

DRAFT

**Suisun Marsh Salinity Control Gates
Salmon Passage Evaluation Report
2004**



Department of Water Resources
and
Department of Fish and Game

DRAFT

May 2005

Adult Salmon Passage Monitoring, Suisun Marsh Salinity Control Gates, September to November 2004

Introduction

The 2004 adult salmon passage study is a continuation of ultrasonic telemetry studies which began in 1993 (Tillman *et al* 1996; Edwards *et al* 1996) to monitor and assess the effects of the Suisun Marsh Salinity Control Gates (SMSCG) on migrating adult Chinook salmon (*Oncorhynchus tshawytscha*), particularly federally listed winter-run, which may be present in Montezuma Slough during the peak operating times of the gates, October – May. The early studies showed that the gates did have a negative effect on salmon passage and the authors recommended making modifications to the existing structure. In 1998, two horizontal openings were incorporated in the existing flashboards to increase the salmon passage rate and decrease passage time through the gates. Results from the 1998 and 1999 studies indicated that the modified flashboards did not improve salmon passage at the SMSCG (Vincik *et al* 2003).

Passage studies were resumed in 2001 focusing on the use of the boat lock as an alternate means of fish passage during normal operations. The open boat lock provided a 20 foot wide by 12 foot (average) depth passage for adult salmon without compromising water quality in the Suisun Marsh. Three configurations (operational phases) were used for the 2001 through 2004 studies of the Salinity Control Gates (Figure 1). The order of the operational phases was changed each study year to minimize the effect seasonal timing of salmon migration might have on passage rates.

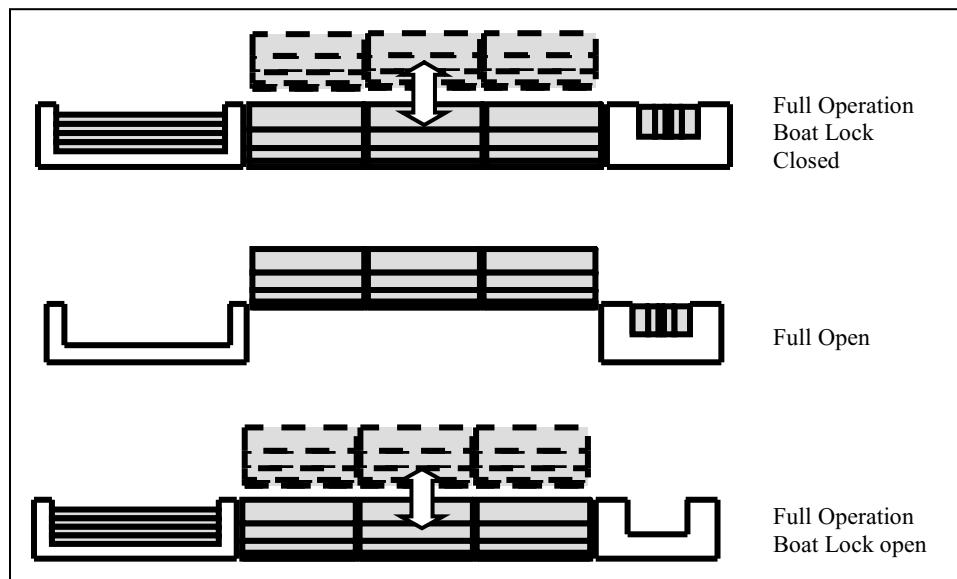


Figure 1. Three operational configurations of the SMSCG.

DRAFT

During the 2004 study a total of 197 adult salmon were captured using a large mesh gill net, measured to the nearest mm fork length, visually sexed and internally implanted with an ultrasonic transmitter. A Floy tag was attached externally just behind and below the dorsal fin to help identify any tagged fish that might be recaptured by the tagging crew. The address of the Stockton Fish and Game office was printed on each Floy tag to aid in the recovery of information from recreational anglers if the fish were caught beyond the study area. Salmon were tagged and monitored through 3 operational phases during September 27 – November 8:

Phase	Gate Configuration	Date	# of Tagged Salmon
I	Full Open	9/27 – 10/10	66
II	Full Operation, Boat Lock Open	10/11 – 10/24	66
III	Full Operation, Boat Lock Closed	10/25 – 11/8	65

Adult fall-run Chinook salmon were used as a surrogate for the federally listed winter-run with tagging being completed by October 28 which did not overlap with the time designated for the presence of winter-run salmon in Montezuma Slough.

