SJC-389

Closing Comments:
Numerical Flow Criteria Necessary to Protect Delta Public Trust Resources

California Department of Fish and Game
Water Branch
830 S Street
Sacramento, CA 95811

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Flow Criteria for the Delta Ecosystem
Necessary to Protect Public Trust Resources
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1 Introduction

This document provides guidance to the State Water Resources Control Board (Water Board) on public trust resources that would benefit most by establishment and implementation of Delta flow criteria. **The flow criteria presented in this document should be viewed as a starting point that will be adjusted to meet specific biological goals and objectives.** Preliminary recommendations are made for biological objectives and flows (quality, quantity and timing) needed to achieve the objectives.

2 Background

This section presents the Water Board and Department of Fish and Game (DFG) mandates to develop flow criteria, principles that underlay DFG's development of flow criteria, and DFG's proposed approach for considering the weight of evidence to support the establishment of biological objectives and flow criteria.

2.1 SB X7 1 Requirements

Both the Water Board and DFG are required to develop flow criteria to protect public trust resources in the Delta. DFG is required by Water Code section 85084.5 to develop quantifiable biological objectives and flow criteria for species of concern dependent on the Delta to be submitted by November 2010 to the board. In developing the objectives and flow criteria, DFG is required to use the best available science and consult with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

The Water Board also has a mandate to develop Delta flow criteria. The Water Board is charged with developing new flow criteria for the Delta ecosystem necessary to protect public trust resources. The flow criteria for the Delta ecosystem shall include volume, quality, and timing of water necessary for the Delta ecosystem under different conditions. The flow criteria shall be developed in a public process by the board within nine months of the enactment of this division.

2.2 Principles for Developing DFG Biological Objectives and Flow Criteria

At present, DFG will use the following principles to guide the development of the Delta biological objectives and flow criteria:

1. Flow criteria and biological objectives will be based on best available data and information contained in existing recovery plans, publications, reports, journal articles, etc. To the extent possible, DFG will use the record developed by the Water Board for flow criteria development. If new or additional information is developed or surfaces after the Water Board completes its flow criteria, DFG will consider the new data and information.
2. It is DFG's intent to coordinate development of flow criteria and biological objectives with the Water Board's efforts.
3. In developing flow criteria, DFG recommendations will follow guidance in Water Code sections 85084.5 and 85086(c)(1).
4. Species to be covered by the biological objectives and flow criteria may include all federal and State listed species in the Delta (e.g., delta smelt, longfin smelt,

etc.), salmon, other commercial/recreational fish species, and other species or habitats known to be influenced by both Delta inflow and outflow.

2.3 Data and Information Used to Develop Biological Objectives and Flow Criteria

DFG has presented several lines of evidence that contribute to recommended flow criteria and biological objectives. Lines of evidence include data or information that pertains to an important aspect of the Delta related to flow quantity, quality, or timing such as:

1. Life history information (e.g., migration timing, etc.)
2. Season or time period when flow characteristics are most important.
3. Relationships of species abundance or habitat to Delta outflow, Delta inflow, water quality parameters linked to water flow, etc.
4. Species environmental requirements (e.g., dissolved oxygen, temperature tolerances, salinity, X_2 location, turbidity, etc.)
5. Relationship of desirable species abundance to invasive species, to the extent possible.
6. Relationship of species survival dependent upon Delta inflow, interior Delta flow, and Delta outflow.
7. Factors influencing and limiting population trends.

2.4 Approach

The steps for developing biological objectives and flow criteria needed to protect public trust resources are:

1. Identify species to include in the weight of evidence approach (based on ecological, recreational, or commercial importance).
2. Identify critical time(s) of year or seasons when species are most affected by flow characteristics. Identify key quantifiable population response or habitat characteristics linked to water flow.
3. Identify mechanisms or hypotheses about mechanisms that link species abundance, habitat, etc. with water flow and water quality variables.
4. Establish biological objectives for priority species. To the extent possible, biological objectives will be quantitative.
5. Assemble evidence in order to establish flow criteria needed to meet biological objectives. This should include all data, information, and analysis that could assist in developing the weight of evidence that would lead to flow criteria.
6. Organize conclusions, relationships, and numerical/narrative recommendations (based on evidence) into a range of values that could provide criteria to be considered in future proceedings.
7. Identify, to the extent possible, the assumptions, judgments, and strength or persuasiveness of each flow criterion (endpoint) and the concurrence (i.e., overlap) or lack of concurrence between endpoints.

