2006 BAY-DELTA PLAN
PHASE II UPDATE: WORKING DRAFT
SCIENTIFIC BASIS REPORT

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

DECEMBER 7, 2016

Staff Presentation

- Introduction and overview of Phase II Bay-Delta Plan Update and Working Draft Scientific Basis Report (Report)
- Use of science in the Report
- Delta outflows
- Sacramento River and Delta tributary inflows
- Coldwater habitat
- Interior Delta flows
- Next steps

Purpose of Workshop

- **Receive public input on the science (Report)**
- Provide overview of Phase II Bay-Delta Water Quality Control Plan (Bay-Delta Plan or Plan) process
- Provide overview of Working Draft Scientific Basis Report (Report)
- Written comments due noon December 16, 2016
- Phase II in early stages- there will be additional opportunities for public participation and comment as planning moves forward

Bay-Delta Plan

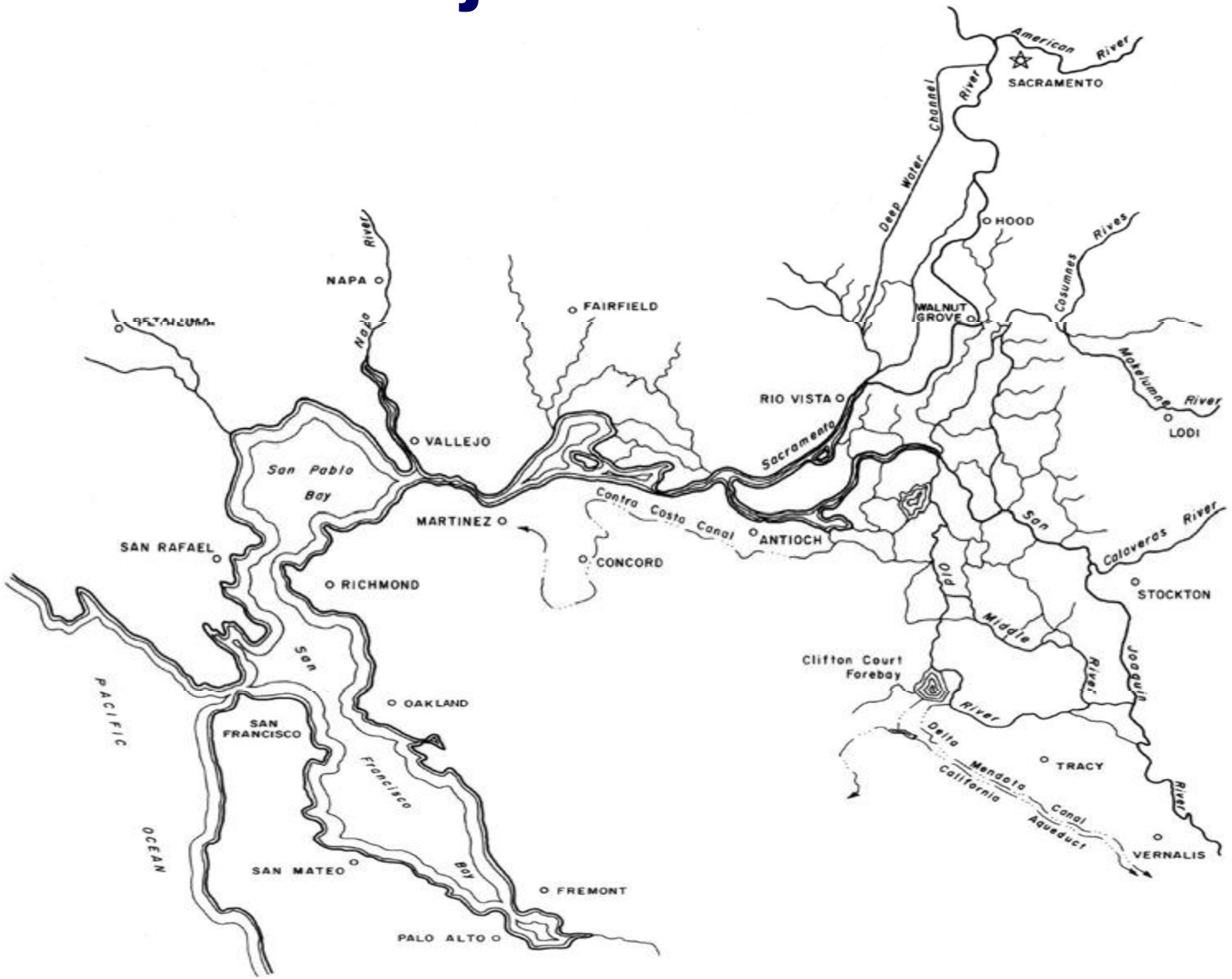
- Bay-Delta Plan: beneficial uses; water quality objectives to protect uses; program of implementation to achieve objectives: flow, water quality actions and other actions; and monitoring and evaluation
  - Last significant update 21 years ago in 1995
- Implementation of Bay-Delta Plan in 2000
  - Decision 1641 (D-1641): Board accepted agreements to implement portions of Bay-Delta Plan
  - Department of Water Resources and U.S. Bureau of Reclamation primarily responsible for implementation
  - Species have experienced significant declines and flows have generally declined over time

Update of the Bay-Delta Plan

- Phase I- separate process focused on San Joaquin River flows and southern Delta salinity
- Phase II- new and updated requirements to reasonably protect fish and wildlife including: Delta outflows; Sacramento River and tributary, and Delta eastside tributary inflows; cold water habitat; interior Delta flows
- Common components: adaptive management with budget of water approach using unimpaired flows, integration with nonflow measures, encouragement of settlements, balancing with competing uses of water

Phase II Project Area

***INCLUDES UPSTREAM AREAS**



Previous Events Informing Phase II

- 2006 Bay-Delta Plan identified fish and wildlife species declines as issue requiring review
- 2009 Period Review Staff Report adopted by Board identified need to update Delta outflows, interior Delta flows and related requirements in Bay-Delta Plan
- 2009 Water Action Plan directs Board to update Bay-Delta Plan to help achieve co-equal goals of Delta ecosystem protection and reliable water supply
- 2010 Delta Flow Criteria Report finds that "There is sufficient scientific information to support the need for increased flows to protect public trust resources…"
- 2009/2012 Notices of Preparation comments
- 2012, 2013 and 2014 State Water Board and Delta Science Program workshops

Phase II Process

- Working Draft Report
  - Update Report based on public comments, Delta Independent Science Board comments
- Health and Safety Code peer review
  - Update Report based on peer review
- Draft Substitute Environmental Document (SED) and proposed changes to Bay-Delta Plan released for public review and comment
  - Includes revised draft Report
- Final SED and proposed changes to Bay-Delta Plan released
- Board considers adoption of changes to Bay-Delta Plan and certification of SED

Purpose and Need for Update

- Bay-Delta ecosystem in a state of crisis
- No recovery of fish species since 1995 Bay-Delta Plan
- Existing regulations not: protective, even or comprehensive
- Existing outflows are inadequate:
  - Reductions in outflows of: average January-June ~60%, mean annual ~48%, and monthly more than 80% at times
  - Existing regulations would allow greater reductions in outflows
- Existing inflows are inadequate:
  - Up to 100% of inflows reduced at times on some tributaries
  - Many tributaries lack any requirements to address current flow needs and reductions in flows from future diversions
- Bay-Delta Plan lacks sufficient requirements to address cold water needs of fish and protect fish from entrainment

Why Focus on Flow?

- Scientific studies show that flow is major factor in survival of fish and aquatic organisms
- **Many benefits of flow:** improved growth and survival of native aquatic species by improving migration, water temperatures and other habitat conditions
- **Flow affects:** risk of disease, risk of predation, reproductive success, growth, smoltification, migration, feeding behavior, and other ecological factors
- Board has primary authority over flow and other agencies have authority to require non-flow measures which the Board will assist with

Phase II Regulatory Approach

- Comprehensive approach to protect Bay-Delta fish and wildlife throughout migratory range
  - Integration of regulations addressing inflows, outflows, and water project operations
- Strategy for timely action, flexibility, and integration with other planning, science, restoration, and regulatory efforts
  - Action can be taken before imperiled species in the watershed are no longer able to be restored
  - Actions can be tailored for specific needs and to integrate with other efforts

Phase II Recommendations

- Inflows and outflows work together
  - Unimpaired flow “budget of water” approach for inflows
  - Index of unimpaired flows for outflows (similar to existing index)
  - Unimpaired inflows of 35-75% and equivalent compatible index
  - Adaptive implementation to achieve functional flows, experiments and respond to new information and changing circumstances
- Coldwater habitat works with inflows and outflows
  - Provides for addressing existing impacts and avoid redirected impacts of new flows
- Interior Delta flows protect fish through the system
  - Provides for complete protection of fish and wildlife in a consistent and compatible manner with existing endangered species requirements

Working with Others

- Multi-facetted approach with flow and other measures needed to address ecological concerns
  - Report discusses other stressors but focuses on flow
  - Program of implementation will address other stressors more completely
- Board committed to collaborating and coordinating with other science, regulatory, and restoration efforts
  - Actions will inform adaptive management and future decisions regarding needed flows and operations
- Board encourages ongoing efforts to develop voluntary agreements
  - Meaningful and effective agreements can achieve greater more durable benefits in short and long term

Scientific Basis Report

- Chapter 1-Introduction and Summary of Findings
- Chapter 2-Hydrology
- Chapter 3-Flow and the Ecosystem, Species-Specific Analyses
- Chapter 4-Other Aquatic Ecosystem Stressors
- Chapter 5-Potential modifications to the Bay-Delta Plan

Scientific Proceedings Informing Phase II

- 2009 Periodic Report Staff Report
- 2010 Delta Flow Criteria Report
- State Water Board Workshops, Fall 2012
  - Ecosystem Changes and the Low Salinity Zone
  - Bay-Delta Fishery Resources
  - Analytical Tools for Evaluating the Water Supply, Hydrodynamic, and Hydropower Effects of the Bay-Delta Plan
- Delta Science Program workshops, 2013-2014
  - Fish Predation on Central Valley Salmonids
  - Delta Outflows and Related Stressors
  - Interior Delta Flows and Related Stressors

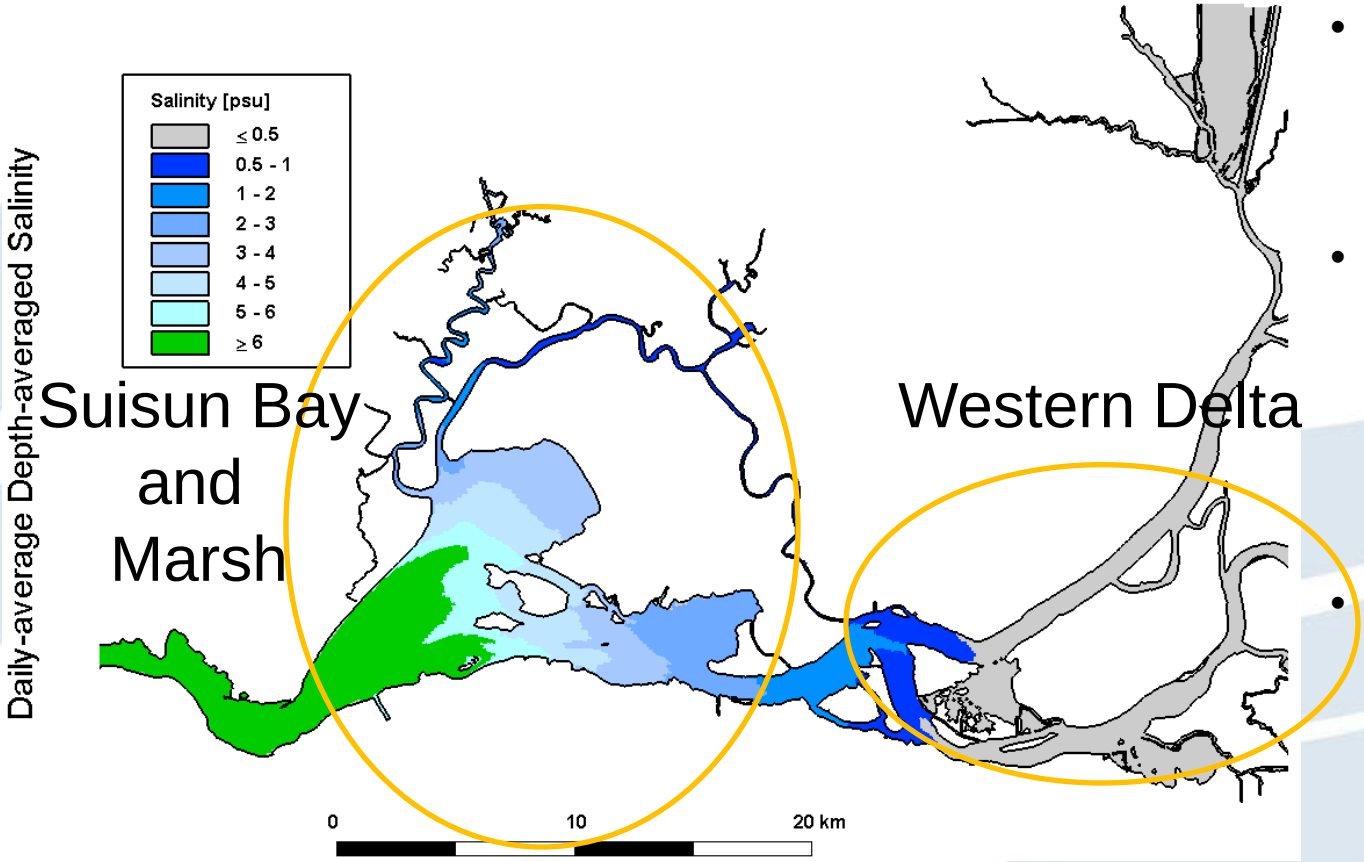
Scientific Information Used to Inform Flow Recommendations

