

**Interpretive Summary  
of the  
2003 EWA Chinook Salmon Workshop**

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## Introduction

The CALFED Science Program convened the 2003 Environmental Water Account (EWA) salmonid workshop on July 15 and 16, 2003. This was the third in a series of workshops dedicated to examining the use of EWA resources for conserving, protecting and restoring salmonid resources in California's Central Valley. This workshop, and its reporting, differs from the previous two workshops by:

- Being organized by the science advisors, with advice from agency and stakeholder biologists.
- Focusing on Chinook salmon, and to a certain extent, on winter Chinook. A discussion of steelhead was not included in this workshop.
- Having one of the EWA Review Panel members, Kenny Rose, as an active workshop participant.
- Having five focus areas in which we believed progress should, and could, be made.
- Balancing the presentation and discussion times approximately equally.
- Providing an interpretive summary of the workshop to the EWA Review Panel separately from the overall workshop summary. The more detailed workshop summary will be available for the panel at the October 2003 EWA Review Workshop.

To provide an idea of the scope of the discussion and the affiliation of the participants, the agenda and attendance roster are included at the end of this paper as Appendices A and B, respectively.

The workshop focused on the following technical topics:

- Modeling salmon populations, with the discussion and summary lead by Kenny Rose.
- A review of Delta Cross Channel results with the emphasis on their use by managers.
- Recent salmon research results presented by several investigators.
- A summary of science needs provided by Pete Adams of NOAA Fisheries.
- The question of regulating take of spring Chinook at the Delta pumps, including what we know about emigration patterns from Deer, Mill, and Butte creeks.
- The potential benefits of EWA actions to Chinook salmon.

We recognized that the agenda was ambitious and these areas were quite complex and could not be addressed completely in a two-day workshop. We hoped, however, that the

workshop could lead to a better understanding of the underlying issues and perhaps to suggestions on how to proceed in the various areas. For this paper, we briefly describe some of the material presented at the workshop and our comments on where the collective salmon research community could consider heading in each area. Note that this paper includes some material not presented at the workshop, and some sections represent the views of the authors, thus the title “Interpretive Summary” rather than an “Executive Summary.”

## Modeling Salmon Populations

We structured this session around four modeling approaches that have been, or are being considered for use, with Central Valley Chinook salmon. The approaches and presenters (in bold type) were:

1. A spatially explicit individual-based model (IBM) of fall Chinook salmon recruitment below the LaGrange Dam on the Tuolumne River (Jager and **Rose** 2003)
2. An IBM of Sacramento River Chinook populations (**Kimmerer** and Jones & Stokes Associates 1999)
3. A proposed integrated modeling framework for Central Valley winter Chinook **Cramer** and Reiser (2003)
4. Reconstructing the winter Chinook cohorts produced at the Livingston Stone National Fish Hatchery (**Dan Viele**)
5. An approach using a state-space time series model to forecast winter Chinook juvenile production (**Steve Lindley** and Ken Newman)

Steve Lindley also presented a discussion of the approach and limitations of the Juvenile Production Estimate (JPE) spreadsheet model used to estimate the numbers of juvenile winter Chinook expected to enter the Delta each year.

### Where Are We With Salmon Modeling?

*Comments by Brown and Kimmerer*

- Although there has been some effort devoted to modeling Central Valley Chinook salmon life cycles, to date there has been no concerted move for the community of Central Valley salmonid biologists to become involved in these modeling activities.
- One of the reasons for this lack of concerted and coordinated approach to modeling salmon populations has been a relatively low funding base. For example the IBM described by

Kimmerer was funded by the USFWS, but funding stopped in 2000 before the model could be completely coded and tested (Note: USFWS is apparently providing some funding to continue that effort).

- Progress on all models is hampered by lack of critical information for use in their development and verification. Better information is required on such essential life cycle components as reliable spawning estimates and percentage of spawners that have coded wire tags and, thus, are mostly of hatchery origin.

In spite of the generally pessimistic nature of the above observations, there is room for optimism based mainly on material not presented at the workshop.

