Ecosystem Restoration: Spring-run Chinook Salmon in Butte Creek

What Is This Indicator, and Why Is It Important?

This indicator reports the in-river spawning escapement (the estimated number of adult salmon escaping ocean harvest and inland recreational fishing and successfully returning each year to spawn) of adult spring-run Chinook salmon in Butte Creek. The Butte Creek population is one of the few remaining self-sustaining populations of spring-run Chinook salmon in the Central Valley. Central Valley spring-run Chinook are listed as threatened under both the state and federal endangered species acts. Because of concerns about its status, it was targeted for restoration efforts, with the same doubling targets as applied to other runs (see Technical Note below and the Systemwide Salmon indicator). As with other runs, this indicator focuses specifically on the instream conditions that are the locus of restoration efforts and that strongly influence the success of four key phases of the species' survival and reproduction in Butte Creek (see conceptual model in Figure 1). This indicator alone is clearly not sufficient to evaluate progress toward the AFRP doubling targets. Any such evaluation would necessarily include a broader range of indicators and information (see Technical Note). However, measures of instream conditions are a valuable part of this broader portfolio of indicators and can provide important insight into the progress of specific restoration actions and the effect of instream conditions on salmon populations.

What Has Happened to Affect the Indicator?

Dams, inoperative fish ladders, and the dewatering of portions of the creek as a result of water diversions have created significant impediments to upstream passage for adults in the spring run in Butte Creek. Since the earlly 1990s, restoration actions in Butte Creek (Figure B2) have focused on improving water flow during the critical spring migration period, thereby increasing the likelihood that fish will succeed in reaching the upstream holding and spawning areas in good health, even in low water years. These restoration actions have included dam removal, installation and/or repair of fish ladders and fish screens, and improvements to base flow through a variety of water exchanges and flexible water management policies. As a result, the minimum flow for successful passage has decreased and is currently estimated at 80 cfs**.** While minimum flows were undoubtedly much higher in the past, prior to the removal of passage barriers, site-specific flow data are unavailable and it is therefore not possible to estimate minimum flow requirements for earlier periods.

What Do the Data Show?

The data show (Figure 2) that adult spring-run Chinook escapement was extremely low from about 1965 to about 1995, following a period of somewhat higher escapement in the early 1960s. In the years since significant restoration actions began in the early 1990s, escapement numbers have apparently increased. The smaller log-scale plot in Figure 2 shows that escapement is, on average, higher from 1995 onward than it has been at any time since the early 1960s.

The restoration actions described above succeeded both in opening additional stream miles to spawning and in reducing the minimum flow needed for successful passage. As a result, the number of days that flows were less than the minimum needed for successful passage upstream has decreased noticeably since 1994 (see Figure 2). The absence, from the early 1960s to the

early 1990s, of the pronounced cycles of abundance seen in other runs suggests that there were limiting factors operating that were specific to Butte Creek, suggesting further that the increase in escapement beginning in 1995 reflects restoration success. However, changes in ocean harvest regulations since 1995 have also resulted in lower ocean harvest rates on spring-run Chinook, which may have contributed significantly to the higher instream escapements observed since that time. The Discussion and the Technical Note make clear that it will take between 10 and 25 years, including dry periods with low flow, to reliably assess the longer-term success of restoration efforts. The current escapement levels have met the AFRP's population doubling targets for Butte Creek.

Discussion

Impediments to upstream passage and low instream flows reduced the long-term sustainability of the population by diminishing its ability to successfully reproduce in both wet and dry years and thus survive natural fluctuations in habitat conditions. Within the watershed, the ability to migrate upstream and the area and quality of adult summer holding habitat and spawning habitat are of primary importance. In Butte Creek, temperatures in the summer holding areas and human disturbance in both the summer holding and spawning areas are key factors that can affect survival and reproduction. During the juvenile emigration phase, in both Butte Creek and the larger Sacramento River / Bay-Delta system, the extent of shaded riparian habitat, the availability of food, the presence of sufficient transport flows, predation, and entrainment all combine to affect to some degree the success of outmigration.

