

Memorandum

Date: January 24, 2013

To: Marty Gingras
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Subject: Salvage Estimates in Terms of Biomass for the State Water Project's and Central Valley Project's South Delta Export Facilities

The attached Tables A and B provide the annual (by calendar year) estimates of fish salvaged for the State Water Project's (SWP) and Central Valley Project's (CVP) South Delta export facilities from 1993 to 2010. This report represents the first attempt to estimate salvage from these facilities in terms of biomass.

METHODS

Numbers of all fish and mitten crab salvaged and annual water exports were obtained from the 2011 IEP annual salvage report (Aasen 2011). Annual salvage and fish length data for eight common species of fish salvaged at the SWP's Skinner Fish Facility and the CVP's Tracy Fish Collection Facility were obtained using Internet or custom MS Access queries using the DFW salvage database (CDFG 2011a, b). Fish length data and published or calculated fish length-weight relationships were used to calculate the total biomass and mean fish weight (in kg wet weight) by species. The eight fish species selected were striped bass, threadfin shad, American shad, white catfish, splittail, common carp, largemouth bass, and bluegill. These eight species constituted 85 to 99% of the total fish salvage (in numbers) annually.

For each of these eight species, annual biomass estimates were extrapolated by multiplying the mean fish weight by the number of fish salvaged by each species and year. These annual biomass estimates from these eight fish species were summed and divided by their associated number of fish salvaged to obtain a grand mean fish weight for these eight fish species combined. Biomass estimates for all other fish species (and mitten crab) were estimated by multiplying the grand mean fish weight by salvage totals for these other species. To compare the relative differences in biomass estimates between facilities, I used the following formula:

$$(1) \text{ Relative Difference} = [(B_{\text{SWP}} - B_{\text{CVP}})/((B_{\text{SWP}} + B_{\text{CVP}})/2)] \times 100\%.$$

RESULTS

The findings indicate that annual salvage at the SWP represent biomasses in the range of 7,600 to 210,000 kg and from 8,500 to 380,000 kg for the CVP. The annual biomass estimates for both fish facilities ranged from 16,000 to 410,000 kg (Table A). For the period examined, no obvious time series trend was observed although the lowest estimates have occurred in recent years (Figures A and B). Rare episodic events such as the extremely large number of juvenile common carp salvaged at the CVP in 2006 can influence the annual biomass estimates (Figure A, Table B).

Biomass estimates at the CVP were frequently greater than those from the SWP. Fourteen out of 18 years the annual CVP biomass estimates were greater than those of the SWP. Relative differences between the two facilities indicate the SWP's annual biomasses were 48% less than those from the CVP (Table A). These differences merit further analysis for determining the possible cause.

Plotting the annual biomass estimates against the annual water exports show weak positive relationships (Figure C). The lack of a strong relationship may be due partially to the contribution of nearshore (e.g., largemouth bass, splittail, and bluegill) and demersal (e.g., white catfish and common carp) fishes to the annual salvage. Entrainment of these fishes may be more influenced by pelagic life stages or behavior (e.g. migration or feeding) than water exports (Grimaldo et. al. 2009). Recent export reductions during the winter and spring to reduce the entrainment of listed fish species may have altered past relationships between the salvage of pelagic fishes and water exports.

I would like to acknowledge that annual fish salvage and export numbers were obtained from previous work done by Geir Aasen. I also thank Jerry Morinaka who provided field data from the Resident Fish Project, verified the accuracy of my computations, and helped proof-read this report.

Table A: Annual salvage as biomass (kg) for the State and Federal fish facilities

<i>Facility Biomass Trends (kg)</i>				
YEAR	SWP	CVP	REL DIFF	TOTAL
1993	210,000	160,000	29%	370,000
1994	14,000	31,000	-74%	46,000
1995	58,000	75,000	-25%	130,000
1996	34,000	53,000	-43%	87,000
1998	28,000	43,000	-42%	71,000
1997	21,000	77,000	-114%	98,000
1999	32,000	38,000	-17%	69,000
2000	90,000	53,000	51%	140,000
2001	41,000	41,000	0%	81,000
2002	39,000	59,000	-39%	98,000
2003	25,000	69,000	-95%	94,000
2004	19,000	56,000	-101%	75,000
2005	23,000	31,000	-28%	54,000
2006	30,000	380,000	-170%	410,000
2007	15,000	28,000	-63%	43,000
2008	8,300	41,000	-132%	49,000
2009	7,600	8,500	-11%	16,000
2010	24,000	21,000	13%	45,000
Mean =			-48%	

