Splittail Revisited

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The native cyprinid splittail (*Pogonichthys macrolepidotus*) is found in fresh and brackish water of the Sacramento-San Joaquin estuary and upstream tributaries. The species matures at about 2 years and frequently lives up to 5 years. Adults undertake an annual upstream spawning migration from the estuary in fall and winter – we believe they spawn primarily in winter and spring on flooded vegetation. The young rear in the delta and tributaries before gradually moving to brackish areas.

Concerns about reduced abundance and distribution formed the basis of the 1994 proposal to list splittail as threatened under the Federal Endangered Species Act (Meng and Kanim 1994). Following the proposed listing, the Resident Fishes Project Work Team began a series of studies of the biology of splittail, which led to our paper, "The Resilience of Splittail in the Sacramento-San Joaquin Estuary", to be published this fall in *Transactions of the American Fisheries Society*.

Our studies focused on trends in abundance and distribution and factors that regulate them. Methods included analyzing long-term databases and collecting new field data. Extreme variation in hydrology provided a good opportunity to determine whether the reduced abundance and range reported in the listing proposal and by Meng and Moyle (1995) would prevent the population from responding to high streamflow.

Review of nine IEP databases showed that young splittail abundance was dramatically reduced during the 1987-1992 drought (Figure 1). Nonetheless, it is clear that the drought did not compromise the ability of the stock to rebound. Wet conditions in 1995 resulted in record indices for most of the measures of young-of-the-year abundance. This response is similar to other extremely wet years, such as 1982, 1983 and 1986, which also produced high indices.

In contrast to young splittail, adult abundance showed no obvious decline during the 1987-1992 drought (Figure 2). There is some indication that the adult stock may have decreased somewhat in 1988 or 1989, but the change was not as striking as it was for juveniles. The greater stability of the adult stock is not surprising given the long life span of the species. However, we acknowledge that the indices are subject to several biases, so it is also possible that the data are not sensitive enough to demonstrate downward trends. Another key point is that there was a major increase in adult abundance in 1993 following six consecutive years of drought; this contradicts the notion that recruitment was poor throughout the drought. Clearly, there must be at least some recruitment in all water year types.