- Ecological function-based analyses for desirable species and ecosystem attributes, for example
  - Physical responses to flow, including floodplain inundation, salinity conditions, turbidity, and geomorphic processes
  - Migration cues and transport flows
  - Knowledge of species characteristics and community ecology
- Statistical relationships between flow and species abundance or migration success
- Unimpaired flows and historical impaired flows that better supported native species
- Supported by most current science with references to literature and updated original analysis

Delta Outflow

- Western Delta and Suisun region
- Estuarine species have declined
- Delta outflow affects salinity
- Native species respond to Delta outflow and salinity
- Existing Delta outflow conditions and requirements
- Delta outflow recommendations

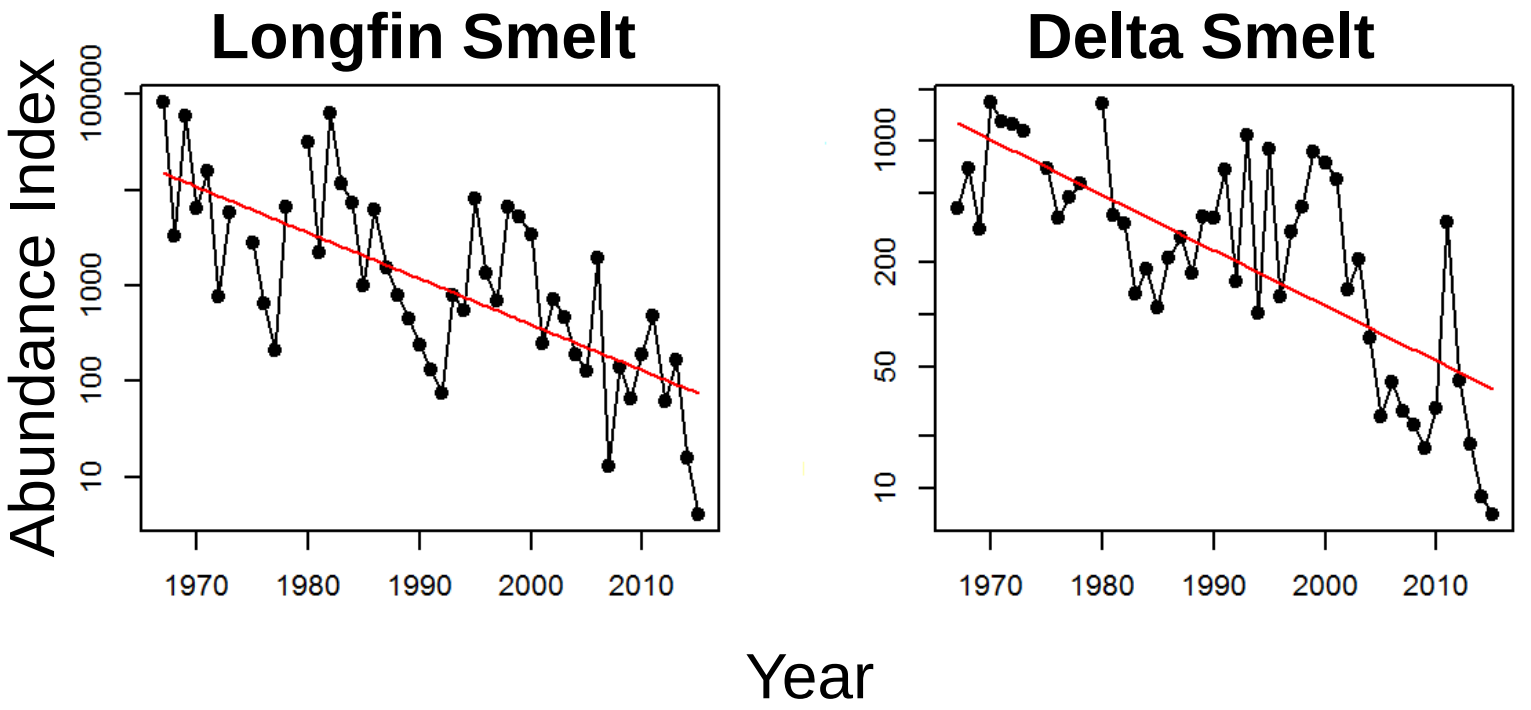
Western Delta and Suisun Region



- **Western Delta:** deep, confined channels, poor habitat
- **Suisun region:** shallow, broad, turbid, variable habitat connected to productive tidal marsh
- Habitat has <u>stationary</u> (geography) and <u>moving</u> (flow, water quality) elements

Figure modified from MacWilliams and Bever 2014 Low Salinity Zone Flip Book Version 2.0

Dramatic Declines of Estuarine Species



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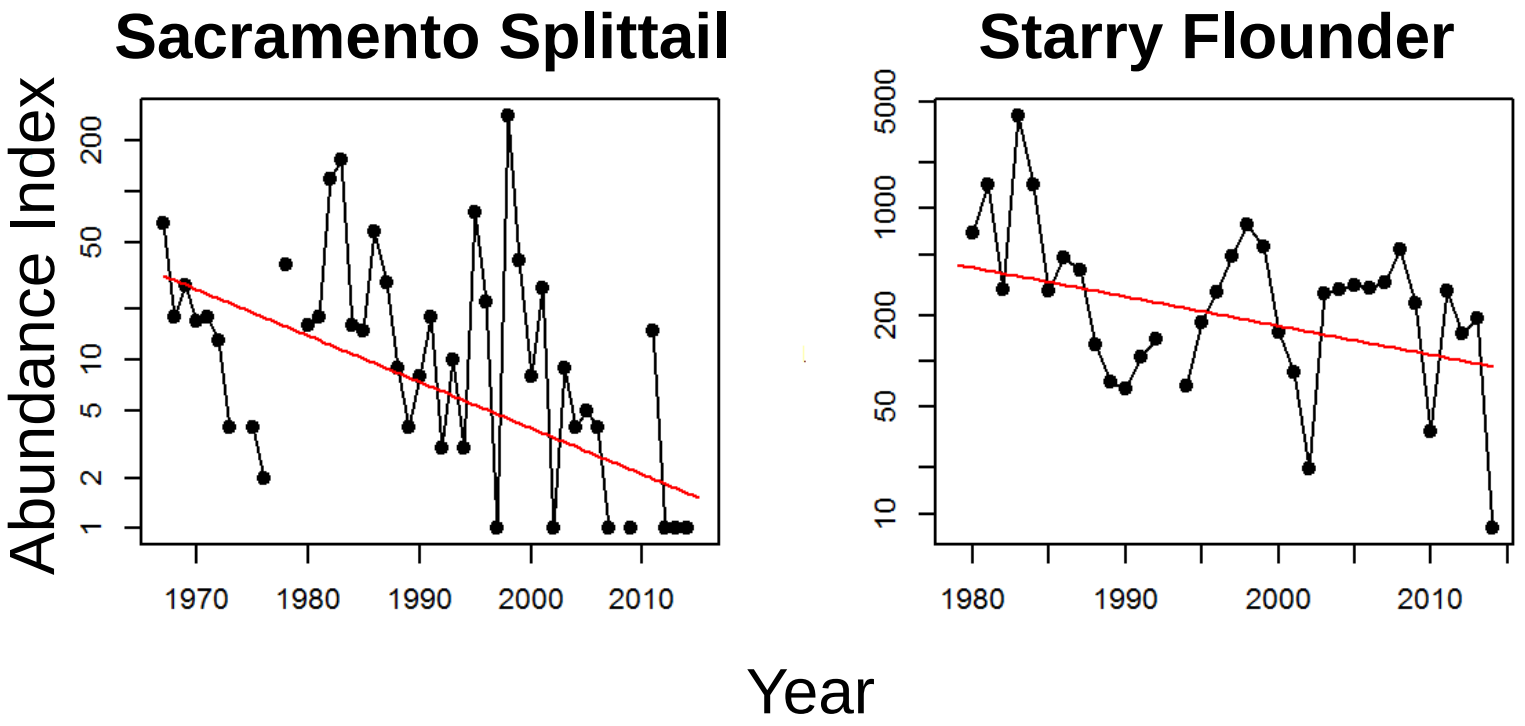
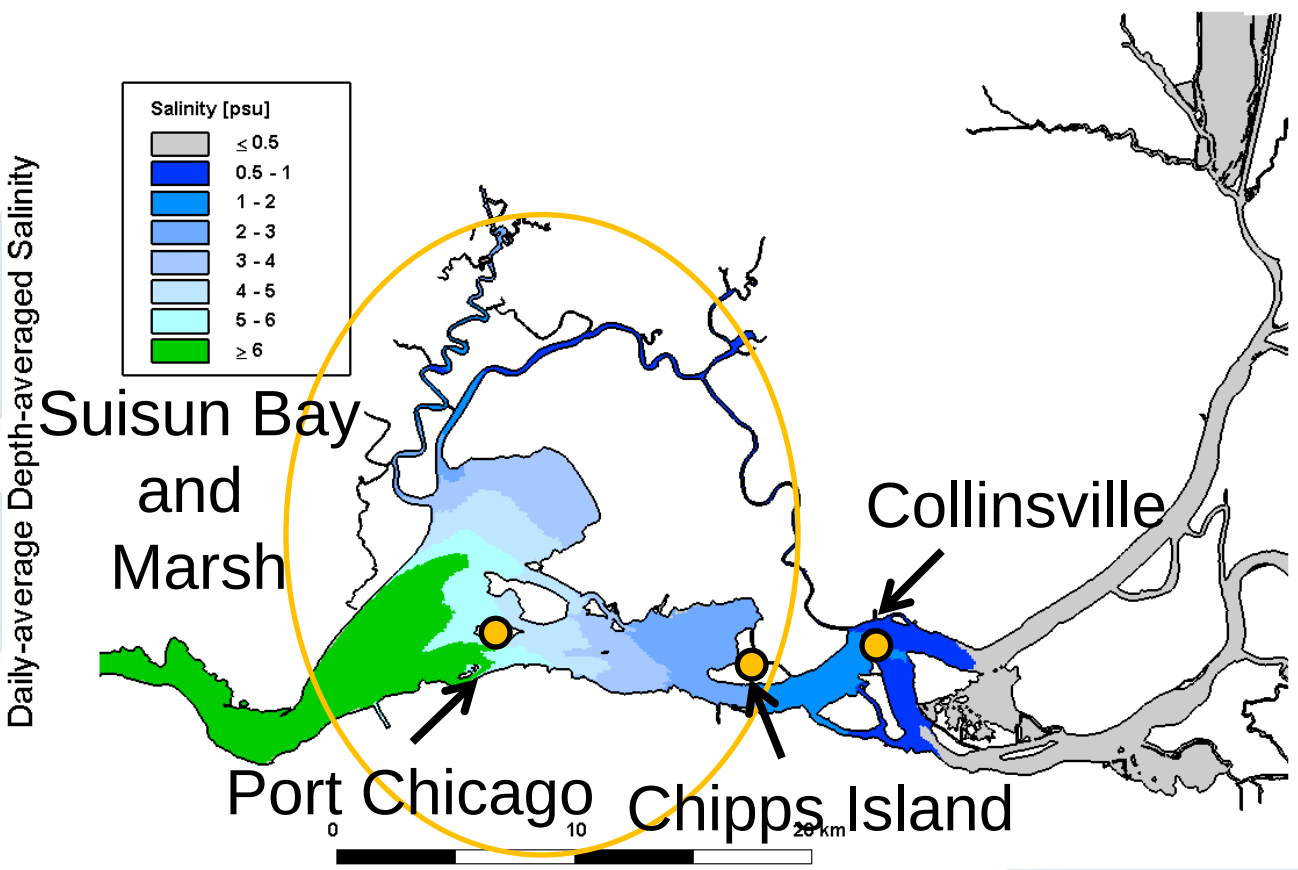