For the 2001 and 2002 studies, Sonotronics telemetry equipment was used to track and monitor tagged salmon. In 2003, due to equipment problems, Sonotronics equipment was replaced with Vemco brand products which required less maintenance and were easier to deploy in and around the SMSCG. Each ultrasonic tag was coded with a unique signal to identify individual tagged fish. The signals were recorded at stationary monitoring sites located upstream and downstream of, and on the SMSCG (Figure 2).

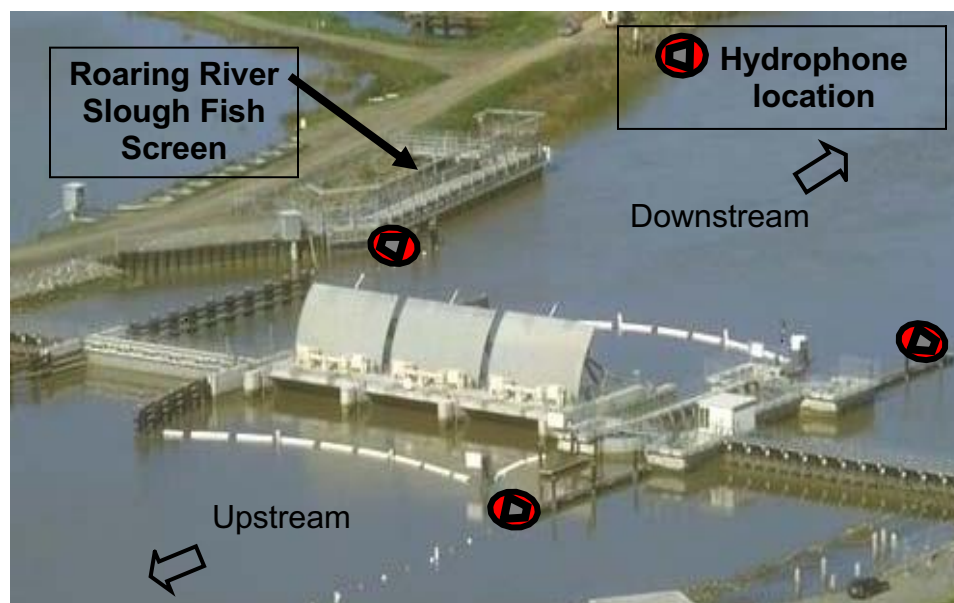


Figure 2. Location of hydrophones at the SMSCG Sept – Nov 2004

DRAFT

In 2004, additional monitoring sites were set up further upstream and downstream on the Sacramento and San Joaquin Rivers to record fish migration beyond the study site (Figure 3).

