

Memorandum

Date: March 7, 2023

To: Mr. Dean Messer, Division Manager
Department of Water Resources
Division of Environmental Services
3500 Industrial Boulevard
West Sacramento, California 95691-6521

Original signed by

From: Erin Chappell, Regional Manager
Department of Fish and Wildlife – Bay Delta Region 3, 2109 Arch Airport Road, Suite 100, Stockton, CA 95206

Subject: Mitigation Loss Calculations for the 1986 Delta Fish Agreement

The State Water Project (SWP) mitigation loss calculation for 2022 is complete as required by the 1986 Delta Fish Agreement between the Department of Water Resources and the Department of Fish and Wildlife. As previously agreed, loss of Striped Bass under 21 mm is based on the mean loss from 1985 through 1995. The estimated mitigation losses for 2022, which are based on five-year mean values, are as follows:

<u>SPECIES</u>	<u>NUMBER OF EQUIVALENTS</u>
Striped Bass	39,968 (yearlings)
Chinook Salmon	15,809 (smolts)
Steelhead Rainbow Trout	2,737 (yearlings)

The enclosed table lists the annual SWP loss estimates for yearling-equivalent Striped Bass, smolt-equivalent Chinook Salmon, and yearling-equivalent Steelhead Rainbow Trout (Table 1). The five-year loss running averages are also enclosed (Table 2).

Appendix A: There is a comparative table and graphs from 2010 are shown in this appendix to compare SAS and R Code results.

If you have any questions, please contact Mr. Geir Aasen, Environmental Scientist, at (209) 639-2750/ Dr. Samreen Siddiqui, at (209) 638-8729.

Attachments

cc: Department of Water Resources, West Sacramento
Mr. Dan Riordan, Program Manager
Mr. Anthony Linarez, Program Lead

Department of Fish and Wildlife
Dr. Timothy Malinich, Stockton
BF/djh

Table 1. Yearling-equivalent losses for Striped Bass and Steelhead Rainbow Trout and smolt-equivalent losses for Chinook Salmon for the State Water Project, 1984-2021.

YEAR	Yearling-Equivalent Striped Bass			Smolt-Equivalent Chinook Salmon			Yearling-Equivalent Steelhead		
	≤ 20 mm	> 20 mm	Total Loss	YOY	Yearling	Total Loss	YOY	Yearling	Total Loss
1984		873,853	873,853	290,696	947,503	1,238,199	0	1,713	1,713
1985	65,177	370,976	436,153	472,512	489,713	962,225	0	15,621	15,621
1986	35,315	944,061	979,376	1,147,249	2,300,866	3,448,115	0	15,663	15,663
1987	41,726	954,958	996,684	528,544	713,791	1,242,334	747	21,266	22,013
1988	59,625	874,055	933,680	409,103	747,953	1,157,056	0	25,080	25,080
1989	56,306	579,003	635,309	373,717	246,641	620,358	253	32,571	32,824
1990	7,717	401,353	409,070	90,098	188,228	278,326	0	19,187	19,187
1991	15,117	192,765	207,882	122,127	128,466	250,593	0	38,430	38,430
1992	13,452	299,687	313,139	21,341	224,603	245,944	275	39,931	40,206
1993	25,766	1,194,011	1,219,777	17,547	68,521	86,068	0	47,782	47,782
1994	2,253	122,656	124,909	8,217	25,073	33,290	0	1,738	1,738
1995	3,256	265,225	268,481	26,224	199,012	225,236	0	4,802	4,802
1996*	29,610	214,213	243,823	28,425	121,437	149,862	0	14,240	14,240
1997*	29,610	219,225	248,835	39,792	38,973	78,765	0	1,153	1,153
1998*	29,610	71,980	101,590	10,107	28,683	38,790	0	352	352
1999*	29,610	271,436	301,046	199,537	73,867	273,404	0	4,917	4,917
2000*	29,610	926,501	956,111	173,324	71,333	244,657	74	27,848	27,922
2001*	29,610	262,459	292,069	97,264	80,472	177,736	67	35,146	35,213
2002*	29,610	243,270	272,880	16,914	36,751	53,665	24	9,606	9,630
2003*	29,610	173,492	203,102	43,318	96,780	140,098	0	25,262	25,262
2004*	29,610	161,021	190,631	26,479	84,691	111,170	0	20,321	20,321
2005*	29,610	101,999	131,609	38,600	63,400	102,000	0	9,859	9,859
2006*	29,610	39,341	68,951	26,330	38,851	65,181	0	5,837	5,837
2007*	29,610	85,342	114,952	4,862	10,904	15,766	11	6855	6,866
2008*	29,610	62,853	92,463	12,876	27,618	40,494	0	8,721	8,721
2009*	29,610	44,822	74,432	7,563	9,627	17,190	0	2,942	2,942
2010*	29,610	89,520	119,130	3,086	26,308	29,394	14	6,686	6,700
2011*	29,610	253,776	283,386	20,997	197,196	218,193	0	5,501	5,501
2012*	29,610	82,007	111,617	3,477	26,421	29,898	0	2,044	2,044