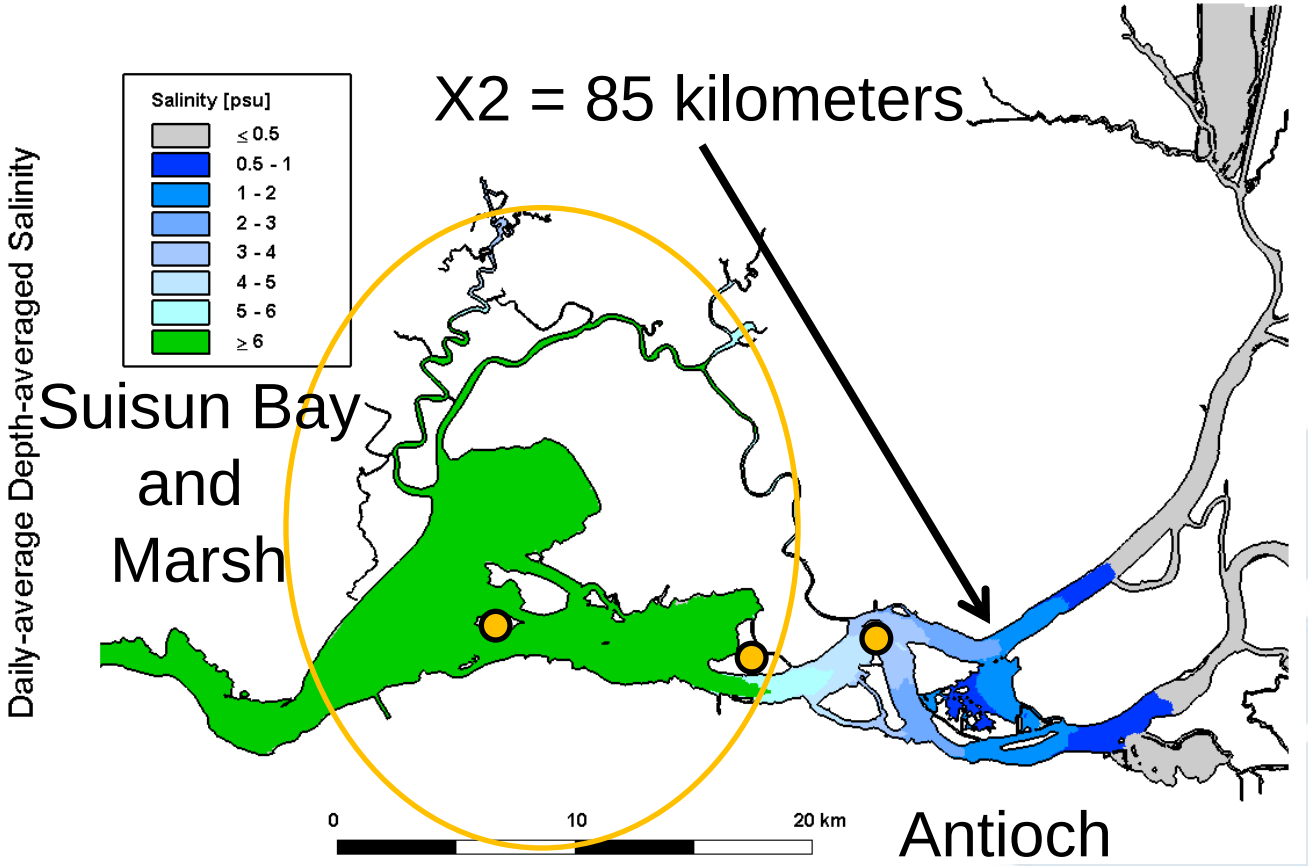
Delta Outflow affects Salinity (X2)



- **X2 =** distance from Golden Gate to salinity of 2 practical salinity units (psu)
- **More outflow =** lower X2 (further downstream)
- Index of estuary's response to freshwater flow
- Control points at Collinsville, Chipps Island, and Port Chicago

Figure modified from MacWilliams and Bever 2014
Low Salinity Zone Flip Book Version 2.0

Delta Outflow and Low Salinity Habitat



- X2 near Antioch
- Low salinity habitat (light to dark blue) confined to deep channels
- Poor conditions for native fish

Figure modified from MacWilliams and Bever 2014
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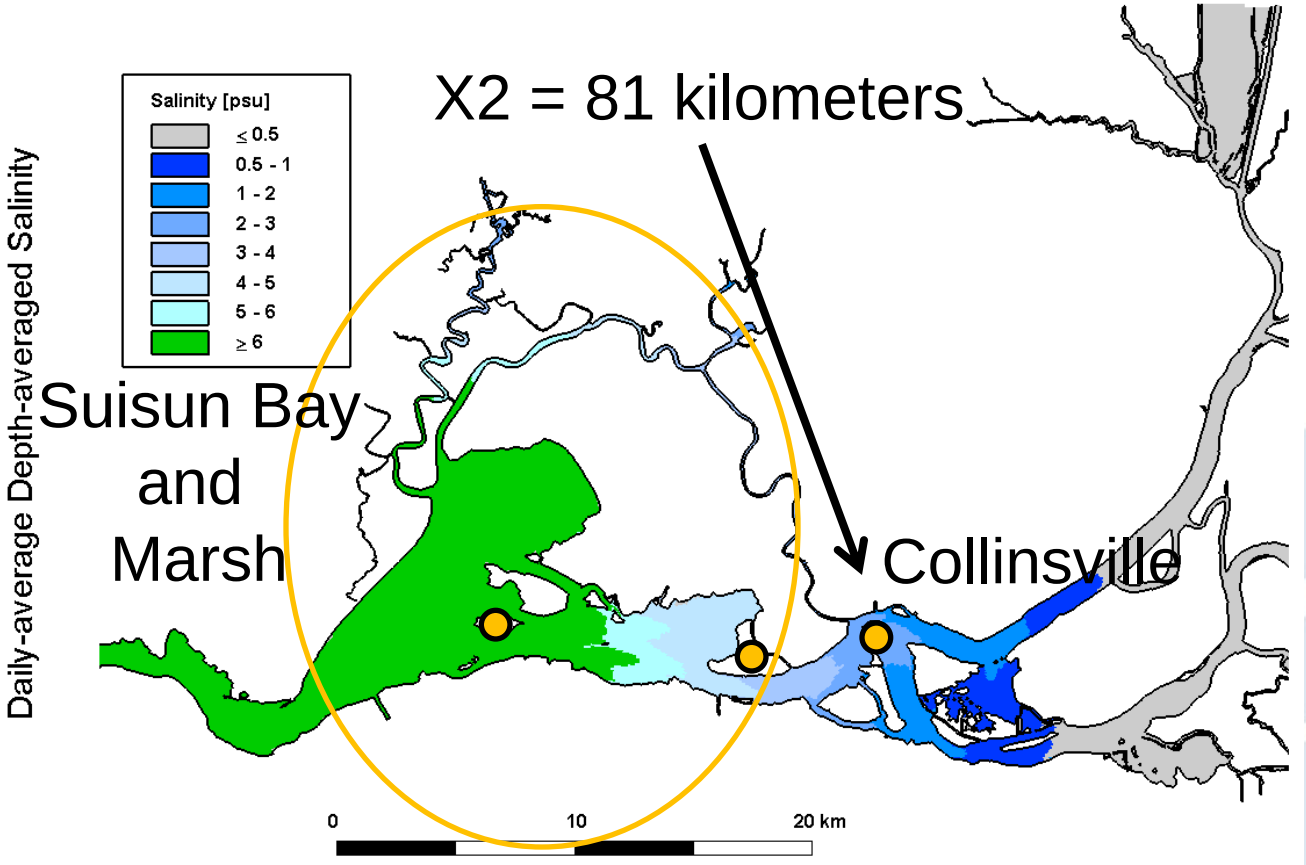
Delta Outflow and Low Salinity Habitat



- X2 near Collinsville
- Low salinity habitat (light to dark blue) begins to enter Suisun Bay
- Somewhat better conditions for native fish

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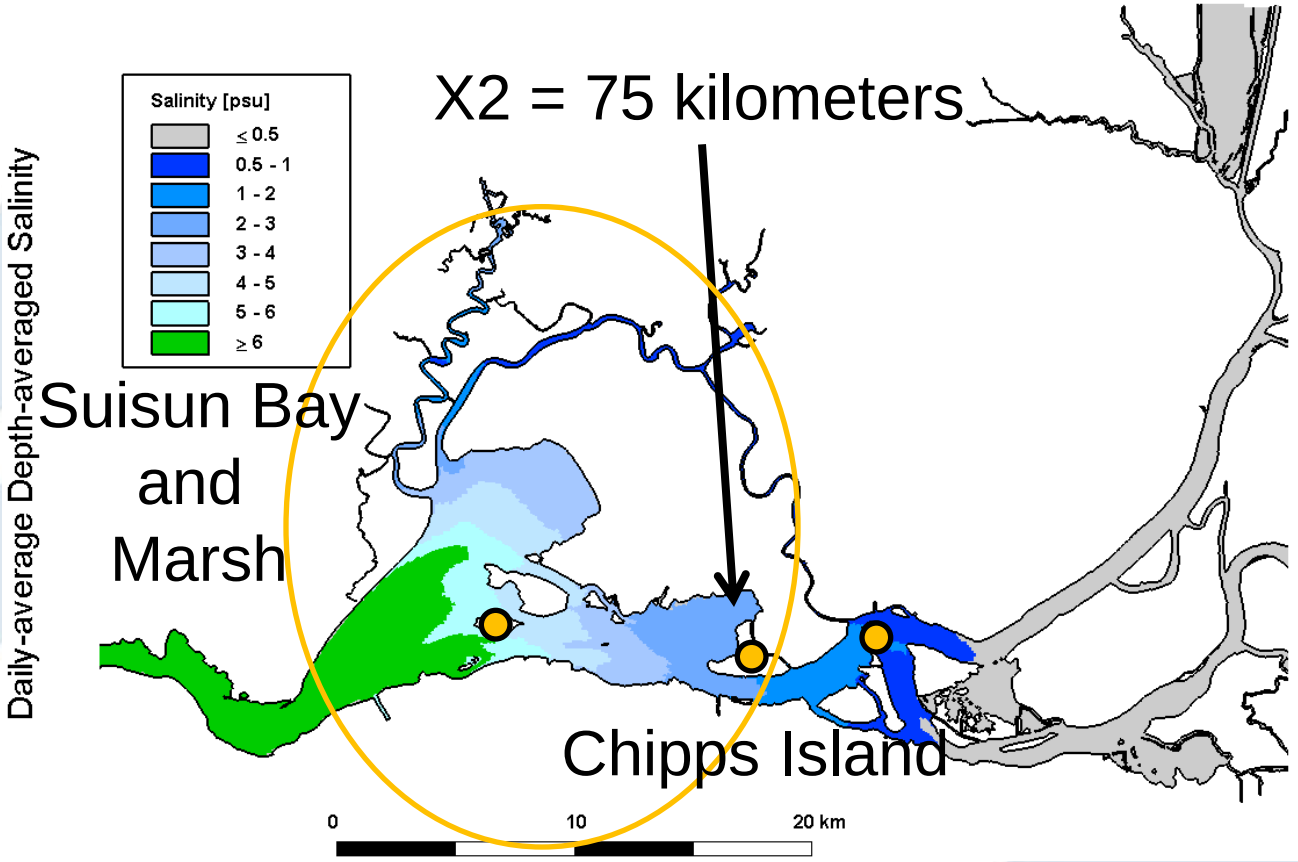
Delta Outflow and Low Salinity Habitat



- X2 near Chipps Island
- Low salinity habitat (light to dark blue) in much of Suisun Bay
- Better conditions for native fish