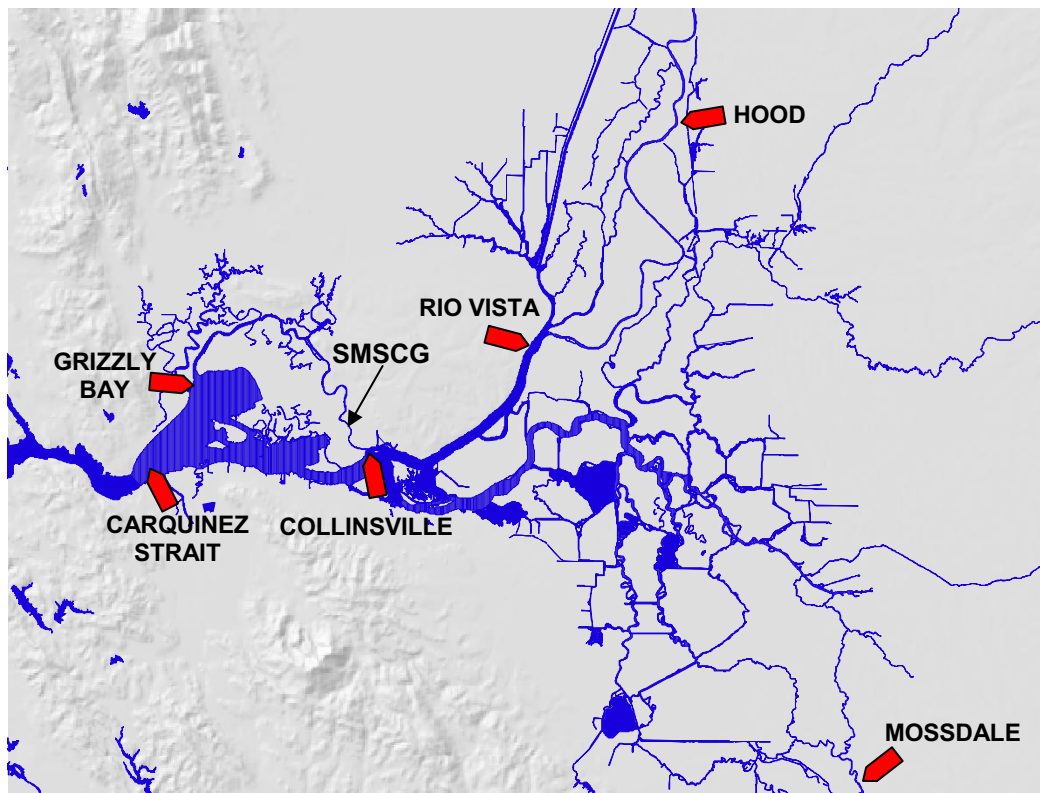


Figure 3. Monitoring sites on the Sacramento and San Joaquin Rivers

2004 Results

Ninety-seven tagged salmon passed through the SMSCG during all three phases of the 2004 tagging study representing 49% of the 197 total tagged adult salmon. One hundred tagged salmon did not pass the gates (51%) and returned downstream after tagging. The full open configuration had the highest percentage of passage (58%), and the full operation, boat lock closed configuration had the lowest percentage of passage (35%) (Figure 4).

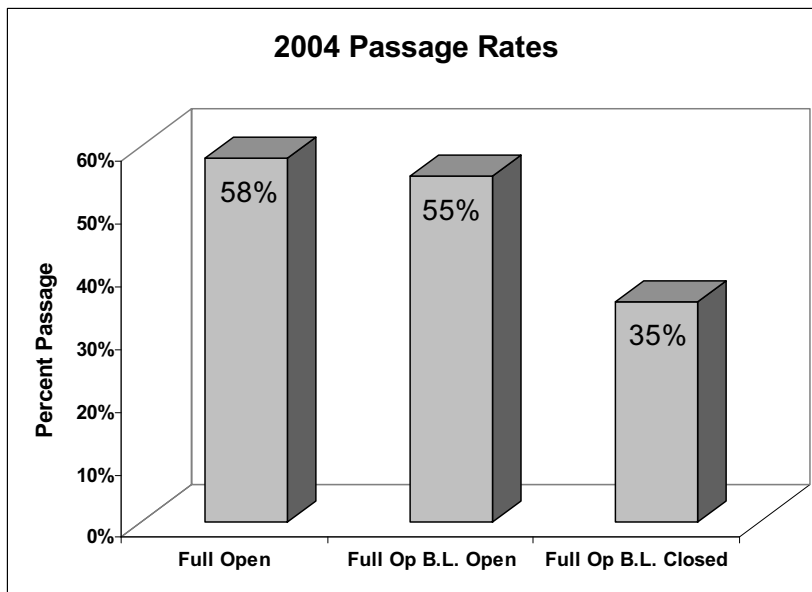
DRAFT

Figure 4. Passage rates by phase at the SMSCG, Sept-Nov 2004

Passage times for tagged salmon ranged from 1.6 to 327.9 hours with the full operation, boat lock closed configuration having the longest mean passage time (60.6 hours) and the full operation, boat lock open configuration having the lowest mean passage time (27.9 hours) (Figure 5).