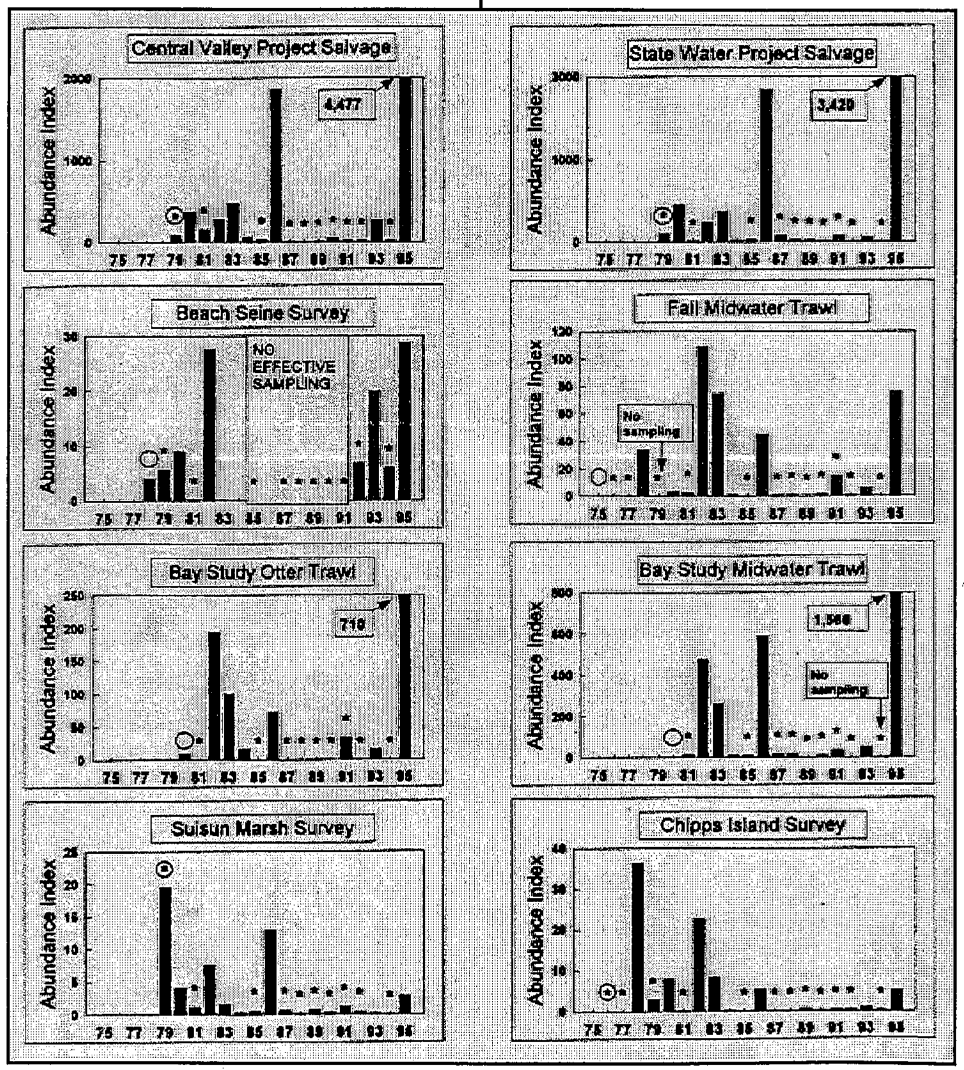

Figure 1
TRENDS IN AGE-0 SPLITTAIL ABUNDANCE FOR 1975-1995, AS INDEXED BY EIGHT SURVEYS
The first data point in each series is marked with a circle.
Dry years are identified with asterisks above the data points; all other years are wet.

