APPENDIX 1

TO SWANSON DECLARATION

CHRISTINA SWANSON

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EDUCATION

Ph.D., Biology, University of California, Los Angeles, 1991

B.A., Biology, Cornell University (with distinction in all subjects), 1980

PROFESSIONAL EXPERIENCE

Senior Scientist/Fisheries Scientist
The Bay Institute of San Francisco, Novato, California, 1999 to present

- Conducted applied research and integrated analysis of environmental, hydrologic, biological, and management in the Sacramento-San Joaquin Watershed and San Francisco Bay; developed and wrote public outreach reports and technical memoranda; represented and provided technical expertise to the environmental community; and communicated with the public and press about issues and conditions in the estuary and watershed

Visiting/Post-doctoral Research Scientist
Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, 1991-2005

- Conducted research on fish biology; wrote grant proposals and scientific journal articles; supervised student and staff research assistants; managed large multi-department collaborative research projects; guest lectured in departmental courses and seminars

Lecturer
Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, 2000

- Developed and taught upper division course, Physiological Ecology of Wildlife

Teaching Fellow/Teaching Assistant
University of California, Los Angeles, 1983-1986, 1990.

- Lectured, conducted laboratory and discussion sessions, and supervised students in several upper and lower division biology and marine ecology courses

Science Curriculum Consultant
Redwood City School District (San Mateo County) and Jefferson School District (San Benito County), California, 1986, 1987

- Conducted in-service education workshops and developed curricula for activity-based science and math education

Laboratory Director/Marine Science Instructor/Maritime History Instructor
Orange County Marine Institute, Dana Point, CA, 1981-1983

- Developed, organized, and taught field and laboratory programs in marine and coastal biology and ecology, and maritime history (grades: K-college)

HONORS and AWARDS

President, California-Nevada Chapter of the American Fisheries Society, 2004-2005

Distinguished Professional Achievement Award, California-Nevada Chapter of the American Fisheries Society, 2003

Graduate Woman of the Year, University of California, Los Angeles, 1991.

Fulbright Scholar, Philippines, Fulbright-Hays Dissertation Research Abroad, 1988-1989.

Phi Beta Kappa, Cornell University, 1980.

REVIEW PANELS and WORKTEAMS

The Bay Center Science Content Committee
Development of exhibit themes and scientific content for the Bay Center, a public museum for the San Francisco Bay to be located at Fisherman's Wharf

CALFED Adaptive Management Planning Team
Development of conceptual models and assessment and prioritization of proposed ecosystem restoration projects for the Delta Regional Ecosystem Restoration Implementation Program

Central Valley Technical Recovery Team
Evaluation of population status and recovery planning for Endangered Species Act-listed Central Valley salmon species

CALFED Data Assessment Team
Realtime evaluation and management of water management operations in the Sacramento-San Joaquin Watershed and Delta for the protection of native inland and anadromous fishes, estuarine habitat, and water quality

CALFED Operations and Fisheries Forum
Stakeholder oversight team for evaluating and commenting on water management operations and fisheries protection actions in the Sacramento-San Joaquin Watershed and Delta

Central Valley Fish Facilities Review and Coordination Teams
Interagency project workteams charged with technical and policy review and oversight of fish facilities (i.e., fish screen, ladders, and dams) in the Sacramento-San Joaquin Watershed and Delta

San Joaquin River Restoration Program Restoration Oversight Team
Technical review and oversight of development a comprehensive plan to restore the San Joaquin River and reestablish salmonid fishes in the reach from the Merced River to Friant Dam

PROFESSIONAL AFFILIATIONS

American Association for the Advancement of Science
American Association of University Women
American Fisheries Society (President, California-Nevada Chapter, 2004-2005)
Union of Concerned Scientists

PUBLICATIONS

Peer-reviewed articles

White, D. K., C. Swanson, P. S. Young, J. J. Cech, Jr., Z. Chen, and M. L. Kavvas. 2007. Close encounters with a fish screen II: delta smelt behavior before and during screen contact. *Transactions of the American Fisheries Society* (in press).

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Viability of threatened and endangered Chinook salmon and steelhead ESUs in the Sacramento-San Joaquin basin. *San Francisco Estuary and Watershed Science* (in press).