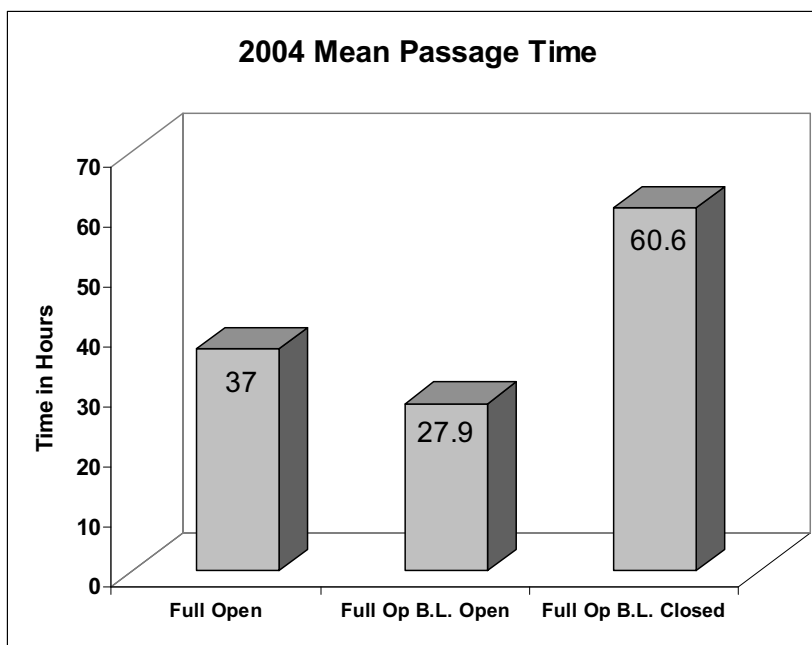


Figure 5. Mean passage time by phase at the SMSCG, Sept-Nov 2004

DRAFT

Tagged salmon ranged from 600 to 1150 mm fork length and were evenly distributed between males and females.

Passage by Phase

Phase I (full open) – of the 66 salmon tagged during this phase 38 (58%) passed the gates with a mean passage time of 37 hours. After passing the gates, 11 tagged salmon moved back downstream, and 28 (42%) moved downstream without passing the gates.

Phase II (full operation, boat lock open) – of the 66 salmon tagged during this phase 36 (55%) passed the gates with a mean passage time of 27.9 hours. After passing the gates, 11 tagged salmon moved back downstream and 30 (45%) moved downstream without passing the gates.

Phase III (full operation, boat lock closed) – of the 65 salmon tagged during this phase 23 (35%) passed the gates with a mean passage time of 60.6 hours. After passing the gates, 2 tagged salmon moved back downstream and 42 (65%) moved downstream without passing the gates.

Phase I (full open) had the best passage rate and was significantly different ($P < 0.05$) from the Phase III (full operation, boat lock closed). There was also a significant difference between Phase II (full operation, boat lock open) and Phase III (full operation boat lock closed) ($P < 0.05$). There was no significant difference in passage times between all three phases (Table 1).

Table 1 Chi-square and probability for passage rates

Phase I vs. Phase II:	$\chi^2 = 0.12, P = 0.729$
Phase I vs. Phase III:	$\chi^2 = 6.48, P = 0.011^*$
Phase II vs. Phase III:	$\chi^2 = 4.86, P = 0.027^*$

Kruskal-Wallis Analysis of Variance for passage times

Phase I vs. Phase II vs. Phase III: $P = 0.078$

* indicates significant difference.

Salmon Usage of the Boat Lock

During the full operation, boat lock open phase, of the 36 tagged salmon to pass through the gates 11 (33%) used the boat lock for passage. Seven salmon passed during a flood current, three salmon during ebb and one salmon during slack. Current flows were determined using the *Tides and Currents for Windows* program set for the east end of Montezuma Slough. Eleven of the twelve tagged salmon passed during daylight hours with an average passage time of 14 minutes through the gates. Seven were female and five male.

