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9
 10 IN THE UNITED STATES DISTRICT COURT
 11 FOR THE EASTERN DISTRICT OF CALIFORNIA

12 **THE CONSOLIDATED SALMONID CASES**

13 **SAN LUIS & DELTA-MENDOTA WATER**
AUTHORITY; WESTLANDS WATER
 14 **DISTRICT v. GARY F. LOCKE, as Secretary**
of the United States Department of
 15 **Commerce; et al.**

16 **STOCKTON EAST WATER DISTRICT, et**
al. v. NATIONAL OCEANIC AND
 17 **ATMOSPHERIC ADMINISTRATION, et al.**

18 **STATE WATER CONTRACTORS v. GARY**
 19 **F. LOCKE, Secretary, et al.**

20 **KERN COUNTY WATER AGENCY, et al. v.**
UNITED STATES DEPARTMENT OF
 21 **COMMERCE, et al.**

22 **OAKDALE IRRIGATION DISTRICT, et al.**
v. UNITED STATES DEPARTMENT OF
 23 **COMMERCE, et al.**

24 **THE METROPOLITAN WATER**
 25 **DISTRICT OF SOUTHERN CALIFORNIA**
v. NATIONAL MARINE FISHERIES
 26 **SERVICE, et al.**

1:09-cv-1053 OWW-DLB
 1:09-cv-1090 OWW-DLB
 1:09-cv-1378 OWW-DLB
 1:09-cv-1520 OWW-SMS
 1:09-cv-1580 OWW-DLB
 1:09-cv-1625 OWW-SMS

**DECLARATION OF BRADLEY
 CAVALLO IN SUPPORT OF
 PLAINTIFFS' MOTION FOR
 PRELIMINARY INJUNCTION**

Date: March 8, 2011
 Time: 9:00 a.m.
 Ctrm: 3
 Judge: The Honorable Oliver W. Wanger

1 I, Bradley Cavallo, declare as follows:

2 1. I have 13 years of experience working with anadromous fishery issues in Central
3 California. I am currently a Senior Scientist and President of Cramer Fish Sciences in Auburn,
4 California, where I have worked since 2006. Prior to this position, I was employed from 2003
5 until 2006 as a Senior Environmental Scientist and from 1999 to 2003 as an Environmental
6 Scientist at the California Department of Water Resources in Sacramento, California. Prior to
7 these positions, I was employed as a Fisheries Biologist at the California Department of Fish and
8 Game in Stockton, California. In 1997, I earned a Master of Science degree in Aquatic Ecology
9 from the University of Montana at Missoula. In 1994, I earned a Bachelor of Science in Wildlife
10 and Fisheries Biology from University of California at Davis. I have authored numerous fishery
11 reports, published papers and made many scientific presentations in the field of fisheries science.
12 In the course of my professional career and education, I have attained expert knowledge of
13 regulated rivers and estuaries, particularly related to the ecology of Chinook salmon and other
14 anadromous fishes.

15 2. In my previous declarations I have shown, through extensive review of quantitative
16 evidence, that reasonable and prudent alternative (RPA) Actions IV.2.1 and IV.2.3 are not
17 supported by best available science

18 3. Rather than reiterating these arguments, this declaration addresses NMFS principle
19 rationale for RPA Actions IV.2.1 and IV.2.3. Specifically, I critically evaluate NMFS contention
20 that exports profoundly influence net flows in the Delta, and the related conclusion by NMFS that
21 resulting flow changes cause harm to juvenile salmon. As an alternative to the PTM results and
22 qualitative assessments relied on by NMFS, I provide results from DSM2 HYDRO and the Delta
23 Passage Models. These models provide a robust, direct quantitative assessment of flows in the
24 Delta, and thus make it possible to properly assess export-related flow effects on salmon, and to
25 evaluate the related effectiveness of RPA Actions IV.2.1 and IV.2.3.

26 **I. THE RPA INTENDS TO MANAGE NET FLOWS IN THE DELTA**

27 4. The stated purpose of RPA Action IV.2.1 is to provide flows in the lower San Joaquin
28 River (SJR) to increase survival of emigrating Central Valley steelhead (*Onchorynchus mykiss*)

1 originating from the SJR, as well as to enhance the survival of Sacramento River (SR) salmonids
2 (BiOp 644-645, AR 106724-106725). Similarly, the stated purpose of RPA Action IV.2.3 is to
3 reduce adverse export effects on SR and SJR origin salmonids. To achieve this objective, Action
4 IV.2.3 prescribes minimum flows in Old and Middle River (OMR).

5 5. In support of these prescriptions, NMFS relied heavily on particle tracking model
6 (PTM) simulations to represent changes in what they describe as *net* Delta flows. For example,
7 the BiOp states, “the risk of entrainment into the channels of the south Delta is reduced when
8 exports are lower and the *net flow* in the OMR channels is more positive – that is, in the direction
9 of the natural flow toward the ocean.” (BiOp 652, AR 00106732, emphasis added.) This point is
10 made again in Mr. Stuart’s memo detailing the results of the PTM simulations, where he states,
11 “*Net flows* leading south toward the pumps will provide flow cues to the fish that are incorrect
12 and contrary to the direction the fish needs to move to successfully exit the delta” and that fish
13 may follow these cues and “be entrained into the salvage operations.” (PTM Memo at 6, AR
14 00106026, emphasis added.)

15 6. In describing the rationale for the San Joaquin River I:E ratio of Action RPA IV.2.1,
16 the BiOp states that increased flows within the San Joaquin River portion of the Delta will also
17 benefit Sacramento River salmonids due to “increased *net flow* toward the ocean” resulting from
18 increased SJR inflows and reduced exports (BiOp. 645, Appendix 5 at 74, AR 00106014,
19 emphasis added.) In describing the rationale for the minimum OMR flows prescribed by RPA
20 IV.2.3, the BiOp states that:

21 The data output for the PTM simulation of particles injected at the confluence of the
22 Mokelumne River and the San Joaquin River (Station 815) indicate that as *net OMR*
23 *flow* increases southwards from -2,500 to -3,500 cfs, the risk of particle entrainment
24 nearly doubles from 10 percent to 20 percent, and quadruples to 40 percent at -5,000
25 cfs. At flows more negative than -5,000 cfs, the risk of entrainment increases at an
26 even greater rate, reaching approximately 90 percent at -7,000 cfs. Even if salmonids
27 do not behave exactly as neutrally buoyant particles, the risk of entrainment escalates
28 considerably with increasing exports, as represented by the *net OMR flows*. The
logical conclusion is that as OMR reverse flows increase, risk of entrainment into the
channels of the South Delta is increased.

(BiOp 652, AR 00106732, emphasis added.) It is therefore apparent that the ostensible purpose
of both Action IV.2.1 and Action IV.2.3, is to reduce net negative flows in the Delta. The BiOp

1 does not define net flows, nor does it describe the appropriate time interval for which net flows
2 should be evaluated to determine the potential for adverse effects on juvenile salmonids. Instead,
3 the BiOp relies upon PTM simulations to establish the effect of exports and to represent net flows
4 in the Delta.

5 **II. AN ALTERNATIVE METHOD FOR ASSESSING FLOW EFFECTS ON JUVENILE SALMON**

6 7. I previously have identified DSM2 HYDRO as a readily available tool which
7 provides channel specific flow data at 15-minute time intervals. Unlike PTM results which must
8 be compiled over 30 to 90 days (Cavallo Dec. in Supp. of DWR Mot. For Summ. J. at 10. (Doc.
9 452)), DSM2 HYDRO results may be evaluated at 15-minute, hourly or daily time increments.
10 The migratory process of salmon smolts in estuaries is thought to occur in steps, “characterized
11 by swimming in the direction of the current followed by periods of holding in areas of low current
12 velocity.” (2010 Independent Review Panel Report at 25.) And recent Delta telemetry tagging
13 studies shows that salmon smolts spend minutes or hours at channel junctions (Bureau et al., 2007,
14 AR00109732) and only days migrating through longer Delta reaches (Vogel 2004, AR00217955).
15 Thus, a relatively short time interval (e.g. 1 day) is an appropriate scale at which to examine the
16 potential for adverse hydrodynamic effects on juvenile salmon. Analyses of net flows calculated
17 over weeks or months (as with PTM) are inappropriate because migrating juvenile salmon do not
18 stay in one place long enough to be subjected to such gradual effects.

