. The tag recovery (and release) data are sent to the PSMFC in Portland to be entered in the Regional Mark Information System (RMIS) database described later in this summary.

If sufficient tags were applied in CV hatcheries, ocean fishing effort and tag recoveries could be used to estimate the hatchery contribution to the fisheries – as DFG and NOAA Fisheries are doing for Klamath Basin Chinook salmon. With the low tagging rates for CV Chinook is not now possible to reliably estimate hatchery contribution. Allen did use an example from the FRH where he and his staff were attempting to recreate the 98 and 99 cohorts. In a full cohort reconstruction, tag recovered in the ocean fisheries, inland fisheries, CV stream surveys and hatcheries would be used to estimate such important parameters as contribution to the fisheries, straying and percent hatchery fish in the runs,

With the currently available data, it is not possible to make solid estimates of contribution and straying rates but the '98 cohort data Allen presented offer a glimpse of the possibilities. (The final '98 and '99 cohort reconstructions can be found in Palmer-Zwahlen et al. 2006). Below are three figures from Allen's presentation that show the

inland distribution of the recovered tags, the age distribution of the ocean recoveries and the locations where the tags were recovered. (Also included is a map showing the naming convention for the ocean recovery locations.) A few notes below each table may help explain the data and their meaning.

Summary of Feather River CWT '98 brood year Chinook Inland Recoveries

FRH CWT release groups	#CWTed	Total Returns	% Total Recovered	Feather Basin	Yuba Carcass	Lower Sac. Sport	Outside Basin
In-basin FRH Fall (INBF)	771,600	2,898	0.38%	90%	_	5%	4%
Trucked FRH Fall (TRKF)	457,500	4,188	0.92%	85%	0%	7%	7%
Experimental FRH Fall (XHAF)	301,100	573	0.19%	54%	1%	4%	42%
Trucked FRH Spring (FRHS)	309,600	3,685	1.19%	90%	0%	1%	9%
Wild Feather River stock (FRWI)	133,000	20	0.01%	100%	_	_	_

Table 1. Inland recoveries for BY '98 FRH fall Chinook. (slide courtesy of Allen Grover DFG)

Notes:

1. INBF were released in Feather River to evaluate this release strategy
2. Trucked fish were released in San Pablo Bay
3. Experimental fish were part of Yolo Bypass studies
4. Wild fish were captured in FR rotary screw traps for tagging.

Comments:

1. Note that trucked fall and springs are recovered at higher rates than fish released in the river.
2. Note that tagged wild juveniles survived at very low rates

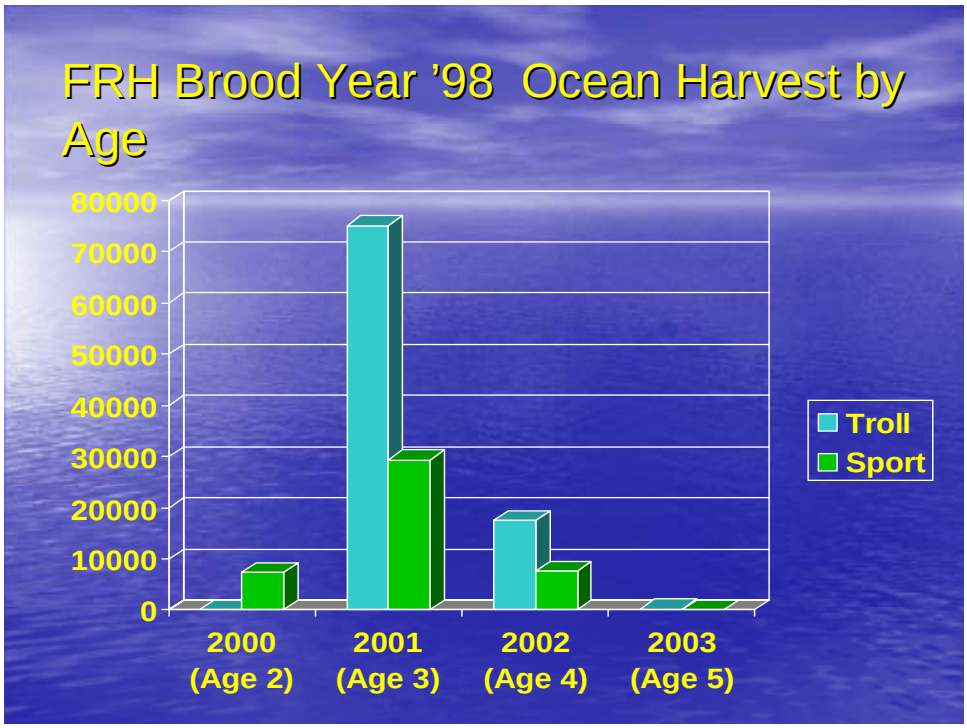


Figure 1. Age structure of BY '98 FRH caught in the ocean commercial and recreational fisheries. (slide courtesy Allen Grover, DFG)

Comments:

1. As expected most fish were harvested at age three. Looking at other years shows the same general trend, although the exact percentages among 2, 3 and 4 year olds vary among years. Five year olds are always relatively rare.
2. Sports fisheries can harvest fish that are 20 inches or longer whereas the ocean troll fishery takes fish that are 27" or larger, thus the differences at age 2 harvest.