Table B: Annual salvage biomass (kg) by species and facility

Facility SWP	Striped bass	Threadfin shad	American shad	White catfish	Splittail	Common carp	Largemouth bass	Bluegill	Subtotal WT	Mean WT per fish*	WT Others Species**	Total WT all species
1993	130,227	43,296	8,000	13,705	6,980	68	147	216	202,640	0.0119	10,226	212,866
1994	6,466	2,516	2,253	777	40	11	170	89	12,322	0.0084	2,157	14,479
1995	13,687	3,461	12,651	5,116	19,461	492	59	152	55,081	0.0100	2,955	58,035
1996	9,599	5,222	11,727	4,885	398	51	173	143	32,199	0.0090	2,013	34,212
1997	10,592	7,256	6,224	1,219	1,164	5	83	82	26,626	0.0085	1,297	27,923
1998	1,640	6,086	2,190	3,699	4,007	1,646	17	135	19,420	0.0049	1,687	21,106
1999	12,318	4,426	5,919	4,144	942	130	75	32	27,986	0.0078	3,685	31,671
2000	39,338	14,143	19,271	2,476	5,072	23	260	43	80,626	0.0115	9,053	89,680
2001	11,482	17,833	6,018	921	2,271	1	67	40	38,633	0.0079	2,193	40,826
2002	13,093	15,017	4,585	1,551	1,529	0	16	39	35,829	0.0085	3,607	39,437
2003	6,854	5,656	8,244	2,137	494	0	29	23	23,438	0.0058	1,387	24,825
2004	7,337	5,251	2,483	1,148	1,246	1	16	46	17,529	0.0101	1,070	18,599
2005	5,784	4,385	7,509	3,324	1,241	19	57	115	22,433	0.0077	746	23,179
2006	3,317	2,895	4,372	3,219	839	14,875	116	151	29,784	0.0059	675	30,459
2007	5,498	3,698	3,511	827	66	112	23	83	13,818	0.0065	782	14,600
2008	2,980	722	2,492	310	746	29	50	100	7,429	0.0128	854	8,283
2009	2,447	891	2,693	565	257	40	50	84	7,027	0.0091	573	7,600
2010	7,582	2,501	10,672	1,143	630	25	76	431	23,060	0.0117	827	23,888

Facility CVP	Striped bass	Threadfin shad	American shad	White catfish	Splittail	Common carp	Largemouth bass	Bluegill	Subtotal WT	Mean WT per fish*	WT Others Species**	Total WT all species
1993	84,988	16,433	5,000	27,773	3,378	1,312	343	4,399	143,626	0.0183	15,464	159,091
1994	10,991	5,213	4,110	7,231	135	598	117	1,360	29,757	0.0090	1,626	31,382
1995	12,636	5,770	7,687	29,302	9,347	2,524	265	2,512	70,045	0.0119	4,773	74,818
1996	4,118	7,093	11,052	24,735	617	509	229	1,440	49,794	0.0166	3,322	53,115
1998	4,807	18,432	5,995	8,950	687	413	223	1,573	41,080	0.0086	1,778	42,858
1997	3,547	26,121	3,215	20,491	9,124	9,787	130	996	73,412	0.0093	3,144	76,555
1999	5,138	10,871	7,135	6,771	496	477	168	815	31,872	0.0090	5,724	37,596
2000	5,248	23,911	10,894	5,599	1,204	49	108	434	47,447	0.0100	5,912	53,359
2001	10,352	19,232	4,069	3,143	355	326	101	588	38,166	0.0075	2,470	40,636
2002	5,424	39,975	3,225	4,848	624	39	99	1,254	55,487	0.0096	3,306	58,794
2003	4,225	45,852	7,070	7,413	551	50	210	1,839	67,210	0.0093	2,245	69,454
2004	8,467	26,648	10,158	6,065	544	157	178	1,539	53,756	0.0096	2,487	56,243
2005	4,721	6,258	5,694	6,318	3,499	121	306	2,031	28,948	0.0127	1,808	30,756
2006	2,849	4,003	1,851	9,138	7,563	351,314	568	795	378,080	0.0102	2,990	381,070
2007	4,326	15,095	1,680	4,585	65	375	277	475	26,878	0.0089	1,186	28,064
2008	5,540	29,110	1,217	2,143	154	30	453	668	39,314	0.0076	1,418	40,732
2009	2,128	1,608	1,524	1,864	36	3	107	299	7,569	0.0099	930	8,498
2010	5,403	5,802	2,389	3,355	1,790	26	192	646	19,604	0.0151	1,355	20,959