3 Closing Comments

DFG has provided to the Water Board data and information that links the abundance and habitat of key species that live in, move through, or otherwise depend for survival upon the Delta and its ecosystem. DFG Exhibits 1 through 4 presented the relationship between water flow quantity, quality and timing for the following species: (1) Chinook salmon, (2) Pacific herring, (3) longfin smelt, (4) prickly sculpin, (5) splittail, (6) delta smelt, (7) starry flounder, (8) white sturgeon, (9) green sturgeon, (10) Pacific lamprey, (11) river lamprey, (12) bay shrimp, (13) mysid shrimp and a copepod, *Eurytemora affinis*, and (14) American shad.

3.1 Findings from DFG Exhibits: Water flow is a major determinant of species abundance and fish production

In general, the data and information available to DFG indicates:

1. For many species, abundance is related to water flow timing and quantity (or the placement of X_2).

2. For many species, more water flow translates into greater species production or abundance.

3. Species are adapted to use the water resources of the Delta during all seasons of the year, yet for many, important life history stages or processes consistently coincide with the winter-spring seasons and associated increased flows because this is the reproductive season for most native fishes and the timing of emigration of most salmonid fishes.

4. The source, quantity, quality, and timing of Central Valley tributary outflow affects the same characteristics of mainstem river flow to the Delta and interior Delta water flows. Flows in all three of these areas influence production and survival of Chinook salmon in both the San Joaquin River and Sacramento River basins.

5. Some invasive species negatively influence native species abundance. The best evidence is the negative effects of overbite clam and several species of aquatic plants.

3.2 The Water Board Should Identify Priority Species

DFG recommends that the Water Board establish flow criteria for species that are of priority concern and will benefit most by improving water flow conditions. The following table identifies the species that are of ecological, commercial, or recreational importance that are influenced by Delta inflow (including mainstem river tributaries) or Delta outflow. The table identifies the species life stage most affected by water flow, the mechanism most affected by flow, the time when water flow is most important to the species, and a reference to the location in the DFG exhibits where a more complete description is provided.

Priority Species	Life Stage	Mechanism	Time When Water Flows are Most Important	Reference
Chinook salmon (San Joaquin River basin)	Smolt	Outmigration	March – June	Exhibit 1 – page 2; Exhibit 3 – pages 7-10, 21-35.
Chinook salmon (Sacramento River basin)	Juvenile	Outmigration	November – June	Exhibit 1 – page 1-2, 6-8
Chinook salmon (San Joaquin River tributaries)	Egg/fry	Temperature, dissolved oxygen, upstream barrier avoidance	October – March	Exhibit 3, pages 2-4; Exhibit 4
Longfin smelt	Egg	Freshwater-brackish habitat	December – April	Exhibit 1 – page 2, 9-12
Longfin smelt	Larvae	Freshwater-brackish habitat; transport; turbidity	December – May	Exhibit 1 – page 2, 9-12
Splittail	Adults	Flood plain inundating flows	January – April	Exhibit 1 – page 2, 13-14
Splittail	Eggs and larvae	Flood plain habitat persistence	January – May	Exhibit 1 – page 3, 13-14
Delta smelt	Larvae and Pre-adult	Transport; habitat	March – November September – November	Exhibit 1 – page 2,14-15
Starry flounder	Settled juvenile; Juvenile-2 yr old	Estuary attraction; habitat	February – May	Exhibit 1 – page 3, 15-16
Bay shrimp	Late-stage larvae and small juveniles	Transport	February – June	Exhibit 1 – page 4; 22-25
Bay shrimp	Juveniles	Nursery habitat	April – June	Exhibit 1 – page 4; 22-25
Mysid shrimp (zooplankton)	All	Habitat	March – November	Exhibit 1 – page 5; 25-26
Eurytemora affinis (zooplankton)	All	Habitat	March – May	Exhibit 1 – page 5; 25-26
American shad	Egg/larvae	Transport; dispersal; habitat	April – June	Exhibit 1 – page 5; 26-28

3.3 The Water Board Should Identify Biological Goals and Objectives

The Water Board should establish both biological goals and objectives before adopting flow criteria. These goals and objectives should focus on the needs of priority species that live in and migrate through the Delta. Suggestions are provided below.