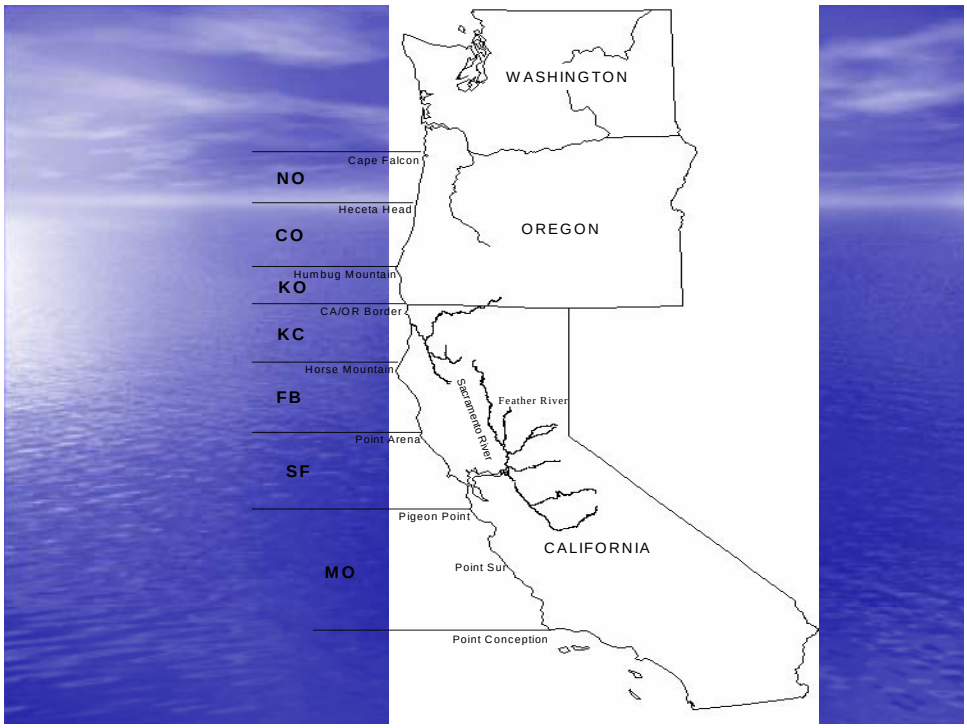


Figure 2. Naming convention for ocean landing areas. (Slide courtesy Allen Grover, DFG)

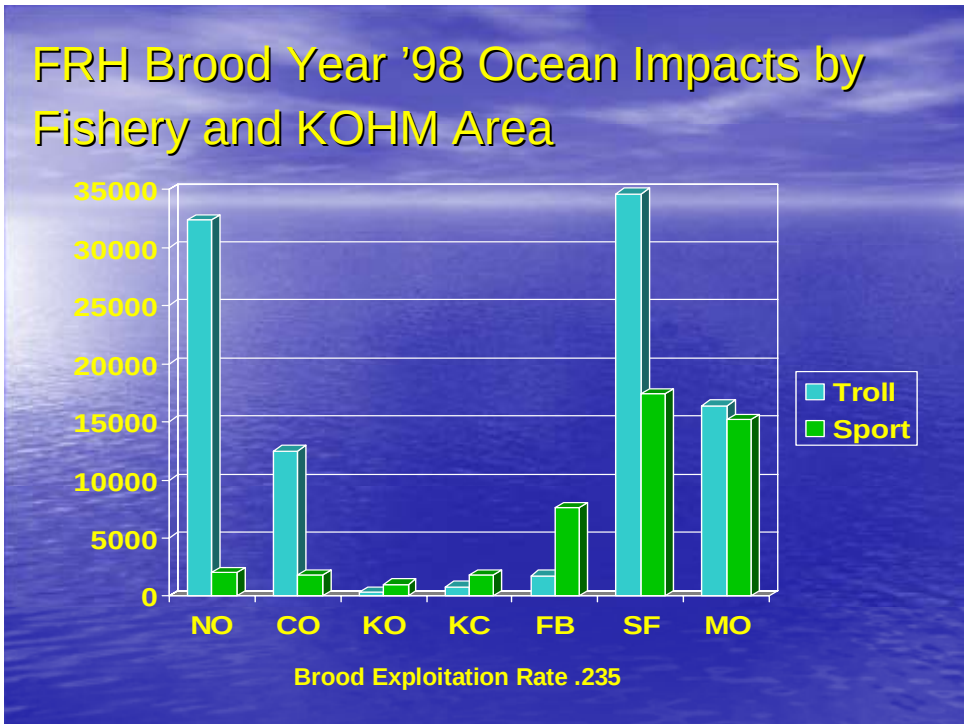


Figure 3. Catch of BY '98 FRH Chinook salmon by area. (Slide courtesy Allen Grover, DFG. See Figure 2 for naming convention.)

