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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF CALIFORNIA
FRESNO DIVISION

THE CONSOLIDATED SALMONID CASES	Lead Case: 1:09-cv-1053-LJO-DLB **Declaration of Dr. Michael H. Schiewe in Support of Joint Motion to Extend the Remand Schedule**
THE DELTA SMELT CONSOLIDATED CASES	Lead Case: 1:09-cv-00407-LJO-DLB

I, Michael H. Schiewe, PhD, declare as follows:

1. I am an aquatic scientist with more than 40 years of experience in research and recovery of salmonid populations in the Pacific Northwest. I have been employed since 2003 as a Principal Scientist with Anchor QEA, L.L.C., in Seattle Washington, an environmental science and engineering firm that focuses on aquatic, shoreline and river resource projects. Prior to my current employment, I worked for the National Marine Fisheries Service (NMFS) beginning in 1968 and retired in 2002 in the dual role of Director of the Fish Ecology Division and Director of Salmon Research for the NMFS Northwest Fisheries Science Center. I have been involved in a variety of scientific investigations, including fish passage, fisheries enhancement, fish health, population biology and genetic stock structure of Pacific salmonids. I have authored more than 50 peer-reviewed journal articles and book chapters, and served on the Affiliate Faculty of the School of Fisheries and Aquatic Sciences, University of Washington, from 1980 to 2004. I have testified to U.S Senate Committees on topics that include salmon recovery planning and the effects of river flow on salmon survival. My Curriculum Vitae is attached as Exhibit 1.

2. I have been retained by NMFS as the Senior Scientific Advisor to the Central Valley Office of NMFS' Southwest Region. In that capacity, I have assisted NMFS technical staff in the development of the Bay Delta Conservation Plan (BDCP) goals and objectives for survival of juvenile salmonids migrating from the San Joaquin River through the south Delta. I also worked with NMFS and California Department of Water Resources (DWR) staff to establish a South Delta Salmonid Research Collaborative (SDSRC) to develop research plans for improving survival of salmonids migrating from the San Joaquin River through the south Delta. As will be described below, the goal of the SDSRC is to complete a research plan by August 2013 and begin implementation of the plan in Water Year 2014.

3. I have reviewed the Court's January 30, 2013 Order in response to the Joint Motion to Extend the Remand Schedule. Doc.728. The Court sought further explanation about how: (1) circumstances have changed in significant, unforeseen ways since the judgments were entered; (2) the changed circumstances make compliance with the remand schedules contrary to

the public interest; and (3) the requested continuance is tailored to the changed circumstances. I have also reviewed the Declaration of Maria Rea in support of the Joint Motion for Extension, filed concurrently with this declaration. In that declaration, Ms. Rea explains that NMFS would not be able to commit to participation in the multi-year collaborative science and adaptive management process, called the "CSAMP," and also meet the current remand schedule, and that under the current schedule, studies that are being developed, including the SDSRC, may not be completed in time to fully inform a new biological opinion for the long-term operations of the Central Valley Project (CVP) and State Water Project (SWP).

4. I submit this Declaration in support of the Joint Motion for Extension. My focus will be to discuss: (1) the benefits of participating in the SDSRC, which will be a subgroup of the CSAMP; and (2) the benefits of delaying revision of the Biological Opinion until results of current and new scientific studies conducted by NMFS and others can be considered; and (3) the consequences of foreclosing or limiting these efforts.

5. There is a pressing need for a comprehensive plan to guide research on factors affecting survival of salmonids transiting the south Delta. Recent studies employing acoustic tags and sophisticated route entrainment and survival estimation models have shown that survival rates of San Joaquin salmonids transiting the Delta are generally less than 10 percent. Salmonid populations incurring such low survivals are of uncertain sustainability.

6. While there is consensus that salmonid survival rates are low, there is a diversity of scientific opinions about the causes of these low survivals. Given the diversity of scientific opinions regarding causes of this low survival and, in particular, uncertainty about how this low survival relates to management actions and options available for enhancing south Delta survival, the planning and design of new research needs to be statistically rigorous and scientifically robust. Further, because of the far-reaching societal impacts of decisions informed by the results of any new scientific studies, acceptance of new data will likely be improved by developing any new studies in a transparent and collaborative environment with scientists and technical staff from all stakeholder groups participating.

7. Meaningful results from research involving ecological interactions must be conducted over multiple years to incorporate environmental variability. It is not unusual for such studies to require years or even decades of continuous research and monitoring to encompass the full range of natural variation.

8. As noted in Ms. Rea's declaration, the three-year extension will allow NMFS the time to better address how low survival rates relate to management actions through its participation in the multi-year collaborative science and adaptive management process, called the "CSAMP," and that the SDSRC will be a key subgroup of that process.

9. It is my understanding from Ms. Rea's declaration that without an extension, NMFS would be unable to participate in the CSAMP process and would have to significantly scale back its participation in the SDSRC. This would have several negative consequences. For instance, NMFS would not be able to directly participate in the design and implementation of new statistically rigorous studies originating in the CSAMP. Without NMFS co-leadership in the SDSRC its future as a forum to focus on south Delta operational changes is uncertain. And finally, NMFS would not be able to participate in the transparent and collaborative environment of the CSAMP with scientists and technical staff from all stakeholder groups.

10. The SDSRC has adopted a traditional scientific approach in the development of research plans. The initial steps are the development of a conceptual model or models and identification of ecological drivers and their linkages to outcomes. These foundational pieces are used to develop testable hypotheses and detailed study plans. The study plan that will be implemented in 2014 will be subject to peer review, with an emphasis on analytical approach and statistical power. This measured approach, which would be overseen and synthesized with other research through the CSAMP, is highly likely to yield vital information needed to support a new or revised Biological Opinion.

11. The three-year extension would allow the SDSRC to fully implement its multi-step approach to developing, reviewing, and implementing a scientifically robust research

agenda, including: (1) the development of conceptual models;[1] (2) a clear articulation of testable hypotheses; (3) design of statistically rigorous experiments to initiate tests of key hypotheses; and (4) prior to implementation, the peer review of the experimental designs by external scientists with expertise in the relevant scientific disciplines. This would also provide the needed time for CSAMP to review and synthesize this research with other ongoing efforts.

12. To date SDSRC has met three times, on November 1, 2012, January 29, 2013, and February 27, 2013. In addition a science working group (a subset of the SDSRC) met on February 22, 2013; additional full participation meetings and science working group session are planned at roughly monthly intervals. The SDSRC envisions developing conceptual models and draft testable hypotheses by the end of March 2013 and a study plan by May 2013; conducting and responding to peer review of the study plan in June and July; and finalizing the study plan in August 2013, for implementation in Water Year 2014 (Exhibit 2 - SDSRC January 29, 2013, Meeting Agenda). The group also discussed the need for a more strategic research plan to focus the south Delta research effort to the most critical questions, which would be developed by October 2013. At its meetings to date, the SDSRC identified some initial hypotheses that might be tested with new studies, as well as some hypotheses that might be tested with existing data sets. These studies include investigations of route- and reach-specific movement of salmonids, predators and alternative prey in the south Delta, and a comparison of effectiveness of different management tools/actions to improve survivals (Exhibits 3 and 4: SDSRC Meeting Minutes from November 1 2012, and January 29, 2013).