- Better data collection, at least for some key system components, may be on the horizon. For example:
  - This fall the IEP's Central Valley Salmonid Escapement sub-team will release a proposal for enhanced salmon escapement and coded-wire-tagged (CWT) data collection and analysis.
  - Also this fall, Hankin and Newman will provide CALFED with recommendations for a constant fractional marking program to help sort out hatchery from wild fish in the ocean and inland catches and spawning escapement.
- The DAT/EWA process in the Delta has resulted in much of the data about salmon in the Delta from the watershed being posted and available within a few days of collection.
- Significant numbers of non-hatchery origin Chinook salmon are being coded-wire tagged on Butte Creek and the Feather River and their recovery may shed light on the movement and fate of these fish once they leave their natal streams.
- In August 2003 Cramer and Reiser released their draft Step 1 report describing a conceptual framework for an integrated winter Chinook life cycle model based on previous modeling efforts in the Central Valley. The consultants have limited funding from the California Urban Water Agencies (CUWA) to develop a modeling framework, and started by providing a winter run conceptual model and constructing an operational spreadsheet model. These efforts involve many of the agency salmon biologists as part of a collaborative process.

Our general conclusion is that over the next few months, the current CUWA sponsored modeling efforts should form the core around which the models develop. The current spreadsheet model is clearly a temporary stage in a process that can lead to an IBM Chinook salmon model. The collaborative process will require that salmon biologists continue to be actively involved. Eventually additional funding will be needed for model development and verification, as well as data collection. At that time, the modeling effort should probably migrate to CALFED or an agency for care and feeding. (See the following salmon science section for additional thoughts on data collection.

## **Salmon Research and Monitoring**

The general approach for this session was to include brief presentations on some interesting studies and innovative research and monitoring techniques followed by a presentation by Pete Adams of NOAA Fisheries about salmon-related information needs. Below are a few observations from the presentations, as well as the highlights of Adams' presentation. (Information from two of the talks in this session related to salmon mortality in the Delta is covered later under the session on EWA benefits to salmon.)

### **Recent Advances in the Use of Otolith Microchemistry and Morphology to Understand Salmon Origin and Life History**

*Chris Donohoe, NOAA Fisheries*

Fish otoliths (earbones) can provide a wealth of information about the fish. The shape of the otolith can show if the fish is of hatchery origin. Daily growth increments in the otoliths provide an accurate record of the age of juvenile salmon, which can be used to deduce growth history. The chemical composition of the otolith at a microscopic scale, together with similar data from streams and the estuary, can be used to deduce the watershed of origin and the history of the fish's movement. Finally, active temperature manipulation in the hatchery (thermal marking) can lay down patterns on the otoliths that can subsequently be used to identify the hatchery where the fish was raised.

### **Juvenile Salmon Development in the San Francisco Estuary**

*Bruce MacFarlane, NOAA Fisheries*

MacFarlane reported on the use of such variables as age, size, lipid and protein content, and feeding habits (stomach contents), together with environmental variables, to evaluate growth, development, and habitat use by juvenile salmon in the San Francisco Estuary. The impetus for the study came in part from the observation that while juvenile Chinook salmon often spend considerable time in Northwest estuaries, the importance of estuarine rearing has not been as clearly demonstrated in the San Francisco Estuary. In part, the study showed that juvenile Chinook typically enter the estuary at age 4 to 5 months and grow relatively little during the month or so they spend there. Condition factor declined during estuarine residence as the fish grew longer and more slender. This study is no longer being conducted in the estuary – Bruce is now working with Chinook in the coastal ocean.

(Note: MacFarlane's definition of the estuary did not include the Delta, where numerous salmon fry rear and are being monitored. His study seems to relate to smolts migrating through the estuary rather than to fry rearing within it. See MacFarlane, R.B., and E.C. Norton. 2002. Fish. Bull. 100:244-257.)

## **Direct and Indirect Approaches to Estimating Juvenile Winter Chinook Production**

*Phillip Gaines, U.S. Fish and Wildlife Service*

Gaines and his colleagues in Red Bluff used a series of rotary screw traps below the Red Bluff Diversion Dam (and below most of the winter run spawning habitat) to estimate annually the numbers and emigration timing of juvenile winter Chinook. They compared their production estimates (the Juvenile Production Index or JPI) with the JPE, which is based on number of salmon spawned, fecundity and survival from eggs to emigration. The correlations between the JPI and JPE for five years were quite good, thus providing direct evidence that the JPE procedure is in the right ballpark for this reach of the river. After one year without funding, the sampling program is back in operation.