Comments:

1. The catch distribution in Figure 3 represents the majority of the ocean catch by area in all years. Very few FRH (and likely other CV Chinook) are taken north of Oregon.
2. The catch distribution among landing ports may vary from year to year depending perhaps on ocean conditions and fishery effort.
3. The low catches in the Klamath and Fort Bragg areas may have been due to management efforts to reduce the harvest of Klamath River falls
4. The hatchery contribution (catch) may vary from year to year. For example it appears that the contribution from the '99 cohort was much lower than from the '98, perhaps due to a viral (IHNV) outbreak at the FRH.

An alternative to coded wire tagging **Eric Anderson** (NOAA Fisheries) described an emerging genetic technology, full parental genotyping ((FPG), that shows considerable promise for monitoring CV Chinook salmon to accurately estimate or evaluate:

1 hatchery contribution to fisheries and escapement
2 straying rates of hatchery fish
3 ocean and inland harvest rates of hatchery fish
4 effects of hatcheries on naturally spawning populations
5 effects of hatchery production on genetic composition
6 rates of hybridization among Chinook salmon races in hatcheries
7 effects of alternative hatchery/release practices

8 homogenization of CV Chinook genotypes

As described by Eric (and in more detail in Anderson and Garza 2006), FPG differs from genetic stock identification (GSI) genetic techniques that have been used for the past few decades to identify populations of origin of individual fish. FPG allows exact identification of parents of an individual and does not require the genetic identification among populations required by GSI.

Although all the details and costs of FPG have not been worked out, in general the procedure is to collect tissue samples (a fin clip for example) from all hatchery spawners. The tissue samples are used to create a database of all possible parent pairs that can be used to match recovered offspring genotypes against. The offspring can be assigned to parent pairs (and to cohort) with a total accuracy rate (false positive, or assigning a progeny to the wrong parent) on the order of 23 of 50,000.

Preliminary FPG costs estimates indicate that it is likely to be competitive with coded wire tagging and the rapidly changing genetic technology is improving efficiency and reducing costs, Eric provided some interesting statistics regarding coded wire tagging:

- Since 1968 71 agencies have used 34,000 individual codes and 573 miles of magnetic wire to tag about 959,000,000 salmon and steelhead.
- In Alaska alone, since 1976 about 900,000 heads (weighing 677 tons) have been sent to the Juneau lab for decoding.

Overall we believe the FPG offers unique opportunities to learn more about the effects of hatcheries on CV Chinook salmon and steelhead and monitoring program designers should follow the technology and determine how it can best fit into the overall strategy. In a similar vein, thermal marking of otoliths should be kept in the possible mix of marking technologies. After a pilot thermal marking program in 2004, FRH staff attempted to mark all 2005 fall Chinook production with a unique mark on the otolith. Due to the very wet hydrologic conditions in early 2006, and lack of chiller capacity, the goal of marking all fall Chinook production was not achieved but more than 90 percent were marked.

Managing the tag CWT data (**Randy Brown**, CALFED) Although Allen and Alice mentioned the tag data base in passing, I believe it is so important to a hatchery evaluation program that it justifies a few more words. Since 1977 the Regional Mark Processing Center has provided an essential data storage and retrieval system for agencies, tribes and others marking fish and inserting coded wire tags. The data include releases, recoveries and associated catch/sample information. The RMIS is operated and maintained by the PSMFC in Portland, Oregon. Center staff validates multi-agency submissions of CWT related data in the RMIS. The data are readily available to all and the format is user friendly.

Recent experience by Allen and his staff trying to reconstruct the 1998 and 1999 FRH cohorts has clearly demonstrated the importance of error checking the CWT related

data going to the RMIS. It has taken an inordinate amount of time to get the data in good enough shape to do a useful cohort reconstruction. Even with correct tag release and ocean tag recovery data, the inland tag recovery data set is still not in good enough shape to calculate reasonably reliable estimates of the numbers of adult FRH Chinook salmon that stray to other streams when returning to freshwater. One of the significant problems is not having a good handle on the number of carcasses examined to collect the CWTs. An example of the tag collection versus tag sampling problem Brad Cavallo described in his talk.