19 8. Similarly, much of the Delta is heavily influenced by tides, and in such reaches
20 simple measures of net flow (whether averaged over days or weeks) are misleading because the
21 magnitude of tidal flux far exceeds the subtle influence of net flows. As an example of this point,
22 I have plotted DSM2 HYDRO based estimates of channel flows at 15-minute increments for a
23 location in the western Delta (RSAN014) and provided it as Exhibit 1. (RSAN014 represents
24 reach SJ3 in the Delta Passage Model (DPM); Both DSM2 HYDRO and the DPM are described
25 in greater detail in later paragraphs). Exhibit 1 illustrates that the magnitude of tidal flux can be
26 very large (in excess of 100,000 cfs in this example) and as such the influence of exports is very
27 small. Yet, a simple calculation of net flows from the same data plotted in Exhibit 1 would
28 indicate average flow values of -220, -2,263, and -4,337 at exports of 2,000, 6,000 and 10,000

1 respectively. In reaches with large tidal flux, and given the directed movement and strong
2 swimming behavior of juvenile salmonids, it is very likely that these changes in average or net
3 flow are nearly imperceptible.

4 9. I have used DSM2 HYDRO and completed an evaluation of export and river inflow
5 effects on Delta flow conditions. I used DSM2 HYDRO results from Kimmerer and Nobriga
6 (2008) (AR 00122248-00122252) representing three levels of exports and three levels of river
7 inflows. Exhibit 2 provides a summary of the river inflow and export conditions modeled.
8 Further details on the assumptions of the DSM2 HYDRO simulations are provided in Kimmerer
9 and Nobriga (2008).

10 10. DSM2 HYDRO estimates flow every 15 minutes at 517 separate channels within the
11 Delta. Following Kimmerer and Nobriga (2008) I used estimated flows every 15-minutes over a
12 single 24-hour period of simulation (including tidal oscillations but where inflows and exports
13 were constant). I summarized this very large data set by calculating the percentage increase in
14 negative flow occurrence resulting from exports increasing from 2,000 to 6,000 cubic feet per
15 second (cfs) and from 6,000 to 10,000 cfs. Thus, if half (50%) of all flow observations at a
16 specific channel were negative at 2,000 cfs, we would report the percentage increase in those
17 negative flows resulting from exports at 6,000 cfs. Channel locations solely influenced by river
18 flows would always have positive flows. Conversely, channel locations very close to export
19 facilities would always have negative flows. In both of these instances, no change in the
20 occurrence of negative flows would be expected as exports increased. However, these extremes
21 are not typical for most Delta channel. In a channel only influenced by tides, we would expect
22 flows to be negative about 50% of the time and positive for the remaining 50%. That is, flows
23 would be positive on ebb (outgoing) tides and negative on flood (incoming) tides (as depicted in
24 Exhibit 1). My analysis sought to illustrate the spatial extent of increased negative flows in the
25 Delta and to depict how the incidence of flows changes as a function of exports and inflows.

26 11. Exhibit 3, Exhibit 4, and Exhibit 5 depict the percentage increase in the occurrence of
27 negative flows during low river inflow conditions with three contrasting levels of exports. As
28 exports change from 2,000 cfs to 6,000 cfs (upper panels) and from 6,000 cfs to 10,000 cfs (lower

1 panels) the colors of Delta channels change in relation to the incidence of negative flow. OMR
2 flows also change, and values are indicated on each panel of these Exhibits. Channels in which
3 negative flows change very little (<1%) are indicated in grey. Channels in which negative flows
4 increases from 1 to 2% are indicated as yellow and orange. Channels in which negative flows
5 increased by greater amounts are depicted as red (3-4%) and purple (5-30%).

6 12. Closely examining Exhibit 3 reveals two significant observations. First, large
7 changes (>5%) in the occurrence of negative flows are confined to channels in close proximity to
8 the south Delta export facilities. Second, channel junctions along the San Joaquin River which
9 were identified by NMFS as primary areas of concern for juvenile salmonid migration (AR
10 00106022) are relatively insensitive to increasing exports. The incidence of negative flows at
11 these locations only increased by at most 1% to 2% as OMR values decreased from -2298 to
12 -5400 and from -5400 to -8503 (Exhibit 3).

13 13. Exhibit 4 and Exhibit 5 depict the same increase in exports as shown in Exhibit 3, but
14 with greater river inflows (total inflow of 21,000 cfs for Exhibit 4 and 38,000 cfs for Exhibit 5).
15 Patterns in the increase of negative flows were generally similar regardless of river inflow levels.

16 14. DSM2 HYDRO analysis results differ starkly from comparable PTM analyses. For
17 example, NMFS conducted PTM analysis and released particles at Station 815 (the approximate
18 location of Station 815 is labeled as Mokelumne River on Exhibits 3 to 5), and reported a 3900%
19 increase in particles entrained at the export facilities (from 0.6% to 23.5%) as OMR values
20 decreased -1250 to -3500. (PTM Memo, p. 3, AR 00106023.) As shown in Exhibits 3, 4 and 5
21 such an increase in exports (or decrease in OMR) produces only slight (if any) changes in the
22 incidence of negative flows within a 24-hour period; nothing like the dramatic increase in
23 negative flows which is implied by the PTM-based assessment at this same location.

24 15. Similarly, Kimmerer and Nobriga (2008) (AR 00122249) assessed particle
25 entrainment at locations "Med" and "Sto" on the San Joaquin River. These two locations
26 correspond to the areas labeled as Columbia Cut and Turner Cut on Exhibits 3, 4 and 5.
27 Kimmerer and Nobriga reported that 58% and 48% of particles were entrained for particles
28 released at these two locations under low inflows (12,000 cfs) and low exports (2,000 cfs). (AR

1 00122255.) Again, DSM2 HYDRO simulations show that the actual changes in the incidence of
2 negative flows at these locations over a 24-hour period is very small.

3 16. Collectively these results confirm previous my previous observation that, “given the
4 rapid and directed movements of salmonid smolts, it is both inappropriate and inaccurate to use
5 the fate of particles integrated over weeks or months to even roughly assess salmonid smolt
6 effects.” (Cavallo Dec. in Supp. of DWR Mot. For Summ. J. p. 11 (Doc. 452).) The long time
7 period over which PTM integrates the fate of particles greatly exaggerates the perception of
8 export impacts on juvenile salmonids. Indeed, recent telemetry studies shows that salmon smolts
9 spend minutes or hours at channel junctions (Burau et al. 2007, AR00109732) and only days
10 migrating through longer Delta reaches (Vogel 2004, AR00217955). Given the fractional
11 changes in negative flows which occur along the primary migration route of the San Joaquin
12 River there is little reason to expect an adverse impact such has been hypothesized by NMFS to
13 support Actions IV.2.1 and IV.2.3.

14 17. The results of the DSM2 HYDRO analysis presented here are entirely consistent with
15 and help to explain the difficulty nearly all investigations have had in finding evidence of adverse
16 export effects on the survival and route selection for San Joaquin River juvenile salmonids. The
17 very small changes in negative flows which occur along the mainstem San Joaquin River as
18 exports increase may be an all but undetectable effect on migrating juvenile salmonids. Given
19 these results, it is perhaps not surprising that Vogel (2004) (AR 00217996), Newman (2008) (AR
20 00127219-00127220) and others have been unable to observe evidence for an adverse export
21 effect.

22 **III. DELTA PASSAGE MODEL MORE ACCURATELY ESTIMATES THROUGH-DELTA**
23 **SURVIVAL**

24 18. The Delta Passage Model (DPM) is a simulation tool which allows us to specifically
25 track the routing and survival of salmonid smolts as they migrate through the Delta. The DPM
26 incorporates the results of best available scientific information regarding race-specific arrival
27 timing, route selection, behavior and mortality of juvenile salmon. The DPM includes results of
28 the Delta Action 8 study (including variability in predicted response to exports) as described by

1 Newman and Brandes (2009) (AR 00089863) and applies estimated export-related mortality to
2 the sub-set of fish which pass through Georgiana Slough. Positive relationships between survival
3 and river flow, as shown by Newman (2008) (AR 00127219) and others, are also included in the
4 Delta Passage Model. This integration of factors influencing through-Delta survival provided by
5 the Delta Passage Model provides an example of the quantitative approach recommended to
6 NMFS by the CALFED Independent Science Panel. (Anderson et al. 2009, 5-6, 9-10, 13, 19-22,
7 28-29; AR 00108163 et passim.)