## **Data from Carcass Surveys and Catches of Juvenile Chinook Salmon at Balls Ferry and Knights Landing Screw Traps – What Do They Tell Us About Production, Emigration and Survival?**

*Rob Titus and Bill Snider, California Department of Fish and Game*

Titus and Snider used the data from the two DFG-operated screw traps (one at River Mile 278, near the spawning grounds and the other just above the Delta at RM 88) in conjunction with winter Chinook carcass surveys to examine emigration patterns. Among other things, Rob pointed out that winter run emigrants move past Knights Landing earlier in years with early increases in river flow and, in general survival to Knights Landing appeared to be higher in years with early high river flows. Titus and his colleagues also looked at survival-recruit relationships and ages of individual emigrants as estimated by otolith aging. Analysis such as those presented can be an important step toward an empirically based production model.

## **Genetics of Central Valley Chinook Salmon**

*Sheila Greene, California Department of Water Resources*

Sheila updated the group on progress that has been made towards understanding the genetic makeup of Central Valley Chinook – progress which increased dramatically in the mid-1990s with initiation of the microsatellite work at the UC Davis Bodega Marine Laboratory (BML). The research using microsatellites and other genetic markers is continuing at UC Davis under the direction of Bernie May and at Oregon State University's Hatfield Marine Science Center under Michael Banks, formerly at BML. Genetic markers have allowed biologists to better understand winter Chinook emigration through the Delta, to assess the actual winter Chinook losses at the intakes to the state and federal water projects, and to determine that Mill, Deer and Butte creeks support genetically distinct runs of spring Chinook. Although not reported at this workshop, recent work by Kevin Williamson (a doctoral candidate under Bernie May at UCD) has shown that Central Valley fall Chinook are genetically very homogenous; for example, San Joaquin fall Chinook can not be distinguished genetically from Sacramento Valley fall Chinook.

## **A Research and Monitoring Agenda for Salmon and Steelhead**

*Pete Adams, NOAA Fisheries*

The above descriptions of specific research projects provide snippets of the sort of information being collected about Central Valley Chinook. Adams took a different approach by describing a science agenda that could help scientists and managers determine where to allocate their science dollars and also to obtain the information as a basis for tough decisions, such as allocation of EWA water. In our view, some key points from the presentation were (A more complete description of the salmon science agenda can be found in the workshop summary report):

- The agenda must be a collaborative effort between agency scientists and managers as well as scientists from the academic and stakeholder communities. At present there is relatively little participation by academia.
- The agenda must be based on a rigorous foundation of conceptual models, testable hypotheses, and goals.
- Data collection, storage, and synthesis are keys to arriving at conceptual models and testing hypotheses. Without data, decisions are based only on informed opinions.
- Fish population abundance has temporal and spatial components, and long-term monitoring is needed to sort them out.
- We need to understand, and take into account, the uncertainty surrounding our population estimates. When giving advice, include an idea of the statistical power of our various estimates and regressions.
- The salmon science agenda should consider the needs of population viability assessments; for example, we need good population estimates and the percentage of hatchery fish in these estimates.
- We know relatively little about steelhead.
- The influence of ocean conditions, including harvest, needs to be considered when developing a salmon science agenda.

## **Where Are We and Where Should We Go With a Salmon Science Agenda?**

*Comments by Brown and Kimmerer*

The following was not presented at the workshop and strictly represents our thoughts on a salmon science agenda, much of which we owe to Pete Adams' thoughtful summary.

Although there is considerable excellent salmonid research and monitoring being conducted in the Central Valley, we believe there are significant limitations that make present efforts less effective than they could and should be.

1. There is no overall salmonid science agenda. We are now working with an ad hoc process of data collection and analysis, and collaboration is rather hit and miss.
2. There has been no consistent modeling effort – either conceptual or mechanistic – to help guide the salmon-related science in the Central Valley. The CUWA effort may invigorate efforts at modeling, but this will require a significant commitment of funds over a period of years if it is to be useful.
3. The salmon research and monitoring community remains balkanized. Although communication has been improving, most of the active researchers in the Central Valley are still examining only parts of the life cycle.
4. The academic community has not been very involved in salmon-related research, perhaps in part due to the lack of salmon programs in local universities.

Without a salmonid science agenda it will be impossible for biologists to evaluate the effects of individual salmon protection/recovery programs such as the EWA. We find it astounding that a program as well-funded as EWA has been unable to muster the resources to answer the critical questions about the magnitude of its benefits to salmonids. CALFED should lead a collaborative effort to develop and implement a salmonid science agenda, perhaps in conjunction with the NOAA Fisheries Central Valley Salmonid Technical Recovery Team. The salmonid science agenda should be a consideration in a decision about continuing the EWA past its first four years. In addition, CALFED, its member agencies, and the academic community need to form a partnership to develop a sustained academic involvement in Central Valley salmonid research.