3.3.1 **Biological Goal**

Halt species population declines and increase populations of ecologically important native species as well as species of commercial and recreational importance by providing sufficient water flow and water quality at appropriate times to propagate species life stages that use the Delta.

3.3.2 Biological Objectives

To meet the biological goal the following draft biological objectives are recommended. At present, these objectives are limited to findings, data, and information analyzed in the DFG Exhibits and would be implemented using the numerical flow criteria presented in the next section. Additional objectives should be developed based on information in the Board's record.

- For the San Joaquin River basin, provide sufficient water flow depending on year type to transport salmon smolts through the Delta during spring in order to contribute to attainment of the salmon protection water quality objective[1].

- For the Sacramento River basin, provide sufficient water flow to transport salmon smolts through the Delta during the spring in order to contribute to the attainment of the salmon protection water quality objective[1].

- For tributaries of mainstem rivers that flow into the Delta, maintain water temperatures and dissolved oxygen at levels that will support adult migration, egg incubation, smolting, and early-year and late-year juvenile rearing.

- Create shallow water habitat for longfin smelt, delta smelt, starry flounder, bay shrimp, American shad, and zooplankton in Suisun Bay (and farther downstream) by maintaining X_2 between 65 km and 74 km between January and June.

- Depending on year type, provide sufficient water flow to increase abundance of desirable species that depend on the Delta (longfin smelt, delta smelt, starry flounder, bay shrimp, American shad, and zooplankton) to pre-1987 abundance levels.

- To favor Sacramento splittail recruitment, during above normal and wet years, once flood plain inundation has been achieved based on runoff and discharge for 10 days between March and May, maintain continuous inundation for at least 30 days in the Yolo Bypass and at suitable locations in the Sacramento River or in the San Joaquin River.

4 Numerical Flow Criteria Necessary to Protect Delta Public Trust Resources

The numerical flow criteria below are based only on the information presented in the DFG exhibits provided to the Water Board in February 2010 and are intended to be used to meet the biological goal and objectives presented above. As DFG prepares its Delta flow criteria report other available information will be included. Each of the recommendations below is:

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[1] Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Water Board Resolution No. 2006-0098. Table 3. Page 14.

1. Applicable to public trust resource beneficial use (e.g., fish and wildlife habitat, migration, spawning, etc.).
2. Protective of the beneficial use.
3. Linked to water flow characteristics (i.e., flow quantity, quality, or timing)
4. Well described.
5. Scientifically based and reviewed (either through peer review or other vetting process).
6. Based, to the extent possible, on studies where causal mechanisms have been identified. A causal link is not available for all important species or processes.

OUTFLOW CRITERIA

Location *Species*	Parameter	Effect or Mechanism	Timing	Minimum	Maximum	Reference
Sacramento-San Joaquin Delta						
Longfin smelt						
	Flows	Incubation, early rearing dispersal, habitat	January – June[2]	X_2 at 65 km	X_2 at 74 km[3]	DFG Exhibit 1, Page 10; Exhibit 2, page 6
Starry Flounder						
	Flows	Estuary location, immigration, rearing	February – June	X_2 at 65 km	X_2 at 74 km	DFG Exhibit 1, Page 16; Exhibit 2, page 6
Bay Shrimp						
	Flows	Immigration of late-stage larvae and small juveniles	February – June	X_2 at 65 km	X_2 at 74 km	DFG Exhibit 1, Page 23; Exhibit 2, page 6
Zooplankton						
	Flows	Habitat	February – June	X_2 at 65 km	X_2 at 74 km	DFG Exhibit 1, Page 26; Exhibit 2, page 6
American Shad						
	Flows	Spawning, nursery	April – June	X_2 at 65 km	X_2 at 74 km[4]	DFG Exhibit 1, Page 26; Exhibit 2, page 6
Sacramento Splittail						
	Habitat	Incubation, early rearing, Egg and larval habitat and survival	January – May In Above Normal and Wet Years	$\geq$30 day floodplain inundation		DFG Exhibit 1, Page 13