*mean fish weight of the 8 most common fish species in salvage

**includes mitten crab

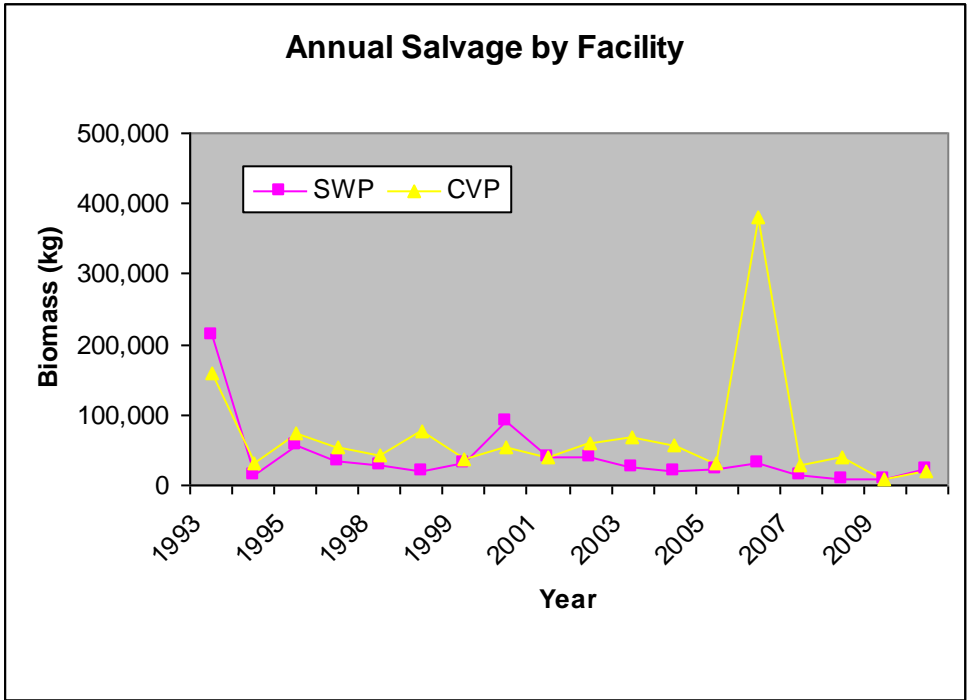


Figure A: Annual salvage as biomass (kg) for the State and Federal fish facilities