The values of hatchery coded wire tagging data Many of the points **Brown** made in his talk already had been made above. As he emphasized in the presentation, the tag data are only important if a series of events takes place. If the series is not complete, the information may be of little use to managers and biologists. These events are:

- The tagging itself, including quality control (for example tag retention) and accurate reporting of tag codes, numbers, size and release locations.
- Error checking in the data base to ensure that the tagging data are accurately entered.
- Statistically robust tag sampling methods in the ocean and freshwater fisheries. Assume hatchery staff inspects all fish for tags and collects heads of ad clipped fish.
- Statistically robust escapement and harvest estimates.
- Accurate reporting and entering of tag recovery, escapement and harvest data.
- Converting data to information. Some version of a cohort reconstruction model, such as the Klamath Basin Fall Chinook Cohort Reconstruction (Goldwasser et al. 2001) should be used to track the fate of the released fish.
- Reporting the data. To be most useful, this reporting should be at several levels. This reporting system, in particular for managers, still needs to be worked out. Some ideas are presented in discussion/recommendation section.

Estimating inland harvest

Duane Massa (DFG) briefly described recent (the 1990s) efforts to estimate the numbers of Chinook salmon harvested in several CV streams. In the most recent studies (for example, Schroyer et al. 2002), DFG sampled 18 reaches in 7 CV streams – the Sacramento and San Joaquin river mainstems, and the Feather, Yuba, American, Stanislaus and Mokelumne rivers. The program was terminated in 2003 due to lack of funding. Alice Low indicated that funding from the Sport Fish Restoration Act (SFRA) and Bay-Delta Enhancement Stamp programs will be used to restart the program in 2007. The program will cost approximately $1.4 million/year. Although details are still to be worked out, the efforts will focus on the same seven streams.

Using ultrasonic tagging to examine survival and movement of juvenile Chinook salmon and steelhead in the Sacramento River and the San Francisco Estuary.

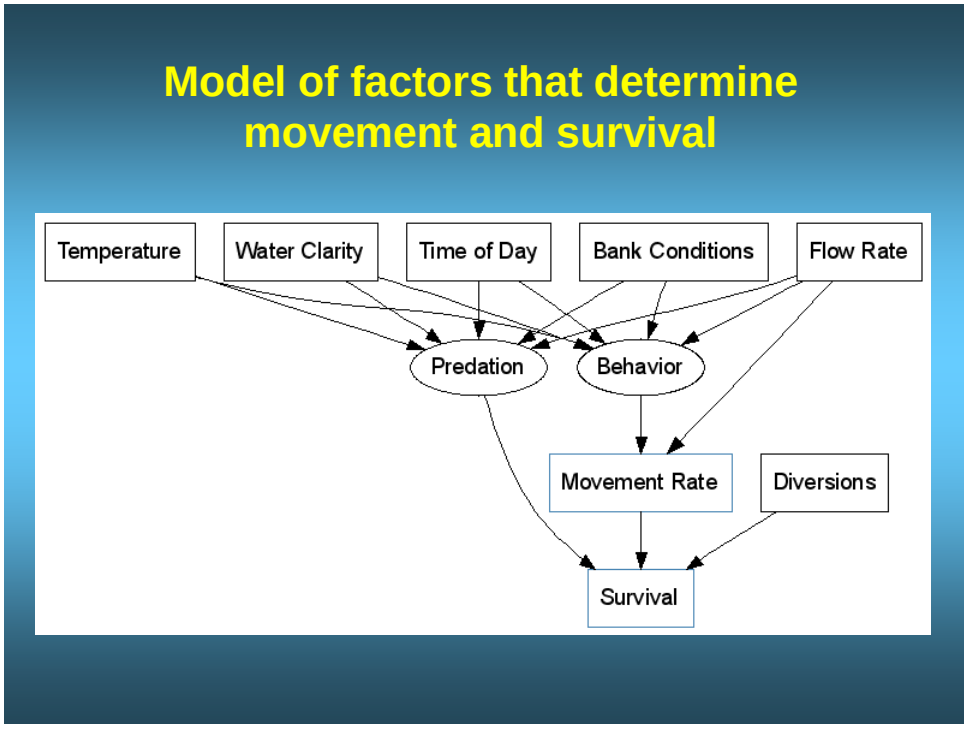
Peter Klimley (UCD) and Arnold Amman (NOAA Fisheries) described a new CALFED funded project that is to answer the following general questions regarding

CNFH late fall smolts and yearling steelhead movement and survival down the Sacramento River:

1. Do the migration rates vary among river reaches (including the estuary) and, if so, why?
2. Does survival vary among reaches and, if so, why?

Stated another way, the goal is to describe movement and survival rates at the scale of river reaches and to explain variations in these rates.

The following conceptual model was used when considering factors that influence movement and survival.