[2] The timing for this flow recommendation includes an additional month when water flow is important (compare DFG Exhibit 2).
[3] Equivalent to a 3-day running average Net Delta Outflow Index of 11,400 cfs (Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Water Board Resolution No. 2006-0098. Table 4. Page 21).
[4] For American shad, X_2 is a surrogate for tributary and mainstem river inflows to the Delta that support egg and larval survival.

INFLOW CRITERIA

Location *Species*	Parameter	Effect or Mechanism	Timing	Minimum	Maximum	Reference
Sacramento River						
Chinook Salmon						
	Base Flow	Smolt outmigration	February – October	6,000 cfs		DFG Exhibit 14 (WRINT-DFG-8, page 11)
	Pulse Flows at Rio Vista (cfs)	Smolt outmigration	April – June		20,000 cfs – 30,000 cfs	DFG Exhibit 1, page 1, 6
San Joaquin River						
Chinook Salmon						
	Flows at Vernalis (cfs)	Smolt outmigration	Critical Dry Year (Mar 15 – Jun 15)	Base - 1,500 cfs Pulse (4/15-5/15) - 5,500 cfs Total - 7,000 cfs		DFG Exhibit 3, page 34, Table 10 & Figure 19
	Flows at Vernalis (cfs)	Smolt outmigration	Dry Year (Mar 15 – Jun 15)	Base - 2,125 cfs Pulse (4/11-5/20) - 4,875 cfs Total - 7,000 cfs		DFG Exhibit 3, page 34, Table 10 & Figure 19
	Flows at Vernalis (cfs)	Smolt outmigration	Below Normal Year (Mar 15 – Jun 15)	Base - 2,258 cfs Pulse (4/6-5/25) - 6,242 cfs Total – 8,500		DFG Exhibit 3, page 34, Table 10 & Figure 19
	Flows at Vernalis (cfs)	Smolt outmigration	Above Normal Year (Mar 15 – Jun 15)	Base - 4,339 cfs Pulse (4/1-5/30) - 5,661 cfs Total – 10,000 cfs		DFG Exhibit 3, Page 34, Table 10 & Figure 19
	Flows at Vernalis (cfs)	Smolt outmigration	Wet Year (Mar 15 – Jun 15)	Base - 6,135 cfs Pulse (3/27-6/4) - 8,685 cfs Total – 15,000 cfs		DFG Exhibit 3, Page 34, Table 10 & Figure 19
	Dissolved Oxygen (mg/L)	All life stages	Jan through Dec	5.0 mg/L		DFG Exhibit 3, Page 3

Location *Species*	Parameter	Effect or Mechanism	Timing	Minimum	Maximum	Reference
San Joaquin River Tributaries						
Chinook Salmon						
	Temperature (°C)	Adult Migration	September through January		18°C 7DADM[5]	DFG Exhibit 4, Page 2, Table 1, and Exhibit 3, Page 11, Table 3
	Temperature (°C)	Incubation	October through December		13°C 7DADM	DFG Exhibit 4, Page 2, Table 1, and Exhibit 3, Page 11, Table 3
	Temperature (°C)	Smolting; smolt outmigration	March through June		15°C 7DADM	DFG Exhibit 4, Page 2, Table 1, and Exhibit 3, Page 11, Table 3
	Temperature (°C)	Juvenile rearing	June through September		18°C 7DADM	DFG Exhibit 4, Page 2, Table 1, and Exhibit 3, Page 11, Table 3

[5] The identified temperature unit is: Seven day average of the daily maximum water temperature (7DADM).