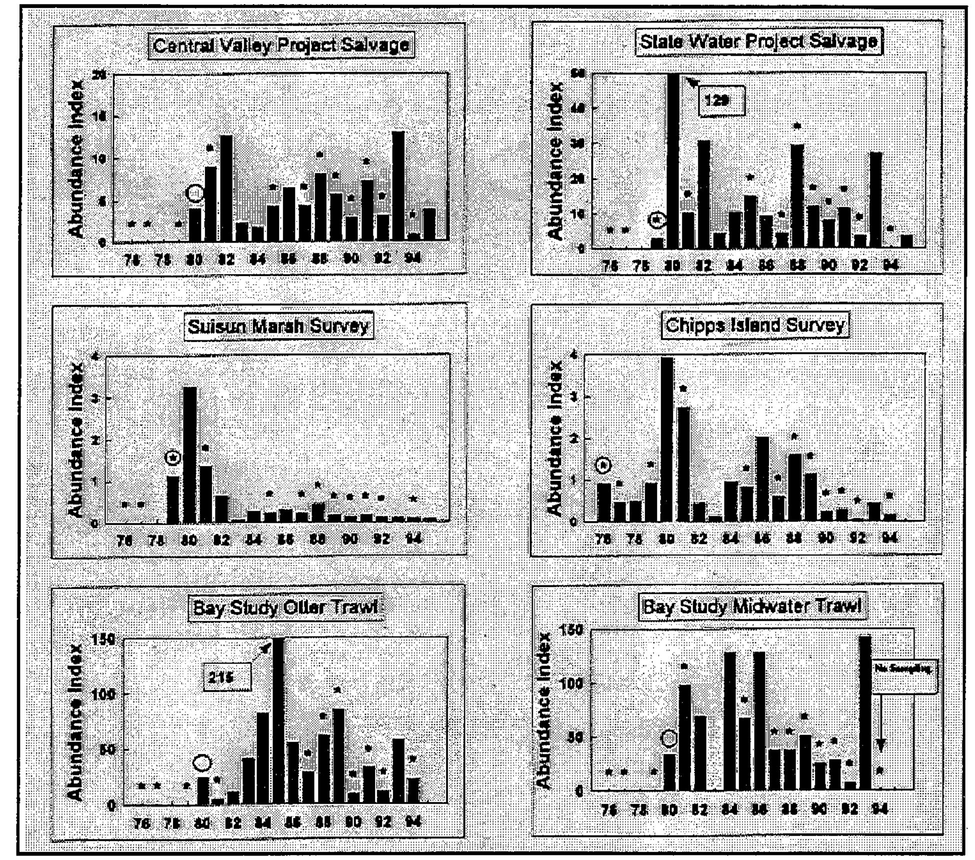

Figure 2
TRENDS IN ADULT SPLITTAIL ABUNDANCE FOR 1976-1995, AS INDEXED BY SIX SURVEYS
The first data point in each series is marked with a circle.
Dry years are identified with asterisks above the data points; all other years are wet.

Review of historical and recent splittail data showed that the range of the species has not changed much over the past two decades. Although splittail range has been lost as a result of dam and levee construction, we disagree with suggestions by Meng and Moyle (1995) that runs in the Sacramento and San Joaquin tributaries have largely disappeared. In the 1990s, splittail were collected as far north as Glenn-Colusa Irrigation District's Sacramento River diversion, as far south as the Tuolumne River, and to the Petaluma and Napa rivers in the west. Tributary collection sites within this broad area included Butte Creek and the Feather, American, Cosumnes, and Mokelumne rivers. Based on the recent farthest upstream collections, splittail still occupy more than 75% of the rivers available to them below the dams on the Sacramento, San Joaquin, Feather, and American rivers (Figure 3).

Analysis of the distribution of splittail is complicated by monthly and annual variability. Geographic distribution is broadest in winter, when adults migrate upstream to spawn, and narrowest in summer, when most return to the estuary. Records from earlier this century suggest this was also the case historically. For example, in 1928 the commercial splittail catch in the Sacramento and San Joaquin rivers peaked in late autumn and winter, suggesting the fishery targeted the splittail spawning migration. The distribution of young splittail also appears to be highly variable on a year-to-year basis. Catch in the FWS beach seine survey is typically highest in the upper Sacramento River and northern delta, but in some years much of the distribution shifts toward the southern and western delta.

Like many other estuarine species, splittail abundance is significantly higher in wetter years. However, splittail is one of the few species for which we have some understanding of the underlying mechanism controlling abundance. We found a significant relationship between splittail fall midwater trawl abundance and the number of days the Yolo Bypass is flooded each year. Yolo Bypass, the major floodplain area of the delta, is typically inundated when Sacramento River flows

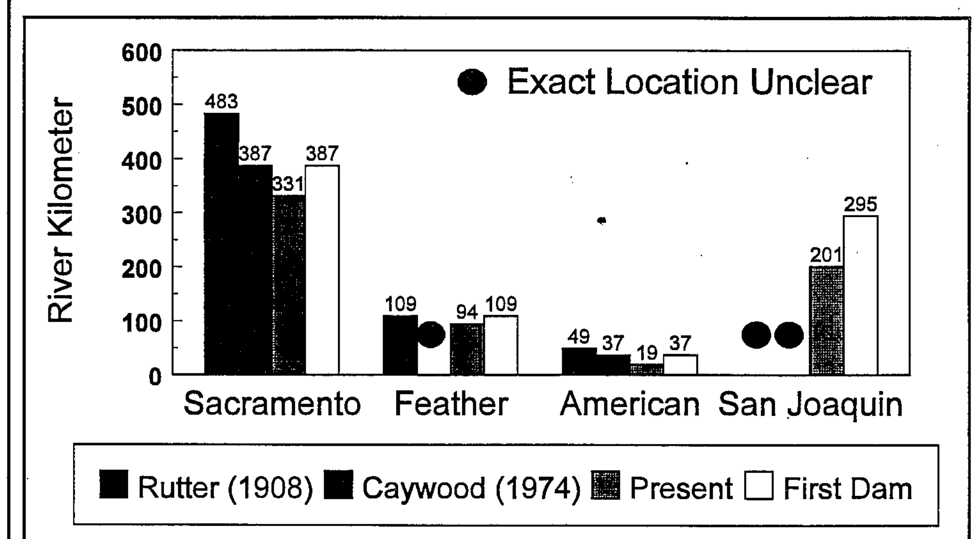

Figure 3
COMPARISON OF RECENT AND HISTORICAL COLLECTION OF SPLITTAIL FROM SITES FARTHEST UPSTREAM ON DELTA TRIBUTARIES
Location of the first dam or major migration barrier is provided for reference.
Circles indicate splittail were present but exact collection site is unknown.