The experimental design consists of releasing 200 CNFH late fall smolts and 200 steelhead yearlings near the mouth of Battle Creek each year for three years (2007-2009). (The releases will consist of 10 late fall and 10 steelhead per day for 20 days in January of each year.) The fish will have radio transmitters implanted surgically into their peritoneal cavities. Studies have shown that this procedure has little or no adverse effect on the fish – although the fish have to be larger than 150mm for the technique to work. Fish movement will be tracked by an array of shore mounted receivers/data loggers positioned between Battle Creek and the Golden Gate. The number of transmitter and the transmitter range (on the order of 300 meters) will ensure adequate tracking as the fish move downstream towards the ocean.

Ancillary data such as water velocity and temperature, riparian vegetation and rip-rap, will be acquired from various agencies and used to help explain observed movement and survival.

An additional benefit of such an innovative approach to investigating questions about salmon movement and survival is that the presence of the fish and the transmitters allows other investigators and agencies to "piggyback" onto the basic design and infrastructure This is happening in this study with the US Army Core of Engineers and others providing equipment or funding for specific areas or questions. The USACE is particularly interested in the effects of dredging on salmon movement and survival and will add 50 monitoring stations to help in these efforts. Members of the audience noted that tracking Delta movement (in particular near the export pumps) and it might be helpful to re-establish Derek Stein's monitoring stations in the Delta.

Data management

Data management is an essential component of a comprehensive monitoring program. **Karl Jacobs (**DWR) described one approach to data handling – the Bay-Delta and Tributaries Data Base (BDAT) that is being developed through the IEP with financial support from various entities including CALFED and the AFRP.

Developing this distributed data base has required cooperation among agencies and stakeholders and is a result of the recognition of common data management needs by biologists, managers and modelers. The goal is to make various types of data readily available in a timely manner. The BDAT is designed to provide data for:

- predictive tools such as models
- project operations
- adaptive management
- distributing GIS data and model output
- evaluating restoration and mitigation measures and facilities

The BDAT system starts with the data collector who validates the data and enters them in a local MS Access data base for eventual uploading to the comprehensive database. BDAT staff can provide training and, in some cases equipment and software, to facilitate local data handling efforts. One objective is to ensure local control and responsibility for individual program datasets. The local data bases are keys to the entire system and must meet certain criteria.

- data need to be accessible to the system
- data entry needs to be quick, dynamic and easy
- the data providers need to have the tools necessary to participate

With respect to salmonid data, the use of BDAT is still somewhat hit and miss in the CV. Some of the salmonid and related data bases now on the system are:

- CVPIA/CAMP Fish and basic water quality information including
    - DFG Region 4 – Tuolumne, Merced and Stanislaus rivers
    - Mokelumne River
    - Battle Creek and Clear Creek
- DWR's Feather River studies
- GCID screw trap data

- Some of the IEP salmon monitoring data collected by the FWS, Stockton

The BDAT also stores much of the IEP monitoring data, including much of the background environmental data in the Sacramento-San Joaquin Delta. Jacobs and his staff are currently working with the nine regional water boards to implement a data management system for the Surface Ambient Water Monitoring Program (SWAMP) which will used in regional watershed assessments. SWAMP will include tissue analysis, macroinvertebrate assessments + water chemistry + bioassays. These environmental and other data will be useful when thinking about the effects of local conditions on salmonid populations.

Reporting and presenting monitoring data

Jim Smith discussed data collection, storage and reporting from the perspective of field office manager or field project leader. Jim and his staff receive requests for data as well as descriptions of what they are doing and how they are doing it. The requests are often somewhat vague and the requestor may not be clear as what sort of data is needed and the level of detail required, Jim mentioned that the salmonid monitoring summary reports that Alice Low and Kerrie Pipal prepared will go a long ways towards helping respond to these requests and thanked the authors for all their hard work.

Jim used several slides from previous workshop presentations to illustrate issues associated with reporting and presenting monitoring data, with the overall question: *Is there an ideal system for this?* The data can be used by biologists and managers to do:

- Management evaluations such as stock distribution, run reconstruction, survival trends, etc.
- Hatchery/wild evaluations such as straying and contribution rates as well as genetic and ecological effects.
- Hatchery evaluations to examine the time and location of release and different rearing strategies.
- Habitat improvement project evaluations

A good data management system will be readily accessible, user friendly and contain the sorts of metadata needed to determine how the data were acquired – including any limitations. A distributed data base system, such BDAT described by Karl Jacobs, meets some of these attributes but not others – for example BDAT is not now particularly user friendly. The question of a distributed data base as compared to a central data base, as John Wicket called for in his presentation, has not been resolved,

Jim concluded is presentation by asking the somewhat rhetorical question "*Is there salmon monitoring data report system that will meet everyone's needs?"* It is doubtful that such a system exists and we certainly do not have it in the CV. Jim suggested we might want to consider forming a new PWT to look into data management and reporting. **Authors' note**: In the Northwest NOAA Fisheries and the Northwest Power Planning Council (and others) are dealing with similar issues and it might we worthwhile to find out more about what they are doing - http://www.nwcouncil.org/ned

A representative could be asked to come to the CV for a seminar or a presentation to the CV Salmonid Team or one of the PWTs.