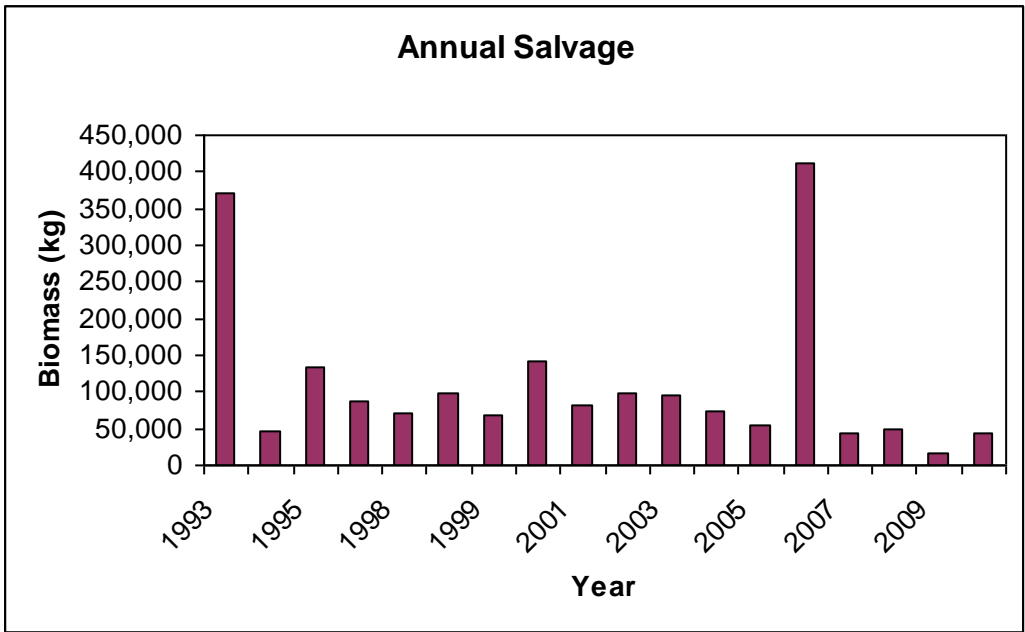


Figure B: Annual combined salvage (SWP+CVP) as biomass

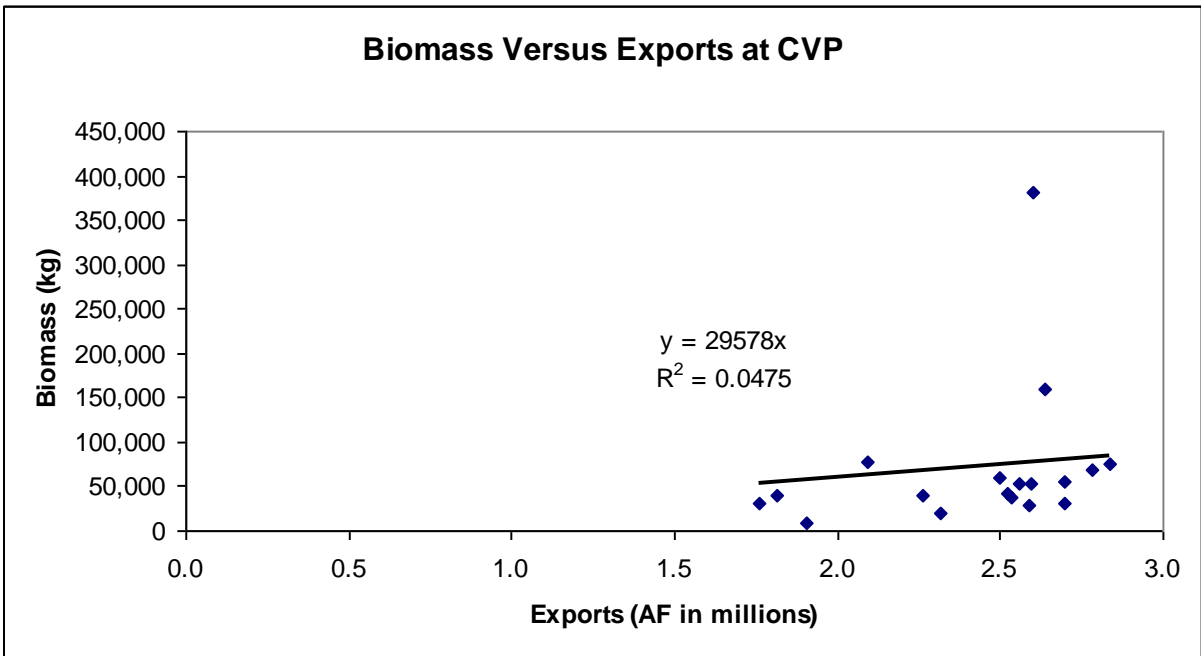
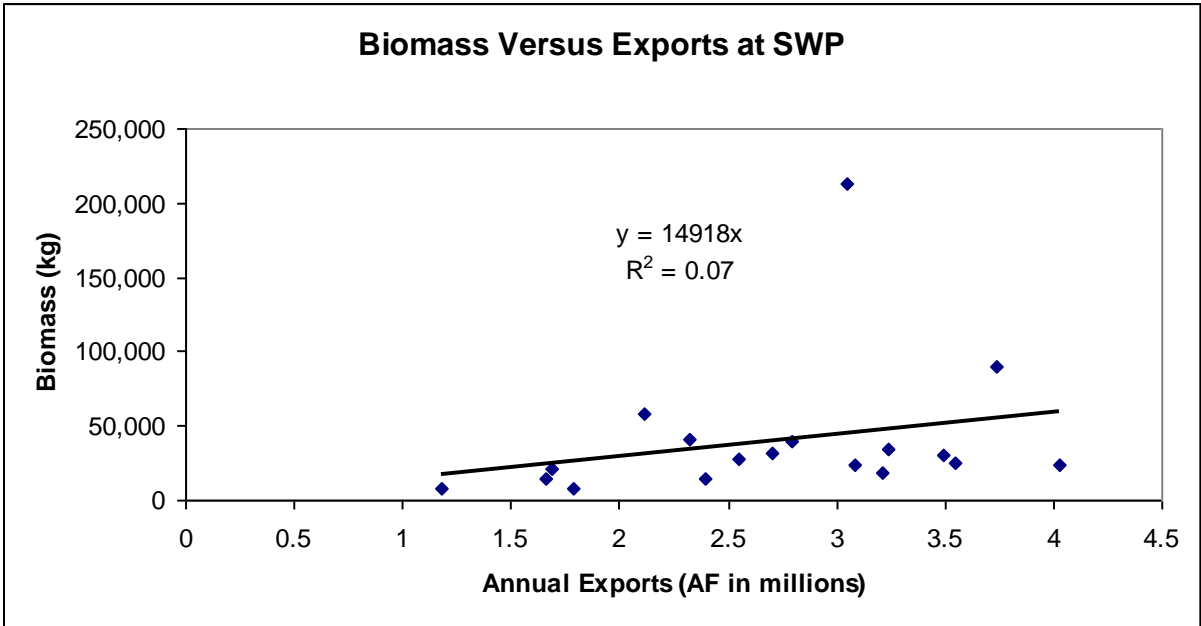