Returns of adult spring-run Chinook salmon are influenced by factors within the Butte Creek watershed, in the Sacramento River and Delta/estuary, and the Pacific Ocean (see Figure 1). In the Pacific Ocean, the ocean fishery and conditions related to both shorter-term events (such as El Niños) and longer-term shifts in ocean climate (such as the Pacific Decadal Oscillation) also affect overall patterns of salmon abundance. Changes in ocean harvest regulations since 1995 have also significantly changed ocean harvest rates of spring-run Chinook. This wide range of influences can contribute to year-to-year variability in escapement, as well as to longer-term fluctuations in population levels. In addition, these factors can interact in complex ways and the degree to which they become limiting, either individually or in combination, depends on their relative severity and on the state of the population at any given time. However, it is probably safe to say that factors related to ocean climate are unlikely to have been confounding factors during the period of extremely low escapement (1965-1995) because low escapement occurred in both wet and dry periods and this run did not exhibit the fluctuations seen in other runs. However, as restoration actions lead to increased escapement, these other sources of variability may exert more influence on trends in escapement. In that case, it will take some time to determine whether the increase in escapement in the late 1990s is part of a long-term increasing trend or merely the upward-trending portion of another cycle of abundance such as those that have occurred in other salmon runs in the Central Valley since the 1950s.

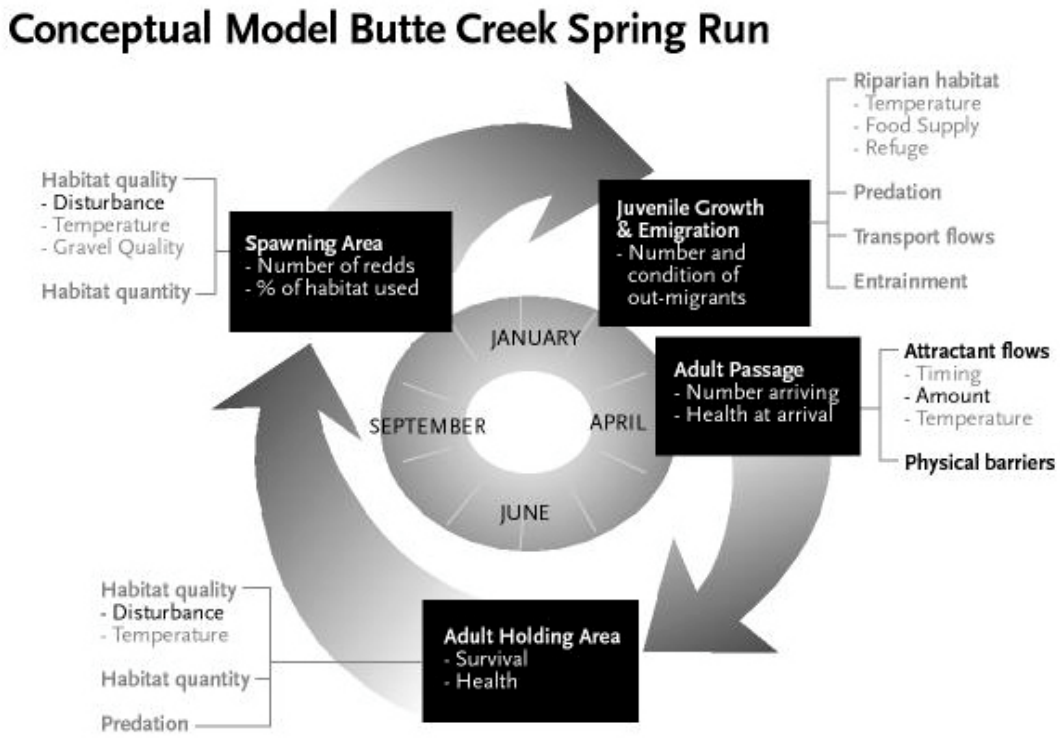

Figure 1. Conceptual model of the Butte Creek spring run, emphasizing factors and processes that operate within Butte Creek itself. Elements in bold text have a larger influence on overall success of the run. The ocean life history phase is not included, and processes in the Delta are subsumed under juvenile growth and emigration.