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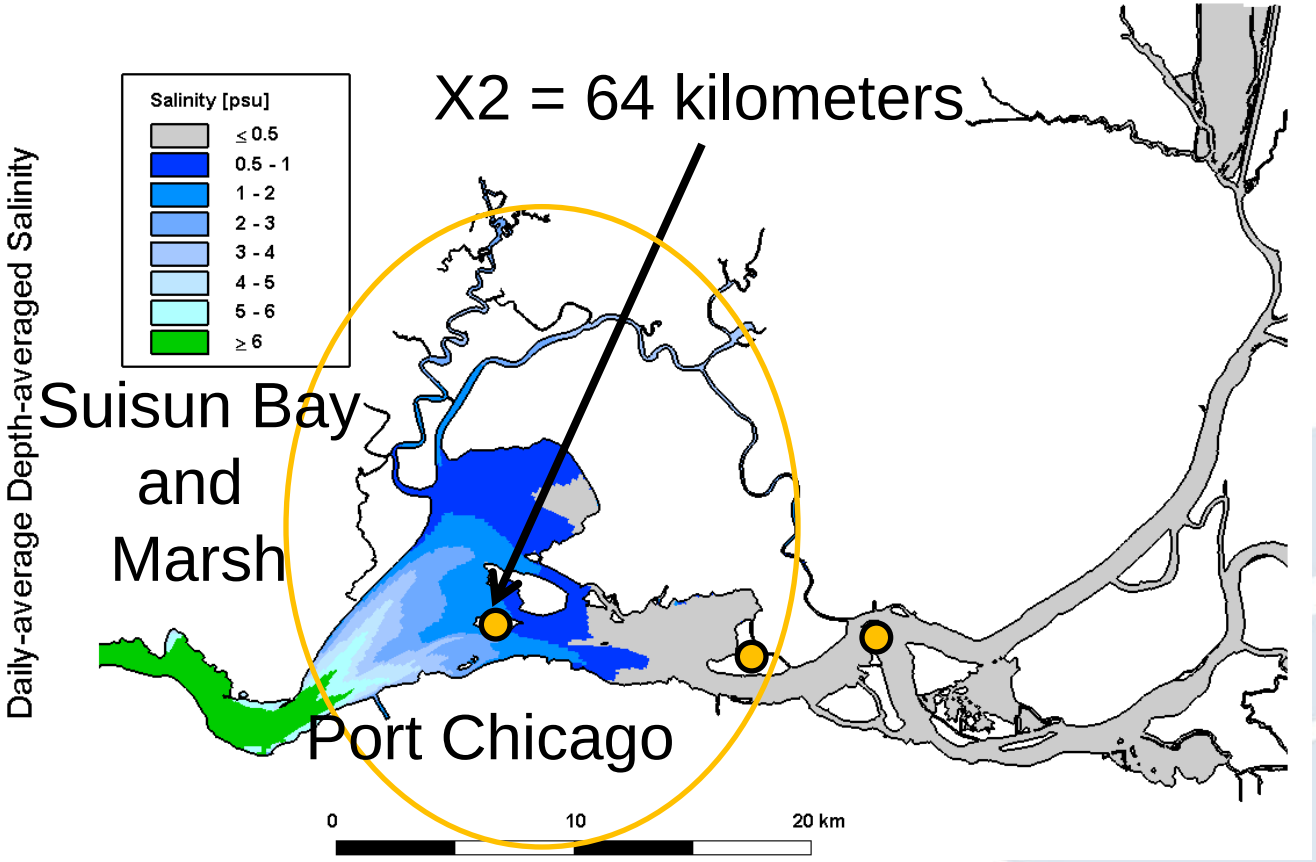
Delta Outflow and Low Salinity Habitat



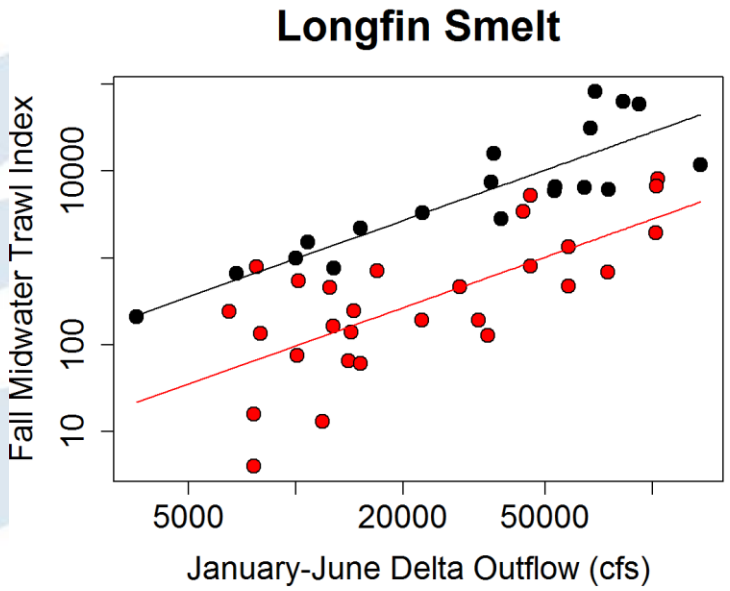
- X2 near Port Chicago
- Suisun Bay almost entirely low salinity to fresh
- Still better conditions for native fish

Figure modified from MacWilliams and Bever 2014
Low Salinity Zone Flip Book Version 2.0

Native Species Respond to Delta Outflow and X2

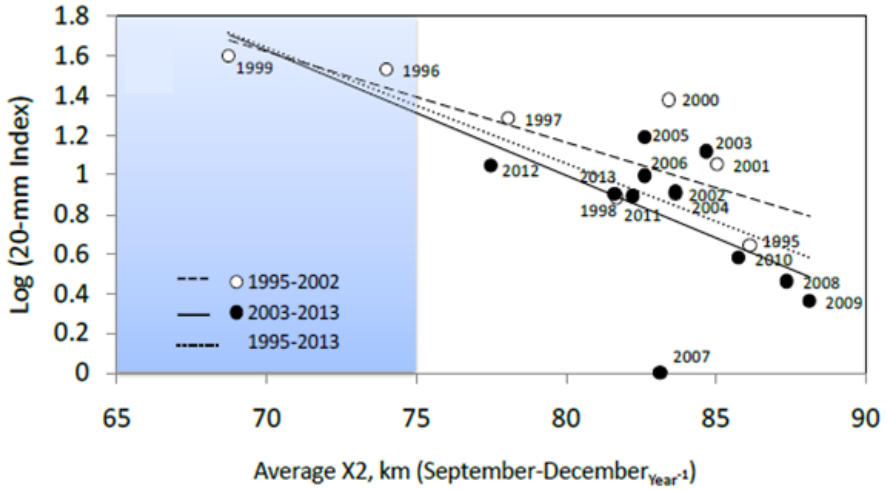
- Freshwater inflow drives estuary function
  - Stationary and moving habitat
  - Community-wide response to flow
  - General feature of estuaries worldwide
- Support estuarine habitat and function
  - Connect low salinity zone to productive tidal marsh
  - Migration and transport flows
  - Low salinity zone away from export influence
- Support native estuarine species
  - Flow-fish relationships

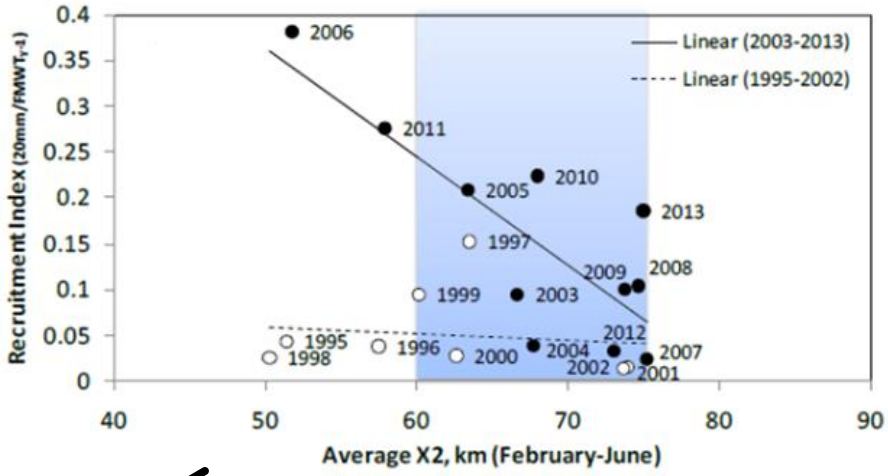
Longfin Smelt Increase with Delta Outflow



- Strong flow-abundance relationship
- Precise mechanism uncertain, may be related to spawning habitat quantity and quality
- Step decline in flow response since introduction of *Corbula*

Delta Smelt More Abundant Under Wet Conditions

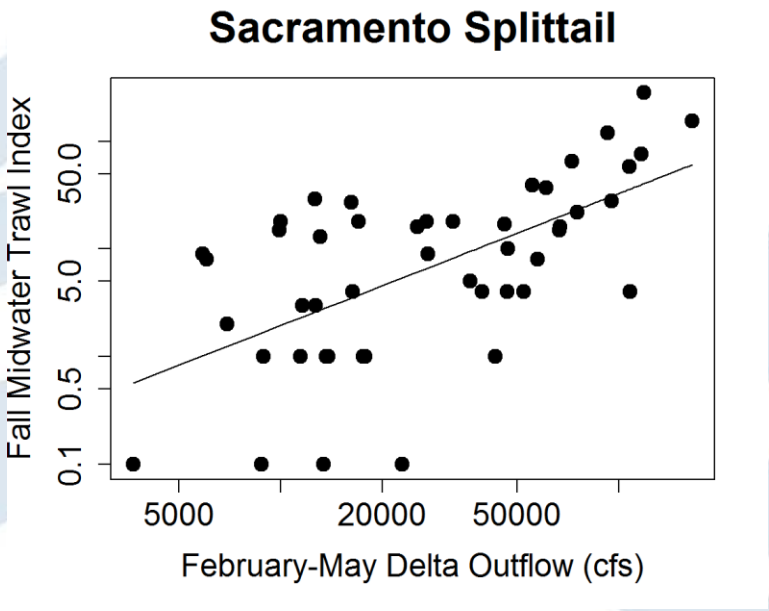




More Delta Outflow

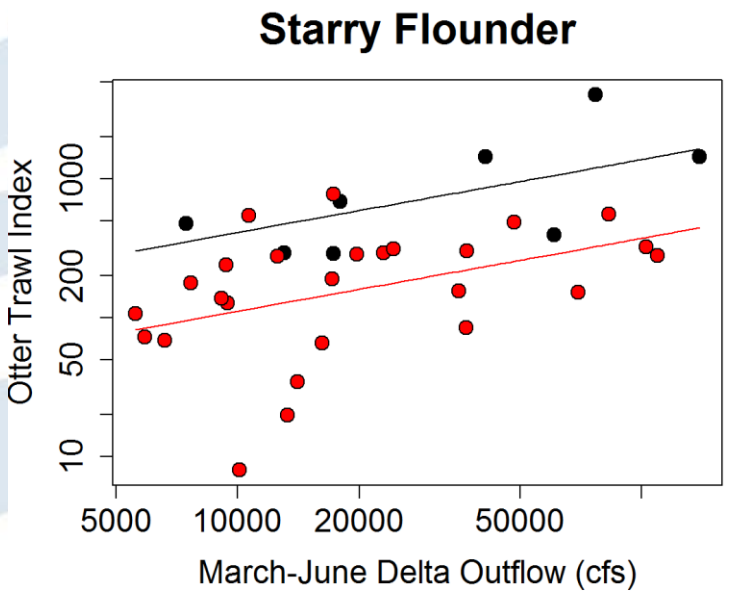
- Fall low salinity habitat in Suisun Bay may improve survival of maturing Delta Smelt and increase larval production
- Over last decade, Delta smelt abundance appears to respond to spring outflow
- Delta smelt likely need favorable conditions year-round: “it takes a year to make a smelt”

Sacramento Splittail Increase with Delta Outflow



- Sacramento splittail spawn on flooded terrestrial plants
- Floodplain habitat mechanism clearest of flow-fish relationships
- May be improved by flooding Yolo Bypass at lower flows

Starry Flounder Increase with Delta Outflow

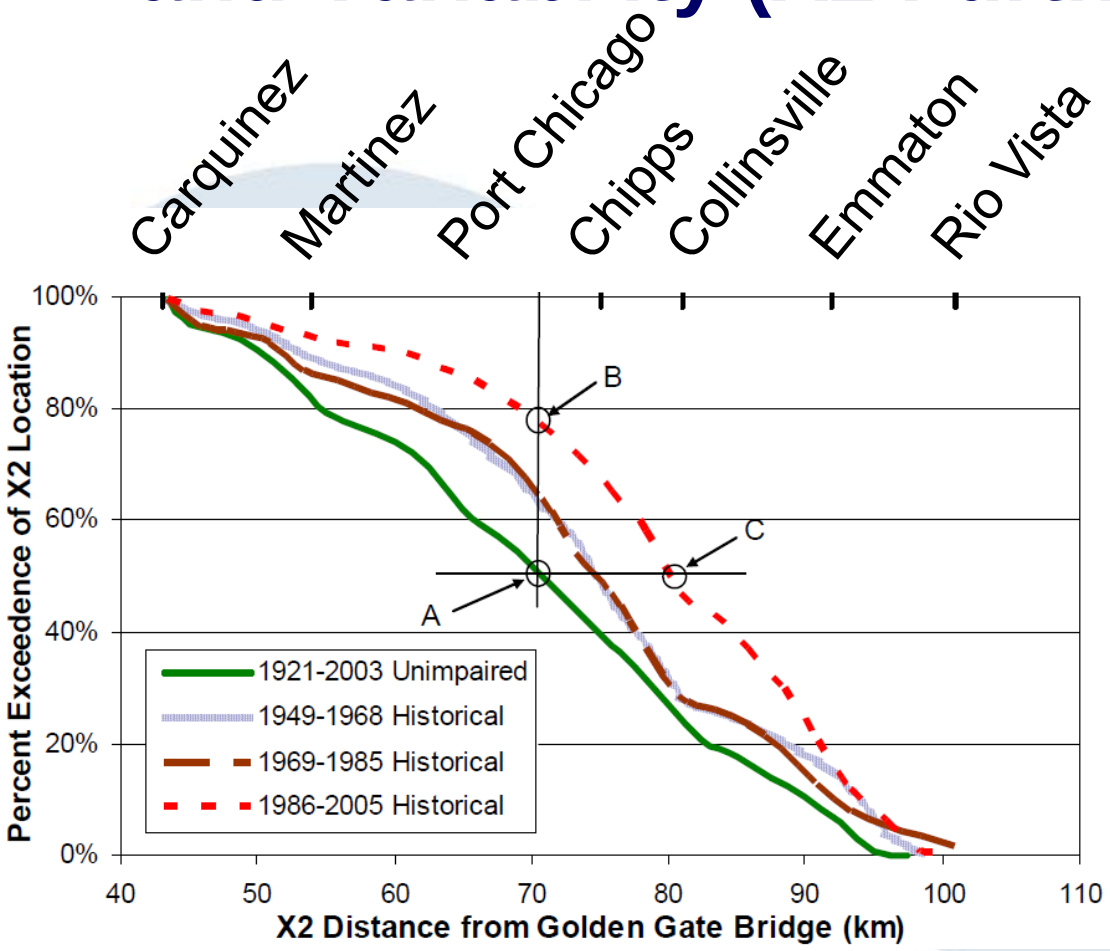


- Starry flounder spawn in the coastal ocean and rear in the estuary
- Landward bottom currents strengthened by high outflow likely lead to improved migration into and survival in the estuary
- Step decline since introduction of *Corbula*