13. The benefits of NMFS fully staffing the SDSRC are many, but by far and away the most important is that it puts the very staff charged with analyzing the action and writing the Biological Opinion in a position to directly influence the directions and priorities of new studies. No one is in a better position to know what is needed in the way of new data and results than

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[1] Conceptual models are qualitative models which describe the current understanding of how a system works. They are routinely designed by scientists to identify and evaluate alternative restoration actions. They are not quantitative, numeric computer models that can be "run" to determine the effects of actions. Rather they are designed to facilitate informed discussions regarding expected outcomes resulting from restoration actions and the scientific basis for those expectations. The building blocks of a conceptual model are driver-linkage-outcomes, which can be alternatively thought of as cause-and-effect relationships. An example of a driver-linkage-outcome would be that high flows into and through the Delta reduce smolt travel times (i.e., they migrate faster), thus minimizing a smolt's exposure to predators and hence improving its likelihood of survival. Where there is uncertainty in a cause-and-effect linkage, alternative hypotheses can be crafted and experiments can be designed to test whether the hypothesized causal relationship is valid.

those who have to use it in a complex regulatory context. Further, staying fully involved provides the additional advantage of providing NMFS staff with a detailed understanding of strengths and limitation of any new data, and affords how it might be used to adjust or change modifiable operations.

14. If NMFS is unable to fully staff the SDSRC, none of the above benefits will be realized which would, in turn, undermine its major value, which is to bring new data and analysis to bear on south Delta operations that are currently unfavorable for the survival of salmonids. Moreover, the future existence of the SDSRC as a forum for developing, reviewing and implementing collaborative research would be uncertain without NMFS participation.

15. Prior to establishing the SDSRC in November of 2012, NMFS and DWR began laying the foundation for such a collaboration by working together on an experimental approach to generate information on migration routes and survivals across different operating conditions in the south Delta to inform decision-making for project operations. This approach is referred to as the "2012 Stipulation Study" because it was described and agreed to in a joint stipulation signed and filed by the Plaintiffs, Plaintiff-Intervener, and Federal Defendants to the Consolidated Salmonid Cases. It specified both the study approach and CVP and SWP operations for April and May 2012.

16. The 2012 Stipulation Study was an effort to balance the needs between gaining new empirical information and providing protection for the listed Central Valley steelhead. The plan involved implementing different Old and Middle River (OMR) "treatment levels" for multiple releases of acoustically tagged steelhead (to gather information about responses of tagged fish to different hydrodynamic conditions within the adaptive range). It included an "exposure trigger" as a screening criterion for OMR flow management. If the "exposure trigger" was reached or exceeded, OMR flows were to be shifted from the experimental OMR level to -1,250 cfs (the most positive OMR level within the adaptive range) in order to protect steelhead by shifting hydrodynamic conditions in a direction that may be less disruptive to outmigration routing or timing, offsetting the potential risk to wild steelhead posed by the experimental OMR levels.

17. Despite the many logistical challenges of carrying out the 2012 Stipulation Study with limited time for detailed planning and staffing prior to the April 2012 start date, the study generated important new information directly related to testing the feasibility of the real-time management based on tag detections, and to the benefits of new empirical data on fish behavior relative to flow. Regarding the former, within the first few weeks it was clear that the rapid movement of fish and complex data sets generated by acoustic tag detections were not well-suited for real-time management of water exports. These data typically require months to quality assure/quality control, analyze, and interpret. Furthermore, the delayed release of the first sentinel groups of steelhead forced reliance on the use of DWR's Particle Tracking Model (PTM) as a surrogate for estimating steelhead smolt migration, which ultimately contributed to empirical information documenting that fish migrated through the Delta at a much faster rate than the predicted water particle travel time.

18. As required by the Reasonable and Prudent Alternative (RPA) (page 583 of NMFS' CVP/SWP long-term operations 2009 biological opinion), in November 2012, NMFS and the Bureau of Reclamation (Reclamation), in conjunction with the Delta Stewardship Council's Delta Science Program (DSP), hosted a workshop to review the prior water years' operations. One focus of the 2012 annual review was the preliminary analyses of the 2012 Stipulation Study. Although the DSP's Independent Review Panel (IRP) was encouraged by the collection of new empirical information about steelhead movement in the south Delta, they opined that the goal of relating survival to mean or average weekly flow in the south Delta was inadequate to, by itself, explain survival. In their view, survival was a function of travel time, which was largely controlled by tidal dynamics and water quality, the complex routing of fish through the Delta, and the abundance of predators in different Delta reaches. As a result, they concluded that there was no expectation that survival could be explained by mean flows only. The IRP recommended a redirection of south Delta studies to focus on the influences of tidal forcing on reach-level fish transit time. Further, the IRP concluded that any new studies include

consideration of residence time of not only salmonids, but also predators and alternative prey. New data from such studies will not be available unless an extension is granted.

19. In addition to the 2012 Stipulation Study and the IRP review, there are several additional studies that are currently generating new information on south Delta survival of salmonids. In my opinion, all of these studies will likely contribute significant new understanding of the interaction between water export and factors directly or indirectly affecting juvenile salmonid survival. These include the Six-Year Acoustic Tag Experiment being conducted by Reclamation as required by the CVP/SWP long-term operations 2009 Biological Opinion RPA Action IV.2.2, and fall-run Chinook salmon survival studies (formerly implemented via the Vernalis Adaptive Management Program (VAMP), to name a few.

20. These efforts are still in their early phases and their full value to a new a Biological Opinion will not be realized unless additional time is granted to incorporate their use in new biological analyses. For example, while 2013 will mark the third year of steelhead releases under the Six-Year Acoustic Tag Experiment, data from the initial two years of data collection are currently being analyzed, and are not yet available.

21. Similarly, while the VAMP fall-run Chinook salmon studies have produced a time series of survival estimates for fall-run Chinook originating in the San Joaquin River for many years, until recently these estimates were calculated from recoveries of coded-wire-tagged (CWT) fish sampled near Chipps Island where the Delta transitions to San Francisco Bay, and in ocean fisheries. The study approach has recently transitioned to the use of acoustic tags to determine Delta reach entrainment and survival probabilities, which has greatly improved the statistical confidence in the accuracy and precision of the survival estimates. For example, it is on the basis of acoustic tag data from 2011 that through-Delta survival of fall-run Chinook salmon released in the San Joaquin River was estimated to be less than 5 percent.

22. In addition, the life-cycle model being developed at NMFS' SWFSC (currently for Sacramento River winter-run Chinook salmon) will greatly enhance the ability to estimate improvements in full life cycle survival of salmonids associated with actions expected to

improve survival of salmonids in individual life history stages. Such an analytical framework is needed to estimate the cumulative effects of multiple actions affecting multiple life stages. In my experience, developing quantitative life cycle models is an iterative process that involves testing and validating life stage-specific transition probabilities over multiple generations and years. I would expect each additional year made available by the 3-year extension to significantly improve the utility of the SWFSC model. This is especially the case in the first few years after a new model is released.