8 19. The DPM is based on a detailed accounting of migratory pathways and reach-specific
9 mortality as Chinook salmon smolts travel through a simplified network of reaches and junctions
10 in the Delta. The DPM is composed of 10 reaches and four junctions (Exhibit 5A) selected to
11 represent primary salmonid migration corridors where high quality fish and hydrodynamic data
12 were available. For simplification, Sutter Slough and Steamboat Slough are combined as the
13 reach SS and the forks of the Mokelumne River and Georgiana Slough are combined as
14 Geo/DCC. The Geo/DCC reach is accessed by Sacramento runs through the combined junction
15 of Georgiana Slough and Delta Cross Channel (Junction C). Different areas of the Interior Delta
16 reach can be entered from three different pathways: 1) Geo/DCC, 2) SJ2, or 3) Old River Junction
17 (Junction D). The four distributary junctions depicted in the DPM are: A) Sacramento River at
18 Freemont Weir (head of Yolo Bypass), B) Sacramento River at head of Sutter and Steamboat
19 Sloughs, C) Sacramento River at the combined junction with Georgiana Slough and Delta Cross
20 Channel, and D) San Joaquin River at the head of Old River (Exhibit 5A).

21 20. Though NMFS was provided with preliminary results of a DPM-based assessment of
22 their proposed RPA Actions IV.2.1 and IV.2.3 on April 24, 2009 (AR 00105439-00105451), we
23 have now completed a more thorough analysis using CALSIM data provided by DWR and using
24 the most current version of the DPM. The version of the DPM used for this analysis has
25 undergone extensive review and revisions in collaboration with resource agency scientists as part
26 of the Bay Delta Conservation Plan (BDCP) process. The version of the DPM used for the
27 analysis is fully documented and available in Appendix E10 of the BDCP effects analysis
28 expected to be released in February 2011. CALSIM data used for this analysis is based upon 81

1 years of hydrologic conditions (i.e. precipitation history) ranging from 1922 to 2003 with two
2 contrasting scenarios of required water project operations: “BiOp” and “Pre-BiOp”. The “BiOp”
3 scenario represents water project operations as expected to occur under the provisions of the 2009
4 OCAP Biological Opinions (both NMFS and USFWS). In contrast, the “Pre-BiOp” scenario
5 represents water project operations as would be expected to occur without the 2009 OCAP
6 Biological Opinion. Thus, in the “Pre-BiOp” Delta water project operations were primarily
7 determined by the D-1641 agreement and conditions of earlier BiOps.

8 21. In a previous declaration, I observed that, “while Action IV.2.1 purports to manage
9 both flows and exports for the benefit of juvenile salmonids, in fact it only restricts exports.
10 There is no evidence available to suggest that the Action IV.2.1 will result in increased SJR
11 flows.” (Cavallo Dec. in Supp. of DWR Mot. For Summ. J. at 3 (Doc. 452).) Results provided
12 by the CALSIM analysis now confirm this observation. Exhibit 6 plots the difference in monthly
13 average flows between the “BiOp” and “Pre-BiOp” scenarios. Exhibit 6 clearly shows that the
14 2009 BiOp does not increase San Joaquin River flows entering the Delta.

15 22. Estimates of winter run Chinook through-Delta survival using the DPM show an
16 average survival improvement of 1.3% with the “BiOp” relative to the “Pre-BiOp” (Exhibit 7).
17 The upper panel of Exhibit 7 illustrates that there is considerable year-to-year variation in winter-
18 run Chinook survival through the Delta. This variation is due to changes in water years types
19 which have a very strong influence on river inflows to the Delta. To better explain the relative
20 importance of export effects addressed by Action IV.2.1 and IV.2.3, I plotted the through-Delta
21 mortality for winter run Chinook which is attributable to exports relative to other stressors which
22 are not addressed by RPA Actions IV.2.1 and IV.2.3 (Exhibit 7A). Exhibit 7A clearly illustrates
23 that the effect of exports is very small relative to non-project stressors. Non-project stressors
24 include factors such as water year type, predation, degraded habitat, temperature, turbidity, and
25 river inflow management.

26 23. Estimates of spring run Chinook through-Delta survival using the DPM show an
27 average survival improvement of 0.2% with the “BiOp” relative to the “Pre-BiOp.” (Exhibit 8.)
28 The upper panel of Exhibit 8 illustrates that there is considerable year-to-year variation spring run

1 Chinook survival through the Delta. This variation is due to changes in water years types which
2 have a very strong influence on river inflows to the Delta.

3 24. Estimates of San Joaquin River (SJR) fall run Chinook through-Delta survival using
4 the DPM show an average survival decrease of 1.1% with the “BiOp” relative to the “Pre-BiOp.”
5 (Exhibit 9.) Survival through the Delta from the SJR appears to be extremely low and improves
6 with greater SJR inflows to the Delta. However, as described in paragraph 18, “BiOp” operations
7 (including Actions IV.2.1 and IV.2.3) do not appear to increase SJR river inflows to the Delta.
8 The small observed decrease in SJR survival with the “BiOp” is due to the reduction in exports
9 associated with Actions IV.2.1 and IV.2.3. This occurs because recent acoustic tagging studies
10 and analysis of CWT data show that survival through the Old River route is higher with greater
11 exports because greater exports increase flows through Old River. The mechanism by which
12 these export benefits occur, if they occur at all, is highly uncertain and debatable. I
13 conservatively interpret the results of the DPM for SJR Chinook salmon to indicate there is no
14 difference in through-Delta survival with “BiOp” conditions relative to “pre-BiOp” conditions.

15 **IV. BEST AVAILABLE SCIENCE DEMONSTRATES NO APPRECIABLE BENEFIT FROM THE**
16 **RPA**

17 25. Results presented in my analysis of the DSM2 HYDRO model with varying levels of
18 exports (and OMR flows) clearly show that the potential for exports to adversely impact
19 migration of juvenile salmonids is relatively small, and that PTM analyses relied upon by NMFS
20 in developing Actions IV.2.1 and IV.2.3 greatly exaggerates the potential hydrodynamic impact
21 of exports on juvenile salmonids. As I have described previously and at length (Cavallo Dec. in
22 Supp. of DWR Mot. For Summ. J. at 9-15 (Doc. 452)) the PTM is an inappropriate tool to assess
23 flow effects on juvenile salmonids in tidally-driven portions of the Delta. Its use for this purpose
24 is entirely without scientific basis or precedent, and experts have uniformly reported the failure of
25 PTM to comport with the observed fates and behavior fish. In contrast, DSM2 HYDRO results
26 appear to be very consistent with observations of fish behavior and entrainment risk.
27 Collectively, Newman (2008) (AR 00127219-00127220), Vogel (2004) (AR 00217996) and
28 others were unable to find an export effect on survival or migration route for fish on the San

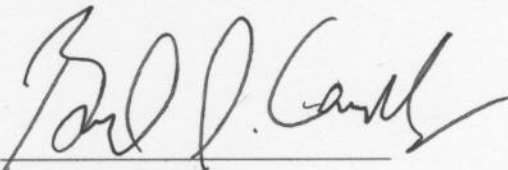
1 Joaquin River. (VAMP Review Panel Report (2010) at 5.) DSM2 HYDRO results reported here
2 comport with these findings and illustrate that the export-influenced hydrodynamic effect
3 hypothesized to exist for juvenile salmonids is either absent, or simply too small to be reliably
4 detected.

5 26. Analysis of the DPM revealed small (1.3% on average) survival benefits for winter
6 run Chinook from operations under the "BiOp" scenario. However, most winter run Chinook will
7 have already migrated out of the Delta by March 15th, and thus the benefits observed are
8 attributable to RPA actions implemented earlier in the year and are not substantially attributable
9 to the disputed portions of Actions IV.2.1 and IV.2.3. Thus, in my professional opinion enjoining
10 RPA Actions IV.2.1 and IV.2.3 will not appreciably harm Sacramento winter-run Chinook.

11 27. Sacramento River spring run Chinook and the San Joaquin River component of the
12 Central Valley steelhead will be actively emigrating during the period of time affected by RPA
13 Actions IV.2.1 and IV.2.3. However, DSM2 HYDRO and DPM analysis presented here clearly
14 show that potential adverse impact to these species and to their critical habitat would not
15 appreciably occur if RPA Actions IV.2.1 and IV.2.3 were enjoined.

16 28. Based upon the analysis contained in this declaration, it is my opinion that enjoining
17 the calendar based Old and Middle River component of Action IV.2.3 and the inflow-export ratio
18 component of Action IV.2.1 through this water year will not reduce appreciably the likelihood of
19 survival or recovery or appreciably diminish the value of the critical habitat of the listed
20 salmonids in the BiOp.

21 I declare under penalty of perjury under the laws of the State of California and the United
22 States that the foregoing is true and correct. Executed this 3rd day of February 2011 at Auburn,
23 California.