Lindley, S. T., R. S. Schick, A. Agrawal, M. Goslin, T. E. Pearson, E. Mora, J. J. Anderson, B. P. May, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2006. Historical population structure of Central Valley steelhead and alteration by dams. *San Francisco Estuary and Watershed Science.* Volume 4, Issue 1, Article 3. Available at: http://repositories.cdlib.org/jmie/sfews/vol4/iss1/art3.

Swanson. C. P. S. Young, and J. J. Cech, Jr. (2005) Close encounters with a fish screen: integrating physiological and behavioral results to protect endangered species in exploited ecosystems. *Transactions of the American Fisheries Society* 134:1111-1123.

Young, P. S., C. Swanson, and J. J. Cech, Jr. (2004) Photophase and illumination effects on the swimming performance and behavior of five California estuarine fishes. *Copeia* 2004(3):479-487.

Swanson. C. P. S. Young, and J. J. Cech, Jr. (2004) Swimming in two-vector flows: performance and behavior of juvenile Chinook salmon near a simulated screened water diversion. *Transactions of the American Fisheries Society* 133:265-278.

Swanson, C., D. B. Antonio, P. S. Young, J. J. Cech, Jr., and R. P. Hedrick (2002) Reduced swimming performance in delta smelt infected with *Mycobacterium* spp. *Journal of Fish Biology* 61:1012-1020.

Swanson, C., T. Reid, P. S. Young, and J. J. Cech, Jr. (2000) Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced wakasagi (*H. nipponensis*) in an altered California estuary. *Oecologia* 123:384-390.

Antonio, D. B., Swanson, C., Cech, J. J., Jr., Mager, R. C., Doroshov, S., and Hedrick, R. P. (2000) Prevalence of *Mycobacterium* spp. in wild and captive delta smelt. *California Fish and Game* 86:233-243.

Swanson, C. (1998) Interactive effects of salinity on metabolic rate, activity, growth and osmoregulation in the euryhaline milkfish (*Chanos chanos*). *Journal of Experimental Biology* 201:3355-3366.

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1998) Swimming performance of delta smelt: maximum performance, and behavioral and kinematic limitations on swimming at submaximal velocities. *Journal of Experimental Biology* 201:333-345

Swanson, C. (1996) Early development of the milkfish, *Chanos chanos*: effects of salinity on embryonic and larval metabolism, yolk absorption, and growth. *Journal of Fish Biology* 48:405-421.

Swanson, C., R. Mager, S. I. Doroshov, and J. J. Cech, Jr. (1996) Use of salts, anesthetics, and polymers to minimize handling and transport mortality in delta smelt. *Transactions of the American Fisheries Society* 125:326-329.

Bradford, D. F., C. Swanson, and M. S. Gordon (1994) Effects of low pH and aluminum on amphibians at high elevation in the Sierra Nevada, California. *Canadian Journal of Zoology* 72:1272-1279.

Bradford, D. F., C. Swanson, and M. S. Gordon (1993) Effects of low pH and aluminum on two declining species of amphibians in the Sierra Nevada, California. *Journal of Herpetology* 26:369-377.

Walsh, W. A., C. Swanson, and C.-S. Lee (1991) Combined effects of temperature and salinity on embryonic development and hatching of striped mullet, *Mugil cephalus*. *Aquaculture* 97:281-289.

Walsh, W. A., C. Swanson, and C.-S. Lee (1991) Effects of development, temperature and salinity on metabolism in eggs and yolksac larvae of milkfish, *Chanos chanos*. *Journal of Fish Biology* 39:115-125.

Walsh, W. A., C. Swanson, C.-S. Lee, J. Banno, and H. Eda (1989) Oxygen consumption by eggs and larvae of striped mullet, *Mugil cephalus*, in relation to development, salinity and temperature. *Journal of Fish Biology* 35:347-358.

Books, book chapters, and proceedings

Hayes, D. E., S. D. Mayr, M. L. Kavvas, Z. Q. Chen, E. Velagic, A. Karakas, H. Bandeh, E. C. Dogrul, J. J. Cech, Jr., C. Swanson, and P. S. Young. (2000) Fish screen velocity criteria development using a screened, circular swimming channel. In *Advances in Fish Passage Technology, Engineering Design and Biological Evaluation*, (M. Odeh, ed.), pp. 137-147. American Fisheries Society: Bethesda, MD.