23. Although a life cycle model is an important new recovery planning tool, perhaps more relevant to the specific question of improving Delta survival of salmonids migrating from the San Joaquin River through the south Delta are the behavioral models. Currently, DWR uses a hydrodynamics model (DSM2) to simulate flow and water quality in the Sacramento-San Joaquin Delta. Flow and water quality are the physical conditions largely influenced by operations of Delta facilities (pumps, flow barriers), inflow of freshwater, and the tides. DWR's PTM is a quasi 3D model and uses the output of DSM2 hydrodynamic module to simulate the movement of immortal, neutrally-buoyant particles released at specific locations. The PTM has been used to try to understand how operations and hydrologic conditions affect the movement of juvenile salmon.

24. In an effort to better understand and predict salmonid behavior in the Delta, the NMFS' SWFSC is using the PTM as the basis for a fish tracking model by allowing modeled particles to sense their environment and respond behaviorally. The latter would include suffering mortality that may be a function of spatial location, time and distance travelled, and other factors such as abundance and behavior predators and alternative prey. The object-oriented design of the PTM software makes this relatively tractable. The resulting suite of models (with the original PTM viewed as a null model) can be used to simulate experimental releases of acoustically- and coded-wire-tagged groups of juvenile salmon. By comparing model predictions of the proportions and timing of release groups arriving at various sampling locations (*e.g.*, salvage facilities, Chipps Island trawl), unknown parameters of the models can be estimated and the best behavioral models identified. These models may then be used to predict the effects of various management actions on survival of juvenile salmon entering various locations in the delta. The granting of a 3-year extension will provide time to begin development

of this suite of behavioral models which could ultimately be used to predict effects of different south Delta operations on salmon migrational behavior and survival.

25. In summary, taken together -- the availability of new data, the development of new quantitative life cycle and behavioral models, and new scientific guidance from peer reviews -- present NMFS and DWR an important opportunity to further investigate and understand how south Delta hydrodynamics affect salmonid survival and chart a significantly expanded research path forward. The research that could be conducted during the three-year extension, and the results of refocused, more carefully designed studies, new data from ongoing studies, and a life cycle context into which to organize and interpret these data will unquestionably make an important contribution to drafting a revised CVP/SWP long-term operations Biological Opinion and potentially revised RPA.

26. If given three years, NMFS will be able to fully staff the SDSRC, play an important role in CSAMP, and be in a position to influence the direction of new and refocused research to issues that are vital to completing a new or revised Biological Opinion. Without the extension it is my understanding that NMFS will not be in a position to participate in either CSAMP or the SDSRC, and the future of the SDSRC without NMFS co-leadership is uncertain. Perhaps even more importantly, the results from route entrainment and survival studies currently being conducted will not be available, new behavioral models will not be an option to evaluate alternative operations, and it is unlikely that any results of new studies focusing on the effects of tidal forcing on reach-level fish residence time and survival will be available for consideration by NMFS staff evaluating the proposed action. Failing to take advantage of these new data, study results, and life cycle and behavioral models will contribute to the same environment of continued uncertainly that fueled the current unproductive cycle of litigation.

I declare under the penalty of perjury under the laws of the State of California and the United States, that the foregoing is true and correct to the best of my knowledge.

Executed on this fourteenth day of March, 2013 in Hansville, Washington

Michael H. Schiewe, PhD

EXHIBIT 1

CURRICULUM VITAE

NAME Michael H. Schiewe

ADDRESS Anchor QEA, L.L.C.
1423 3rd Avenue, Suite 300
Seattle, Washington 98101

EDUCATION
Humboldt State University, Arcata, CA, B.S. Fisheries 1968
University of Washington, Seattle, WA, M.S. Fisheries 1976
University of Washington, Seattle, WA, Ph.D. Fisheries 1980

PROFESSIONAL POSITIONS

2003- present	Principal Scientist, Anchor QEA, L.L.C., Seattle, WA.
1997-2002	Director, Fish Ecology Division and Senior Salmon Scientist, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.
1991-1997	Director, Coastal Zone and Estuarine Research Division, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.
1992-2004	Affiliate Associate Professor, School of Fisheries, College of Ocean and Fishery Sciences, University of Washington, Seattle, WA.
1988-1991	Supervisory Fishery Biologist (Research) and Manager, Habitat Investigations Program, Coastal Zone and Estuarine Studies Division, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.
1984-1988	Supervisory Fishery Biologist (Research) and Leader, Experimental Biology Program, Environmental Conservation Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, Seattle, WA.
1981-1992	Affiliate Assistant Professor, School of Fisheries, College of Ocean and Fishery Sciences, University of Washington, Seattle, WA.
1973-1984	Fishery Biologist (Research), Fish Disease Program, Environmental Conservation Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, Seattle, WA.
1971-1973	Fishery Biologist, Gas Supersaturation Program, Coastal Zone and Estuarine Studies Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, Seattle, WA.

1968-1971	U.S. Army
1968	Biological Technician, Salmonid Outmigration Studies, Bureau of Commercial Fisheries, US Fish and Wildlife Service, Astoria, OR.

RESEARCH INTERESTS

- Riverine, estuarine, and ocean ecology of Pacific salmon
- Effects of environmental factors on the health of marine and anadromous fish

PROFESSIONAL ACTIVITIES

Consulting (Selected recent examples)

NorthernStar Natural Gas, Bradwood Landing LNG Terminal and Pipeline, Senior Scientific Advisor (2008 – ongoing).

Douglas PUD, FERC Relicensing of Well Hydroelectric Project, Chair of Aquatic Settlement Workgroup (2009 – ongoing).

King County Strategic Watershed Assessment and ESA Planning, WRIA 8 and 9 Watershed Technical Committees and Planning Teams (2003 – 2007).

Oroville Dam FERC Relicensing/ESA Technical Advisor, Metropolitan Water District of Southern California (2003-2005)

Habitat Conservation Plan Implementation/HCP Committee Chair, Chelan County PUD, Douglas County PUD (2004-ongoing).

Habitat Restoration Priorities for the Deschutes River, WA. Squaxin Tribe, (2005- 2007)

Various Clients (including Bureau of Reclamation; Bonneville Power Administration; US Army Corps of Engineers; States of Washington, Idaho; Colville and Spokane Tribes; Chelan PUD), Senior Technical Advisor for fisheries and operation of the Federal Columbia River Power System (2003-2008).

Research

Director, Fish Ecology Division (1996-2002).

Provided scientific leadership and oversight for $8-11M of research annually (of which $6-8M was supported by extramural grants and contracts). Research included the ecological effects of low-head dams and associated water regulation on salmon, development of innovative tagging and monitoring technology for salmon, ocean and estuarine ecology of salmon, and assessing the status of West Coast salmon populations relative to the federal Endangered

Species Act. Primary sponsors of the reimbursable research were the U.S. Army Corps of Engineers (Portland District, Walla District) and the Bonneville Power Administration.

Director, Coastal Zone and Estuarine Studies Division (1992-1996).