Native Species Respond to Delta Outflow and X2

- Freshwater inflow drives estuary function
  - Stationary and moving habitat
  - Community-wide response to flow
  - General feature of estuaries worldwide
- Support estuarine habitat and function
  - Connect low salinity zone to productive tidal marsh
  - Migration and transport flows
  - Low salinity zone away from export influence
- Support native estuarine species
  - Flow-fish relationships

Delta Outflow Reduced in Magnitude and Variability (X2 Further Upstream)

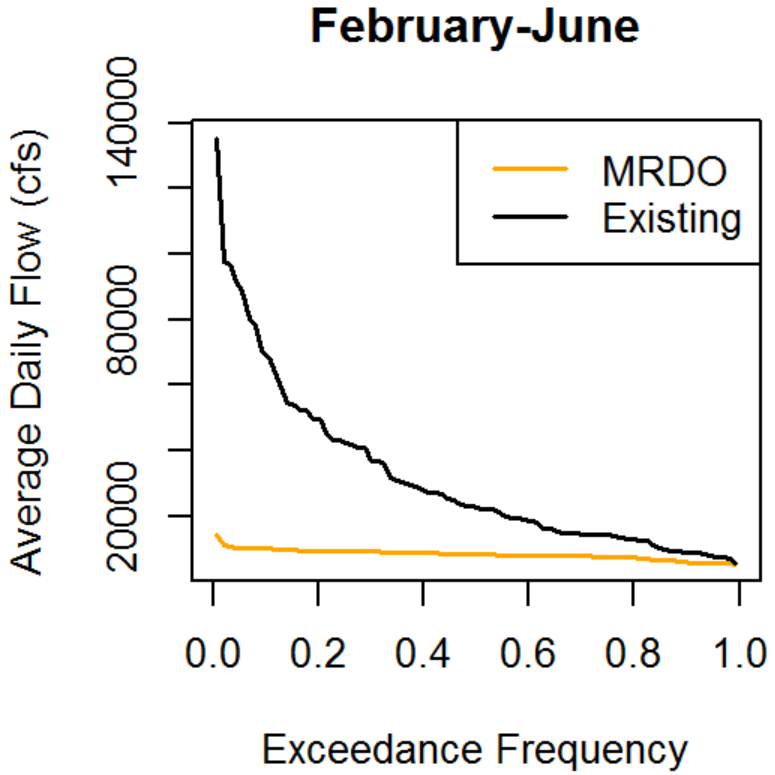


- Daily X2 positions have moved upstream with water development (less Delta outflow)
- This has occurred year-round, with reductions in magnitude and variability of winter-spring and summer-fall Delta outflow
- Points A & C: 50% exceedance at 71 km (unimpaired) versus 80 km (recent)
- Point B: 80% exceedance at 71 km (recent)

Existing Delta Outflow Requirements

- 2006 Bay-Delta Plan and Decision 1641(D-1641)
  - July-December: minimum net outflow by water year type
  - January-June: minimum net outflow in all years
    - Additional Delta outflows determined by previous month's Eight River Index, a measure of unimpaired inflow
- U.S. Fish & Wildlife Service (USFWS) Biological Opinion (BO)
  - September-October following above normal (AN) & wet (W) year: X2 downstream Collinsville (AN) or Chipps Island (W)
  - November: inflows to State & Federal Sacramento Basin reservoirs bypassed up to September-October requirement

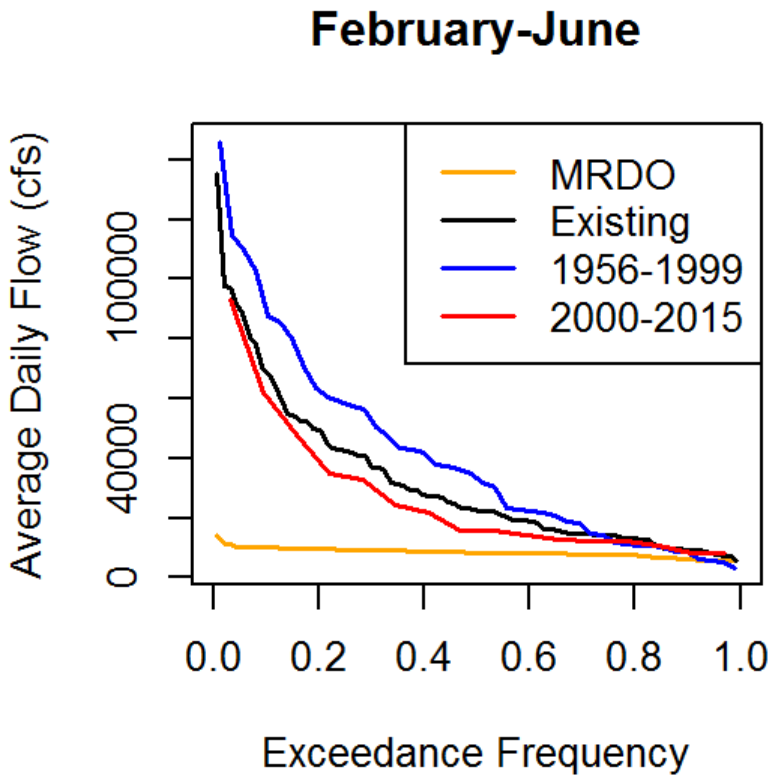
Existing Winter-Spring Delta Outflow Conditions and Requirements



- "Existing" shows CalSim II modeled Delta outflow for 1922-2003, as if current requirements operated
- Required (MRDO) very low relative to existing
- Other requirements (e.g., export limits) and limited ability to capture high flows account for this difference
- Future water development could further reduce Delta outflow

MRDO = "minimum required Delta outflow" includes outflow to meet D-1641 and Bay-Delta Plan objectives to protect fish and wildlife, salinity control for agricultural, municipal & industrial uses

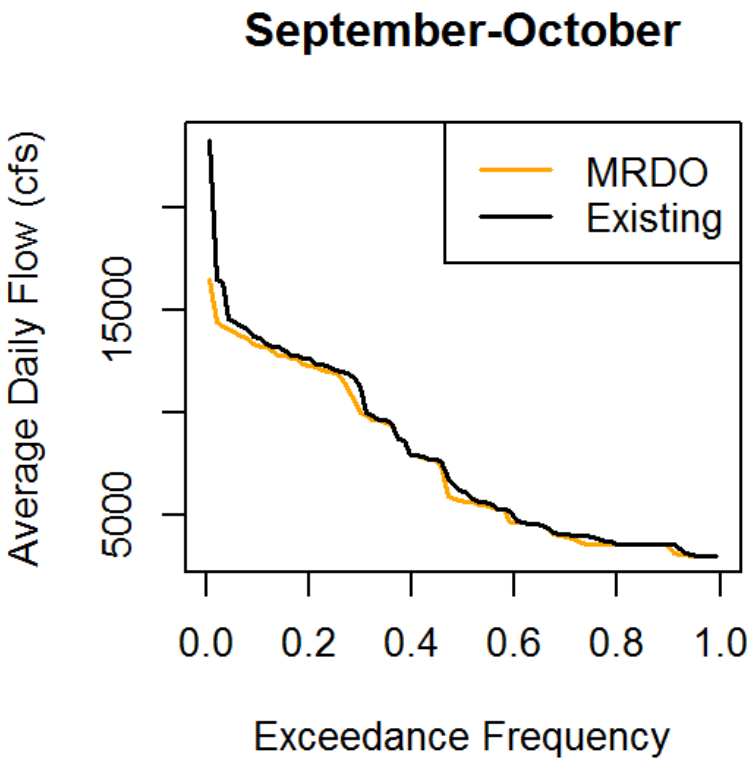
Existing Winter-Spring Delta Outflow Conditions and Requirements



- Existing and recent historical similar; both lower than earlier historical
- Future water development could further reduce Delta outflow

MRDO = “minimum required Delta outflow” includes outflow to meet D-1641 and Bay-Delta Plan objectives to protect fish and wildlife, salinity control for agricultural, municipal & industrial uses

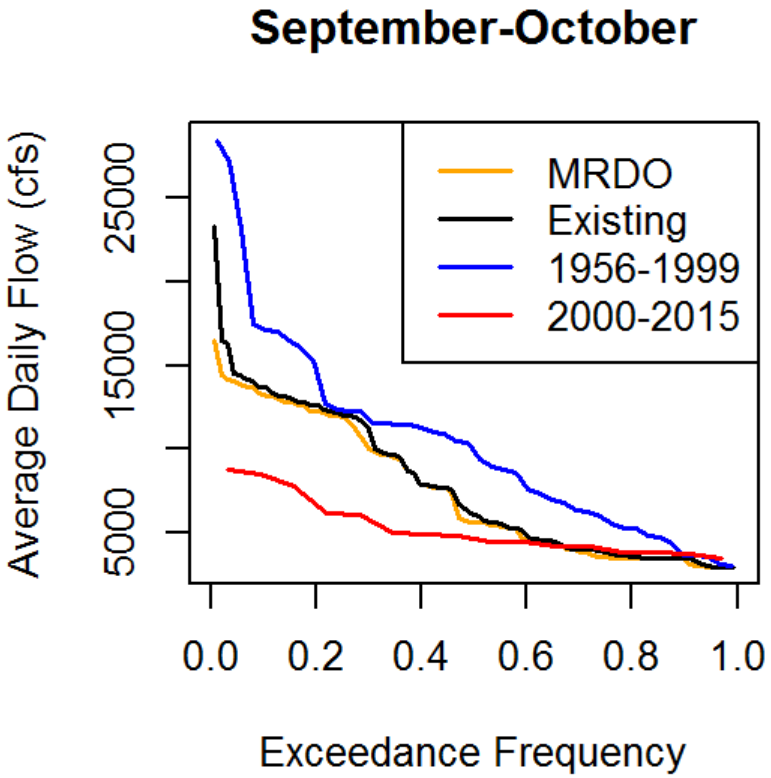
Existing Fall Delta Outflow Conditions and Requirements



- "Existing" shows CalSim II modeled Delta outflow for 1922-2003, as if current requirements operated
- Existing and requirement (MRDO) very close

MRDO = "minimum required Delta outflow" includes outflow to meet D-1641 and Bay-Delta Plan objectives to protect fish and wildlife, salinity control for agricultural, municipal & industrial uses, and USFWS 2008 BO Fall X2

Existing Fall Delta Outflow Conditions and Requirements



- "Existing" shows CalSim II modeled Delta outflow for 1922-2003, as if current requirements operated
- Existing and requirement (MRDO) very close
- Both existing and requirement higher than recent historical and lower than earlier historical flows

MRDO = "minimum required Delta outflow" includes outflow to meet D-1641 and Bay-Delta Plan objectives to protect fish and wildlife, salinity control for agricultural, municipal & industrial uses, and USFWS 2008 BO Fall X2

Delta Outflow Recommendations

Numeric Range:

- January-June based on Eight River Index
  - Range corresponding to inflow range
- Fall X2 consistent with 2008 USFWS BO
- Possible summer outflow increase to benefit Delta smelt