## **Delta Cross Channel Studies of Salmon Movement and Survival**

The Bureau of Reclamation constructed the Delta Cross Channel in the 1950s to help move water from the Sacramento River to Central Valley Project (CVP) pumps in the southern Delta and to maintain good water quality at the intakes. When Sacramento River flows are greater than about 25,000 cfs, the manually operated DCC radial gates are closed to prevent scouring of interior Delta channels. Beginning in the 1970s studies using tagged salmon have shown that emigrating salmon entering the DCC had lower survival to the western edge of the Delta at Chipps Island. Operation of the DCC gates is now one of the primary means of salmon protection in the Delta, with the gates closed from February 1 through the end of May each year. The gates may also be closed up to 45 days during the October 1 through January 31 period, at the request of the Management Agencies, generally through the DAT. When the gates are closed and projects continue to pump water, Delta water quality may be degraded through landward dispersion of brackish water from the western Delta and Suisun Bay.

In November 1999, a period of low Delta inflow, the fish agencies requested that the gates be closed to protect emigrating juvenile Chinook salmon. With continued high project pumping, water quality conditions in the Delta quickly degraded to levels that had not been seen since



1977 – the second year of one of the worst droughts on record. Partly as a result of the 1999 conflict between fish protection and water quality, the IEP and CALFED sponsored an interagency multi-disciplinary study to answer the following questions.

1. How does operation of the DCC gates affect interior Delta water quality?
2. How does operation of the DCC gates affect passage of adult Chinook salmon through the Delta?
3. How does operation of the DCC gates affect passage and survival of Chinook salmon smolts through the Delta?

The team used a combination of several field monitoring techniques to help answer these questions. The techniques included velocity meters, radio-tagged adult and juvenile salmon, releases of CWT smolts, hydroacoustic fish detection, and conventional trawling. These studies focused on relatively small time frames using intensive field sampling, and investigated effects of tidal operation of the DCC gates for short periods.

The workshop summary contains some detail on the study results. Here we focus on a some points made Jon Burau (USGS) on the management implications of these important studies.

- Our conceptual model of how smolts move through the Delta has been too simplistic. Variability at the tidal time scale is important to determining how salmon move. In contrast to
  - previous assumptions, the fish are not uniformly distributed in the water column and don't necessarily go with the flow. Stated another way, it may be possible to move water through the DCC without taking fish. On the other hand, fish may go into Georgiana Slough (just downstream of the DCC) at higher rates than suggested by flow.
- Based on the new model of smolt movement and distribution in time and space, it may be possible to improve smolt movement past the gates by less than full gate operation; for example, gate openings timed with tides or with the diel vertical movement of salmon smolts.
- DCC gate operation affects water flow in several Delta channels including Georgiana as well as Sutter and Steamboat sloughs (the latter two bypass Sacramento River water around the DCC-Georgiana junction). Applying this finding to salmon, the salmon survival question broadens to encompass the effects of gate operation on salmon survival through the North Delta, not just simply at the DCC itself.
- The radio tagging studies identified some areas of apparent high losses of smolts to predators, generally around structures on the outside of bends.
- There was wide variation in the paths adult salmon took to transit the Delta, and a similar wide variation in the time it took salmon to move through it.
- The studies to date only provide snapshots – a more comprehensive approach using

different techniques may be needed.

## **Where Are We With the DCC Studies and Using the Results from These Studies?**

*Comments by Brown and Kimmerer*

The following observations on the DCC studies were not presented at the workshop:

1. The collaborative, interdisciplinary DCC studies have made a major contribution to our understanding of water and fish movement in the Delta (but see the next item). For example, the fate of tagged salmon may depend on when (flood or ebb tide, day or night) and where (inside of bend, in the main flow field) the fish are released.
2. Unfortunately, the DCC results have been presented orally at several venues, but have not been published and there is apparently no process for publishing them; instead, the researchers involved have moved on to other projects. Thus, it is impossible for anyone to evaluate these results or even to apply them, because the peer review necessary for this work to be validated as a piece of scientific research has not been done. The Science Program needs to determine the value of continued field studies in the light of this continued lack of written output from the DCC team.
3. The field approach used in the DCC studies can be used profitably in other areas of the Delta, the watershed and the estuary.
4. The pool of research scientists that can collaborate in such studies in this system is extremely limited.
5. As described by the DCC researchers, some additional studies are needed before managers can effectively consider alternative DCC operations.