Provided scientific leadership and oversight for $12-14M in research annually (of which $9-12M was supported by extramural grants and contracts). Research foci included the ecological effects of low-head dams and associated water regulation on salmon, development of hatchery and captive broodstock technology for Pacific salmon, biological effects of dredging and dredged-material disposal, development of innovative tagging and monitoring technology for migrating salmon, genetic stock identification of Pacific salmonids, and assessing the status of Pacific salmon stocks relative to the federal Endangered Species Act. Primary sponsors of the contract research were the U.S. Army Corps of Engineers (Portland District, Walla District) and the Bonneville Power Administration.

Portland District, U.S. Army Corps of Engineers, Co-PI (1988-1989).

Long-term management strategy: Dredged-material disposal in the Columbia River estuary.

Seattle District, U.S. Army Corps of Engineers, Co-PI (1986-1987).

East, West, and Duwamish Waterways navigation improvement project: Physical/chemical/biological analyses of sediments proposed for dredging.

District, U.S. Army Corps of Engineers, Co-PI (1986-1987).

Seattle Harbor operations and maintenance project: Physical/chemical/biological testing of sediments proposed for dredging.

Seattle District, U.S. Army Corps of Engineers, Co-PI (1984).

Seattle Harbor navigation project operations and maintenance: Sampling and testing of Duwamish River sediments.

National Cancer Institute, National Institutes of Health, Co-PI (1984-1987).

Etiology of tumors in bottom-dwelling marine fish.

National Ocean Services, NOAA, Co-PI (1981-1984).

Bioavailability and toxicity of sediment-associated chemical contaminants to marine biota. Ocean Assessments Division.

COMMITTEES AND SPECIAL ASSIGNMENTS

Technical Advisor, Scientific American Frontiers *Deep Crisis*, National Public Television, Chedd-Angier Productions, January 2003

Member, Puget Sound Nearshore Executive Committee, U.S. Army Corps of Engineers, Seattle District and Washington Department of Fish and Wildlife, 2001-2002

Testimony on salmon recovery. United States Senate Committee on Environment and Public Works, Field Hearing, Boise, Idaho. November 2000.

Testimony on salmon recovery. United States Senate Committee on Environment and Public Works. Washington, D.C. September 2000.

Testimony on effects of river flow on salmon survival. United States Senate Committee on Environment and Public Works. Field Hearing, Hood River, Oregon. April 1999.

Testimony on effects of dam operations on survival of salmon. United States Senate Committee on Environment and Public Works. Washington, D.C. June 1995

Member, Steering Committee, University of Washington, Massachusetts Institute of Technology, and National Oceanic and Atmospheric Administration Working Group on Ecologically Sustainable Hydropower, 1998-1999.

Ex-Officio Member, Independent Scientific Advisory Board, National Marine Fisheries Service, Columbia River Inter Tribal Fish Commission, and Northwest Power Planning Council, 1997-2002.

Chair, Organizing Committee, Workshop on Estuarine and Oceanic Survival of Northeast Pacific Salmonids, Newport, Oregon. 1995-1996.

Manager and Co-Chair, Northwest Region Endangered Species Act Biological Review Team for NW Pacific Salmon Stocks, National Marine Fisheries Service, 1990-1999.

Member, Scientific Review Panel, Lower Columbia River Bi-State Water Quality Study, 1990-1991.

Member, Fish Research Needs and Priorities Committee, Fish Passage Development and Evaluation Program, North Pacific Division, U.S. Army Corps of Engineers, 1990-1991.

Member, Strategic Planning Team, National Marine Fisheries Service, 1989-1991.

Member, Steering Committee, Spring Chinook Salmon Workshop, National Marine Fisheries Service, 1989.

Member, Technical Committee, Tillamook Bay Restoration Project, Oregon Coastal Zone Management Association, 1989-1990.

Member, Biological Effects of Toxics Workgroup, Puget Sound Water Quality Authority, 1987-1988.

AWARDS

1996: NOAA Administrators Award: Development of a research and monitoring plan for the Federal Columbia River Power System Biological Opinion.

1**999**: NOAA Administrators Award: Leadership in development of the Anadromous Fish Appendix to the Lower Snake River Migrational Feasibility Study and Environmental Impact Statement.

1999: Department of Commerce Silver Medal: Innovative scientific leadership in implementing the Endangered Species Act.

2003: NOAA Administrators Award: Recognition for substantial contributions to fishery science in the Pacific Northwest.

TECHNICAL REVIEWER

Aquatic Toxicology

Canadian Journal of Microbiology

Current Microbiology

Diseases of Aquatic Organisms

Journal of Aquatic Animal Health

Sea Grant -- University of Washington, Oregon State University, University of Maine.

Transactions of the American Fisheries Society

Fisheries

PROFESSIONAL SOCIETIES:

American Fisheries Society

American Institute of Biological Sciences

PUBLICATIONS:

Schiewe, M.H. 1974 Influence of dissolved atmospheric gas on swimming performance of juvenile chinook salmon. Transactions of the American Fisheries Society 103:717-721.

Harrell, L.W. and M.H. Schiewe. 1975. Further evidence of two strains of pathogenic vibrios in salmon in Puget Sound. IN: Proceedings Northwest Fish Culture Conference, pp. 50-52, 25th Annu. Mtg., Seattle, WA.

Schiewe, M.H. and D.D. Weber. 1976. Effect of gas bubble disease on lateral line function in juvenile steelhead trout. IN: Gas Bubble Disease (D.H. Fickeisen and M.J. Schneider, eds.), pp.89-92. Energy Res. Div. Adm., Off. Public Affairs, Tech. Inf. Center, Oak Ridge, TN.

Dawley, E.M., M.H. Schiewe, and B. Monk. 1976. Effect of long-term exposure to supersaturation of dissolved atmospheric gases on juvenile chinook salmon and steelhead trout n deep and shallow test tanks. IN: Gas Bubble Disease (D.H. Fickeisen and M.J. Schneider, eds.), pp. 1-10. Energy Res. Div. Adm., Off. Public Affairs, Tech. Inf. Center, Oak Ridge, TN.

Gunnels, R.D., H.O. Hodgkin, and M.H. Schiewe. 1976. Failure of vaccines to protect salmon from vibriosis endemic in Puget Sound, Washington. American Journal of Veterinary Research 37:737-740.

Harrell, L.W., A.J. Novotny, M.H. Schiewe, and H.O. Hodgins. 1976. Isolation and description of two vibrios pathogenic to Pacific salmon in Puget Sound, Washington. Fisheries Bulletin 74:447-449.

Weber, D.D. and M.H. Schiewe. 1976. Morphology and function of the lateral line of steelhead trout in relation to gas bubble disease. Journal of Fishery Biology 9:217-233.

Schiewe, M.H., J.H. Crosa,, and E.J. Ordal. 1977. Deoxyribonucleic acid relationships among marine vibrios pathogenic to fish. Canadian Journal of Microbiology 23:954-958.

Schiewe, M.H. and H.O. Hodgins. 1977. Specificity of protection induced in coho salmon (*Oncorhynchus kisutch*) by heat-treated components of two pathogenic vibrios. Journal of the Fisheries Research Board of Canada 34:1026-1028.