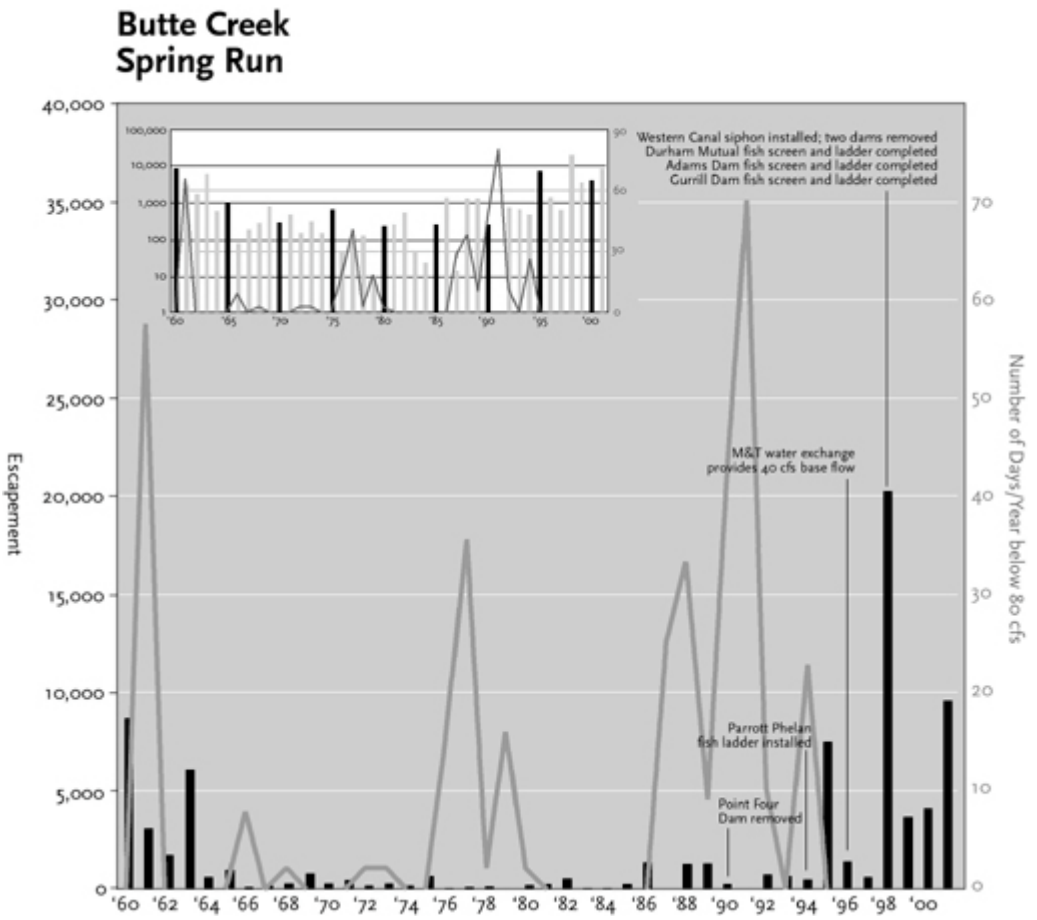

Figure 2. Long-term trend in in-river spawning escapement (vertical bars) shown in the context of key restoration actions and the number of days in each year's upstream migration period that flows were below the critical minimum passage threshold of 80 cfs (continuous line).

Technical Note: Spring-Run Chinook Salmon in Butte Creek

The Indicator

Goal: See Technical Note for the Systemwide Salmon indicator.

Response Time: See Technical Note for the Systemwide Salmon indicator.

The Data

Data Collection: Escapement data on Butte Creek extend back to 1960. Data represent a combination of visual counts made from the creek bank, snorkel data, and, more recently, mark-recapture sampling on carcasses.

Long-term flow data have been measured since the early 1930s with a gauge at Centerville and more recently with additional gauges at other locations. In addition, monitoring has recently been expanded to include the number and distribution of redds in spawning areas.

See Technical Note for the Systemwide Salmon indicator for further discussion of methods of estimating escapement and gathering flow and temperature data.

Data Quality / Limitations: See Technical Note for the Systemwide Salmon indicator for further discussion of data quality issues related to escapement estimates. Spring run escapement is particularly difficult to sample because the fish travel high up into the watershed and distribute themselves along many stream miles of rugged terrain that is difficult to access. In these environments, carcass surveys can also be biased because bears may eat carcasses before they are sampled by the monitoring team.

The estimate of current minimum passage flows was based on interviews with a biologist with a long history of personal experience in the watershed.

Longer-Term Science Needs

See Technical Note for the Systemwide Salmon indicator for a discussion of science needs related to improving estimates of escapement and juvenile production, and to developing improved, quantitative recovery goals.

Another possible research focus is the potential for restoration actions in the Sutter Bypass/Butte Sink area that would enhance its production and utility for juveniles migrating downstream.