exceed 75,000 cfs. We believe the Yolo Bypass and similar areas provide important spawning, rearing, and foraging habitat, leading to successful recruitment. In support of that hypothesis, Resident Fishes PWT surveys of the basin demonstrated that:

- Adult splittail move into the bypass during spawning periods, and
- Catch of larval splittail at the Yolo Bypass outfall was significantly higher than at stations in the Sacramento, American, and Feather rivers. In fact, larval density was among the highest observed anywhere in the estuary.

We also reviewed other factors that may influence splittail abundance, including salinity and water project entrainment. Analysis of Suisun Marsh field data confirmed the findings of UC-Davis laboratory studies (Young and Cech 1995) that splittail are fairly halotolerant. They are abundant across a broad range of salinity, as opposed to delta smelt, which show a distinct peak in abundance around 0.2-1.0 ppt. Salvage data since 1979 suggest the SWP has not had an important effect on splittail population level. Splittail abundance is positively correlated with salvage, contrary to the hypothesis that entrainment losses should decrease abundance. In other words, splittail entrainment is primarily determined by abundance in the system, rather than vice versa. Entrainment is, therefore, highest in wet years, when the splittail population is best able to accept losses. This contrasts to delta smelt and longfin smelt, which show higher salvage in drier years, when their populations are typically lowest.

Conclusions

Despite reduced abundance of young splittail during extended drought, the population still appears resilient. The strong 1995 year class is an excellent example — record indices were produced after drought in 7 of 8 preceding years, a period that could reasonably have been expected to deplete the stock. Attributes that help the population respond quickly to improved environmental conditions include a long life span and high fecundity. Splittail distribution does not appear to have changed much over the past two decades, although it varies substantially between years. Year class strength appears to be controlled primarily by inundation of floodplain areas, such as Yolo Bypass, which provide spawning, rearing, and foraging habitat. Water project entrainment does not appear to have an important effect on population level, but the variability in distribution of young splittail suggests we should continue to monitor their distribution and salvage. A shift in distribution toward the export facilities coupled with reduced abundance in dry years could affect population levels, but this has not been detected.

Finally, several important issues should be pursued. Splittail remains under consideration as a threatened species — better data are needed on its basic biology to help guide policy-makers and regulators. In particular, we need to determine why abundance of splittail young and adults has remained relatively low in the Suisun Marsh/Chipps Island region since the early 1980s. One possibility is that high abundance in the late 1970s and early 1980s was the result of a localized spawning event. Additional studies are needed to answer this question. Another key issue is whether splittail abundance can be improved in dry years by constructing more habitat. At present, the Yolo Bypass floods in only one-third of water years, and it appears that at least 30 days of flooding during the splittail spawning season are needed for development of a strong year class. Proposals to increase the amount of shallow water and floodplain habitat might have major benefits to abundance in dry to moderately wet years. However, we need better information on the optimum habitat features for spawning and rearing to help design restoration efforts.

References

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Unusual Weather

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December and January were the wettest 2-month period in our record, with some record-breaking floods, but February through May were the driest 4-month sequence on record at most locations from Interstate 80 southward. June may have marked a turn-around, in that northern Sierra precipitation was more twice the average. June precipitation is only 2% of the annual total, so the high percentage doesn't mean much for runoff. Figure 1 shows how this water year's precipitation in the northern Sierra compares with average and with 1995 and 1996.