Crosa, J.H., M.H. Schiewe, and S. Falkow. 1977. Evidence for plasmid contribution to the virulence of the marine fish pathogen *Vibrio anguillarum*. Infection and Immunity 18:509-513.

Hodgins, H.O., M.H. Schiewe, A.J. Novotny, and L.W. Harrell. 1977. Pacific salmon diseases. IN: Disease Diagnosis and Control in North American Marine Aquaculture (Developments in Aquacult. and Fish. Sci. vol. 6) (C.J. Sindermann, ed.), pp. 227-249. Elsevier Sci. Publ. Co., Amsterdam-Oxford-New York.

Harbell, S.C., H.O. Hodgins, and M.H. Schiewe. 1979. Studies on the pathogenesis of vibriosis in coho salmon *Oncorhynchus kisutch* Walbaum). Journal of Fish Diseases 2:391-404.

Crosa, J.H., L.L. Hodges, and M.H. Schiewe. 1980. Curing of a plasmid is correlated with an attenuation of virulence in the marine fish pathogen *Vibrio anguillarum*. Infection and Immunity 27:897-902.

Schiewe, M.H. 1980. Studies on the pathogenesis of vibriosis in salmonid fish. Ph.D. Dissertation. University of Washington, Seattle, WA. 159 p.

Schiewe, M.H. and J.H. Crosa. 1981. Molecular characterization of *Vibrio anguillarum* biotype 2. Canadian Journal of Microbiology. 27:1011-1018.

Schiewe, M.H. 1981. Taxonomic status of marine vibrios pathogenic for fish. Developments in Biological Standardization 49:149-158.

Trust, T.J., I.D. Courtice, A.G. Khouri, J.H. Crosa, and M.H. Schiewe. 1981. Serum resistance and hemagglutination ability of marine vibrios pathogenic for fish. Infection and Immunity 34:702-707.

Schiewe, M.H., T.J. Trust, and J.H. Crosa. 1981. *Vibrio ordalii sp. nov*.: A causative agent of vibriosis of fish. Current Microbiology 6:343-348.

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Schiewe, M.H. 1983. Vibrio ordalii as a cause of vibriosis in salmonid fish. IN: Bacterial and Viral Diseases of Fish: Molecular Studies. (J.H. Crosa, ed.), pp. 31-40. Washington Sea Grant Publ., University of Washington, Seattle, WA.

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EXHIBIT 2

South Delta Salmon Research Collaborative Process

January 29, 2013, 10:00a to 2:00p

Huntington Room; 1st Floor at 650 Capitol Mall

877-785-0805; PC: 2662693

Agenda

1. **Welcome/Introductions/Meeting Guidelines/Review of Agenda -- Mike Harty**
2. **Goals of the Collaboration and This Meeting -- Maria Rea, Dale Hoffman-Floerke**
3. **Background -- Mike Schiewe/Heidi Rooks**
    - **Review and status of South Delta survival *s*tudies**
        - **2012 Steelhead Stipulation Study**
        - **6-Year Steelhead Study**
        - **VAMP Fall Chinook Study**
    - **Report of the 2012 Delta Science Program Independent Review Panel of the 2012 Stipulation Study**
4. **Scope of New Studies -- NMFS**
    - **Effects of inflow/export on South Delta hydrodynamics; and the effects of hydrodynamics on the behavior and survival of salmonids**
    - **Species**
    - **Geographic Focus**
    - **Timing**

LUNCH: Either bring your own or send out will be available

5. **Steps/Milestones and Timeline –Mike Schiewe**
    - **Conceptual Model(s) – Qualitative; Driver-Linkage-Outcome; Testable Hypotheses; January-March 2013**
    - **Research/Study Plan(s) – April-May 2013**
    - **Peer Review – June-July 2013**
    - **Final study plan(s) – August 2013**
    - **Implementation -- 2014**
6. **Development of Conceptual Model(s) – Mike Schiewe**
7. **Summary; Next Meetings – Mike Harty**

EXHIBIT 3

South Delta Salmonid Research Collaborative
Draft Agenda, November 1, 2012, 9:00 a.m. – 2:00 p.m.
NMFS Sacramento offices, 650 Capitol Mall, 5th Floor, San Joaquin Conference room

Attendees:
USFWS: Leigh Bartoo, Roger Guinee
Cramer Fish Sciences: Brad Cavallo, Paul Bergman, Jenny Malgo
Hanson Environmental: Chuck Hanson
NMFS: Maria Rea, Dave Swank, Barb Byrne, Garwin Yip, Mike Schiewe, Steve Lindley, Arnold Ammann
University of Washington: Rebecca Buchanan
DWR: Dale Hoffman-Floerke, Tara Smith, Kevin Clark, Heidi Rooks
Reclamation: Sue Fry, Liz Kiteck, Josh Israel
State Water Contractors: Terry Erlewine
Westlands Water District: Sheila Greene

Purpose: To bring together lead researchers on salmonid questions related to survival and hydrologic conditions in the South Delta, and agency managers, to discuss conceptual theories and need for ongoing analyses of existing data sets, development of modeling related tools, and discuss new management-driven research needs for experimental design to be implemented in Spring 2014.

Availability and analyses of existing data sets (2012, 2011, 2010):

1. VAMP study – Fall-run Chinook (Brandes, Buchanan)
   a. 2010, non-physical barrier: mostly completely analyzed, report is out;
   b. 2011, no barrier (HTI technology): data analyzed, report not out yet, maybe early 2013. Also effect of ag barriers in 2011. Steelhead study analysis of route specific survival, route entrainment, survival through the delta for 2011 will be done before the Chinook analyses.
   c. 2012, rock barrier (Vemco technology): Rebecca hasn't gotten data yet (see 2.f, below). Analyses of route entrainment at Head of Old River as function of flow, and also function of exports, has started but not written up yet, may be done by early fall 2013.
2. 6 year acoustic tag study – Steelhead (Israel)
   a. Independent review before study plan was implemented, also Stuart and Oppenheim reviewed to make sure we get the research questions we want answers to…at least at the time. Questions separate the riverine section from the tidal section.
   b. Used same model as VAMP to look at reach specific survival. Looked at influence that exports have for reach selection and survival. Quantity of predator habitat and how that influences reach selection. Also will look at surrogacy between fall-run Chinook and hatchery steelhead (residualization, upstream movement)
   c. Technology is evolving.
      i. We should PIT tag more, have more receivers out there. There are more and more tagging studies now, for example, Clifton Court Forebay, San Joaquin River Restoration Project.

ii. Genetic tagging may be a future option/consideration, but will take some time to collect.
iii. We may need to reconsider our study design if technology changes over the next 2 years.

d. Consider tagging steelhead, setting the tag pings at a longer gap, and tracking them through the season(s) to see when they go, where they go, *etc*. We don't know much about their outmigration timing, destination, *etc*.
e. 2013 plan to have releases in early March, early April, and early May. Tag order placed, all on track, regardless of whether rock barrier or non-physical barrier is placed. Goal is to spread out the releases more so they could experience different flow and export conditions.
2 years (2011 & 2012) of research so far -- Rebecca will be working on 2011 (see 1.b, above). Goal to have USGS put together the 2012 data for Rebecca to analyze after. Goal to have a draft report of 2011 data to DOSS in spring of 2013 for review. First time run maybe with no predator rule, then put in a predator rule.
f. 6-year study looks at I:E ratio by default, but not in 2012.
g. Comment from 2011 annual review – we are never going to be able to tease out the discrete variable that we want to test because of changing conditions.