## **Take at the Pumps, With Special Emphasis on Take of Juvenile Spring Chinook**

Along with DCC operation, actions to limit take at the state and federal export pumping facilities are among the primary means of minimizing the direct effects of water project operations on listed salmonids. In turn, one of the primary uses of the EWA resources is to limit take of winter Chinook and other older juveniles. Since the first biological opinion in 1992, biologists have learned a lot about winter Chinook emigration and the take process for this race is working reasonably well. Information from DNA analyses has been used to revise the size-at-date run classification system and the system now provides useful, albeit imperfect, estimates of winter Chinook losses.

The same cannot be said for take of spring Chinook. These fish may emigrate from streams as fry, smolts, or yearlings, and therefore are not easily classified by the size-at-date system. Genetic techniques are not yet adequate to identify individual spring Chinook. Late-fall Chinook from the Coleman National Fish Hatchery released near the hatchery have been used as surrogates to represent take of spring-run Chinook. In the 2002-2003 EWA season, the take of some of these surrogate releases exceeded the target levels, but the take of the surrogate hatchery fish may not adequately represent take of the threatened wild spring run.

This workshop session included a description of spring run emigration patterns from the Mill, Deer, and Butte creeks followed by a presentation on take limits, including some new ways in which they might be applied. Note that, although the focus was on spring Chinook, similar concerns have been raised about the adequacy of take limits for steelhead, mainly because we know little about the pre-screen and through-screen losses of these larger juveniles.

### **Spring Chinook Emigration Patterns in Mill, Deer and Butte Creeks**

*Colleen Harvey-Arrison, California Department of Fish and Game*

Colleen's summary at the workshop describes the findings of her and her colleagues quite well:

1. Rotary screw trap data from Mill, Deer, and Butte creeks are useful in determining timing and length frequency of emigrating spring Chinook from these streams. The data are not adequate to estimate production.
2. Spring Chinook emigrate from these streams as young of the year (YOY) and yearlings. Ratios of YOY to yearlings are unknown and may vary annually and between streams.
3. Spring run yearlings can emigrate over an 8-month period, from October through May. YOY can emigrate over a 9-month period, from November through July.
4. Limited CWT data suggest that yearlings survive at a much higher rate than YOY emigrants.
5. Butte Creek CWT results show that the Sutter Bypass is a significant nursery area for emigrating juvenile spring Chinook. Once the salmon leave the Bypass, residence time in the lower river and Delta is brief.

Thus the spring run shows a complex and variable life cycle and designing Delta protection measures is a challenge. On the other hand, if the behavior of Butte Creek emigrants is typical, they don't spend much time in the Delta.

## **Estimating Take Limits at the Pumps**

*Bruce Oppenheim, NOAA Fisheries*

Although Bruce discussed winter Chinook and steelhead take limits, we focus on new methods that might be considered to improve the take estimation process for spring Chinook at the water project intakes. Bruce suggested the following methods for spring Chinook take.

1. Refine use of surrogates – for example, select one group of tagged late fall run each year that best represents peak natural emigration. Rotary screw trap data or first storm could be used to estimate the time of peak natural emigration.
2. Consider Feather River or Butte Creek emigrants as wild surrogates.
3. Use real time sampling with genetic markers or otoliths at the salvage facilities to determine fish origin.
4. Based on spawning in key streams, develop a target survival index of tagged wild fish to Chipps Island or other downstream sampling site.

Bruce also recommended some additional studies and data related to establishing and evaluating take limits.

1. Conduct mixed-stock analysis of spring run YOY.
2. Use real-time genetic data to estimate take of winter and spring Chinook.
3. Use survival indices to evaluate project impacts.
4. Conduct studies of suitability of hatchery fish as surrogates for wild fish.
5. Use population models to evaluate population effects.

## **Where are We with the Question of Spring Chinook Take Limits?**

*Comments by Brown and Kimmerer*

Colleen's description of spring Chinook emigration patterns demonstrated the complexity of the task of establishing useful spring Chinook take limits at the Delta pumps. The extended, and variable, emigration period means that juvenile spring-run Chinook of all sizes and ages may be in the Delta at any given time. As described by Greene earlier, spring run from Deer, Mill and Butte Creeks have unique genetic signatures but are not yet distinctive enough to identify

individual fish. A mixed stock analysis may provide useful information about the proportion of fish are likely to be spring Chinook from each of the spawning creeks. An extensive mixed-stock analysis of juvenile salmon collected at the pumps would be expensive, but may be the only means of getting a good handle on spring Chinook take, and a better understanding of their migratory patterns through the Delta.