Figure C: Relationships between annual biomass and exports for the State Water Project (top) and Central Valley Project (bottom)

Fish length-weight relationships and other metadata

Censored all length observations < 20 mm or > published maximum sizes (Nobriga et al. 2005 or Moyle 2002).

Striped bass: L-W relationship (FL in mm and mg wet weight; Kimmerer et al. 2005): $0.0066L^{3.12}$; maximum size = 1250 mm (Nobriga et al. 2005)

White catfish: L-W relationship (FL in mm; wet weight in g; Schaffter 1997): $\ln(\text{wt}) = 3.193\ln(L) - 12.283$; maximum size = 407 mm (Nobriga et al. 2005)

American shad: L-W relationship (FL in mm and mg wet weight; Kimmerer et al. 2005): $0.0074L^{3.09}$; maximum size = 600 mm (Nobriga et al. 2005)

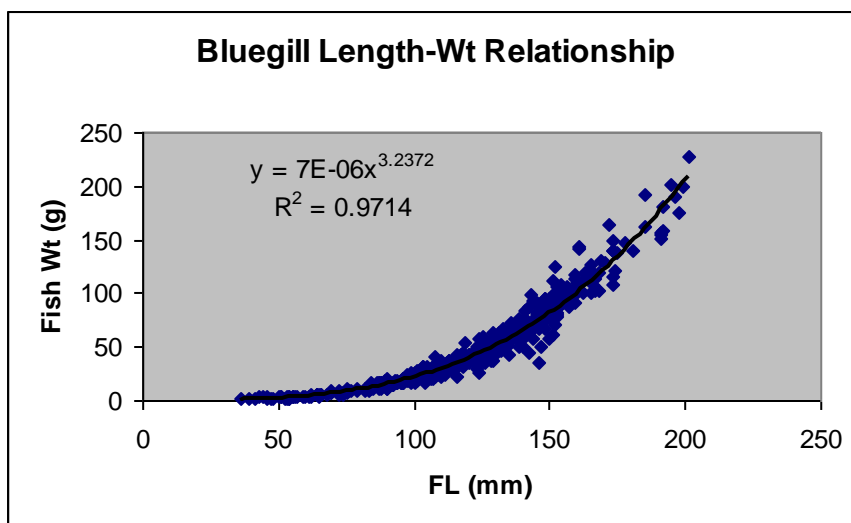
Threadfin shad: L-W relationship (FL in mm and mg wet weight; Kimmerer et al. 2005): $0.0072L^{3.16}$; maximum size = 220 mm (Nobriga et al. 2005)

Splittail: L-W relationship (FL in mm and mg wet weight; Kimmerer et al. 2005): $0.0030L^{3.27}$; maximum size = 450 mm (Nobriga et al. 2005)

Common carp: L-W relationship (FL in mm and mg wet weight; Kimmerer et al. 2005): $0.0670L^{2.85}$; maximum size = 800 mm (Moyle 2002)

Largemouth bass: L-W relationship (FL in mm and g wet weight; Nobriga 2009): $\ln(\text{wt}) = 3.10\ln L - 11.7$; maximum size = 760 mm (Nobriga et al. 2005)

Bluegill: Used a calculated L-W relationship based on censored Resident Fishes Project data from 2001 (FL in mm and g wet weight): $\text{Wt (g)} = 0.000007L^{3.2372}$; maximum size = 260 mm (Nobriga et al. 2005)



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