2013*	29,610	33,655	63,265	8,218	3,362	11,580	0	3,916	3,916
2014*	29,610	4,609	34,219	53	3,102	3,155	0	418	418
2015*	29,610	6,825	36,435	54	1,862	1,916	0	1,976	1,976
2016*	29,610	51,895	81,505	487	5,901	6,388	0	3,600	3,600
2017*	29,610	84,214	113,824	34,500	205,695	240,195	0	340	340
2018*	29,610	10,867	40,447	22,507	9,882	32,389	0	4,996	4,996
2019*	29,610	30,366	59,976	10,862	24,533	35,395	0	6,844	6,844
2020*	29,610	4,700	34,310	3,678	3,979	7,657	0	1,059	1,059
2021*	29,610	4,690	34,300	668	2,413	3,081	0	321	321
2022*	29,610	1,167	30,777	398	127	525	0	467	467

* After the sampling program was eliminated, Yearling-Equivalent Striped Bass ≤ 20 mm estimate is the average of 85-95 loss.

Table 2 Five-year running averages for yearling-equivalent losses for Striped Bass and Steelhead Rainbow Trout and smolt-equivalent losses for Chinook Salmon for the State Water Project, 1984-2021.

Period	Yearling-Equivalent Striped Bass			Smolt-Equivalent Chinook Salmon			Yearling-Equivalent Steelhead		
	≤ 20 mm	> 20 mm	Total Loss	YOY	Yearling	Total Loss	YOY	Yearling	Total Loss
Mean 84-88	50,461	803,581	854,041	569,621	1,039,965	1,609,586	149	15,869	16,018
Mean 85-89	51,630	744,611	796,240	586,225	899,793	1,486,018	200	22,040	22,240
Mean 86-90	40,138	750,686	790,824	509,742	839,496	1,349,238	200	22,753	22,953
Mean 87-91	36,098	600,427	636,525	304,718	405,016	709,733	200	27,307	27,507
Mean 88-92	30,443	469,373	499,816	203,277	307,178	510,455	106	31,040	31,145
Mean 89-93	23,672	533,364	557,035	124,966	171,292	296,258	106	35,580	35,686
Mean 90-94	12,861	442,094	454,955	51,866	126,978	178,844	55	29,414	29,469
Mean 91-95	11,969	414,869	426,838	39,091	129,135	168,226	55	26,537	26,592
Mean 92-96	14,867	419,158	434,026	20,351	127,729	148,080	55	21,699	21,754
Mean 93-97	18,099	403,066	421,165	24,041	90,603	114,644	0	13,943	13,943
Mean 94-98	18,868	178,660	197,528	22,553	82,636	105,189	0	4,457	4,457
Mean 95-99	24,339	208,416	232,755	60,817	92,394	153,211	0	5,093	5,093
Mean 96-00	29,610	340,671	370,281	90,237	66,859	157,096	15	9,702	9,717
Mean 97-01	29,610	350,320	379,930	104,005	58,666	162,670	28	13,883	13,911
Mean 98-02	29,610	355,129	384,739	99,429	58,221	157,650	33	15,574	15,607
Mean 99-03	29,610	375,432	405,042	106,071	71,841	177,912	33	20,556	20,589

