

2/\$63.60

HEARING PROCESS
SAN FRANCISCO BAY / SACRAMENTO - SAN JOAQUIN DELTA ESTUARY

NOTICE OF INTENT TO APPEAR

HEARING PHASE I

California Department of Fish and Game

PARTICIPANT Denis D. Smaage, Deputy Attorney General

PAGE 1 OF 1

I plan to attend the water right / water quality hearing scheduled for September 21, 22, 23, 1987 intend to call the following witnesses to testify at the hearing:

NAME	SUBJECT OF PROPOSED TESTIMONY	EST. LENGTH OF DIRECT TESTIMONY	EXPERT WITNESS YES/NO*	COST OF TESTIMONY SUMMARY	
Dan Odenweller	Estimates of Fish Entrainment Losses	30 min.	Yes	30.90	
	Associated with the SWP and CVP Facilities in the South Delta.				
H.K. Chadwick	Agreement to Offset Fish Losses at Banks Pumping Plant.	20 min.	Yes	.30	all exhibits
H.K. Chadwick	Salmon Management in the Estuary.	15 min.	Yes	.30	

(If more space is required, please add additional pages)

* For each person testifying as a expert witness, please attached a list of his/her qualifications, and assign an exhibit number for each qualification list submitted.

SEND REQUEST FOR COPIES OF TESTIMONY SUMMARIES AND REMITTANCE TO:

Department of Fish and Game
Bay-Delta Project
4001 North Wilson Way
Stockton, CA 95205

**HEARING PROCESS
SAN FRANCISCO BAY / SACRAMENTO - SAN JOAQUIN DELTA ESTUARY**

INDEX OF EXHIBITS

HEARING PHASE I

California Department of Fish and Game

PARTICIPANT Denis D. Smaage, Deputy Attorney General

PAGE 1 **OF** 1

EXHIBIT NUMBER	DESCRIPTION / PURPOSE OF USE (For referenced exhibits, also include the title and portions relied upon)	REFERENCED YES / NO	COST	
DFG 16	Statement of Qualifications - Dan B. Odenweller	No	.30	
DFG 17	Testimony on Entrainment Losses at SWP and CVP Facilities in the South Delta	No	30.90	
DFG 18	Summary of Testimony - Agreement to Offset Fish Losses at Banks Pumping Plant	No	.30	
DFG 19	Summary of Testimony - Salmon Management in Relation to the Estuary	No	.30	
			31.80	x2 = 63.60

SEND REQUEST FOR COPIES OF EXHIBITS AND REMITTANCE TO:

Department of Fish and Game
Bay-Delta Project
4001 North Wilson Way
Stockton, CA 95205

Statement of Qualifications

Dan Bowman Odenweller

Education: California State University at Long Beach, B.S.
Zoology, June 1969

California State University at Long Beach, M.A.
Biology, August 1971

Employment: California Department of Fish and Game, 1971 to
present.

Southern California Subtidal Ecological Studies,
Project Assistant - June, 1971 to July, 1972

Conducted subtidal ecological investigations of
waste treatment plant discharges under contract
to the State Water Resources Control Board.

Artificial Reef Project
Project Assistant - July, 1972 to July, 1974

Worked on the development, construction and
evaluation of artificial reefs in the southern
California marine environment.

Delta Fish Facilities Study
Project Leader - July 1974 to April, 1978
Research Supervisor - May, 1978 to date

Conduct research on fish facilities for water
development projects in the Sacramento-San
Joaquin Estuary. This work included the field
evaluation of existing facilities, including the
John E. Skinner Delta fish Protective Facility
in the southern Delta.

Supervise the fish salvage operations at the
state's John E. Skinner Delta Fish Protective
Facility and the federal Tracy Fish Protection
Facility. This includes the oversight of the
fish salvage operations, and the maintenance and
evaluation of the fish salvage records.

Supervise the Bay-Delta Project staff's
environmental impact assessment activities, both
in the Delta and in our Contract Services unit.

APPENDIX TABLE 6. CHINOOK SALMON ENTRAINMENT LOSSES BY LENGTH GROUP AT THE STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 15%.

<u>Length Group*</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
Year = 1968					
1	39206	33325	24845	24348	14858
2	17258	14669	10528	10528	6730
TOTAL	56,464	47,994	35,373	34,876	21,588
Year = 1969					
1	26462	22493	16776	16440	10022
2	50375	42819	30080	30080	20295
TOTAL	76,837	65,312	46,856	46,520	30,317
Year = 1970					
1	13286	11293	8517	8347	4939
2	71056	60398	42914	42914	28142
TOTAL	84,342	71,691	51,431	51,261	33,081
Year = 1971					
1	20455	17387	12610	12358	8097
2	10129	8610	6038	6038	4091
TOTAL	30,584	25,997	18,648	18,396	12,188
Year = 1972					
1	113853	96775	71581	70149	43704
2	43654	37106	26006	26006	17648
TOTAL	157,507	133,881	97,587	96,155	61,352

* Length Group 1 <= 100 MM
 Length Group 2 > 100 MM

APPENDIX TABLE 6. continued.