## **Benefits of the EWA to Chinook Salmon**

This session focused on EWA benefits to emigrating juveniles. The session included the following parts (in a different order than presented here):

- Thoughts on how emigrating salmon may move through the Delta (BJ Miller).
- Evidence for the role of DCC operation on the numbers of juvenile winter Chinook subsequently taken at the federal and state projects (Alice Low).
- Calculations of reduction of direct losses of Chinook salmon attributable to the EWA (Sheila Greene).
- Thoughts and estimates of the indirect benefits of EWA actions (Pat Brandes and Alice Low).
- A conceptual plan for evaluating the EWA (Pat Brandes).
- Approach to evaluating EWA benefits (Jim White).
- Comments by the EWA advisors on this issue, including suggestions for additional work.

### **Thoughts on Movement of Juvenile Salmon in the Delta**

*BJ Miller, representing the San Luis and Delta-Mendota Water Authority*

BJ provided a personal perspective on how emigrating salmon may move through the Delta – he likened it a “drunkard’s walk.” This movement has three major components:

1. Deterministic with general movement towards the ocean.
2. Random tidal sweeping at junctions, with the sweeping depending on when (tidal phase) and where the fish are in the channel when they reach the junction.
3. Deterministic for those fish that find themselves in the “zone of influence” of project pumps in the South Delta.

Note that component number 1 only operates for those fish that are actively migrating

towards the ocean. Some fish may take up temporary residence in the Delta before emigrating to the lower bays and the ocean.

BJ also provided the following management implications:

1. Barriers to limit tidal sweeping may improve survival.
2. Side channel entrances could be modified to reduce entrainment into the channels.
3. The zone of influence needs better definition.
4. Although incidence of take is predictable, its magnitude may not be. (For another view on this see the next section.)
5. We may need different management actions for the state and federal intakes since the factors influencing entrainment at the two plants appears to differ.

### **Winter-Run Juvenile Emigration and Relation to Delta Losses**

*Alice Low, California Department of Fish and Game*

Alice updated the relationship she presented at the 2002 salmonid workshop showing the relation between DCC operation and calculated take at the pumps. The 2002-2003 data fit nicely into the relationship and Alice concluded that:

- Data from the upstream rotary screw traps continue to show a consistent pattern of juvenile emigration to the Delta.
- DCC operations in December are highly correlated to the ratio of losses of juvenile winter Chinook at the Delta facilities to the JPE.
- The new evidence from 2002-2003 provides additional evidence for the value of DCC closures in December.

### **Reduction of Direct Losses of Winter Chinook Due to EWA Actions**

*Sheila Greene, California Department of Water Resources*

Note that in the workshop Sheila also presented information on calculated losses of older juveniles and fry and smolts at the project intakes. The following estimates are for the first three years of the EWA.

<i>Year</i>	<i>Calculated number not lost due to EWA actions</i>	<i>% of JPE</i>
2000-2001	5,968	0.22
2001-2002	183	0.01
2002-2003	291	0.01

### **Estimates of Relative Winter Run Mortality in the Delta Due to Exports and Potential Population Effects**

*Pat Brandes, U.S. Fish and Wildlife Service and Alice Low, California Department of Fish and Game*

Pat used the mark-recapture data to estimate that, during the period from 1995-1996 through 2002-2003, the export-related mortality through the Delta (including direct and indirect losses) ranged from 4% to 18% of the JPE, with an average of 9%. Alice calculated the long-term changes in adult returnees had the project related mortalities not occurred. These analyses indicated that the numbers of spawners would have significantly higher had not the projects been operating in the Delta. Her overall conclusion was:

- The effects of Delta project operations on winter-run populations may be significant, particularly in recovery periods.

### **EWA for Salmon: Goals, Conceptual Models, Objectives, Performance Measures and Relevant Analyses Plan**

*4/30/03 – Pat Brandes, U.S. Fish and Wildlife Service*

Pat described an approach to the EWA evaluation developed collaboratively by the EWA biologists, designed to:

- Provide a structure and priority for needed analyses.
- Ensure the analyses were relevant to the questions and goals.
- Place the questions and goals into a conceptual model to better understand relative importance.
- Develop performance measures that were directly tied to program objectives.

The goals for EWA actions for salmon were defined as:

- Determine effective and efficient methods to implement existing regulatory

requirements such as take management.