Mean 00-04	29,610	353,349	382,959	71,460	74,005	145,465	33	23,637	23,670
Mean 01-05	29,610	188,448	218,058	44,515	72,419	116,934	18	20,039	20,057
Mean 02-06	29,610	143,825	173,435	30,328	64,095	94,423	5	14,177	14,182
Mean 03-07	29,610	112,239	141,849	27,918	58,925	86,843	2	13,627	13,629
Mean 04-08	29,610	90,111	119,721	21,829	45,093	66,922	2	10,319	10,321
Mean 05-09	29,610	66,871	96,481	18,046	30,080	48,126	2	6,843	6,845
Mean 06-10	29,610	64,376	93,986	10,943	22,662	33,605	5	6,208	6,213
Mean 07-11	29,610	107,263	136,873	9,877	54,331	64,207	5	6,141	6,146
Mean 08-12	29,610	106,596	136,206	9,600	57,434	67,034	3	5,179	5,182
Mean 09-13	29,610	100,756	130,366	8,668	52,583	61,251	3	4,218	4,221
Mean 10-14	29,610	92,713	122,323	7,166	51,278	58,444	3	3,713	3,716
Mean 11-15	29,610	76,174	105,784	6,560	46,389	52,948	0	2,771	2,771
Mean 12-16	29,610	35,798	65,408	2,458	8,130	10,587	0	2,391	2,391
Mean 13-17	29,610	36,240	65,850	8,662	43,984	52,647	0	2,050	2,050
Mean 14-18	26,610	31,682	61,292	11,520	45,288	56,809	0	2,266	2,266
Mean 15-19	26,610	36,833	66,443	13,682	49,575	63,257	0	3,551	3,551
Mean 16-20	26,610	36,408	66,018	14,407	49,998	64,405	0	3,368	3,368
Mean 17-21	26,610	26,967	56,577	14,443	49,300	63,743	0	2,712	2,712
Mean 18-22	26,610	10,358	39,968	7,623	8,187	15,809	0	2,737	2,737

Appendix A

Table 3: 2010 onwards results from R code

Results from R Code	Yearling-Equivalent Striped Bass		Smolt-Equivalent Chinook Salmon	Yearling-Equivalent Steelhead					
YEAR	<20 mm	>20 mm	YOY	Yearling	Total Loss	YOY	Yearling	Total Loss	
2010*	29,610	137,010	166,620	2,999	8,278	11,277	19	6,140	6,159
2011*	29,610	205,783	235,393	20,782	62,596	83,379	0	4,918	4,918
2012*	29,610	211,999	241,609	3,458	8,315	11,773	0	1,885	1,885
2013*	29,610	71,089	100,699	7,964	1,024	8,988	0	3,532	3,532
2014*	29,610	7,343	36,953	49	993	1,042	0	371	371
2015*	29,610	11,985	41,595	55	534	589	0	1,826	1,826
2016*	29,610	75,557	105,167	463	1,792	2,255	0	3,373	3,373
2017*	29,610	157,895	187,505	33,264	63,629	96,893	0	309	309
2018*	29,610	19,382	48,992	19,569	2,744	22,313	0	4,396	4,396
2019*	29,610	33,784	63,394	10,016	7,058	17,074	0	6,192	6,192
2020*	29,610	8,410	38,020	2,449	937	3,386	0	722	722
2021*	29,610	4,425	34,035	437	412	849	0	214	214
2022*	29,610	1,167	30,777	398	360	758	0	466	466

Striped Bass (Yearling Equivalent)

