The Informational Proceeding to Develop Flow Criteria for the Delta Ecosystem

Noticed for March 22, 23, and 24, 2010

WRITTEN TESTIMONY

Submitted on Behalf of
The San Luis & Delta-Mendota Water Authority,
State Water Contractors,
Westlands Water District,
Santa Clara Valley Water District,
Kern County Water Agency, and
Metropolitan Water District of Southern California

B. Flows Adopted For Salmon Migration

Abstract

Predation on salmon juveniles has a much greater effect on emigration than river flows. In recent years, the mortality of juvenile Chinook salmon and steelhead in the Sacramento River upstream of the Delta has been ~90%. The current population of striped bass (Morone saxitalis), only one of a number of predators, is estimated to be nearly 1 million fish. Striped bass alone have been shown to consume a large percentage of juvenile salmon. Predator control mechanisms offer a greater opportunity to improve juvenile emigration than adjusting Delta flows.

1. Ocean conditions

Salmon population size as defined by escapement is affected by many factors both upstream (e.g., upstream water temperatures, availability of proper spawning substrate) and downstream (e.g. ocean conditions, harvest) of the Delta. While some people blame water project operations for the recent declines in salmon returns, unfavorable ocean conditions have been implicated as the real causal mechanism (PFMC 2008; NMFS 2009a). In its Status of the Fisheries report to the Fish and Game Commission, the State Department of Fish and Game reported on populations of Pacific herring (DFG 2008), a key prey of salmonids. Spawning biomass of herring dropped to an all-time low during the 2006-07 season; low spawning biomass occurs during or just after El Niño events (DFG 2008). Sardine and anchovy spawning populations have also dropped significantly from recent high levels (PFMC 2008; Brodeur et al. 2006). Krill, another prey item of Pacific salmonids, have also declined in recent years; the drop in krill populations was associated with massive die offs of seabirds and the complete reproductive failure of Cassin‘s auklets on the Farallon Islands (PFMC 2008). Changes in ocean conditions are associated with the decline in abundance of krill (PFMC 2008). The BiOp even admits (p. 56):

> The unusual and poor ocean conditions that caused the drastic decline in returning fall-run Chinook salmon populations coast-wide in 2007 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run [Chinook] spawning population in 2007.

Conditions in 2008 and 2009 have mirrored those of 2007. When unfavorable ocean conditions persist, no amount of freshwater flow can mitigate; the mechanism is not flow but rather the carrying capacity of the ocean.

2. Predation

Mortality resulting from predation by non-native fishes contributes significantly to the decline of Central Valley salmonids (NMFS 2009). Introduced predators such as striped bass and various centrarchid species (black bass, sunfishes) are among the most abundant fish species found in the Delta. Though much less abundant now than in the early 20th century, the adult striped bass population remains at nearly 1 million individuals (Nobriga 2009). Largemouth bass have also increased dramatically in the Delta since the 1980s, with catch more than quadrupling in most

Delta regions (Brown and Michniuk 2007). Striped bass predation in tributaries of the Delta appears to be the largest single cause of mortality of emigrating juvenile salmon. Studies have shown mortality of juvenile Chinook salmon and steelhead in the Sacramento River upstream of the Delta to be ~90% in recent years (MacFarlane *et al.* 2008; NMFS 2009). Acoustic tagging studies on the Delta portion of the San Joaquin River have found similar high rates of predation mortality (Holbrook et al. 2009). Hanson (2009) analyzed available diet composition data and estimated striped bass annually consume ~21% of juvenile winter-run Chinook salmon production, ~42% juvenile spring-run Chinook salmon production, ~7-15% of juvenile Central Valley steelhead production, and ~13% of delta smelt production. Consistent with Lindley and Mohr (2003) and NMFS (2009b), Hanson (2009) concluded mortality resulting from striped bass predation greatly increases the probability of salmonid extinction and also reduces the probability of species recovery. By comparison, for the years 1993-1998 (the last years for which complete data is available) the export projects annually entrained at most ~3% of all tagged salmon smolts released (Table 1).

Recognizing these dramatic predation losses, the NMFS (2009b) draft Recovery Plan for Central Valley salmon and steelhead concludes that: (1) predation on winter-run Chinook salmon is a "major stressor" with very high importance (p. 42, 48); (2) restoring the ecosystem for anadromous salmonids will require, among other actions, "significantly reducing the nonnative predatory fishes that inhabit the lower river reaches and Delta" (p. 90); and (3) reducing abundance of striped bass and other non-native predators must be achieved to "prevent extinction or to prevent the species from declining irreversibly" (p. 157, 183, 190).

An ESA-mandated tendency to focus on direct mortality and known sources of "take" have historically led to management actions focused on flows, reduced exports, and operating barriers to inhibit movement of fish towards export facilities (e.g. NMFS 2009a). These actions may have reduced export-related "take" (Kimmerer 2008), but they have not addressed predation mortality, the primary cause of poor through-Delta survival among juvenile salmonids. Reducing predator densities in key migration corridors of the Delta during migration periods could yield substantial improvements in through-Delta survival of salmon.