- Determine if minimizing take and closing the DCC provides greatest population benefits relative to other uses of EWA resources.
- Put benefits of EWA actions into perspective relative to other potential actions.

The goals were further subdivided into the following objectives:

- Avoid exceeding specified take levels and minimize take in general.
- Maximize survival through the Delta.
- Use EWA water to maximize population benefits.
- Take the most effective measures to protect the population.

An example of a performance measure was take at the pumps, with the following performance measures suggested.

- Did we avoid “yellow” and “red light” take levels?
- Did we take actions at the appropriate time?
- Did the combination of DAT conference calls, data analysis and the salmon decision tree lead to the appropriate decisions?

Pat emphasized that this is definitely a work in progress and the EWA biologists are working to:

- Determine how to do some of the analyses
- Determine who will do them
- Develop the conceptual models
- Allocate time to do the analyses
- Revise the list of potential studies based on data availability and priority
- Find the resources necessary for some analyses, in particular statistical support

## **How Do We Approach Evaluating EWA Benefits for Salmon?**

*Jim White, California Department of Fish and Game*

Jim outlined a general approach to evaluating EWA benefits for salmon but cautioned that



biologists must also consider the following:

- More than salmon are in the system when EWA actions are taken.
- There are multiple benefits to many, if not all, EWA actions.
- Some EWA uses (for example, pumping reductions at the SWP during VAMP) could be viewed as project obligations.
- For salmonids, the EWA is not just for the spring and winter Chinook – steelhead, fall, and late fall Chinook must be considered when evaluating the EWA.

## **Benefits of the EWA for Salmon and Steelhead**

*Comments by Brown and Kimmerer*

As described above, progress is being made towards evaluating the EWA benefits. Pat Brandes' results indicate that indirect mortality due to pump operations may be significant, although the reduction in indirect mortality due to EWA actions would be smaller. Sheila Greene's calculations indicate that reducing direct losses may not be a significant EWA benefit for winter Chinook. Finally the EWA biologists have developed a useful conceptual framework for evaluating EWA benefits.

As described in this section, progress is being made towards evaluating the EWA benefits. Pat Brandes' results indicate that indirect mortality due to pump operations may be significant, although the reduction in indirect mortality due to EWA actions would be smaller. Sheila Greene's calculations indicate that reducing direct losses may not be a significant EWA benefit for winter Chinook. Finally the EWA biologists have developed a useful conceptual framework for evaluating EWA benefits.

Although progress is being made, considerable work remains – especially at assessing population effects. With our present state of knowledge we don't believe it possible to define population benefits with any degree of accuracy. More importantly, we are unable to determine if EWA assets (both money and water) could have been used more effectively than they have been, for example, through more actions using water upstream or through habitat restoration.

In the absence of solid evidence of the benefits of the EWA to salmon (and also to smelt) should the EWA be continued past year four? The answer to this question cannot be based on the scientific evidence. First, three or four years are too short a period to adequately evaluate such a program. Second, answering this question will require a comprehensive research and monitoring agenda and a strong modeling framework with which we can address the relative benefits of EWA and other actions. In our view the current CUWA-sponsored modeling approach can lay the groundwork for moving towards one or more useful predictive salmon models – although CALFED and the agencies will need to keep the effort moving forward. We recommend that CALFED and NOAA Fisheries take the lead in developing a salmonid science agenda, including a modeling component, and further recommend that it be in place before the EWA proceeds past year four. A sound science program will not only be important to the EWA

but all CALFED and baseline regulatory actions that are intended to protect and restore Central Valley salmonids.

## Appendix A: Agenda

2003 EWA Salmon Workshop  
July 15 and 16, 2003  
Yamshon Alumni Center  
California State University, Sacramento

### *Tuesday, July 15*

0830 - Check in and coffee

0900 - Welcome, workshop goals, housekeeping details - Wim Kimmerer

### **Modeling Approaches to Understanding Chinook Salmon**

0915 - Introduction - Kenny Rose

0925 - Using individual based models - Wim Kimmerer

0955 - Reconstructing the 1998 winter Chinook cohort - Dan Viele

1025 - Break

1040 - The Lindley/Newman approach to modeling Chinook populations - Steve Lindley

1110 - An integrated modeling framework - Steve Cramer

1140 - Lunch

### **Research Findings**

1230 - Recent advances in the use of otolith microchemistry and morphology to understand salmon origin and life history - Chris Donohoe

1300 - Juvenile Chinook salmon development in the San Francisco Estuary - Bruce McFarlane