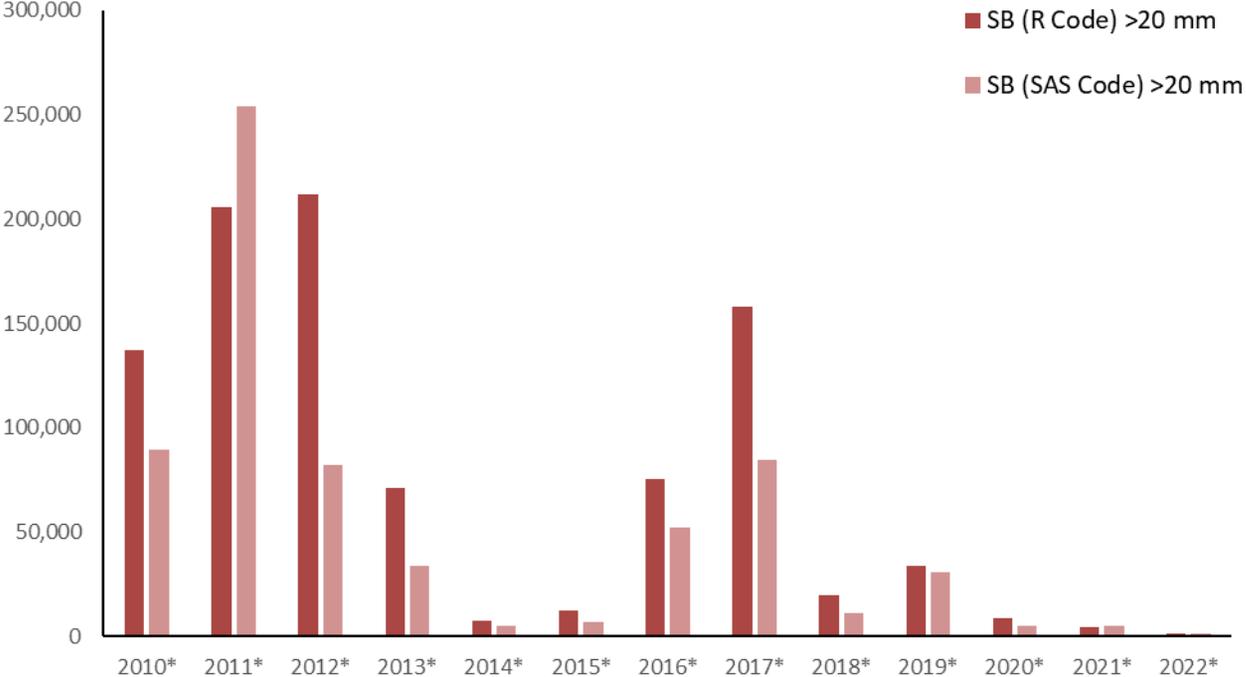


Figure 1: Striped Bass (Yearling Equivalent) results comparison between SAS and R Code