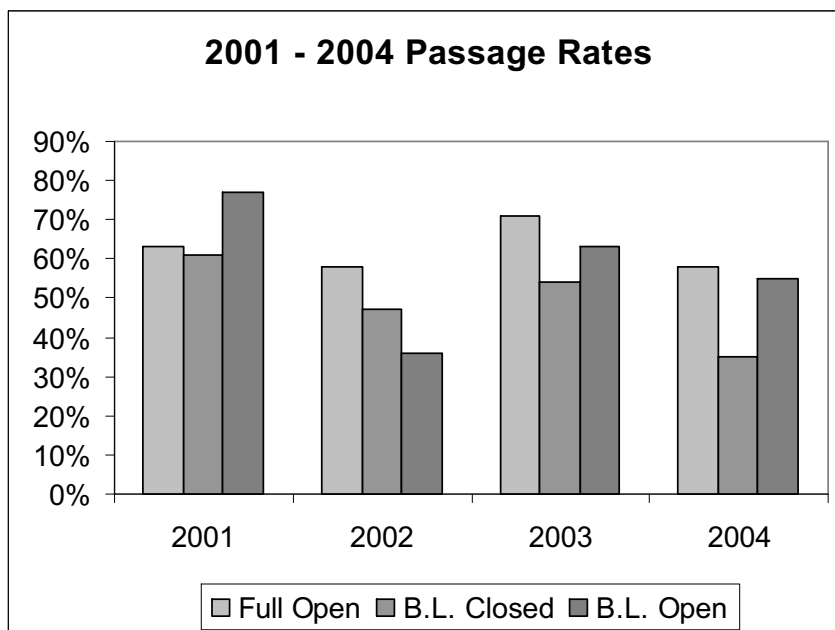
DRAFT

Additional Monitoring Sites

In addition to the monitoring sites set up in Montezuma Slough, tagged salmon were recorded at locations upstream and downstream from the main study. At the upstream locations, ninety-seven tagged salmon were recorded at the Collinsville site. These salmon were made up of the 73 that continued past the gates in addition to several that moved back downstream (without passing the gates) and subsequently moved through Montezuma Slough, into Grizzly Bay then past Collinsville. Fifty-eight were recorded further upstream at Rio Vista and forty-nine at Hood, the uppermost Sacramento River site. Two salmon were recorded at Mossdale Landing on the San Joaquin River. Several tagged salmon were recorded at the downstream sites as well with eighty-five tagged salmon recorded at the Grizzly Bay site. The site located furthest downstream at the Carquinez Strait had 3 records of tagged fish and may have had more except the unit stopped working on October 8th due to a leak in the battery compartment. Tagged salmon were frequently detected at more than one site with several fish moving upstream and downstream. Salmon also exhibited milling behavior, and moved tidally, traits documented in previous studies (Tillman *et al* 1996; Edwards *et al* 1996).

Discussion

The feasibility of using the boat lock for salmon passage was first tested during the 2001 SMSCG adult salmon passage study with favorable results (Vincik 2002). Although the first year's results were not confirmed in the 2002 SMSCG study, they were in the 2003 and 2004 SMSCG studies showing a higher percentage of fish passage during the full operation boat lock open configuration when compared with the full operation, boat lock closed configuration (Figure 6). The full open configuration consistently had a higher percentage of passage when compared with the full operation, boat lock closed configuration.



DRAFT

Figure 6. Passage rates for 2001 – 2004 study years.

Results for migration delay at the gates were less consistent with the passage rate findings. The 2001 study showed a greater mean delay time in the full operation, boat lock closed configuration when compared with the full operation, boat lock open configuration. This relationship was not observed in the 2002 or 2003 SMSCG studies but the 2004 the results were consistent with the first years' study (Figure 7). The full open configuration between study years had a consistently lower mean migration delay when compared with the full operation, boat lock closed configuration.