1330 - Direct and indirect approaches to estimating juvenile winter Chinook abundance in the "Upper" Sacramento River: (JPEs versus JPIs) - Phil Gaines

1400 - What do analyses of screw trap catches and other information tell us about juvenile winter Chinook production, emigration timing and factors affecting their survival? - Rob Titus

1430 - Break

1445 - Winter-run juvenile emigration and relationships to Delta losses - Alice Low

1515 - Estimates of winter run mortality in the Delta due to exports and its potential population level effects - Pat Brandes/Alice Low

1545 - An update on the results of Chinook salmon genetic studies in the Delta - Sheila Greene

1615 - Comments/question/discussion

1645 - Adjourn for the day

*Wednesday, July 16*

### **Delta Cross Channel Study Results – What Do Resource Managers Do with Them?**

- 0830 - Study design and overview - Bruce Herbold
- 0840 - Water movement in the vicinity of the DCC - Jon Burau
- 0900 - Results of fish tagging studies - Bruce Herbold
- 0920 - A hydrodynamic approach to the question - Do fish go with flow? - Mike Horn
- 0940 - Velocity structures and fish movement - Aaron Blake
- 1000 - Break
- 1015 - Management implications of DCC study results - Jon Burau
- 1035 - Future studies - Jon Burau
- 1100 - CWT studies of the DCC: results and cautions - John Williams
- 1115 - Panel discussion and questions - all presenters
- 1200 - Lunch

### **Estimating Spring Chinook Take at the Delta Water Project Intakes**

- 1230 - Spring run emigration - timing, size at emigration and variation among Mill, Deer and Butte creeks - Colleen Harvey-Arrison
- 1300 - Estimating take at the pumps - a review of past methods and suggestion for new approaches - Bruce Oppenheim

### **The EWA and Salmon Protection**

- 1330 - Thoughts on the movement and fate of juvenile Chinook salmon in the Delta - BJ Miller
- 1400 - Reduction in direct take of older juveniles as a result of EWA fish actions - Sheila Greene
- 1430 - Goals, conceptual models, performance measures and plan for relevant analyses - Pat Brandes
- 1500 - Break

### **Summary Session**

- 1515 - Directions in salmon modeling - Kenny Rose
- 1545 - Research and monitoring agenda for salmon? - Pete Adams
- 1615 - How do we approach evaluating benefits of EWA actions for salmon? - Jim White
- 1645 - Where do we go next? Wim Kimmerer

1700 - Adjourn

## **Appendix B: 2003 EWA Salmon Workshop Attendee Roster**

### *CALFED Bay-Delta Authority*

Wim Kimmerer - San Francisco State University  
Zach Hymanson  
Kristen Honey  
Randy Brown  
Jana Machula

### *EWA Review Panel*

Ken Rose, Louisiana State University

### *California Department of Fish and Game*

Treva Porter  
Jim White  
Alice Low  
Rob Titus  
Paul Ward  
Colleen Harvey-Arrison

### *California Department of Forestry*

Chris Keithley

### *California Department of Water Resources*

Jim Long  
Sheila Greene  
Brad Cavallo  
Erin Chappell  
Don Kurosaka  
Dan Fua

### *NOAA Fisheries*

Michael Aceituno  
Bruce Oppenheim  
Bruce McFarlane  
Pete Adams  
Steve Lindley  
Dan Odenweller  
Diane Windham  
Chris Donohoe

### *U.S. Environmental Protection Agency*

Bruce Herbold

### *U.S. Bureau of Reclamation*

Michael Horn

*U.S. Geological Survey*

Larry Smith  
Jon Burau  
Aaron Blake

*U.S. Fish and Wildlife Service*

Phillip Gaines  
Jim Smith  
Roger Guinee  
Nick Hindman  
Pat Brandes  
Kevin Niemela  
Andrew Hamilton  
Melissa Dragan  
Derek Hilts  
Victoria Poage  
Russ Bellmer  
David Hu

*University of California, Davis*

Bill Bennett  
Ron Yoshiyama

*Metropolitan Water District of Southern California*

Rick Sitts

*East Bay Municipal Utility District*

Joe Miyamoto

*The Bay Institute*

Tina Swanson

*Consultants*

BJ Miller - San Luis and Delta-Mendota Water Authority  
John Williams  
Mark Shibata - Montgomery Watson - Harza  
Darryl Hayes - CH2MHILL  
Steve Cramer - Steve Cramer & Associates  
Sagutio Najmus - WRIME