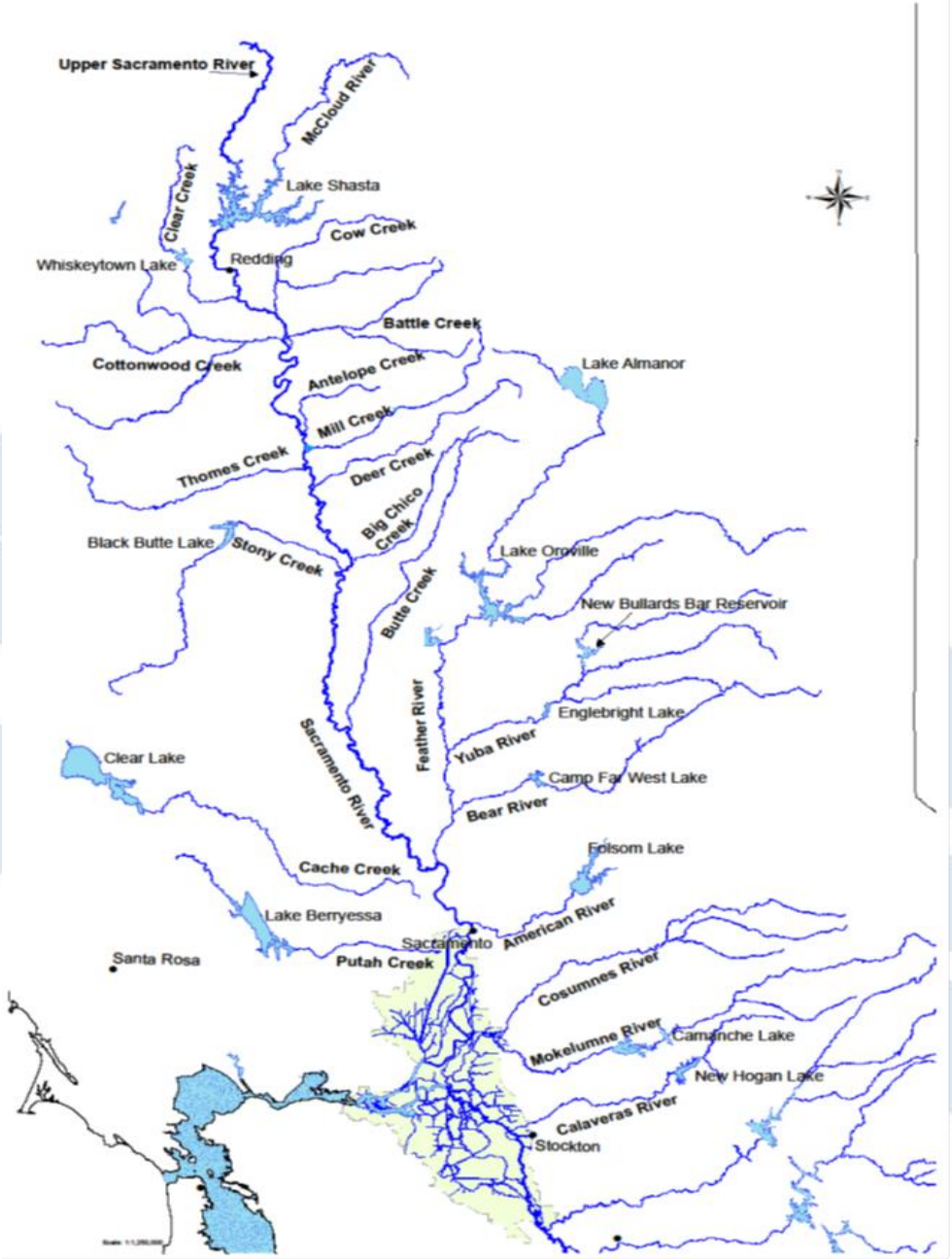
Adaptive Management:

- Seasonal, annual, and multi-year management within an adaptive range coupled to tributary inflow
- Flow shaping and seasonal shifting for functional flows and experiments
- Coordinated with adaptive management of inflow

Tributary Inflows

- Phase II Project Tributaries
- Natural production of salmonids has declined
- Inflows are needed year round:
  - For migration and rearing of anadromous fish species in the Delta and tributaries
  - To contribute to Delta outflows to protect estuarine species
- Existing inflow conditions and requirements
- Inflow recommendations

Tributaries in the Phase II Project Area



American River
Bear River
Yuba River
Feather River
Mokelumne River
Calaveras River
Cosumnes River
Cache Creek
Putah Creek
Clear Creek
Stony Creek
Antelope Creek
Mill Creek
Dear Creek
Battle Creek
Big Chico Creek
Cotton wood Creek
Cow Creek
Thomes Creek
Elder Creek
Payne Creek
Butte Creek

Decline in Natural Production of Chinook Salmon in the Sacramento River Basin

	Natural production annual average baseline (1967-1991) period	Natural production annual average for 1992-2011 period	Decrease in average natural production between 1967-1991 and 1992-2011
Winter run	54,439	6,320	-88 percent
Spring run	34,374	13,654	-60 percent
Late fall run	34,192	17,835	-48 percent
Fall-run	115,371	72,595	-37 percent

- Natural production of steelhead declined by 90% between 1960 and 1998-2000

Year-Round Salmonid Functional Flow Needs

- Adult Attraction Flows
  - Passage, hold, rear, and spawn
- Juvenile Rearing and Outmigration Flows
  - Incubation, feeding/growth, smoltification, passage and survival
- Smolt Emigration Flows From Delta
  - Feeding/growth, passage, and survival

Adult Salmonids Need Year Round Flows

Migration, Holding, Rearing and Spawning

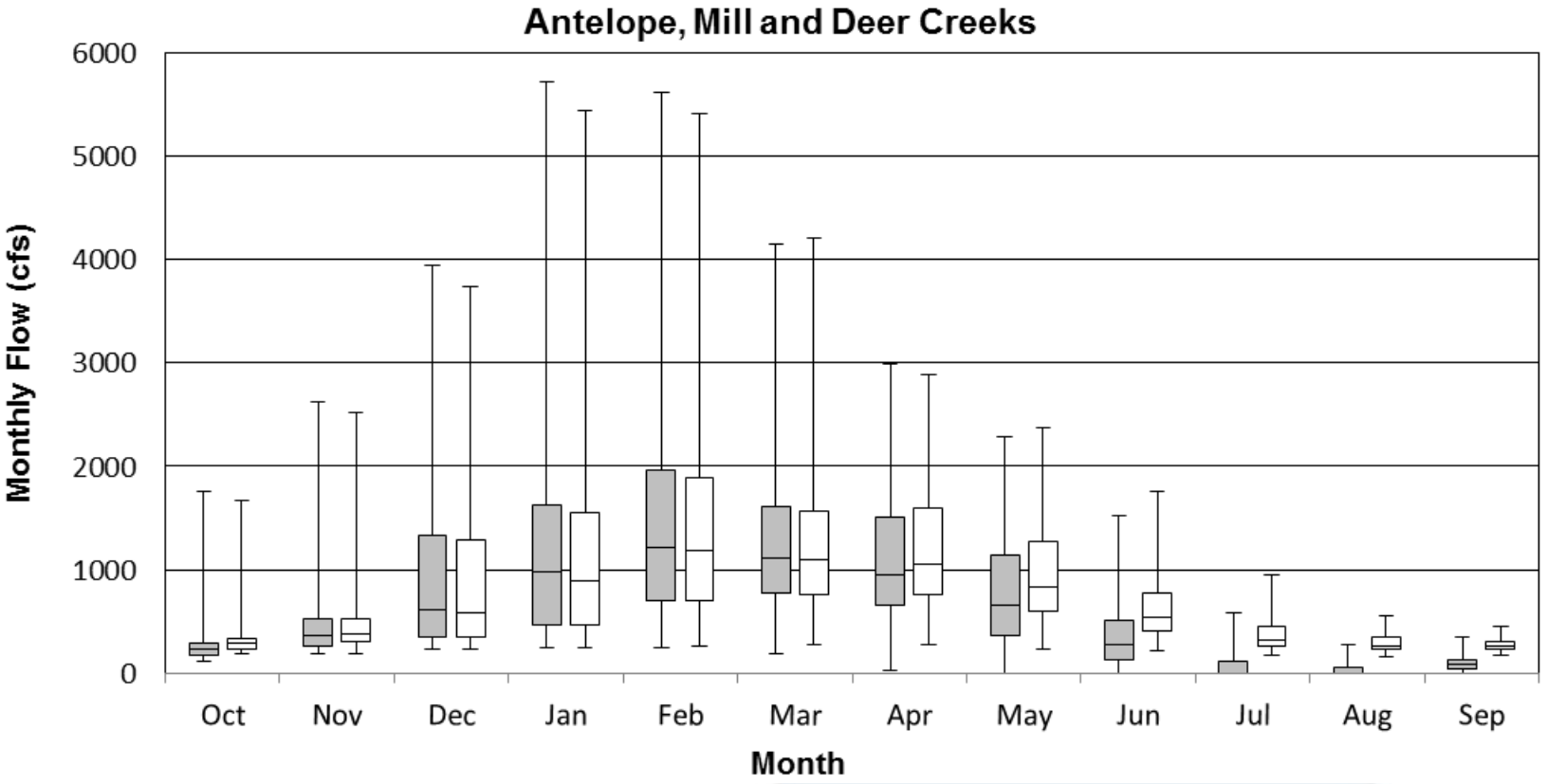
	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fall-run Chinook salmon							■	■	■	■	■	
Spring-run Chinook salmon			■	■	■	■	■	■				
Winter-run Chinook salmon	■	■	■	■	■	■						■
Late fall-run Chinook salmon	■	■								■	■	■
Central Valley Steelhead	■	■	■				■	■	■	■	■	■

Juvenile Salmonids Need Year Round Flows

Incubation, Rearing, smoltification and Outmigration

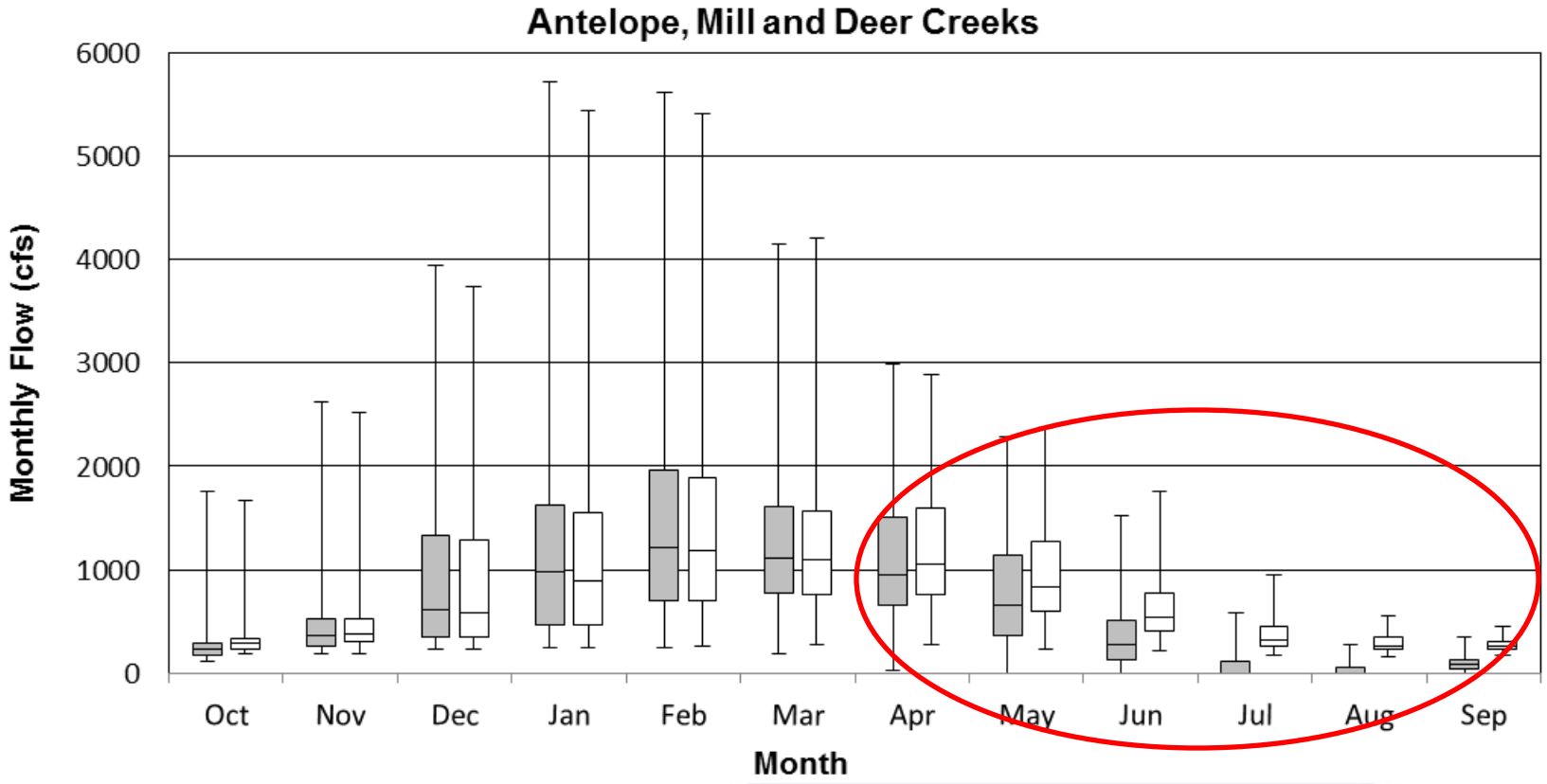
	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central Valley Steelhead												
Spring-run Chinook salmon												
Fall-run Chinook salmon												
Winter-run Chinook salmon												

Tributary Flow Less Than Optimal For Juvenile and Adult Salmonids



Gray boxes represent simulated current monthly hydrologic conditions and white represent simulated monthly unimpaired flows.