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1998) Swimming behavior of delta smelt in multi-vector flow regimes: applications to fish screens. In *Fish Performance Studies*, (D. MacKinlay, K. Howard, and J. J. Cech, Jr., eds.), pp. 115-119. American Fisheries Society, Physiology Section: Bethesda, MD.

Swanson, C., P. S. Young, and D. MacKinlay (1996) *Applied Environmental Physiology of Fishes Symposium Proceedings*. International Congress on the Biology of Fishes, San Francisco State University, July 14-18, 1996. Physiology Section, American Fisheries Society, Bethesda, MD. 232 pp.

Swanson, C., J. J. Cech, Jr., and R. Piedrahita (1996) *Mosquitofish: Biology, Culture, and Use in Mosquito Control*. University of California Mosquito Research Program and Mosquito and Vector Control Association of California. 88 pp.

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1996) Swimming studies on an estuarine fish: Are performance indices the best tool to develop flow management criteria? In *Applied Environmental Physiology of Fishes Symposium Proceedings*, (C. Swanson, P. S. Young, and D. MacKinlay, eds.), pp. 83-91. American Fisheries Society, Physiology Section: Bethesda, MD.

Newsletter Articles, Technical and Public Outreach Reports

Swanson, C. A. Pawley, P. Vorster, and G. Bobker (2005) The Ecological Scorecard – 2005 San Francisco Bay Index. The Bay Institute, CA. 31 pp. (available at: http://bay.org/ecological_scorecard.htm)

Swanson, C. (2004) The Year in Water 2003. The Bay Institute, CA. 36 pp. (available at: http://bay.org/ecological_scorecard.htm)

Swanson, C. A. Pawley, P. Vorster, and G. Bobker (2003) The Ecological Scorecard – 2003 San Francisco Bay Index. The Bay Institute, CA. 102 pp. (available at: http://bay.org/ecological_scorecard.htm)

Swanson, C. (2002) The Second Annual State of the Environmental Water Account Report. The Bay Institute, CA. 25 pp. (available at: http://bay.org/news.htm)

Swanson, C. (2001) The First Annual State of the Environmental Water Account Report. The Bay Institute, CA. 33 pp. (available at: http://bay.org/news.htm)

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1998) Swimming performance, behavior, and physiology of Delta fishes in complex flows near a fish screen: biological studies using the fish treadmill. Interagency Ecological Program for the Sacramento-San Joaquin Estuary Newsletter. 11(4):38-42.

Frink, T., C. Swanson, P. S. Young, B. Fujimura, S. Mayr, J. J. Cech, Jr., and M. L. Kavvas (1998) UC Davis fish treadmill investigations update. Interagency Ecological Program for the Sacramento-San Joaquin Estuary Newsletter. 11(4):37-38.

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1998) Performance, behavior, and physiological responses of Delta fishes in two-vector flows in a fish treadmill. Part 3. Biological studies using the fish treadmill. Final Report, California Department of Water Resources. 59 pp.

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1998) Performance, behavior, and physiological responses of Delta fishes in two-vector flows in a fish treadmill. Part 4. Quality assurance project plan. Final Report, California Department of Water Resources. 160 pp.

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1997) Swimming performance and behavior of delta smelt: maximum velocities, endurance, and kinematics in a laminar flow swimming flume. Final Report, California Department of Water Resources. 67 pp.

Swanson, C., P. S. Young, and J. J. Cech, Jr. (1996) Swimming performance of delta smelt. Interagency Ecological Program for the Sacramento-San Joaquin Estuary Newsletter. 9(3):23-25.

Young, P. S., C. Swanson, and J. J. Cech, Jr. (1996) Can delta smelt swim in the dark? Interagency Ecological Program for the Sacramento-San Joaquin Estuary Newsletter. 9(3):22-23.

Swanson, C. and J. J. Cech, Jr. (1995) Temperature and salinity tolerances of the delta smelt. Interagency Ecological Program for the Sacramento-San Joaquin Estuary Newsletter 8(4):27-29.

Swanson, C. and J. J. Cech, Jr. (1995) Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report, California Department of Water Resources. 71 pp.

Swanson, C. (1993) Tough times for the delta smelt. *Tideline* 13:1-3. U. S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge, Newark, CA.