24 
25 _____
26 BRADLEY CAVALLO

REFERENCE LIST

- James J. Anderson et al., Independent Review of a Draft Version of the 2009 NMFS OCAP Biological Opinion (CALFED Science Program 2009) (AR 00108158)
- James J. Anderson et al., Report of the 2010 Independent Review Panel (IRP) on the Reasonable and Prudent Alternative (RPA) Actions Affecting the Operations Criteria and Plan (OCAP) for State/Federal Water Operations, Prepared for Delta Stewardship Council, Delta Science Program (2010)
- Jon Burau et al., Sacramento/San Joaquin River Delta Regional Salmon Outmigration Study Plan: Developing Understanding for Management and Restoration (2007) (AR 00109732)
- Committee on Sustainable Water and Environmental Management in the California Bay–Delta, National Academy of Sciences National Research Council, A Scientific Assessment of Alternatives for Reducing Water Management Effects on Threatened and Endangered Fishes in California’s Bay Delta (National Academies Press 2010)
- Dennis Dauble et al., The Vernales Adaptive Management Program (VAMP): Report of the 2010 Review Panel, Prepared for the Delta Science Program (2010)
- Wim J. Kimmerer et al., Investigating Particle Transport and Fate in the Sacramento – San Joaquin Delta Using a Particle Tracking Model, San Francisco Estuary & Watershed Science, February 2008 (AR00122246)
- Ken B. Newman, An Evaluation of Four Sacramento – San Joaquin River Delta Juvenile Salmon Survival Studies (2008) (AR 00127144)
- Ken B. Newman et al., Hierarchical Modeling of Juvenile Chinook Salmon Survival as a Function of Sacramento – San Joaquin Delta Water Exports (2009) (AR 00089863)
- San Joaquin River Technical Committee, Summary Report of the Vernalis Adaptive Management Plan (VAMP) for 2000 – 2008, Prepared for the Advisory Panel Review Conducted by the Delta Science Program (2008)
- Jeffrey Stuart, Particle Tracking Model Results for Old and Middle River Flow Manipulation, Unpublished Memorandum (National Marine Fisheries Service 2009) (AR 00106021)
- David A. Vogel, Juvenile Chinook Salmon Radio-Telemetry Studies in the Northern and Central Sacramento – San Joaquin Delta 2002 – 2003 (National Fish and Wildlife Foundation 2004) (AR 00217955)

Exhibit 1. Tidal flux vs. “net flows

RSAN014 (Reach SJ3 in DPM)

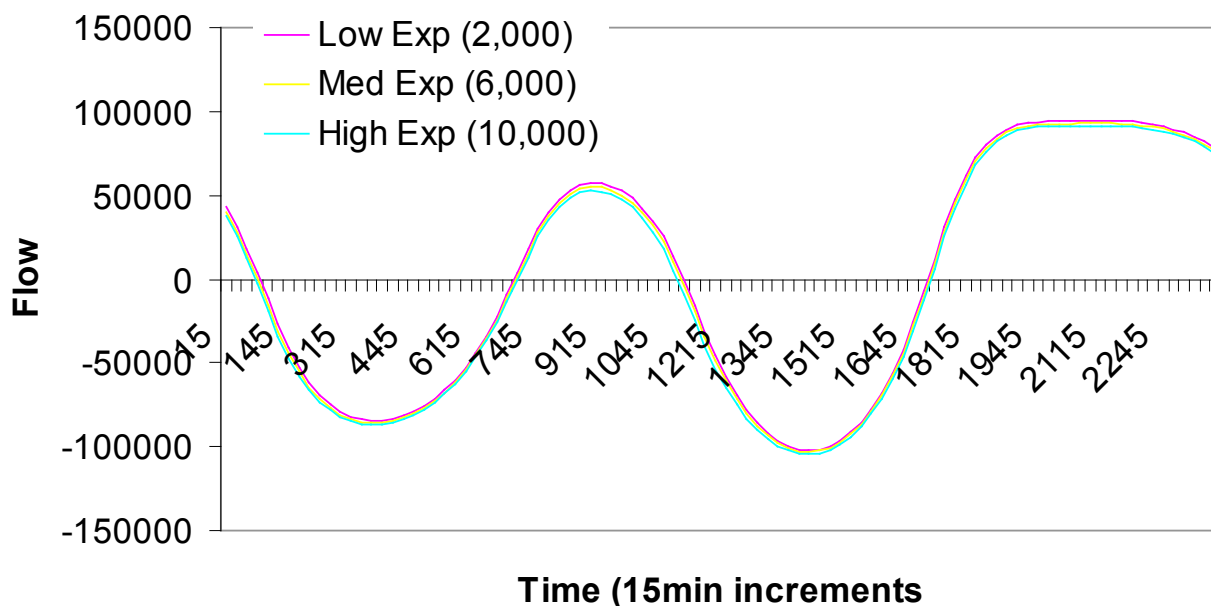


Exhibit 1. DSM2 HYDRO estimated flows in 15-minute increments for a channel in the western Delta for three levels of south Delta exports. Tidal flux approaches 100,000 cfs, but increasing exports have very little influence on observed flow oscillations. Yet, average (or net) flows calculated from this data are -220, -2,263, and -4,337 respectively. Without consideration for the tidal flux, these negative net flows might be interpreted as harmful to juvenile salmon.

Exhibit 2. Scenarios for DSM2 HYDRO

Total Inflow	Inflow Sacramento	San Joaquin	DCC Gate Position	Total Exports	OMR
Low (12,000 cfs)	Low (10,595 cfs)	Low (1,405 cfs)	Closed	Low (2000 cfs)	-2298
Low (12,000 cfs)	Low (10,595 cfs)	Low (1,405 cfs)	Closed	Med (6,000 cfs)	-5400
Low (12,000 cfs)	Low (10,595 cfs)	Low (1,405 cfs)	Closed	High (10,000 cfs)	-8503
Med (21,000 cfs)	Med (18,264 cfs)	Med (2,736 cfs)	Closed	Low (2000 cfs)	-1511
Med (21,000 cfs)	Med (18,264 cfs)	Med (2,736 cfs)	Closed	Med (6,000 cfs)	-4614
Med (21,000 cfs)	Med (18,264 cfs)	Med (2,736 cfs)	Closed	High (10,000 cfs)	-7717
High (38,000 cfs)	High (32,288 cfs)	High (5,712 cfs)	Closed	Low (2000 cfs)	246
High (38,000 cfs)	High (32,288 cfs)	High (5,712 cfs)	Closed	Med (6,000 cfs)	-2856
High (38,000 cfs)	High (32,288 cfs)	High (5,712 cfs)	Closed	High (10,000 cfs)	-5959

Exhibit 2. River inflows, south Delta exports, Delta Cross Channel (DCC) position, and OMR flows conditions assessed by Kimmerer and Nobriga (2008). Kimmerer and Nobriga (2008) reported particle tracking model results from these (and other) scenarios. DSM@HYDRO results for these nine scenarios are depicted in Exhibit 2, Exhibit 3, and Exhibit 4.