Panel Discussion

The panel discussion, with participation by all attendees reiterated points, identified some un-discussed concerns, and reinforced need for more monitoring. The following are many of the major points, not in any order.

- Any data management system must be user friendly. There is a perception, and reality, that BDAT is not as friendly as it might be. The CALFED funded Chinook salmon escapement and steelhead monitoring projects will have data base components and Alice indicated they would be linked to the IEP's BDAT.
- Two perspectives on converting data to information were discussed. On one hand, the folks collecting the data have a responsibility to report the data, and in the open literature to the extent possible. On the other hand, the collectors can not sit on the data waiting to write papers. There appears to be an increasing agency recognition that data should be posted as soon as the basic QA/QC checks have been made to make sure they are reliable. The Environmental Water Account's Data Assessment Team weekly phone conferences have helped by:
    - Making data available to decision makers in near real time.
    - Showing collectors that their data are being used in decision making.
- The Chinook salmon age structure data, and lack thereof, were used to illustrate the point that we often need better definitions and consistency in collecting and reporting data. In many cases the distinction between a grilse and an adult salmon has been arbitrary. Aging the fish by reading the scales or otoliths will be quantitative and provide the data needed to reconstruct cohorts.
- In a similar vein, DFG's GrandTab illustrates a problem with a simple spreadsheet that provides useful numbers but no metadata to allow users to determine the data's reliability. For example the counts are generally reported to the nearest fish (say 22,219) with no indication of error bars. In addition, sampling methods have changed over the years, thus detecting trends is often difficult, most of these data are actually estimated, or qualified numbers.
- There was some discussion of the use of models to help sort things out. Stranding was used to highlight the idea of population level effects and how models might shed light on them. It wasn't clear to some that the stranding and related data are adequate to detect population level effects. It was expressed by some that modeling tools continue to be an underused tool by CV salmonid biologists.
- There is a perceived need for an umbrella structure by which better coordination, collaboration, and cooperation can be achieved, in particular in the upstream areas. Examples were presented such as BDAT for data and IEP Salmonid Project Work Team as a starting point for to address coordination.

- There appeared to be a general recognition that we are not doing a good job at data assessment – both from system wide and individual program standpoints. Part of this problem may be due to the difficulty in making such assessments, part to lack of a formal structure to make such assessments and partly to lack of funds and availability of qualified technical staff. It was suggested that more collaborative proposals be submitted to fund and address this need.
- Which leads us to the thorny question of funding In many instances budgets are being cut (DFG, CAMP) and agencies are reluctant to assume responsibility for conducting monitoring and analysis. Several attendees made the point that monitoring costs are relatively low compared to the project themselves (a figure was tossed out of 1 billion dollars spent on CV salmonid restoration projects) but it is often difficult to convince managers to allocate adequate funds for monitoring – and the rest of the analysis/reporting process needed to prepare convincing assessments of individual and collective benefits of the projects. It will take everyone connected with restoration and monitoring to make the case for adequate funds.
- In summary, workshop attendee appreciated the efforts of the planning committee and the speakers (and those providing background information) for pulling together this workshop. They also pointed out that this workshop was short on the nuts and bolts of a comprehensive plan and additional workshops may be needed.

Some take home messages

Overall we believe the workshop provided a useful forum for discussing several important issues related to a comprehensive CV salmonid monitoring program. The strong turnout and the lively discussion demonstrated that the topic is important to salmonid biologists and managers. The presentations and other material showed that we are making good progress in many areas, there are a few areas where progress is being made but more work is needed, and a couple important areas that seem to be receiving little attention.

<u>The good news</u> The good news is that there is considerable progress being made in several areas – all of which can contribute to an effective monitoring program. A sampling of the encouraging areas includes:

- CALFED has stepped up to the plate and funded several important proposals:
    - Developing a CV Chinook salmon escapement monitoring plan.
    - Developing a comprehensive steelhead monitoring plan
    - A Constant Fractional Marking/tagging program for fall-run Chinook at CV hatcheries
    - Aging CV Chinook salmon by scale reading
    - Developing a winter Chinook life history model
    - Adult escapement monitoring in the upper Sacramento River Basin

- Monitoring inland harvest of CV Chinook salmon and steelhead is being funded using Sport Fish Restoration Act and Bay-Delta Enhancement Stamp funds.