3. 2012 Joint Stip study (Clark, Cavallo)
   a. A couple of meetings, some questions, some hypotheses, but no exact plan forward for the analysis. No exact list of questions, we should get those up front rather than later down the road (*e.g.*, first detection vs. last detection). We should take the time and come up with the list of questions so we don't have to reanalyze.
4. Hydrodynamics and how it fits (Cavallo) -- limiting factor on how to analyze the data.
   a. How do we speak to what we know now compared to what we thought regarding DSM2?
   b. Calibration may not have been done in the specific locations where we are examining fish behavior. We are using DSM2 in ways it was not really intended to be used for, that is, sub-daily, down to the 15-minute increments.
   c. We need to resolve the 2-hour time lag between DSM2 results and CDEC outputs. If we really want to measure hydrodynamics to coincide with our fish studies, then we should add monitoring sites, and not rely on DSM2 to model it.
5. Behavioral PTM (Lindley)
   a. Need data to estimate parameters on movement and survival.
   b. Compare simulations on estimation of fractions at Chipps island and export facilities, travel times, and reach survivals.
   c. Is behavioral PTM more motivated by the life cycle model on the Sacramento River side, or the stipulation steelhead study on the San Joaquin River? If we start looking at specific locations to look at finer scales, then we will have a scale problems.

What other hypotheses/analyses might be tested with existing data sets? Who wants access to data? What logistical or funding resources are necessary for additional analyses or tool development?

1. Two general categories of hypotheses:
   a. How do fish move through the delta?

   i. small spatial scale/short term questions about what fish do in response to a flow cue; and
   ii. "gross" questions such as "what fraction of fish reach Chipps"; and
  b. What do different management tools/actions achieve?
2. There should be a subgroup to hone in on questions asked, *etc*., for the stip steelhead study data. NMFS-SWFSC will decide soon on whether to be involved. Lindley to get back to Kevin Clark on format of the data to get.
3. Power analysis: Needs consideration up front in order to be informed on the back end.
4. We should develop a conceptual model of what we want to study. What do we need to know? That would help formulate what additional hypotheses/analyses might be tested. We need to protect fish and increase survival, but we also need data.
5. Who wants access to Steve's smart particle model?

Initial ideas for priority research questions/design

1. Trap and haul San Joaquin steelhead: Lots of discussion about how, where, how many.
   a. Mike Schiewe to lead a small group. Spreads out risk so they are not all subjected to the conditions of the delta. This is not a fix, though, but a band-aid to low survival through the Delta. Helps buy time and increase survival as we continue to work on improving conditions in the Delta, and also not put all of our San Joaquin survival eggs in one basket. This suggestion is not intended to be in lieu of providing better survival and passage conditions in and through the Delta, but in addition to those. Also gives us data on things like timing and distribution of steelhead smolt movement.
   b. How to trap? If a structure is constructed and installed, consider changes in flow, velocity gradients, *etc*., that may end up drawing predators. Need to consider trapping efficiency and timing of the trapping operation, since steelhead emigration timing is drawn out.
2. Steelhead monitoring plan: One is currently being developed and implemented on the Sacramento River. Now would be a good time to dovetail to it with a plan on the San Joaquin River.
3. Improving juvenile salmonid survival through Clifton Court Forebay (CCF; not just reduce predation): How about something like a perforated canal to get fish through the system in a day or 2 rather than 30 days?
4. Increasing survival at the CVP: Can/Should we draw fish to the CVP faster? That would increase louver efficiency, which would increase survival.
5. Data points for exports:
   a. Zero exports—is that possible?
      i. We could schedule the maintenance at the CVP and SWP at the same time to get a no/low export data point
      ii. The SWP can do a big gulp into CCF, then "sip" exports for ongoing demand.
      iii. Earlier in the season is better than later because demands are lower.
   b. High exports: Need to consider the timing and duration for a high export data point.
   c. Research question: Do fish head into the interior Delta at zero exports, and do they continue to head south?
   d. The low and high export data points could better delineate the footprint of steelhead behavior and how exports influence it

Can we agree on priorities? Who/what/when? Looking towards future: how to design studies for 2014 and beyond?

1. Data quality and reporting:
   a. If we want data (and analyses) sooner than later following a study, maybe automation (software development) should be part of the study plan.
      i. Issues:
         1. Automation may be limiting, depending on the research questions we are asking
         2. What are reasonable questions to ask where we get or need short turnaround time?
   b. If we want hydrodynamic conditions data along with fish (routing) data, we should co-locate hydrodynamic receivers with receiver locations.
      i. Could set up a bunch of closely placed receivers so we could figure out what fish do within a channel.
      ii. We could determine when fish move (day, night, and what cues, like ebb or flood)
      iii. Survival vs. behavioral study has a different layout of receivers.
2. Timing of study development:
   a. Gantt chart of milestones over the next 3-5 years so we could prioritize resources
3. Technology: We should agree on the best bang for our buck regarding the cost of tags, sample size, data the tags will provide, *etc*., in concert with the research questions we want to answer.
   a. PIT tags may be an affordable technology for a larger sample size
4. August 1 should be the deadline for any study the following year, with a complete study design

Action items, next steps:

1. Kevin to lead a subgroup to discuss/determine the types of analyses or research questions the existing sentinel steelhead study data may be able to answer
   a. Stipulation study data: Kevin, Brad, and Jenny to get together to plan the analysis and data dissemination. Steve Lindley to provide input to Kevin on the format of the data he would like to see (*e.g*., raw, filtered, summarized)
   b. Reminder of the initial 2 questions from the joint stipulation:
      i. Does OMR have an effect on fish survival?
      ii. What level of survival are we getting, and what can we do to increase survival?
2. Josh to coordinate with Barb and Rebecca on the 6-year study and consideration of new technology
3. Heidi to take the lead on the development of a Gantt chart to track various experiments, data, analysis, reports, and the timing of those
4. Mike Schiewe to lead a subgroup (at a minimum, Chuck, Brad, Kevin, Jeff, and Josh) to discuss the feasibility of trap and haul, including logistics and improved monitoring
5. Conceptual model:
   a. We should develop a conceptual model of how all of the studies and questions relate to each other and so that we all have the same common currency.
   b. We need to formalize it and stick to it.
   c. Examples of existing conceptual models: VAMP, North Delta study.