Exhibit 3. DSM2 HYDRO, Low Inflows

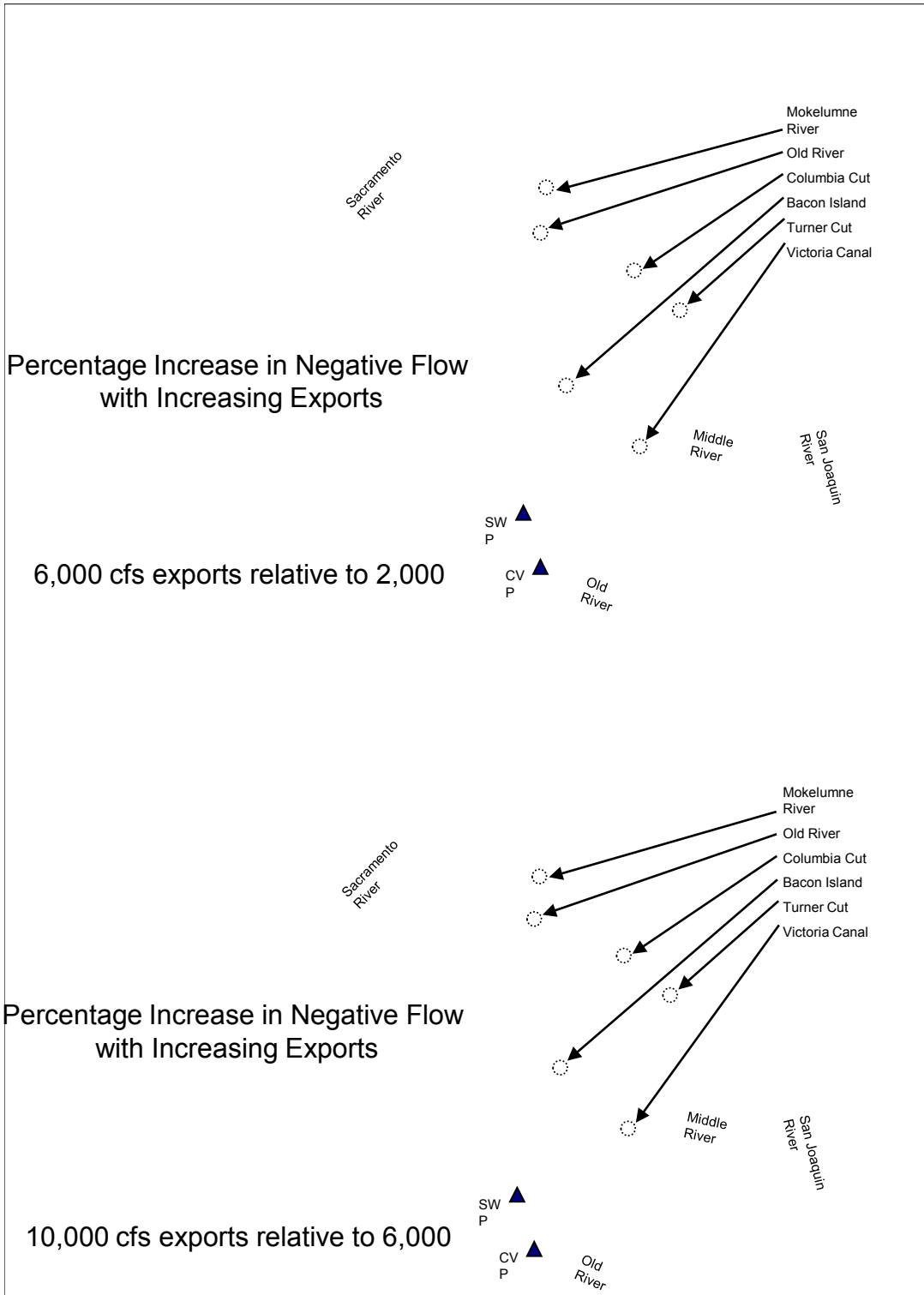


Exhibit 3. Percentage increase in the occurrence of negative flows during low river inflow conditions as exports change from 2,000 cfs to 6,000 cfs (upper panel) and from 6,000 cfs to 10,000 cfs (lower panel). Grey color indicates no change. Yellow, orange, and red indicate 1 to 4% increase in negative flows. Purple and blue indicates negative flow increases from 5 to 30%.

Exhibit 4. DSM2 HYDRO, Medium Inflows

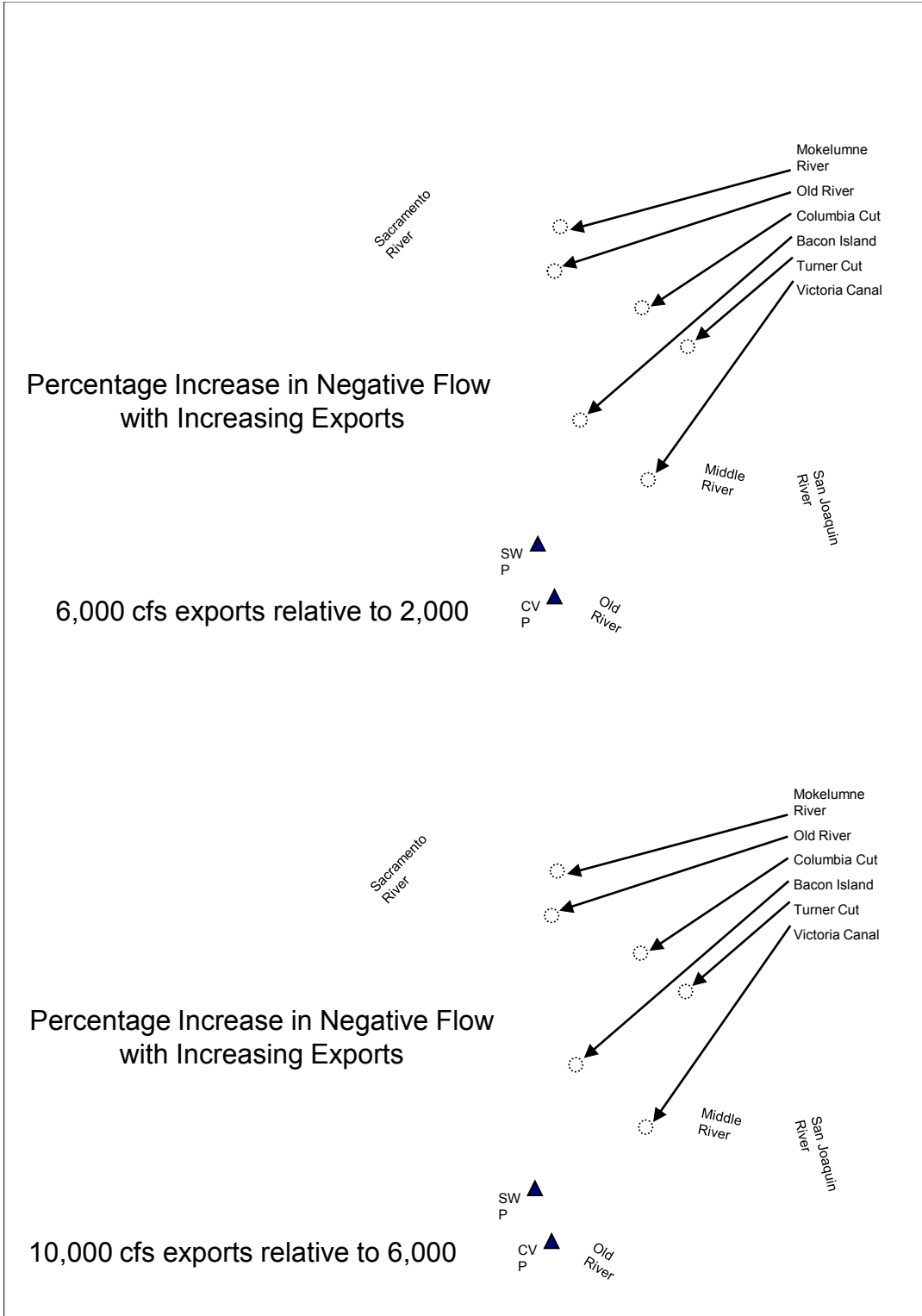


Exhibit 4. Percentage increase in the occurrence of negative flows during medium river inflow conditions as exports change from 2,000 cfs to 6,000 cfs (upper panel) and from 6,000 cfs to 10,000 cfs (lower panel). Grey color indicates no change. Yellow, orange, and red indicate 1 to 4% increase in negative flows. Purple and blue indicates negative flow increases from 5 to 30%.