3. *Emigration and flows*

Chipps Island is located just downstream from the confluence of the Sacramento and San Joaquin Rivers (Figure 4). Downstream of Chipps Island is generally considered the bay portion of the estuary, while upstream of Chipps Island is generally considered to be the Delta (Brandes and McClain 2001; Perry et al. 2009). Cramer Fish Sciences used their Delta Pathway Model[3] defined a simplified Delta channel network following the reaches and junctions depicted in Perry et al. (2009). Specifically, this simplified Delta is composed of 10 reaches and four reach junctions (Figure 5) which represent primary salmonid migration corridors. For simplification, Sutter Slough and Steamboat Slough were combined as reach ***SS*** and the forks of the Mokelumne River were combined as reach ***Mok*** (Figure 5). At junction B, fish exit reach ***Sac2*** and enter either ***Sac3***, Georgiana Slough (***Geo***), or ***Mok*** (Figure 5).

[3] Information on the Delta Pathway Model is available at http://www.fishsciences.net/projects/delta_migration.php.

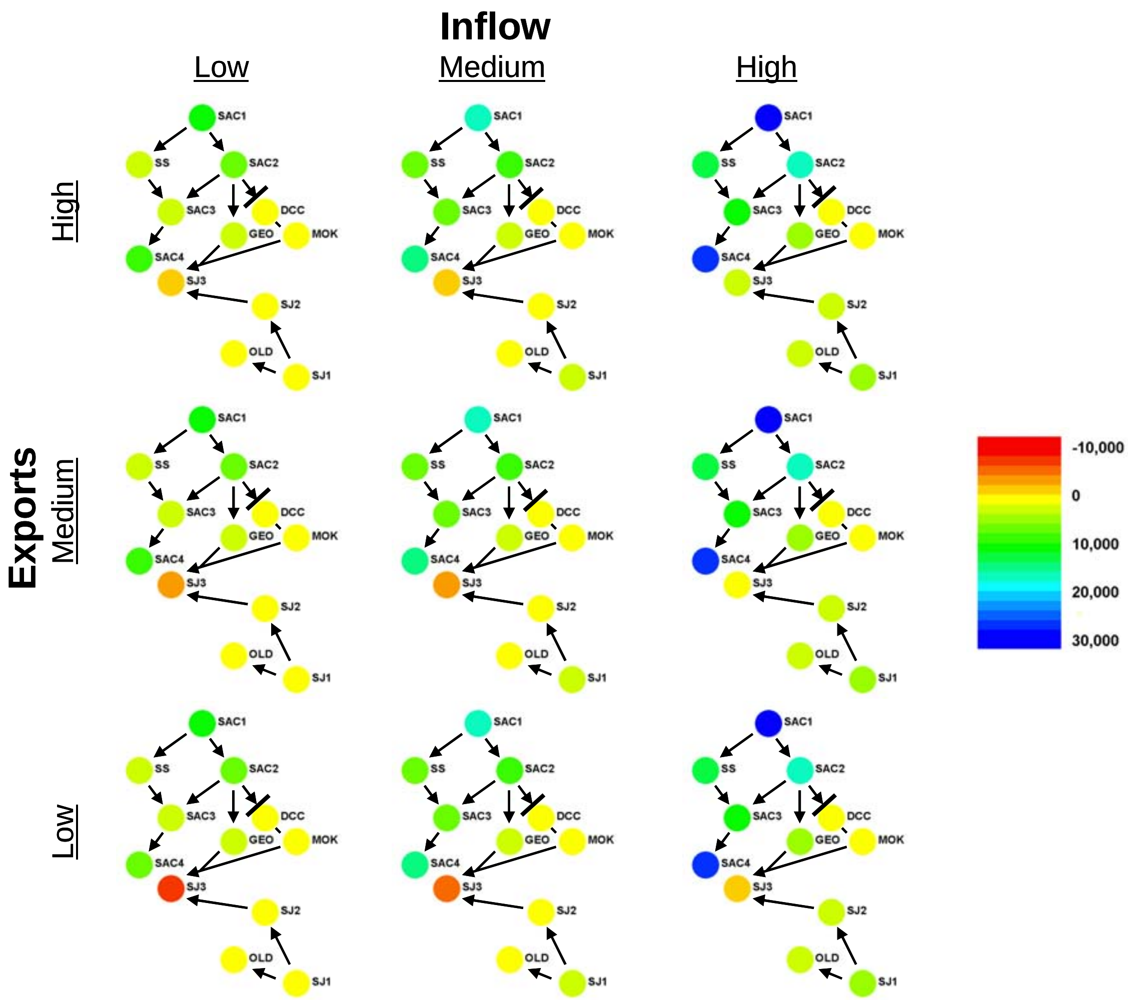

FIGURE 5. Reach specific daily average flow (cubic feet per second) under different combinations of export and Delta inflows. Arrows indicate typical direction of flow between reaches. Blue-green-yellow bubbles indicate net flow towards the Bay. Orange-red bubbles indicate net flow toward the south Delta export facilities. Color changes represent 2,000 cfs increments.