Next meeting:

- Not all folks had their calendars, but we mentioned that the next meeting should be in a month.
- We should have a facilitator
- The focus and agenda should be the development of a conceptual model for our effort

EXHIBIT 4

DRAFT MEETING SUMMARY FOR REVIEW

South Delta Salmon Research Collaborative Process
January 29, 2013, 10:00 a.m. to 2:00 p.m.
Huntington Room, 650 Capitol Mall, Sacramento, CA

Purpose: *To bring together lead researchers and agency staff to review and discuss questions related to salmonid survival and hydraulic conditions in the south Delta, to discuss conceptual theories and the need for ongoing analyses of existing data sets, develop modeling-related tools, and discuss new management-driven research needs for experimental design to be implemented in spring 2014.*

Attendees:
USFWS Leigh Bartoo, Pat Brandes
Cramer Fish Sciences: Brad Cavallo, Paul Bergman, Jenny Melgo, David Delaney (phone)
Hanson Environmental: Chuck Hanson
USGS: Roger Fujii
NMFS: Barb Byrne, Jeff Stuart, Maria Rea, Garwin Yip, Steve Lindley (phone), Shawn Martin (phone)
U of W: Rebecca Buchanan (phone)
NRDC: Doug Obegi
SWC, Inc.: Terry Erlewine
Reclamation: Josh Israel, Liz Kiteck, Sue Fry, David Van Rijn
State Water Contractors: Terry Erlewine
Westlands Water District: Sheila Greene
MWD: Dave Fullerton
DFW: Alice Low, Carl Wilcox (phone), Chad Dibble
DWR: Tara Smith, Heidi Rooks, Kevin Clark, Brett Harvey, Dale Hoffman-Floerke
Delta Stewardship Council: George Isaac (phone)
Anchor QEA: Mike Schiewe

Facilitator: J. Michael Harty, Kearns & West
Meeting summary: Barbara Rocco, NMFS

1. Welcome/Introductions/Meeting Guidelines/Review of Agenda (Harty)

The meeting facilitator welcomed the group and meeting participants introduced themselves. The proposed agenda was reviewed. The facilitator presented the proposed Meeting Guidelines (attached). Individual participation in this process is expected to be consistent with these guidelines. Respectful interactions will be a key to success. Policy will not be discussed except in very specific instances in which it relates to the science under discussion. Attendance is open and assumes adherence to the guidelines.

2. Goals of the Collaboration and This Meeting (Rea, Hoffman-Floerke, Hardy)

NMFS and DWR provided a recap of the goals and purpose of the process. This effort is driven by ongoing concerns about high water costs associated with the San Joaquin Inflow/Delta export ratio which is described in Reasonable Prudent Alternative (RPA) IV.2.1 in the 2009 NMFS OCAP Biological Opinion.

NMFS and DWR would like the group to:

- focus on emigration of salmonids from the San Joaquin river system into and through the south Delta;
- focus on studies that can influence management decisions;
- seek answers to questions that have been an obstacle to progress for a long time; and
- develop statistically rigorous study designs, plans to implement the studies, and plans to analyze and interpret resulting data.

Fundamental ecological information is needed as well as information for focused management actions. The primary objective of this research effort is to improve survival of salmonids in the south Delta, with the expectation of improving the sustainability of fish populations throughout the entire system. There are many aspects of Delta hydrodynamics that potentially affect salmon behavior and survival, and understanding these interactions will help us manage the system to benefit salmon.

To that end, there are two broad purposes for this research process:

- develop sound experimental designs; and
- create a broader collaboration of researchers to review and plan future south Delta research.

The primary focus is on the Delta and not the watersheds. A balance between the RPA actions and other issues affecting salmonids is needed. For example, there are other water and flow issues besides exports that influence fish behavior and survival. Importantly, the Delta is a tidal environment, and there are data from the VAMP fall Chinook and 6-year steelhead studies that can be further analyzed to investigate flow and tidal interactions and how these affect fish behavior and survival.

This process will place a heavy emphasis on information exchange and research collaboration. The process will depend on contribution of individual views and perspectives by participants; it will not seek to develop consensus advice to NMFS or DWR.

The objectives for this meeting are:

1. understand the scope and goal;
2. understand the process and path forward
3. begin development of conceptual model(s); and
4. plan for future working session and meetings

NMFS offered a reminder about the ESA Section 7 regulatory context of any study, i.e., NMFS ultimately must evaluate research designs and other products of this process for their level of protection.

3. Background (Schiewe, Rooks)

Ongoing south Delta survival studies were reviewed:

- 2012 steelhead Stipulation Study
- 6-year Steelhead Study
- VAMP fall-run Chinook Study

Rooks asked Clark, Israel, and Brandes to summarize their respective studies.

Clark (DWR) provided a summary of the 2012 Stipulation Study. The goal was to document steelhead routing and estimate survival in the south Delta in relation to three different OMR flows. The April-May experimental months were divided into three discreet time periods. DWR contractors are still analyzing these data. A preliminary status report was produced in November and we are working to get a task order in place to finish an analysis plan. The final report will be available in late fall.

Israel (USBR) distributed a handout on the 6-year telemetry study (see attached). Buchanan (University of Washington) has completed the analysis of the 2011 VAMP fall Chinook data and is now working with the steelhead data from 2011, and should have results in spring. After that she will focus on analyzing the 2012 VAMP data.

Brandes (USFWS) provided a recap of the 2011 VAMP study results. There were two releases at Durham Ferry, and two additional releases in the south Delta. The two are comparable over time and the information is being pooled. A report should be out within the next month. There was funding for two releases in 2012; however, there not enough funds available for a full study in 2013. USFWS is trying to secure funding for releases at Durham Ferry in order to continue the time series of estimating survival from Durham Ferry and Mossdale that began in 1994. They have limited funds for 2013 for release of tagged fall Chinook at Medford Island, to further investigate the low survival of fall Chinook transiting Franks Tract from Medford to Chipps Island reported in 2011. Brandes will provide DWR a study proposal for Durham Ferry releases in 2013.

Lindley (NMFS) discussed a predation proposal the SWFSC is developing. Predation has been studied at large water diversions on the Sacramento River for several years. There is a potential to use those methods to investigate removing predators at focal locations in the south Delta. The general plan for this winter and spring is to conduct pilot studies using DIDSON sonar and other active sonar methods to characterize selected predator/prey communities and explore removal methods. If successful this year, the plan is to increase the removal effort next year. It was suggested that the effectiveness of removal could be estimated on a localized scale but not likely at the population level.

USBR and DWR reported they are looking at a new tag to determine whether a fish has been consumed by a predator. Also, there is a 5-year effort beginning this month to look at predation in Clifton Court Forebay (CCF) and survival of salmon and steelhead there. Fish survival in relation to the fishing access structure is being determined.

Cavallo (CFS) reported that they are working on several desktop studies, including mining of the CWT database for information on fish salvaged at the export facilities, and updating their fish passage model. They are working on a new version of the Delta passage model and have a draft now using flow data from the Delta hydro model.

ACTION: The presenters agreed to prepare one-page summaries for distribution. The summaries will include the protocols used to develop these projects to ensure good scientific methods, peer review, and stakeholder involvement. The peer review process is important to ensure that results are scientifically credible.