RECENT SELECTED PRESENTATIONS

Swanson. C.*, B. Herbold, and S. Siegel. Plotting the course for delta ecosystem restoration: evaluating and prioritizing restoration actions in a changing landscape. 2006 CALFED Science Conference, Oct. 23-25, 2006, Sacramento, CA.

Swanson, C.*, A. Pawley, P. Vorster, and G. Bobker. Measure for measure: development of an ecological scorecard to track and evaluate the health of the San Francisco Bay Estuary. Annual Meeting, American Fisheries Society, September 10-14, 2006, Lake Placid, NY.

Swanson, C.* and A. Pawley. Assessing Chinook salmon population status using a multi-metric index. Pacific Salmonid Recovery Conference, February 15-17, 2006, Seattle, WA.

Swanson, C.*, S. N. Chun, L.T. Kanemoto, A. Kawabata, T. MacColl, P. S. Young, J. J. Cech, Jr., and D. B. Odenweller. Integrating multiple datasets to estimate entrainment loss of fishes. CALFED Science Conference, October 4-6, 2004, Sacramento, CA.

Swanson, C.*, A. Pawley, P. Vorster, and G. Bobker. Fish and fish communities as indicators of ecosystem health: a chapter in the Ecological Scorecard for San Francisco Bay. Annual Meeting, American Fisheries Society, August 22-24, 2004, Madison, WI.

Swanson, C.*, P.S. Young, J. J. Cech, Jr. Close encounters with a fish screen: use of physiological and behavioral responses to develop regulatory criteria to protect endangered species. Annual Meeting, American Fisheries Society, August 22-24, 2004, Madison, WI.

Swanson, C.*, P.S. Young, J. J. Cech, Jr,, R. Wantuck, and D. Odenweller. Performance and behavior of juvenile Chinook salmon near a fish screen: linking laboratory and field studies. 2003. Annual Meeting, American Fisheries Society, Western Division, April 15-17, 2003. San Diego, CA.

Swanson, C. Irreconcilable differences? The increasing divorce of water from fish. Annual Meeting of the California-Nevada Chapter of the American Fisheries Society, April 18-20, 2002, Tahoe City, CA. (invited presentation)

Swanson, C.* and G. Bobker. New approaches to water management and fisheries protection in the estuary: evaluating CALFED's Environmental Water Account. State of the Estuary Conference, October 9-11, 2001, San Francisco, CA.

Swanson, C.*, P. S. Young, and J. J. Cech, Jr. Development of fish screen criteria using the Fish Treadmill. CALFED Science Conference, October 3-5, 2000, Sacramento, CA.

Swanson, C.*, P. S. Young, and J. J. Cech, Jr. Comparative vulnerability of endangered fishes to a fish screen. International Congress on the Biology of Fishes, July 23-27, 2000, Aberdeen, Scotland.

Swanson, C.*, T. Reid, P. S. Young, and J. J. Cech, Jr. Comparative environmental tolerances of threatened delta smelt and introduced wakasagi: implications for delta smelt protection. American Fisheries Society, California-Nevada Chapter, Annual Meeting, March 25-27, 1999, Redding, CA.

Swanson, C.*, P. S. Young, and J. J. Cech, Jr. Swimming behavior of delta smelt in complex flows: applications for fish screens. Bay Area Conservation Biology Symposium, February 6, 1999, Berkeley, CA.

Swanson, C.*, P. S. Young, and J. J. Cech, Jr. Swimming behavior of splittail in multi-vector flows near a fish screen. American Association for the Advancement of Science, Annual Meeting January 21-26, 1999, Anaheim, CA.

Swanson, C.*, P. S. Young, and J. J. Cech, Jr. Swimming behavior of delta smelt in multi-vector flows: applications to fish screens. International Congress on the Biology of Fishes, Fish Performance Studies Symposium, July 26-30, 1998, Towson University, Baltimore, MD.

Swanson, C.*, P. S. Young, S. Mayr, and J. J. Cech, Jr. Velocity and group effects on delta smelt swimming performance and behavior. American Fisheries Society, Annual Meeting, Monterey, CA, August 24-28, 1997.

Swanson, C.* and J. J. Cech, Jr. Use of physiological studies to assess habitat requirements and management guidelines for a threatened estuarine fish, the delta smelt. Western Society of Naturalists, Annual Meeting, Monterey, CA, December 27-30, 1994.