Exhibit 5. DSM2 HYDRO, High Inflows

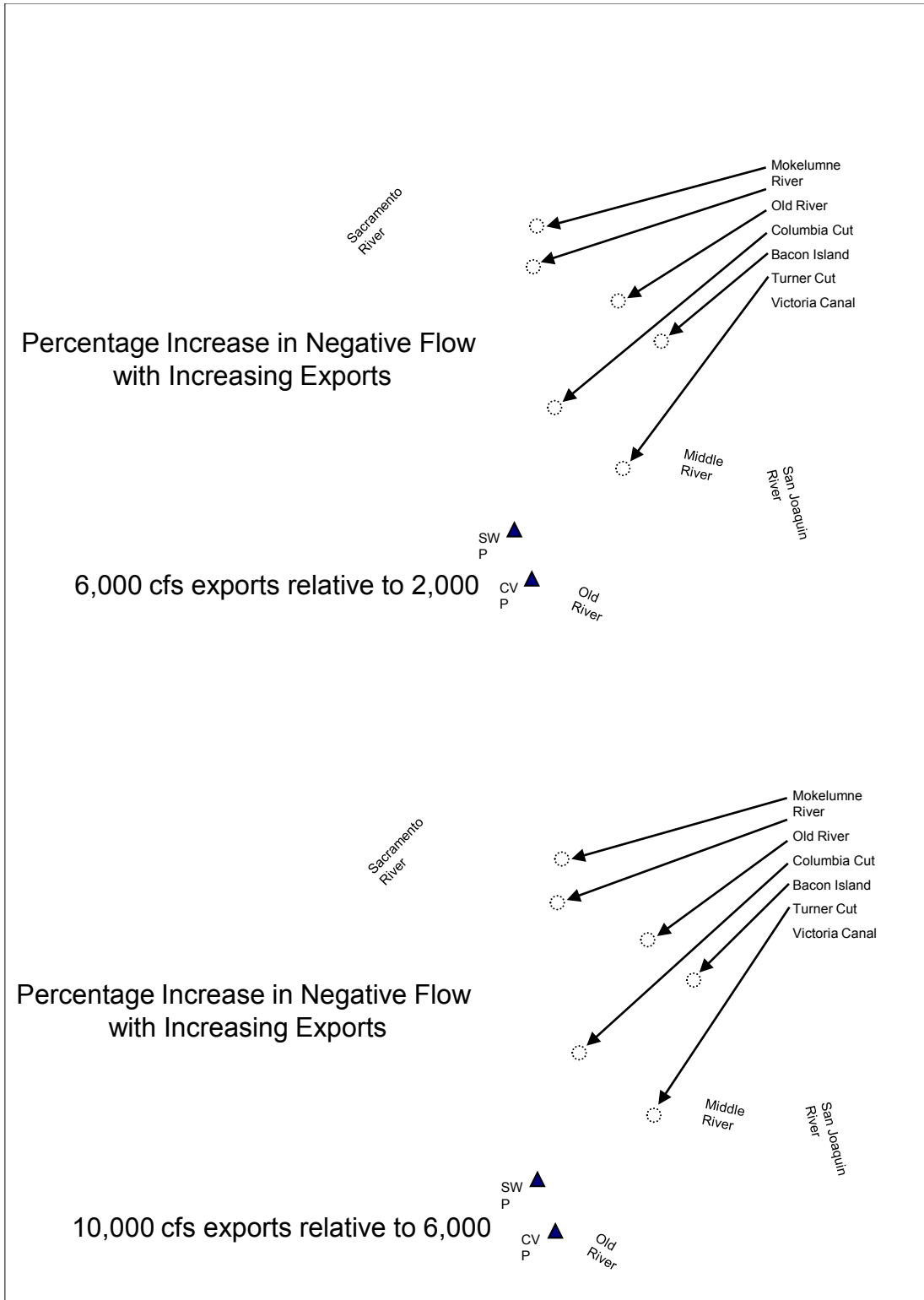


Exhibit 5. Percentage increase in the occurrence of negative flows during high river inflow conditions as exports change from 2,000 cfs to 6,000 cfs (upper panel) and from 6,000 cfs to 10,000 cfs (lower panel). Grey color indicates no change. Yellow, orange, and red indicate 1 to 4% increase in negative flows. Purple and blue indicates negative flow increases from 5 to 30%.

Exhibit 5A. Delta as represented in the DPM

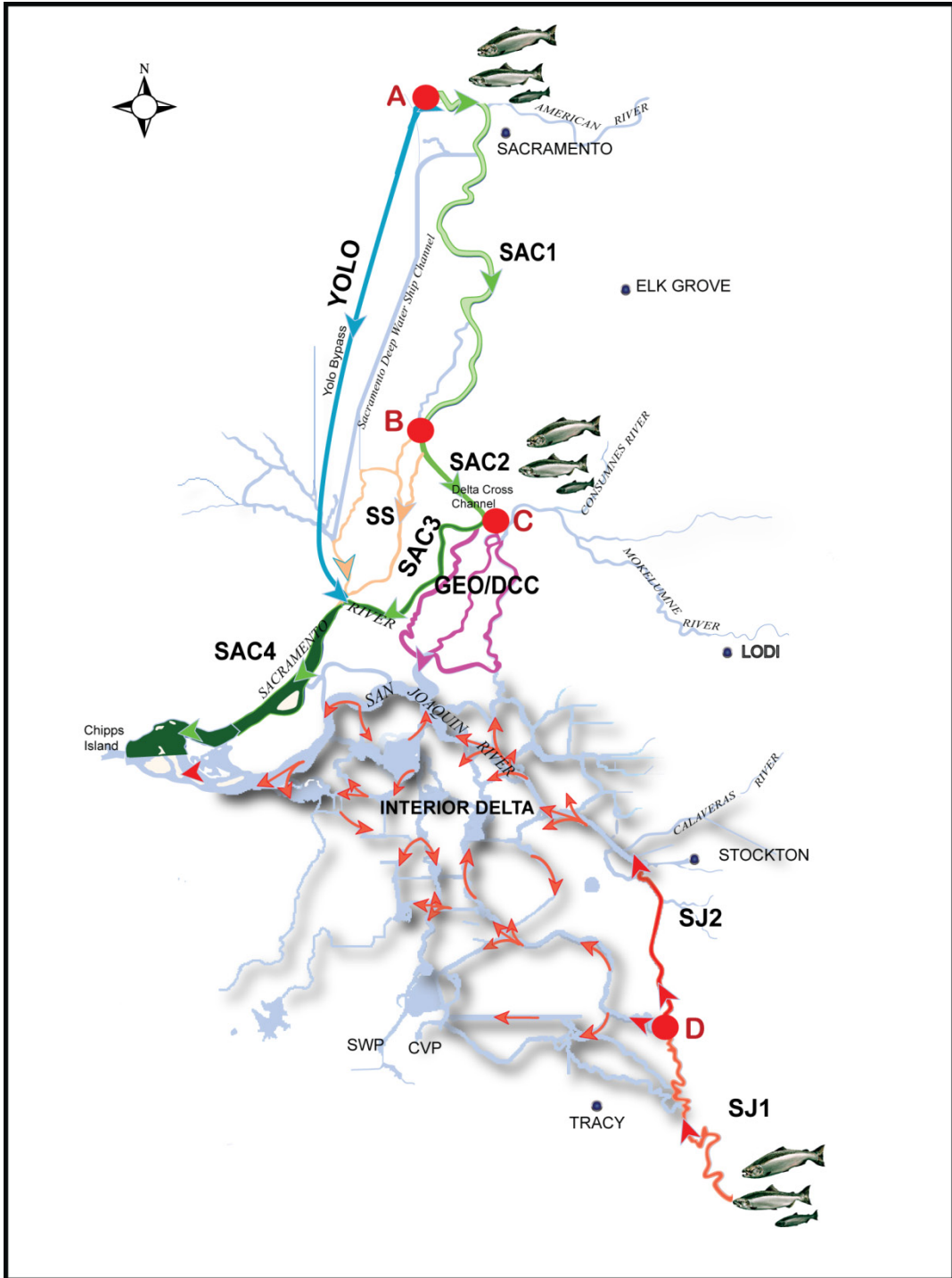


Exhibit 5A. Map of the Sacramento-San Joaquin Delta showing the modeled reaches and junctions represented in the Delta Passage Model (DPM). Colored river channels are modeled reaches and red circles are junctions. Salmonid icons indicate locations where juvenile salmonids can be introduced into the model

Exhibit 6. San Joaquin River flows (at Vernalis)