- Establishment and participation of IEP project work teams in salmonid related studies.
    - The CV Salmonid Team provides overall direction.
    - The Escapement PWT, whose work led specifically to the Chinook salmon escapement monitoring proposal to CALFED.
    - The Steelhead PWT whose work led specifically to the steelhead monitoring proposal submitted to CALFED.
    - The Juvenile Monitoring PWT, where juvenile monitoring methods and results are discussed.
    - The Genetics PWT where application and results of genetic monitoring techniques are discussed.
    - The Delta Rearing PWT where the Delta's role in the salmonid life history is being examined.
    - The newly established but yet to meet Hatchery PWT. Hopefully this PWT can help address hatchery related monitoring issues.
- The CV Technical Recovery Team, established by NOAA Fisheries, with financial support from CALFED, is accumulating and analyzing information about CV Chinook salmon and steelhead. This information is being made available in a series of technical memoranda and publications – for example Lindley et al. 2006a and 2006b and Anderson et al. 2006.) A new salmonid recovery plan will result from these and other efforts. Recovery plans typically identify monitoring and research needs.
- Renewed interest in monitoring, indicators and performance measures on the part of CALFED and the CVPIA's AFRP. These, and others, are recognizing that spending literally hundreds of thousands of dollars to restore CV salmonids is not enough if you don't invest in programs that can be used to evaluate the effectiveness of the restoration actions towards the ultimate goal of recovering and delisting the species.
- Specific watershed monitoring programs that are providing new information on the species and their requirements.
    - Feather River related studies, including the FRH, have now been underway for more than a decade and have provided large amounts of information on this important salmonid stream (for example Brown et al 2004 and Seesholtz et al. 2004. The March 2006 FERC (DWR 2006) draft settlement agreement requires new studies and monitoring, both in the stream and the hatchery.
    - The American River, under the leadership of the Water Forum, is working towards new instream flow standards, accompanied by an expanded monitoring program.
    - The Mokelumne and Tuolumne rivers have extensive monitoring and analysis efforts tied to the water project operations on these streams.
- New technology is being used to address difficult salmonid related questions.

- The ultrasonic tagging study described by Klimley and Amman at this workshop.
- New genetic techniques (full parental genotyping, as described by Anderson at this workshop) that may be used to identify hatchery fish and answer a wide range of hatchery related questions. Michael Banks, Oregon State University and Carlos Garza, Eric Anderson and others at the NOAA Santa Cruz lab continue to examine the genetic structure of CV Chinook salmon.
- The FRH is conducting pilot studies on the use of otolith thermal marking to identify hatchery salmon.
- Pilot level testing of new escapement estimating technology such as Vaki infrared systems and digital optical systems.

Encouraging news – but we are not nearly there yet In a few areas we appear to be making progress but much more is needed. Examples are:

- *Data handling*. Karl Jacobs described a distributed data base system – Bay-Delta and Tributaries Data Base – that has many of the attributes of a comprehensive data base system. Although several CV programs are currently using the data base, it is not universally accepted and used.
- *The role of hatcheries*. There is increasing recognition that we need to better define the hatchery contribution and the impacts of hatcheries on natural stocks. Also the hatcheries, and their potential impacts, need to be more fully considered when managing CV salmonid stocks and fisheries.

Not much progress being made It became clear during the discussion there were several areas in which we either do not know how to proceed or have not made significant efforts to figure out how to handle them.

- *A comprehensive management structure for a monitoring (and research) program.* The IEP is providing an ad hoc structure for some of the functions but there is no entity that handles the entire program, or even much recognition that such a structure is needed.
- *What needs to be reported to whom, by whom and when?* The Pacific Fisheries Management Council annual ocean fishery status reports (for example PFMC 2006) and DFG's GrandTab provide useful data summaries. DFG prepares periodic status reports to the Fish and Game Commission on listed species. However there is no annual other report that can be used by managers and biologists to assess changes in the abundance and distribution of the CV anadromous salmonids. Is such a report – or more likely a series of reports for different audiences – needed and, if so, what form would it take and who would prepare it?
- *A life cycle approach to the species* The animals are still mostly studied by geographic area with limited interaction among programs and areas. An ancillary problem area is modeling which might help tie the areas and information together. Much of the data modelers need to construct their models is not available – either has not been collected or has not been released by the collectors.

- *Funding* CALFED has provided a needed injection of money into many salmonid monitoring programs and research areas. However, funding routine monitoring is not a high CALFED priority. The CVPIA's Comprehensive Assessment and Monitoring Program has received relatively little funding The IEP budget has remained level for several years, with no inflation index. Overall it is not clear where funding will come from in the future.
- *The ocean.* Although Loo Botsford (UCD)and his colleagues (for example Botsford et al. 2002) and Bruce McFarlane (MacFarlane et al. 2005) have been conducting interesting work in the near-shore ocean, the ocean is still largely a blue hole as far as CV salmonid are concerned. Are recent good runs to CV streams due to good ocean conditions, reduced ocean fisheries or improved inland habitat due to CALFED and other actions? This key question can not be answered at this time.