* = presenter for co-authored papers

APPENDIX 2

TO SWANSON DECLARATION

Recommended Interim Protection Actions for Delta Smelt

(To be implemented from August 2007 until completion of the new USFWS Biological Opinion)

Monitoring Actions							
Action #	**Timing**	**Life Stage**	**Trigger(s)**	**Action**	**End of Action**	**Objective**	**Source and Rationale**
1	Year-round as relevant to specific survey	all	none	Continue to fully implement all CDFG surveys for delta smelt, including (but not limited to) the FWMT, Summer TNS, Spring Kodiak, and 20-mm surveys	none	Provide information on abundance and distribution of delta smelt	Continuation of ongoing monitoring programs is essential to ability to assess delta smelt abundance and distribution within their critical habitat
2	December-July	all	1) Increase in Delta outflow by: a) increase in Sac River flow at Freeport to 25,000 cfs; or b) increase in San Joaquin River outflow by >10 % over three days (DSWG notes 10/10/06 and 12/11/06); or 2) FMWT and/or Kodiak survey data on delta smelt distribution indicating fish moving upstream of the confluence and into the Delta; or 3) by January 15 (same DSWG notes); whichever comes first.	Increase frequency of sampling for entrained fish at the CVP fish protective facilities to a minimum of 25% of the time (e.g., a minimum of a 15 min count every 1 h)	June 15 or a minimum of 5 days after the last detection of larval or juvenile delta smelt at the either the SWP or CVP fish protective facilities by either the salvage or larval monitoring program, whichever comes last.	Improve detection of delta smelt entrained into the CVP facilities.	Current sampling frequency at CVP (approximately 8% of time, or 1/12 of the time) has a low level of detection and given current low population abundance of delta smelt is likely to fail to detect delta smelt when they are in fact present and being salvaged.

Action #	Timing	Life Stage	Trigger(s)	Action	End of Action	Objective	Source and Rationale
3	January-May	Larval and young juvenile delta smelt	Onset of spawning as determined by: 1) Kodiak survey data of maturation stage of delta smelt or presence of "spent" delta smelt in survey samples; or 2) Delta water temperature >12ºC (i.e., within the 12-18ºC spawning temperature range); or 3) detection of larval delta smelt in the 20-mm survey or at the SWP and CVP fish salvage facilities (see Monitoring Actions); whichever comes first.	Implement monitoring program for detection of larval delta smelt (i.e., delta smelt <20 mm in length) at both the SWP and CVP fish protective facilities. Sampling should be conducted at a minimum of four times daily, evenly spaced in time during both the day and the night.	June 15 or a minimum of 5 days after the last detection of larval or juvenile delta smelt at the either the SWP or CVP fish protective facilities by either the salvage or larval monitoring program, whichever comes last.	Detect presence of larval delta smelt smaller than 20 mm in length at the SWP and CVP facilities.	Recent research by Dr. W. Bennett suggests that entrainment loss of larval and small juvenile delta smelt is contributing to the population decline. Current sampling at the SWP and CVP neither detects nor reports loss of fish smaller than 20 mm in length. A sampling program for these smaller fish is essential to increase detection of small delta smelt in the southern Delta, improve information on delta smelt distribution during this critical life stage, and trigger changes in water project operations to protect the species.

Water Project Operations Actions							
Action #	**Timing**	**Life Stage**	**Trigger(s)**	**Action**	**End of Action**	**Objective**	**Source and Rationale**
4	Winter (December 25-February)	Pre-spawning adult delta smelt	1) Increase in Delta outflow by: a) increase in Sac River flow at Freeport to 25,000 cfs; or b) increase in San Joaquin River outflow by >10 % over three days (DSWG notes 10/10/06 and 12/11/06); or 2) FMWT and/or Kodiak survey data on delta smelt distribution indicating fish moving upstream of the confluence and into the Delta; or 3) by January 15 (same DSWG notes); whichever comes first.	1) Following trigger event #1, restrict export increases during wintertime pulse flow events to levels that avoid negative flows on Old and Middle Rivers (i.e., ≥0 cfs, 5-day average) for a minimum of 10 days following trigger event #1 and then modify water project operations to achieve combined Old and Middle River flows of >-3500 cfs (5-day average); or 2) If action triggered by #2 or #3, manage water project operations to achieve combined Old and Middle River flows of >-3500 cfs (5-day average).	Onset of spawning as determined by: 1) Kodiak survey data of maturation stage of delta smelt or presence of "spent" delta smelt in survey samples; or 2) Delta water temperature >12ºC (i.e., within the 12-18ºC spawning temperature range); whichever comes first.	Prevent and/or reduce lethal entrainment of pre-spawning delta smelt.	This protective action is based on analyses and protective actions developed by the DSWG (10/10/06 and 12/11/06 notes) and incorporated by CDWR in their Pelagic Fish Action Plan (March 2007). The recommended Old and Middle River flow of >-3500 cfs is: a) equal to the lower end of the range of negative flows recommended by the DSWG (12/11/06 notes); b) the lower end of the range of negative flows specified in the Pelagic Fish Action Plan; and c) higher (i.e., less negative, more protective) than average negative flows measured during January and February during the 1999-2005, 2007 period (Figure 9).