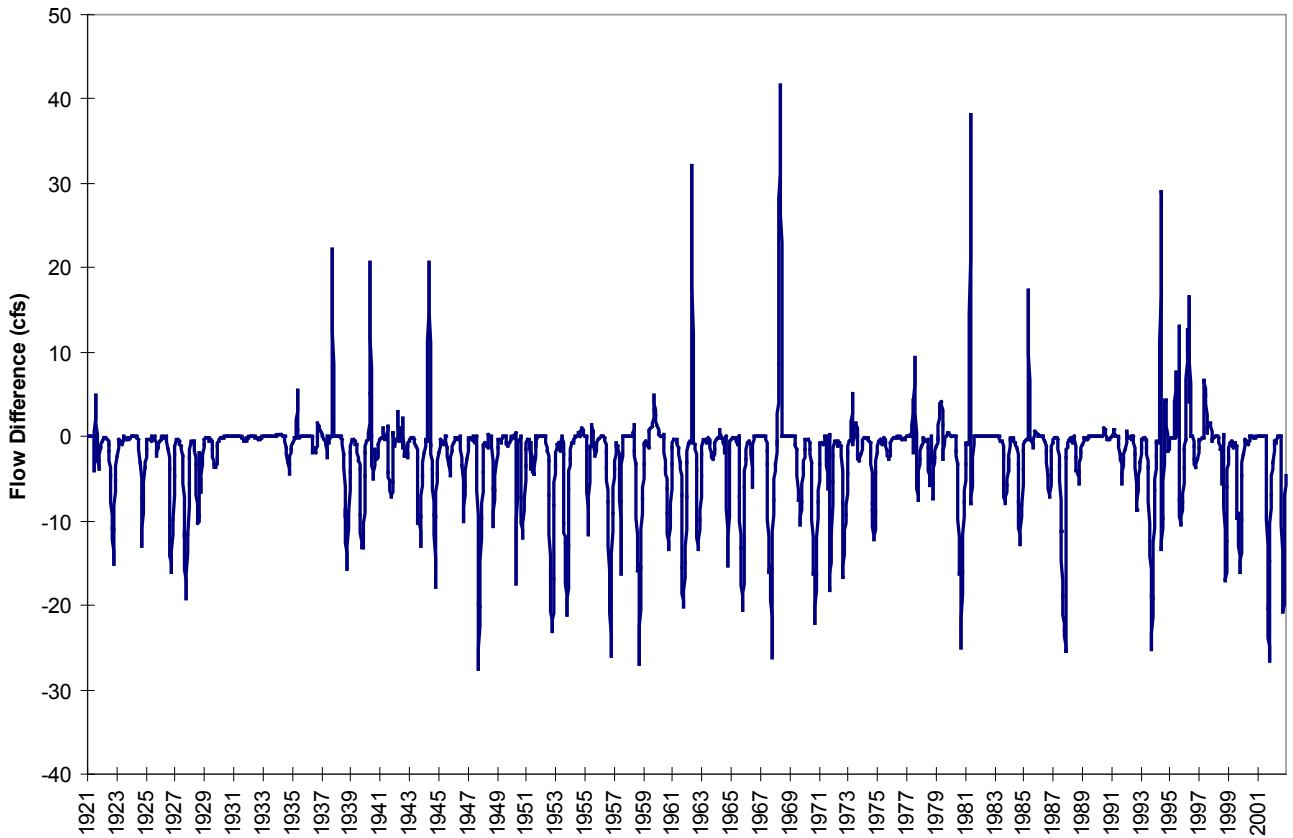


Exhibit 6. Difference in San Joaquin River flows (at Vernalis) with 2009 BiOp requirements relative to “pre-BiOp” requirements. Values less than zero indicate months when flows with the 2009 BiOp were less than flows under pre-BiOp conditions. On average, flows with the “BiOp” were no different from flows with “pre-BiOp”.

Exhibit 7. Winter Run Chinook DPM Results

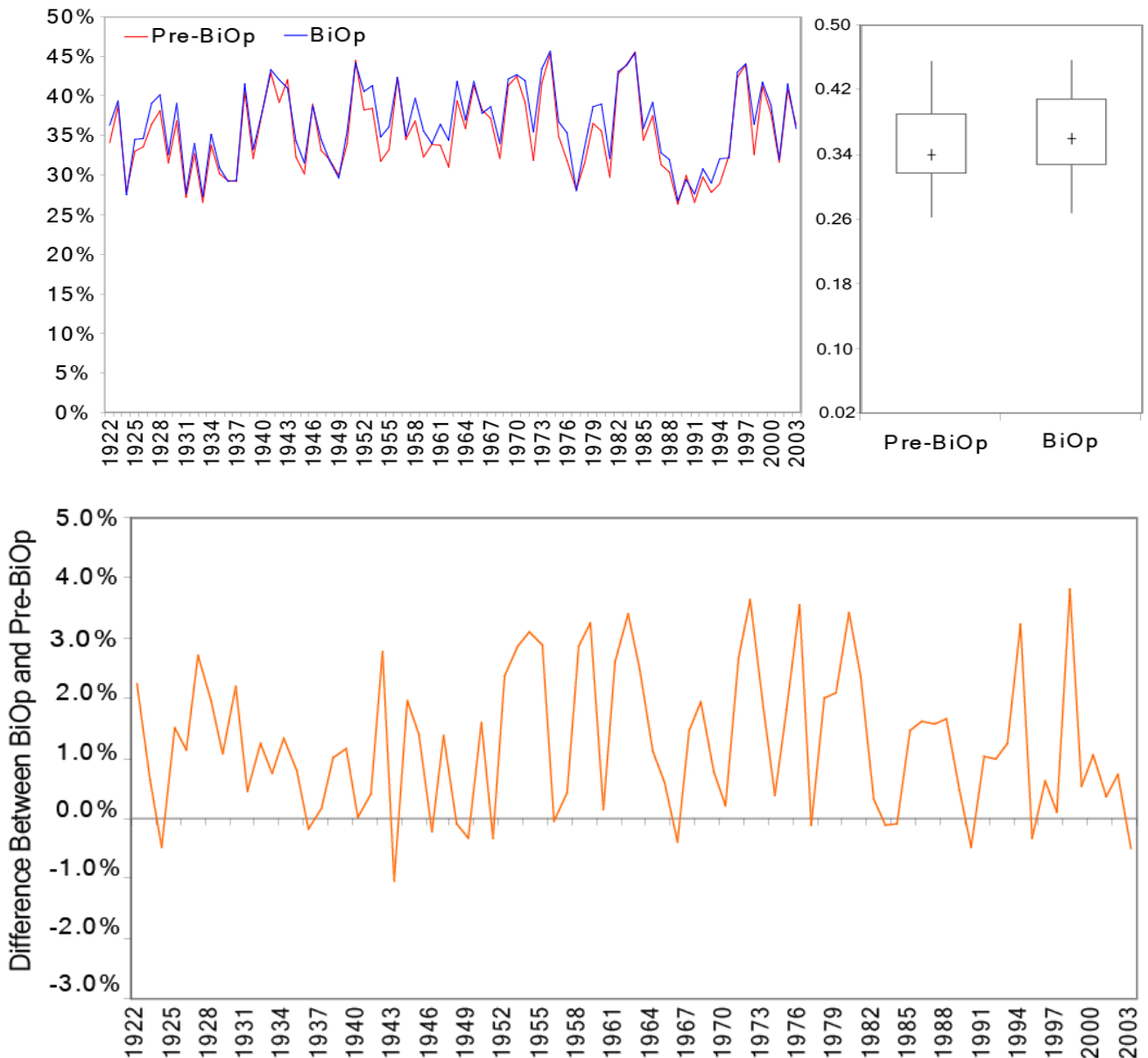


Exhibit 7. Juvenile winter run Chinook through-Delta survival as estimated by the Delta Passage Model (DPM) using CALSIM estimated flow and exports with 2009 BiOps (“BiOp”) and under “pre-BiOp” requirements. Upper panels show distribution of observed survival estimates, lower panel plots observed difference between “BiOp” and “Pre-BiOp”. On average, winter run Chinook survival was 1.3% higher with the “BiOp” condition relative to the “Pre-BiOp”.

Exhibit 7A. Relative Contribution of Exports to Winter Run Chinook Through-Delta Mortality

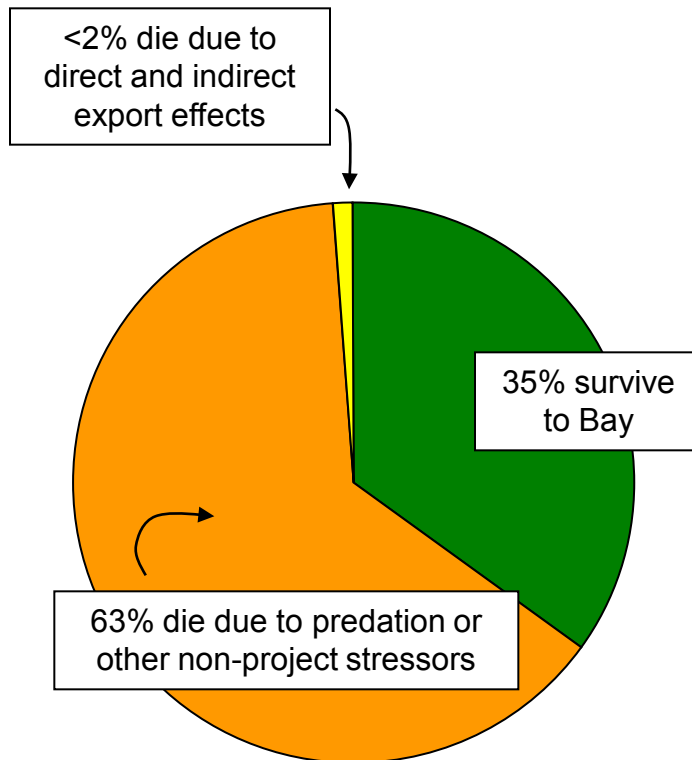


Exhibit 7A. Sources of through-Delta mortality for juvenile winter run Chinook as indicated by the Delta Passage Model and the studies upon which the DPM is based. Accounting for fish routing, river flows and other factors shows that export effects (both direct and indirect) exhibit a relatively small influence on through-Delta salmon survival. Through-Delta survival is poor, but most of losses are unrelated to effects addressed by RPA Actions IV.2.1 and IV.2.3.