Tributary Flow Less Than Optimal For Juvenile and Adult Salmonids



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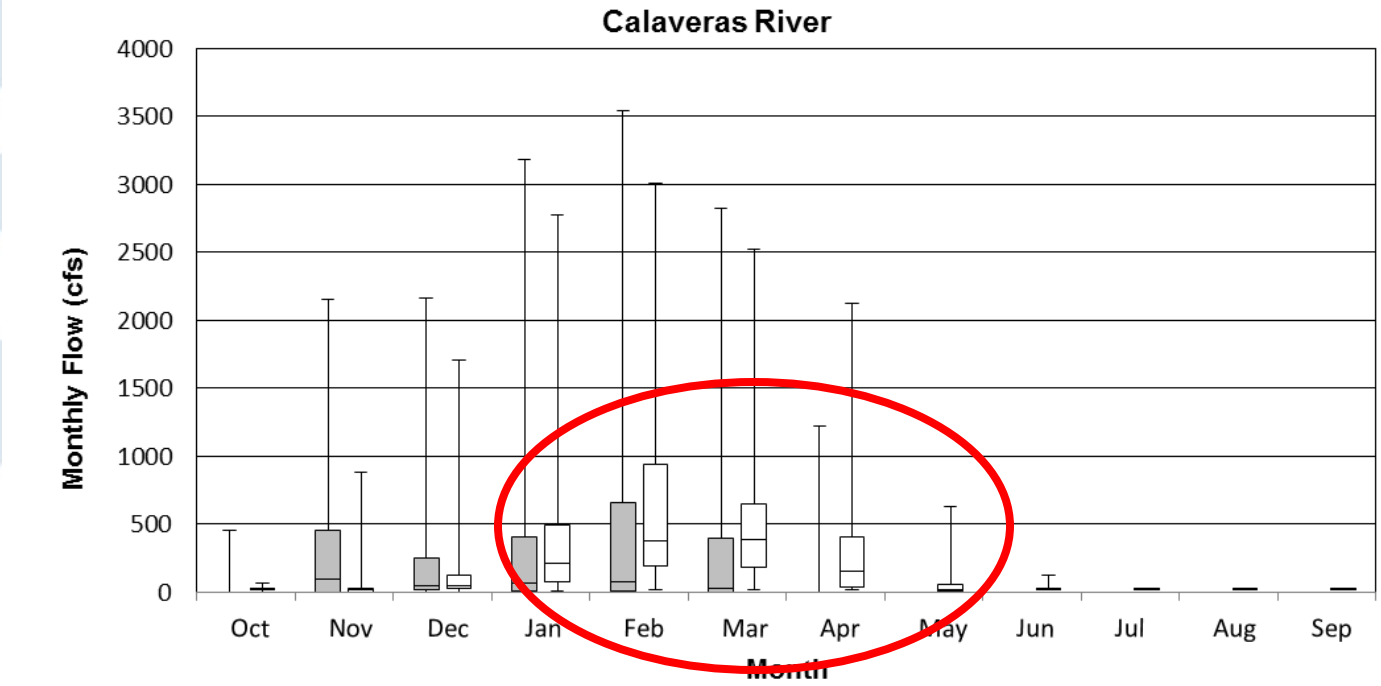
Tributary Flow Less Than Optimal For Juvenile and Adult Salmonids on Calaveras River



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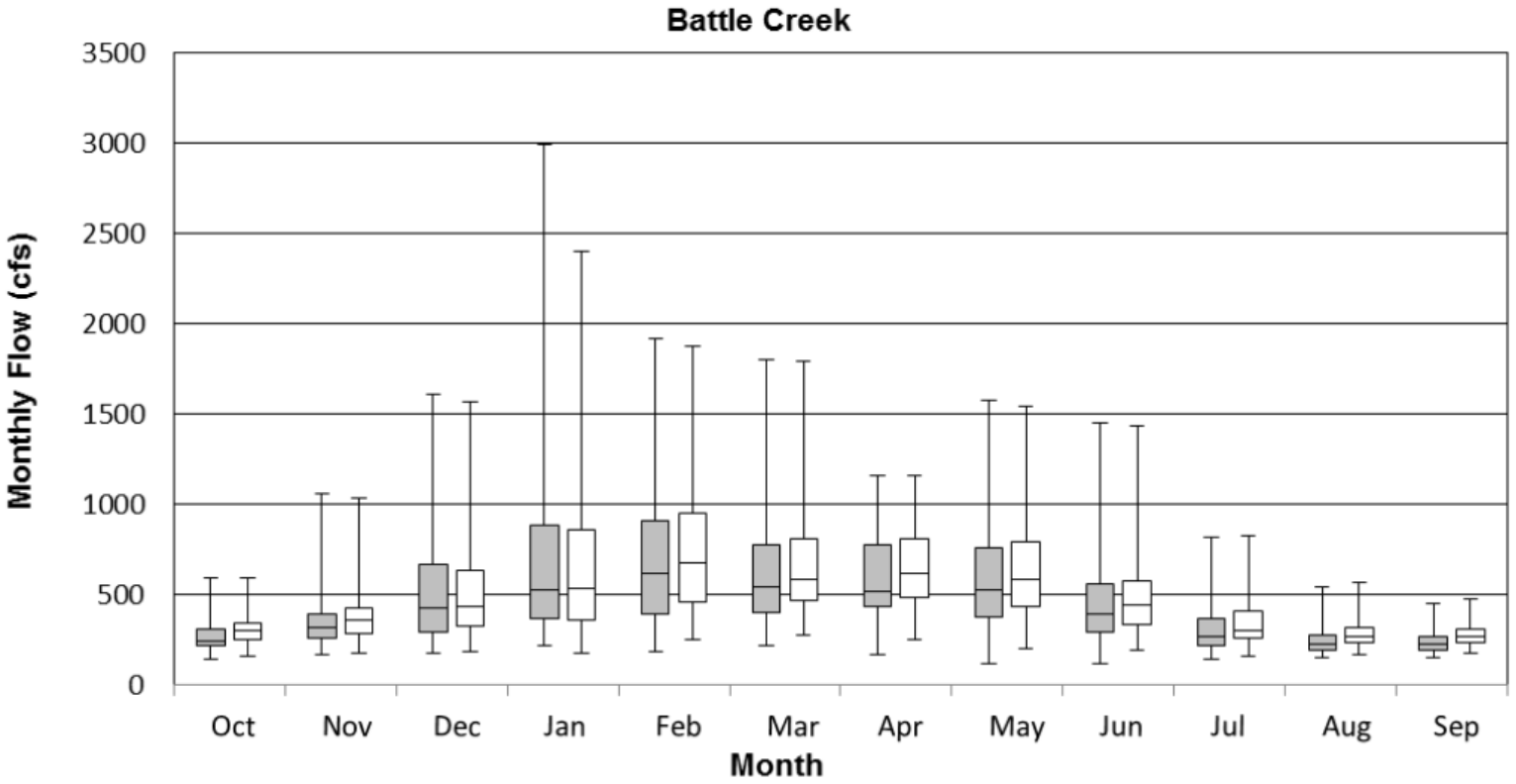
Better Flow Conditions for Salmonids Exist on Battle Creek that Need to be Protected



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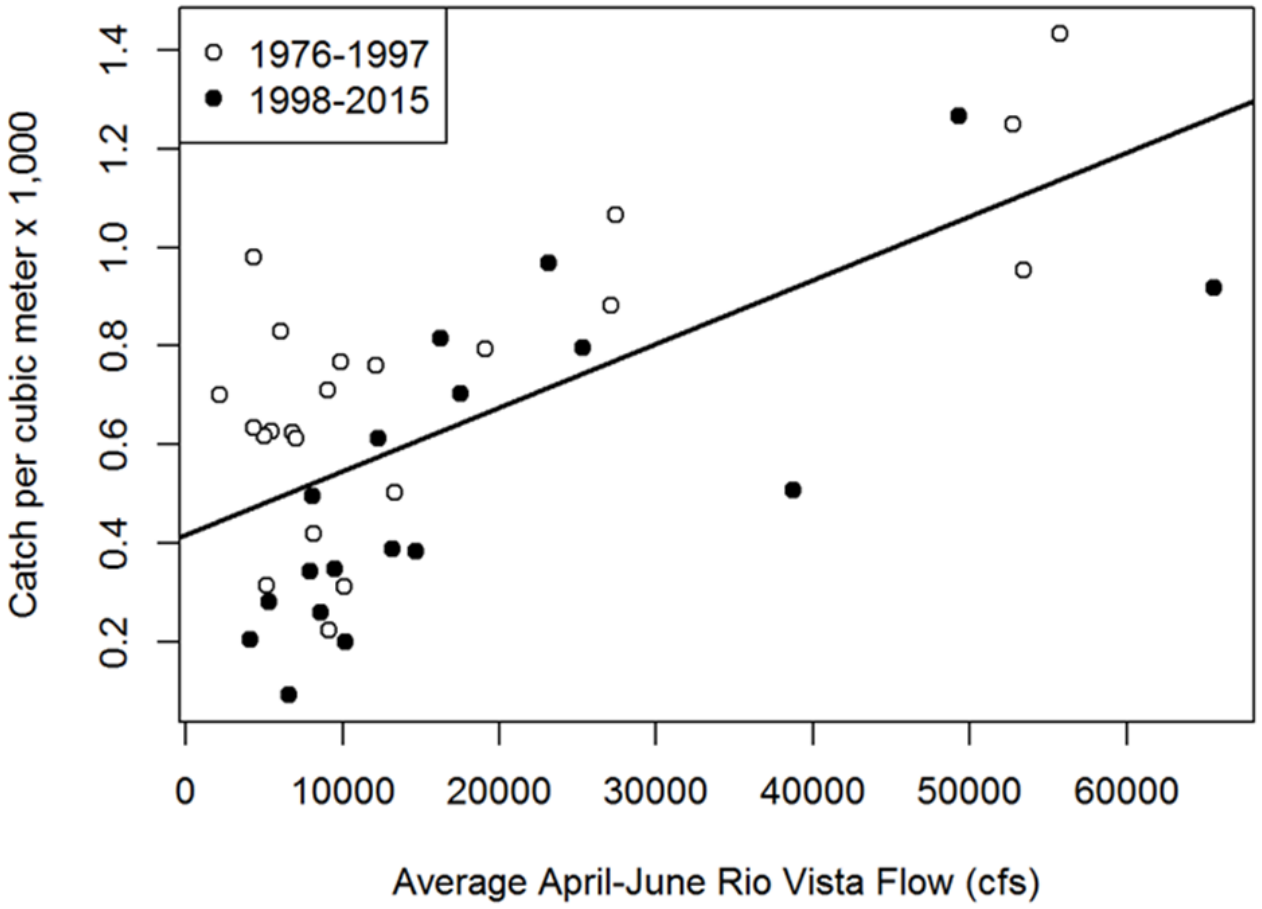
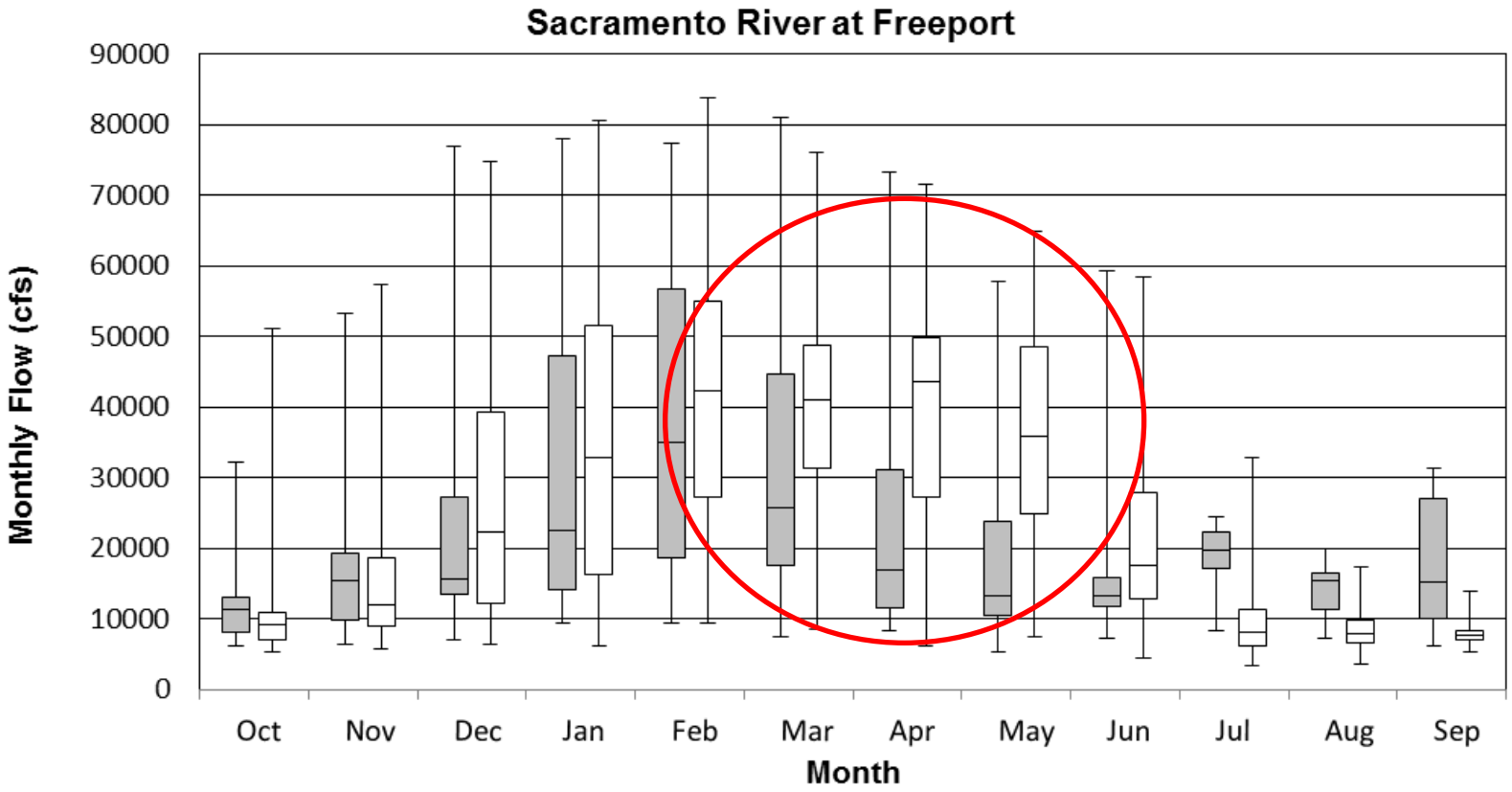
Successful Juvenile Salmonid Emigration From Delta Requires Higher Outflow