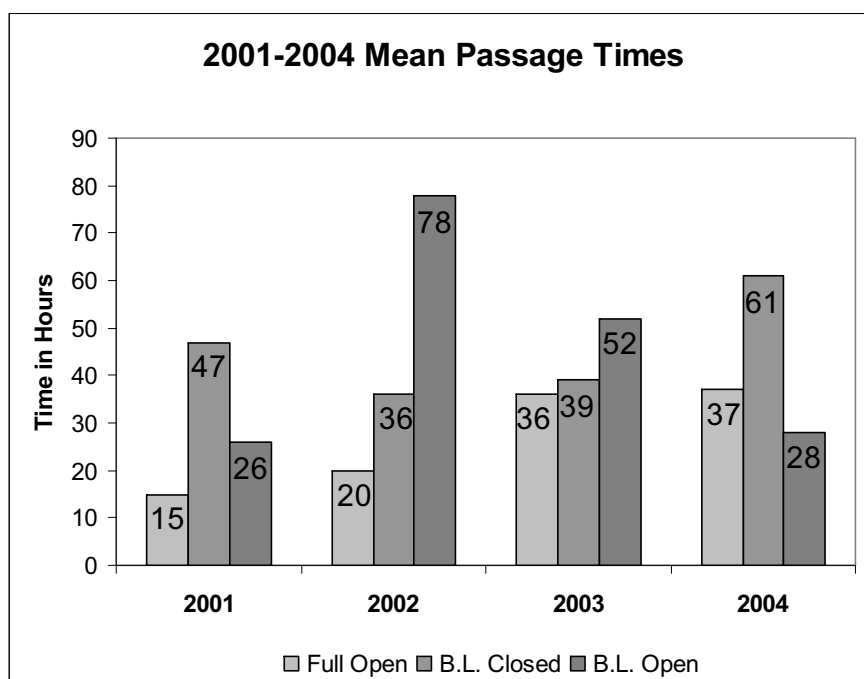


Figure 7. Mean passage times for 2001 – 2004 study years

The 2004 study experienced mechanical problems during the study. At the start of the study a cable failure on the eastern most radial gate (number 1) resulted in the gate not being able to be raised from the closed position. This situation effectively removed one third of the passage area for migrating salmon when the remaining radial gates were in full operation with flashboards installed and the boat lock closed. The options were to continue with the study or immediately begin repairing the gate. Since the receivers were in place, tagging had already begun, and repair operations would greatly interfere with the study, it was decided to continue the study with the damaged gate left in the closed position.

DRAFT

The results for the 2004 SMSCG study show a lower percent of passage during the full operation, boat lock closed configuration when compared with previous years and there is a significant difference in passage ($P < 0.05$) when compared with the 2001 and 2003 studies (Table 2).

Table 2. Chi-square comparison of 2001-2004 Passage Rates for Full Operation, Boat Lock Closed Configuration by Year

Year	χ^2	<i>P</i> value
2001 vs. 2002	1.19	0.275
2001 vs. 2003	0.32	0.572
2001 vs. 2004	8.18	0.004*
2002 vs. 2003	0.26	0.610
2002 vs. 2004	2.88	0.089
2003 vs. 2004	4.86	0.027*

* Denotes significant difference

Although the 2004 results show significant differences in the percentages of fish passage when compared with previous studies, the intra-annual passage rates are still in proportion with the paired rates from these studies. The passage rate for the full operation, boat lock closed configuration has consistently been lower when compared with the full open configuration and lower than the full operation, boat lock open phase, with the exception for the 2002 study (Figure 6).

Even though the passage rate was lower in 2004 the study results confirm that the boat lock open configuration allows a higher percentage of fish passage when the Salinity Control Gates are tidally operated and the flashboards are in place.

DRAFT

References

- Edwards, G.W., K.A.F. Urquhart, and T. L. Tillman. 1996. *Adult salmon migration monitoring, Suisun Marsh Salinity Control Gates, September-November 1994*. Technical Report 50, Interagency Ecological Program for the San Francisco Bay/Delta Estuary. 27pp.
- Tillman, T.L., G. W. Edwards, and D.A.F. Urquhart. 1996. *Adult salmon migration during the various operational phases of the Suisun Marsh Salinity Control Gates in Montezuma Slough, August-October 1993*. Agreement to the Department of Water Resources, Ecological Services Office by Department of Fish and Game; Bay-Delta and Special Water Projects Division. 25pp.
- Vincik, R.F. 2002. *Adult salmon migration monitoring at the Suisun Marsh Salinity Control Gates, Sept.-Nov. 2001*. Interagency Ecological Program for the San Francisco Estuary Newsletter 15:45-48.
- Vincik, R.F., G.W. Edwards, G.A. Aasen, and R.W. Fujimura. 2003. *Suisun Marsh Salinity Control Gates adult salmon passage monitoring, 1998-1999*. Technical Report (unpublished), Interagency Ecological Program for the San Francisco Bay/Delta Estuary. 27pp.