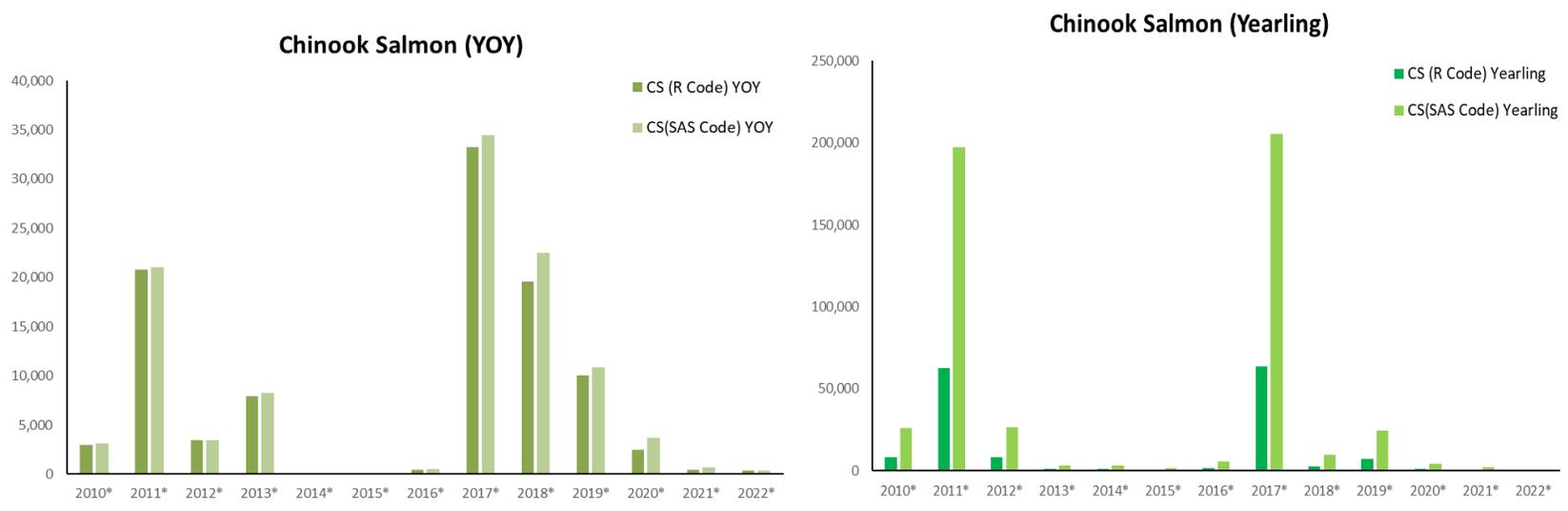


Figure 2: Chinook Salmon, YOY and Yearling results comparison from SAS and R Code.

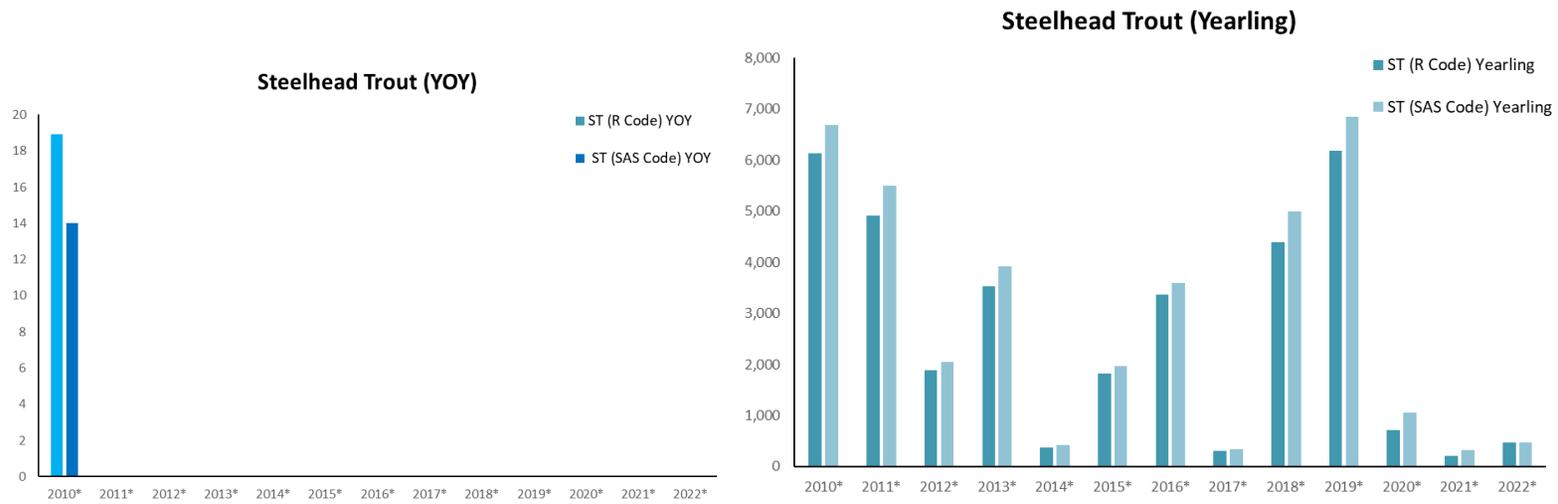


Figure 3: Steelhead Trout, YOY and Yearling results comparison from SAS and R Code.