River flows are thought to effect juvenile salmon by influencing migration speed. Acoustic tagging studies for the north Delta show that fish typically pass through discharge-driven reaches like ***Sac1***, ***SS***, and ***Sac2*** quickly; an average of three days while mean residence time is eighteen days in ***SJ3*** where tidal influence is very strong (Russell Perry, personal communication). Thus, while river flows influence juvenile salmon migration speed, the relationship appears to be more dramatically influenced by the transition from discharge-driven to tidally-driven reaches of the Delta.

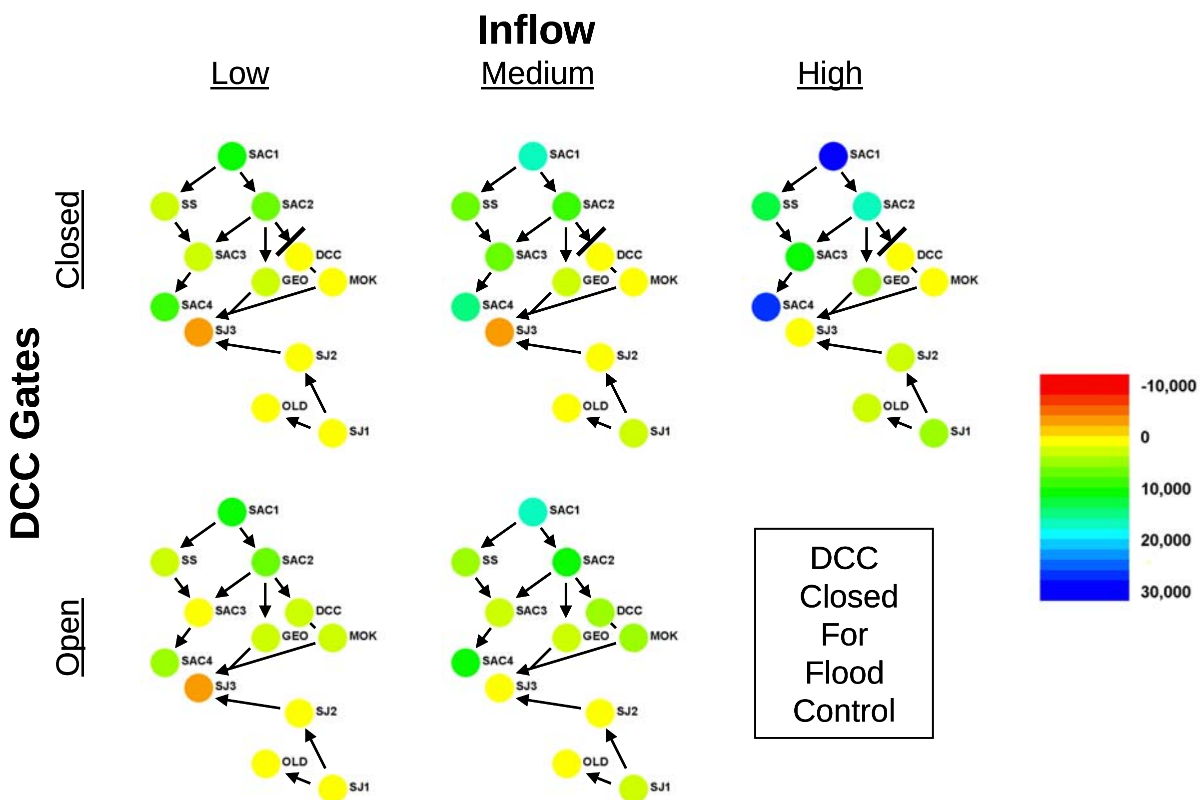

FIGURE 6. Reach specific daily average flow (cubic feet per second) with medium exports and different combinations of Delta inflows and DCC position. Arrows indicate typical direction of flow between reaches. Blue-green-yellow bubbles indicate net flow towards the Bay. Orange-red bubbles indicate net flow toward the south Delta export facilities. Color changes represent 2,000 cfs increments.

Besides migration speed, juvenile salmonid route selection is also important. Although fish route selection is variable, particularly over short periods of time, acoustic tagging studies in the Delta have found that, on average, salmon smolts arriving at distributary junctions tend to enter downstream reaches in proportion to the flow diverted down that junction (Perry et al. 2009; Holbrook et al. 2009). These findings are in contrast to conclusions based on PTM results. For example, at 12,000 cfs Delta inflows, PTM-based analyses by Kimmerer and Nobriga (2008) found that it took 50 days for 75% of particles released at Hood to exit the Delta. In contrast, acoustically tagged salmon smolts migrate through the Hood reach in three days and exit the Delta in just over two weeks. Thus, an abundance of caution must be used when interpreting PTM results for salmon. At present, a much more appropriate mechanism for analyzing salmon emigration is to examine fish migratory behavior using acoustic tagging. Reach-specific survival and associated error estimates are available for several Delta acoustic tagging studies (Burau et al. 2007; Perry et al. 2009; SJRGA 2007); the effect of flow on survival within Delta reaches remains highly uncertain.