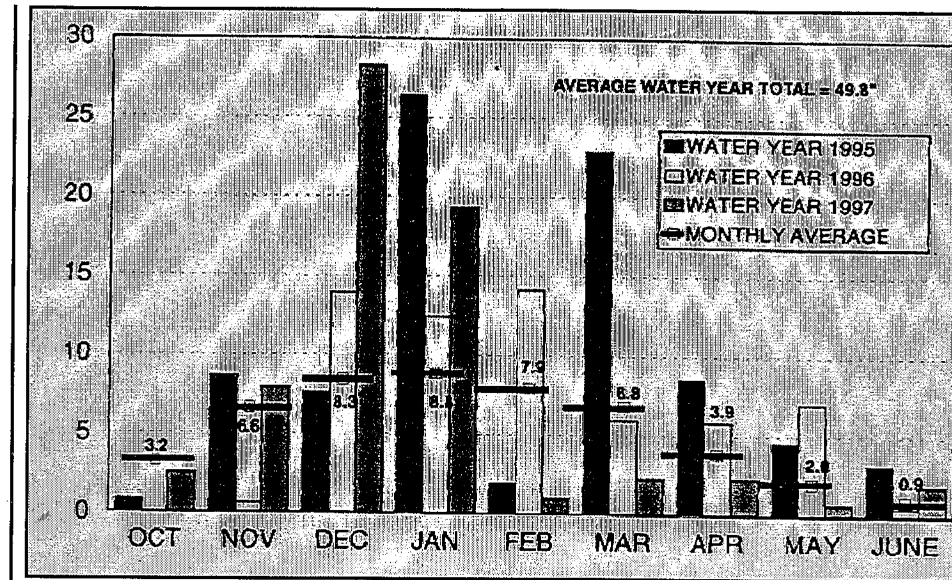

Figure 1
NORTHERN SIERRA PRECIPITATION, 8-STATION AVERAGE
In Inches

This year has also been warmer than average. Sacramento had its warmest spring and third warmest winter on record. Monthly average temperatures at Sacramento are:

	Water Year 1997	1961-1990 Average
October 1996	66.1	65.8
November 1996	57.2	54.9
December 1996	52.4 (2nd warmest)	47.1
January 1997	50.0	47.1
February 1997	54.9	52.9
March 1997	61.2 (2nd warmest)	56.1
April 1997	64.7 (5th warmest)	60.8
May 1997	74.5 (warmest)	67.2
June 1997	74.7	73.0

The lack of spring precipitation caused an unusual snowpack pattern. In an average year, the February 1 snowpack is 65% of the April 1 amount. Accumulation continues through February and March for the peak seasonal amount on about April 1. This year, the February 1 statewide snowpack was estimated to be about 100% of the April 1 average. March 1 snowpack measurements showed essentially no change, still 100%, although there were large regional differences. Warmer than average temperatures in March caused early melting of the snowpack, especially at lower elevations, and the estimated pack was 75% of average on April 1. By May 1, the statewide snowpack had dropped to 45% of the April 1 average, with only about 25% in the Sacramento River region. One could say snowmelt was about a month early in 1997.

There was a good snowpack at Christmas, but the warm flood-producing storms at year end melted the lower elevation snowpack. Since the northern Sierra snow fields are at lower elevation than in the southern Sierra, loss in snowpack and subsequent spring runoff there were proportionately greater in the north. Estimated snowmelt runoff this year is 70% of average in the Sacramento River region, 100% in the San Joaquin River region, and 120% in the Tulare Lake region. The east side of the Sierra had a similar pattern, with amounts south of Lake Tahoe well above average. Table 1 shows some percentage comparisons.

Table 1
ESTIMATED MONTHLY RUNOFF, WATER YEAR 1997
*Percent of Average **

Month	Northern Sierra Precipitation	Estimated Unimpaired Runoff* Statewide	Sacramento	San Joaquin
October	75	80	90	60
November	120	100	100	200
December	340	300	310	380
January	220	390	370	840
February	15	90	90	125
March	35	80	70	125
April	60	85	70	110
May	35	85	60	115
June	230	80*	60*	80*

*Sacramento is the sum of Sacramento (above Bend Bridge near Red Bluff), Feather, Yuba, and American rivers. San Joaquin is the sum of Stanislaus, Tuolumne, Merced, and San Joaquin (at Friant) rivers.
**Estimated