Some suggestions for moving forward

Please note that these suggestions are offered mainly in the spirit of moving the conversation along. As we have all learned over the years, there are no magic answers. The suggestions are not in order of their importance.

- Continue the great work being done by the IEP PWTs. The folks in these working groups are the ones on the ground (or in the stream) and many good things are coming out of them. PWTs members might read this summary to determine if there are areas that they might want advocate and recommend ways to make things happen. The use of new technology and techniques should be carefully tracked and implemented when appropriate.
- Get the IEP Hatchery PWT off the ground, with the first steps being to confirm membership and draft a mission statement or list of objectives.
- Ask the planning committee for this workshop to weigh in on the need for additional workshops and, if so, what topics should be considered. If there are specific workshops, approach the CALFED Science Program for financial or other support.
- Consider preparing a biennial state of the salmonid resources report tied to the CALFED Science Conference. The report could be presented at the conference (either in plenary or at a dedicated salmonid session) and written up as paper in the San Francisco Estuary and Watershed Science on-line journal. There would be lots of details to work out but the conference timing – every two years - might be about right about right for periodically updating the state of knowledge.
- Consider new approaches to moving forward with salmonid monitoring. For example, monitoring needs associated with mitigation hatcheries (about which several speakers expressed interest in more data) could addressed in the following sequence:
    - Commission a white paper on hatcheries – perhaps guided by the IEP Hatchery PWT. One of the key chapters in this white paper would deal with monitoring needs – beyond the need to mark and recover hatchery fish.

- Convene an expert panel to review the paper, including monitoring needs.
- Hold a hatchery summit workshop where monitoring and other issue are presented to the panel and they provide recommendations on how to proceed.
- To the extent possible, implement the monitoring program.
- Reconvene the group and the panel periodically (at least every five years) to evaluate progress towards understanding hatchery impacts and additional monitoring needs.

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ATTACHMENT 2 – WORKSHOP AGENDA

SALMONID MONITORING WORKSHOP
AUGUST 23-25
BAY CONFERENCE CENTER
ROMBERG TIBURON CENTER
SAN FRANCISCO STATE UNIVERSITY

Tuesday, August 23

Note that all time slots are approximate and include about equal time for the presentation and discussion.

1300 – *Introduction* – Russ Bellmer, USFWS
1330 – *Perspectives on monitoring needs*
Stakeholder – Serge Birk, CV Project Water Association
Manager – Jim Smith, USFWS
Modeler – Wim Kimmerer, San Francisco State University
ESA – Bruce Oppenheim, NOAA Fisheries
1500 Break
1520 - *Considerations for a Constant Fractional Marking Program for CV Chinook* – Dave Hankin, Humboldt State University
1600 – *An agency proposal for a CV Constant Fractional Marking Program* - Alice Low, DFG
1620 – *Managing salmonid data* – Karl Jacobs, DWR
1715 Adjourn
1730 – Reception

Wednesday, August 24

0830 – *Estimating Chinook salmon and steelhead escapement – what are we doing now and what is being proposed* – Alice Low, DFG
0930 – *The Feather River – a case history illustrating the challenges of monitoring salmonids on a large river* – Brad Cavallo, DWR
1015 Break
1035 – *Salmonid monitoring needs – including gaps in existing efforts* – Keviin Niemela and John Wikert, USFWS
1115 – *Monitoring CV salmonid movement and survival from origin into the coastal ocean* – Peter Klimley, UCD and Arnold Ammann, NOAA Fisheries

1200 Lunch

1300 - *Estimating ocean harvest and recovering coded wire tags* – Allen Grover, DFG
1400 – *Hatchery monitoring data – an underutilized resource?* – Randy Brown, CALFED

1440 - *Genetic monitoring and a new generation of genetic tags for* hatcheries Eric Anderson, NOAA Fisheries
1520 Break
1540 - *Monitoring salmon and their habitat in the CV: Evolution or Intelligent Design?* John Williams, Consultant
1630 – General Discussion
1700 Adjourn
1730 – Reception and BBQ

Thursday, August 25

0830 – Reporting and presenting monitoring data – Jim Smith, USFWS
0910 - *Where do we go next with CV salmonid monitoring? – a panel discussion, with audience interaction*
Alice Low, DFG
Jim Smith, USFWS
Russ Bellmer, USFWS
Serge Birk, CVPWA
Brad Cavallo. DWR
1015 Break
1035 - Continue panel discussion
1130 – Adjourn