Action #	Timing	Life Stage	Trigger(s)	Action	End of Action	Objective	Source and Rationale
5	Late Winter-Spring (February-April 15)	Spawning adult, larval, and young juvenile delta smelt	Onset of spawning as determined by: 1) Kodiak survey data of maturation stage of delta smelt or presence of "spent" delta smelt in survey samples; or 2) Delta water temperature >12ºC (i.e., within the 12-18ºC spawning temperature range); or 3) detection of larval delta smelt in the 20-mm survey or at the SWP and CVP fish salvage facilities (see Monitoring Actions); whichever comes first.	Manage water project operations to achieve combined Old and Middle River flows of >-1500 cfs (5-day average).	April 15 or the start date of the Vernalis Adpative Management Program (VAMP).	Prevent and/or reduce lethal entrainment of spawning adult, larval and young juvenile delta smelt; facilitate transport of larval and juvenile delta smelt downstream from Delta channels to the confluence and Suisun Bay	This protective action is based on: a) results of analyses by Dr. W. Bennett that showed that only delta smelt hatched during the VAMP survived to the summer and fall; and b) average Old and Middle River flows measured during the VAMP for the 199-2005, and 2007 period (average=-1515 cfs) (Figure 9). It is similar to the protection action to moderate or eliminate Old and Middle negative flows prior to the VAMP identified in CDWR's Pelagic Fish Action Plan.

Action #	Timing	Life Stage	Trigger(s)	Action	End of Action	Objective	Source and Rationale
6	April 15 – May 15, or as specified by VAMP technical Team	Larval and juvenile delta smelt	Beginning of VAMP	Implement the Vernalis Adpative Management Plan (VAMP) San Joaquin River flow enhancement and SWP and CVP export curtailment as specified under the VAMP experimental design.	End of VAMP	Prevent and/or reduce lethal entrainment of larval and young juvenile delta smelt; facilitate transport of larval and juvenile delta smelt downstream from Delta channels to the confluence and Suisun Bay	This protective action is based on results of analyses by Dr. W. Bennett that showed that only delta smelt hatched during the VAMP survived to the summer and fall. Implementation of the San Joaquin River flow enhancement component of VAMP is presently required under the SWRCB's water quality objectives for fish and wildlife beneficial uses (SWRCB 1995)

Action #	Timing	Life Stage	Trigger(s)	Action	End of Action	Objective	Source and Rationale
7	Late Spring -Early Summer (May 15, or end of VAMP – June)	Larval and young juvenile delta smelt	End of VAMP	Manage water project operations to achieve combined Old and Middle River flows levels >-1500 cfs (5-day average).	June 15 or a minimum of 5 days after the last detection of larval or juvenile delta smelt at the either the SWP or CVP fish protective facilities by either the salvage or larval monitoring program, whichever comes last.	Prevent and/or reduce lethal entrainment of larval and young juvenile delta smelt; facilitate transport of larval and juvenile delta smelt downstream from Delta channels to the confluence and Suisun Bay	This protective action is based on: a) results of analyses by Dr. W. Bennett that showed that only delta smelt hatched during the VAMP survived to the summer and fall; and b) average Old and Middle River flows measured during the VAMP for the 1999-2005, and 2007 period (average=-1515 cfs) (Figure 9). This protective action to moderate Old and Middle River negative flows after the VAMP is similar to that recommended by the DSWG in 2007.