Exhibit 8. Spring Run Chinook DPM Results

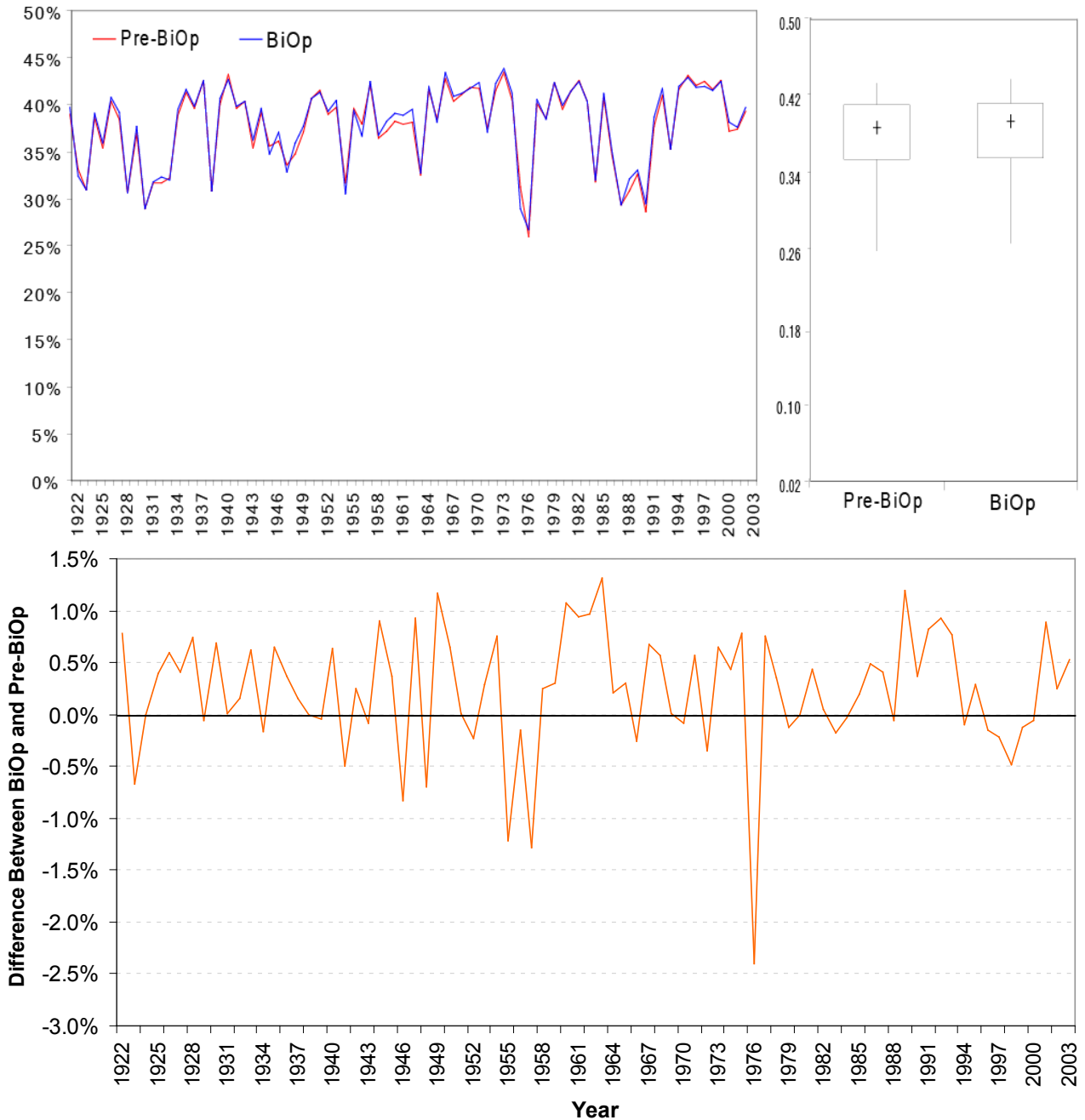


Exhibit 8. Juvenile spring run Chinook through-Delta survival as estimated by the Delta Passage Model (DPM) using CALSIM estimated flow and exports with 2009 BiOps (“BiOp”) and under “pre-BiOp” requirements. Upper panels show distribution of observed survival estimates, lower panel plots observed difference between “BiOp” and “Pre-BiOp”. On average, spring run Chinook survival was 0.2% higher with the “BiOp” condition relative to the “Pre-BiOp”.

Exhibit 9. SJR Fall Run Chinook DPM Results

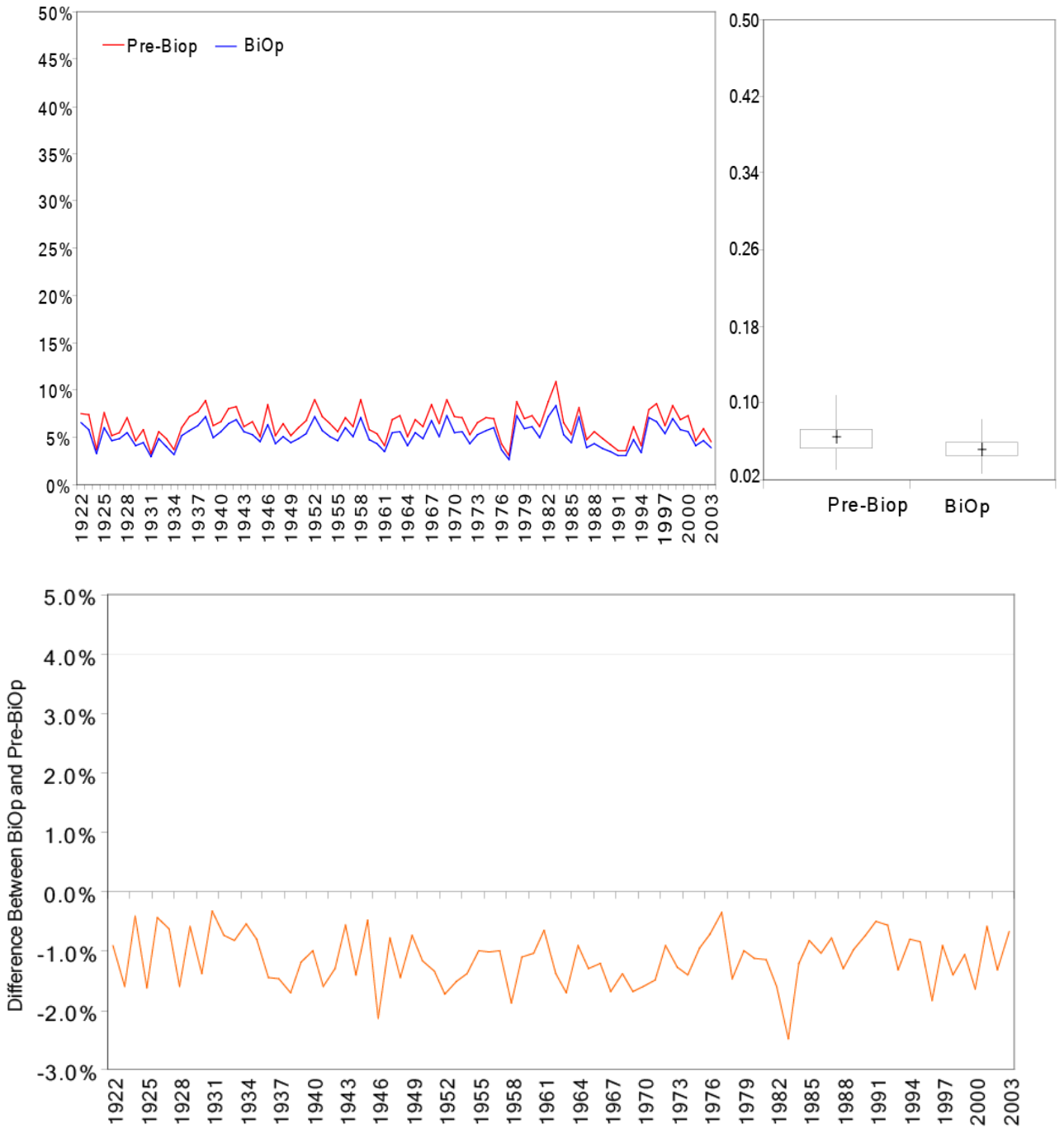


Exhibit 9. San Joaquin River juvenile fall run Chinook through-Delta survival as estimated by the Delta Passage Model (DPM) using CALSIM estimated flow and exports with 2009 BiOps (“BiOp”) and under “pre-BiOp” requirements. Upper panels show distribution of observed survival estimates, lower panel plots observed difference between “BiOp” and “Pre-BiOp”. On average, SJR fall run Chinook survival was 1.1% lower with the “BiOp” condition relative to the “Pre-BiOp”.