Current Flow Not Optimal For Salmonid Emigration From the Delta in the Spring



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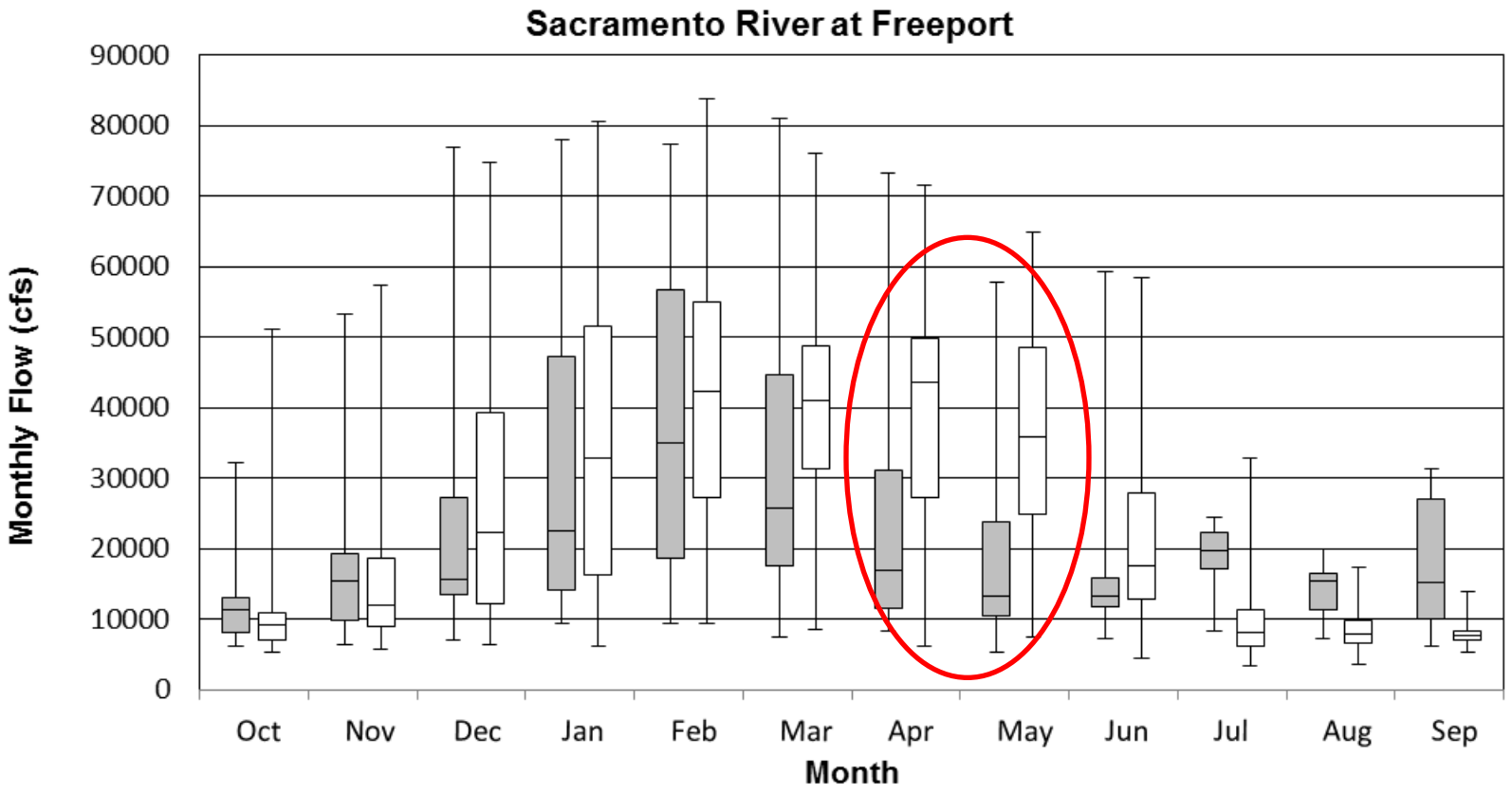
Current Flows Not Optimal For Salmonid Emigration From Delta in Peak April-May Period



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Sacramento River Flows for Successful Salmon Smolt Emigration From the Delta

	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Juvenile Fall-run				>20,000								
Juvenile Winter-run		>20,000										

Few Existing Inflow Requirements

- Bay-Delta Plan/D-1641
  - Sacramento River-fall base flows
  - Mokelumne River-Joint Settlement Agreement
- Other Processes
  - Federal Energy Regulatory Commission Flows
  - Biological Opinions
  - Other agreements and regulations
  - Many tributaries do not have requirements

Inflow Recommendations

- **Numeric Range:**
  - Year-round percent of unimpaired flow from each salmon bearing tributary in Sacramento River Basin and three Delta eastside rivers
  - Range between 35-75% of unimpaired flow
- **Adaptive Management:**
  - Flow shifting and sculpting using “block of water” approach to enhance functional flows for fish and perform scientific experiments
  - Flow range to accommodate specific instream flow needs and implementation of other measures that may reduce need for flow
  - Coordinated with Delta outflows

Cold Water Habitat Protection

- Successful salmonid spawning and rearing requires sufficiently low water temperatures
- Access to historical cold water spawning and rearing habitat is impeded by the presence of reservoirs and reservoir operations
- Comprehensive cold water habitat requirements do not exist
- Proposed new flows and climate change create urgency for protection of cold water habitat

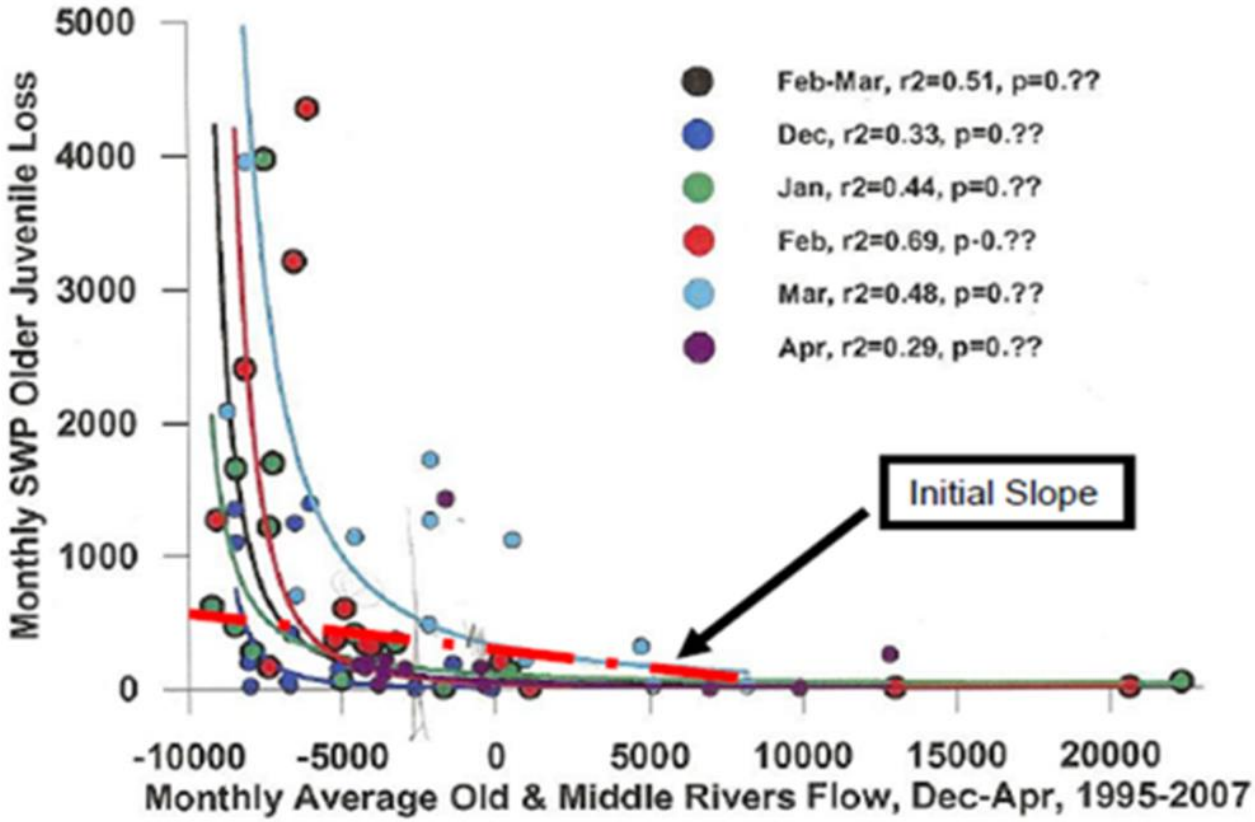
Cold Water Habitat Narrative Recommendation

- Would protect cold water habitat for salmonids and other species
- Would require maintenance and management of cold water pool in reservoirs or other measures
- Would allow for tributary-specific cold water management approaches

Interior Delta Flows

- Salmonids, pelagics, and other species are affected by altered interior Delta circulation patterns due to operation of Delta Cross Channel (DCC) Gates and export pumps
- Current requirements: D-1641/Bay-Delta Plan, USFWS BO, National Marine Fisheries Service BO and Department of Fish and Wildlife Incidental Take Permit
  - Delta Cross Channel (DCC) Gate closure requirements
  - Old and Middle River reverse flow limits
  - Export limits based on Delta inflows and San Joaquin River flows

Negative Old and Middle River (OMR) Reverse Flows Entrain Juvenile Fish at Export Pumps



This slide depicts losses of older juvenile salmonids. Other species are similarly impacted.

Interior Delta Flows Recommendations

- Add October to DCC Gate closure requirements
- Include Old and Middle River Reverse flow limitations

  -1250 cfs to -5000 cfs, January-June
- San Joaquin River flow to export ratio constraints:
  - February – June to protect outmigrating juvenile Chinook salmon (increase from existing 30-day window)
  - Fall export constraints to protect returning adult San Joaquin River Chinook salmon

Adaptive Management: all interior Delta flows adaptively managed in coordination with existing working groups (Delta Operations for Salmonids and Sturgeon, Smelt Working Group)

Next Steps

- Public comments on Report due December 16
- Final ISB comments expected early 2017
- Revised draft Report developed to address comments and submitted for peer review in winter 2017
- Further revisions to respond to peer review comments with new draft Report in summer 2017
- Draft SED/Staff Report with revised draft Report to be released as early as summer 2017