Action #	Timing	Life Stage	Trigger(s)	Action	End of Action	Objective	Source and Rationale
8	Late Winter - Early Summer (December-June)	Spawning adult, larval, and young juvenile delta smelt	Onset of spawning as determined by: 1) Kodiak survey data of maturation stage of delta smelt or presence of "spent" delta smelt in survey samples; or 2) Delta water temperature >12ºC (i.e., within the 12-18ºC spawning temperature range); or 3) detection of larval delta smelt in the 20-mm survey or at the SWP and CVP fish salvage facilities (see Monitoring Actions); whichever comes first.	Prohibit installation or tidal operation of the three south Delta agricultural barriers	June 15 or a minimum of 5 days after the last detection of larval or juvenile delta smelt at the either the SWP or CVP fish protective facilities by either the salvage or larval monitoring program; whichever comes last.	Prevent and/or reduce lethal entrainment of larval and young juvenile delta smelt; facilitate transport of larval and juvenile delta smelt downstream from Delta channels to the confluence and Suisun Bay	This protective action is based on results of particle tracking modeling results that show that tidal operation of the south Delta agricultural barriers increases entrainment of particles into the SWP and CVP under a range of water project operational levels (DSWG notes, 10/30/06, 1/11/07). This protective action is nearly identical to that identified by CDWR in the Pelagic Fish Action Plan and recommended by the DSWG in 2007.

Action #	Timing	Life Stage	Trigger(s)	Action	End of Action	Objective	Source and Rationale
9	Late Winter-Early Summer	Spawning adult, larval, and young juvenile delta smelt	Onset of spawning as determined by: 1) Kodiak survey data on delta smelt maturation stage; 2) Delta water temperature >12ºC (i.e., in the 12-18ºC spawning temperature range; or 3) detection of larval delta smelt in the 20-mm survey or at the SWP and CVP fish salvage facilities (see Monitoring Actions); whichever comes first.	Prohibit installation of the Head of Old River Barrier	June 15 or a minimum of 5 days after the last detection of larval or juvenile delta smelt at the either the SWP or CVP fish protective facilities by either the salvage or larval monitoring program, whichever comes last.	Improve Old and Middle River downstream flows; prevent and/or reduce lethal entrainment of larval and young juvenile delta smelt; facilitate transport of larval and juvenile delta smelt downstream from Delta channels to the confluence and Suisun Bay	This protective action is based on results of hydrodynamic modeling and empirical Delta channel flow observations that show that installation of the Head of Old River Barrier exacerbates reverse flow conditions in Old and Middle River, and USGW analyses that show that take of delta smelt at the SWP and CVP facilities is directly related to the magnitude of reverse flows on Old and Middle Rivers.

Action #	Timing	Life Stage	Trigger(s)	Action	End of Action	Objective	Source and Rationale
10	Fall (September-December)	Juvenile and sub-adult delta smelt	Location of X2 (as 14-day running average upstream of 80 km on September 1.	Manage water project operations to maintain Delta outflows at a minimum of 7500 cfs or maintain X2 (as 14-day running average) at downstream of 80 km, whichever requires less freshwater outflow.	December 15 or first winter pulse flow (see Action 1, trigger #1), whichever comes first.	Improve and protect habitat quality of delta smelt by increasing the volume and quality of low salinity habitat; shift the distribution of the delta smelt population further away from SWP and CVP-related sources of mortality (e.g., entrainment); reduce the abundance and upstream distribution of the invasive clam *Corbula* and resultant impacts of planktonic supply for delta smelt.	This protective action is based on results of research by Feyrer *et al.* (2007) that showed that reduced Delta outflow during the fall degraded delta smelt habitat quality; and results of research by Guerin *et al.* (2006) that showed that abundance of juvenile delta smelt was reduced following fall seasons in which Delta outflows were low and western Delta salinities were elevated (i.e., X2 shifted upstream); and results of research by USGS that showed that *Corbula* had become established further upstream in the estuary following years with reduced fall Delta outflows (J. Thompson, 2007 CALFED Science Program workshop on Variable Salinity in the Delta). It is similar to the summer-fall action identified by CDWR in the Pelagic Fish Action Plan.

Notes:
1. For all delta smelt protection actions, combined Old and Middle River flows are to be calculated as the 5-day average, as recommended by the DSWG (4/2/07 notes).