Independent Review Panel (IRP) Report: Schiewe (Anchor QEA) provided an overview of the IRP review the 2012 Stipulation Study protocols and results. The IRP identified three objectives of the Stipulation Study:

- Provide protection of out-migrating juveniles salmonids by managing flow conditions;
- Increase water exports consistent with providing a successful exit of salmonids out of the Delta; and
- Generate real-time tracking information upon which to base adjustments of water exports and better understand relationships among flow rates, OMR flows, and juvenile steelhead survival

The IRP concluded that the 2012 operation increased exports by 57 TAF above that which would have been otherwise provided under RPA IV.2.1. However, the IRP was not able to determine the level of protection provided for migrating steelhead and concluded that the approach was not adequate to address the question being asked. They observed that there was no information about predation at head of Old River during the test period, and the 2011 VAMP results indicated that the highest fall Chinook survival rate through the Delta was through Old River. The IRP recommended focusing future efforts on understanding behavioral responses of smolts and predators to flow dynamics and tidal changes in specific reaches; that is, travel, route, and survival needs to account for fish behavior and behavior of predators in response to strong tidal influences in the Delta.

4. Scope of New Studies (NMFS)

Yip (NMFS) reviewed the proposed scope for the new studies, including geographic area, focal species and experimental timing.

Geographic scope -- A map of the study area was presented with the proposed boundaries outlined. The map highlighted major pathways for fish movement into the study area. There was considerable discussion regarding the boundaries; the sense of the discussion was that boundaries would include potential upstream release sites of Mossdale and Durham Ferry and extend to Chipps Island. It was noted that although the goal of several previous studies was to measure survival to Chipps Island that monitoring locations near Benicia might be better to install instrumentation.

Species: The proposed primary species are steelhead and fall Chinook entering the south Delta from the San Joaquin River. There was discussion about winter-run and spring-run

Chinook and green sturgeon, but it was noted that the main focus of RPA Action IV.2.1 was San Joaquin steelhead. Fall Chinook are an important species for the Bay Delta Conservation Plan. The potential differences in behavior and timing of wild versus hatchery salmonids were also discussed.

Timing: The period covered by RPA IV.2.1 is April –May, but there is potential to investigate physical and biological interactions in the south Delta at other times during the year when there might be greater opportunities to control conditions.

5. Steps/Milestones and Timeline (Schiewe)

The development of conceptual models is proposed as a starting point for identifying testable hypotheses. NMFS and DWR are proposing that from January through March, the research process focus would be on development of the conceptual models. Draft study plans would follow in April and May 2013; study designs would be peer-reviewed (one or two outside reviewers) and study designs would be finalized by August 2013.

Keys points considered during discussion of steps and milestones included:

- Conceptual models are tools (and not endpoints) and should help focus on key questions to be addressed.
- Missing is an overarching strategic plan; the approach is good but most of these studies are likely to be multi-year and should build on each as we go forward.
- A strategic plan is needed to develop a long-term implementation and funding strategy. Annual plans would include detailed study designs and refined the links to previous years.
- It should be clear that we cannot possibly address in a single year all unanswered questions regarding salmon survival in the south Delta.
- There needs to be greater emphasis on data analysis and management and reporting on a shorter timescale. We should not still be analyzing 2011 data as we plan for 2014.

6. Development of Conceptual Model (Schiewe)

There is nothing in the scientific goals or broad geographic scale that excludes from consideration any aspect of south Delta hydrodynamics and the effects of those hydrodynamics on factors that affect salmonid behavior and survival, and hence inclusion in a conceptual model. It should also be acknowledged that what is proposed for implementation in 2014 may not be a new, stand-alone study but could be a modification or addition to an existing ongoing study. It is also noted that, although the study plan would initially focus on 2014, multiple year studies would likely be needed to address many questions.

Also, because we have more information on fall Chinook salmon than steelhead originating in the San Joaquin River we may want to start with a conceptual model of this species. There is limited information on steelhead at this point, but the 6-year steelhead radio telemetry study conducted by USBR is expected to change that soon. Results from the Stipulation Study indicate that survival of steelhead is very low.

It was suggested that a conceptual model which visually displays the relationships among drivers, linkages, and outcomes would be a logical starting point, and the conceptual model of salmon and steelhead life stage transitions developed by John Williams for DRERIP is a good example. Some important attributes of a conceptual model include:

- Facilitates the consideration of a variety of drivers-linkages-outcomes and the opportunity to develop testable hypotheses and develop experimental approaches to test their validity.
- Arrows (color and thickness) can be used to characterize importance, understanding, and predictability of the drivers, linkages, and outcomes.

To further develop this approach it was suggested that each participant:

- Select one or two drivers and describe associated linkages and outcomes.
- Develop testable hypotheses that would form the basis of study(s) designed to determine the importance of a driver in shaping behavior and survival of salmonids in the south Delta.
- Prepare a brief write up of a recommended experimental approach.

Some selected examples of paired testable hypotheses were discussed, including the following:

- Increased export levels lead to changes in the near-field hydrodynamics of the south Delta
- Increased exports do not affect or alter the near-field hydrodynamics of the south Delta
- Altered near-field hydrodynamics affect the frequency/magnitude of fish entrainment at the CVP and SWP
- Altered near-field hydrodynamics do not affect the frequency/magnitude of fish entrainment

It was suggested that developing an initial model or models, and populating them with drivers-linkages-outcomes, would be more efficient and productive if done in a group working session. Additional discussion focused on the following:

- A conceptual model creates the opportunity to organize, prioritize and address a range of questions. The driver-linkage-outcomes relationships are focal points for developing alternative hypotheses.
- Regarding model scope and scale – A single stand-alone high level model may suffice, but a high level model with linked finer-scale models may better serve our needs.
- There are several approaches to graphic display of models. Another would be similar to food web models that tend to depict both direct and indirect linkages very clearly.

- We might consider a suite of conceptual models emphasizing different features and hypotheses; e.g., one focusing on flows, one on exports, etc., and some alternative hypotheses of how these factors influence behavior and survival.
- As we consider the importance of individual drivers and the predictability of outcomes, it may lead to the need for additional more specific or linked sub models.We want to be open to all possible drivers and create the opportunity for people who have very specific studies to present.
- Our models may ultimately take on the appearance of a web instead of a list that recognizes linked indirect and direct effects.
- The "importance" criterion is where we will likely see the greatest diversity of opinion; hence we might want to stay away from ranking importance right away.
- The importance of a driver for "management" might be different than its importance in a pure scientific context.
- We should make sure that we are not abandoning mathematical models for conceptual models because some already exist and we can use them.
- Developing a model to investigate the impact of an action or one that is predictive of impacts of water management on fish survival is potentially different...and they may have different study routes.

Homework/Next Step

A smaller group of volunteers will meet to develop an initial conceptual model. Those planning to participate in the smaller working group should prepare and bring their list of important driver-linkage-outcomes and associated testable hypotheses. We should plan on a full day or two half day sessions.

The following individuals expressed a willingness to participate in the first working session: Chuck Hanson, Brett Harvey, Pat Brandes, Josh Israel, Sheila Greene, Brad Cavallos, Heidi Rooks, Kevin Clark, Barb Byrne, Jeff Stuart, Alice Lowe, Steve Lindley, Mike Schiewe

Scheduling:

- 2/27 for the next full session
- 2/22 for the conceptual model working group (date determined after the meeting by Doodle poll).

Contact List: We plan to generate one large list of participants so that everyone receives all information.