<u>Length Group</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
Year = 1973					
1	52285	44442	33033	32372	19912
2	14994	12745	9194	9194	5800
TOTAL	67,279	57,187	42,227	41,566	25,712
Year = 1974					
1	174632	148437	108601	106429	68203
2	56296	47852	33202	33202	23094
TOTAL	230,928	196,289	141,803	139,631	91,297
Year = 1975					
1	34676	29475	22057	21616	13061
2	27092	23028	16416	16416	10676
TOTAL	61,768	52,503	38,473	38,032	23,737
Year = 1976					
1	19458	16539	12309	12063	7395
2	32224	27390	19572	19572	12652
TOTAL	51,682	43,929	31,881	31,635	20,047
Year = 1977					
1	11594	9855	7461	7312	4282
2	33246	28259	20878	20878	12368
TOTAL	44,840	38,114	28,339	28,190	16,650
Year = 1978					
1	9045	7688	5904	5786	3259
2	168538	143257	108519	108519	60019
TOTAL	177,583	150,945	114,423	114,305	63,278
Year = 1979					
1	123620	105077	80716	79102	44518
2	66728	56719	41718	41718	25010
TOTAL	190,348	161,796	122,434	120,820	69,528

APPENDIX TABLE 6. continued.

<u>Length Group</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
Year = 1980					
1	14955	12712	9596	9404	5551
2	116851	99323	70411	70411	46440
TOTAL	131,806	112,035	80,007	79,815	51,991
Year = 1981					
1	86248	73311	57427	56278	29970
2	69807	59336	44119	44119	25688
TOTAL	156,055	132,647	101,546	100,397	55,658
Year = 1982					
1	83392	70883	54581	53489	29902
2	369486	314063	234253	234253	135233
TOTAL	452,878	384,946	288,834	287,742	165,135
Year = 1983					
1	24879	21147	16507	16177	8702
2	83662	71113	52427	52427	31235
TOTAL	108,541	92,260	68,934	68,604	39,937
Year = 1984					
1	106594	90605	73188	71724	34870
2	110313	93766	71863	71863	38450
TOTAL	216,907	184,371	145,051	143,587	73,320
Year = 1985					
1	169891	144407	107261	105116	64775
2	55938	47547	33480	33480	22458
TOTAL	225,829	191,954	140,741	138,596	87,233
Year = 1986					
1	415320	353022	270244	264839	150481
2	265078	225316	164987	164987	100091
TOTAL	680,398	578,338	435,231	429,826	250,572

APPENDIX TABLE 7. STRIPED BASS ENTRAINMENT LOSSES BY LENGTH GROUP AT THE STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 82%.

YEAR = 1968

Length Group*	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	190278	34250	2880	935	189343
15	64291499	11572467	1177713	416675	63874830
20	3547083	638475	296649	113913	3433170
25	26567	4782	3297	1371	25196
30	5766933	1038048	746290	334711	5432223
35	439261	79067	63113	30471	408790
40	1455517	261993	208936	108229	1347288
50	226533	40776	33741	19226	207308
60	471344	84842	70958	45967	425378
70	305300	54954	44641	32624	272676
80	663744	119474	96335	78879	584865
90	606567	109182	86584	78947	527619
100	25672	4621	3534	3499	22174
110	1055022	189904	151588	151588	903434
120	400305	72055	57243	57243	343062
130	358278	64490	51512	51512	306766
140	218767	39378	32464	32464	186303
150	0	0	0	0	0
Total	80,048,670	14,408,758	3,127,478	1,558,254	78,490,425

YEAR = 1969

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	7747049	1394469	117309	41504	7705546
20	0	0	0	0	0
25	0	0	0	0	0
30	5915655	1064818	750746	336710	5578945
35	0	0	0	0	0
40	2352428	423437	333210	172603	2179825
50	0	0	0	0	0
60	1418950	255411	210553	136396	1282554
70	468556	84340	68050	49731	418825
80	211544	38078	30155	24691	186854
90	189217	34059	26606	24259	164957
100	14928	2687	2053	2032	12895
110	127511	22952	17757	17757	109754
120	56172	10111	7809	7809	48363
130	40900	7362	5692	5692	35208
140	9433	1698	1297	1297	8136
150	0	0	0	0	0
Total	18,552,343	3,339,422	1,571,237	820,481	17,731,862

* End point of length group

APPENDIX TABLE 7. continued.

YEAR = 1970

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	147662672	26579286	2667589	943793	146718885
20	0	0	0	0	0
25	0	0	0	0	0
30	29720071	5349613	3834120	1719603	28000467
35	0	0	0	0	0
40	26379768	4748358	3779659	1957864	24421907
50	0	0	0	0	0
60	12743438	2293819	1911270	1238121	11505318
70	9429583	1697325	1408312	1029194	8400388
80	2608961	469613	378540	309949	2299013
90	1055105	189919	150727	137433	917673
100	0	0	0	0	0
110	424533	76416	60586	60586	363947
120	56900	10242	7773	7773	49127
130	50522	9094	6947	6947	43575
140	4261	767	596	596	3665
150	0	0	0	0	0
Total	230,135,814	41,424,452	14,206,119	7,411,859	222,723,965

YEAR = 1971

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	340050176	61209042	6138106	2171662	337878573
20	0	0	0	0	0
25	0	0	0	0	0
30	40758852	7336593	5216196	2339464	38419389
35	0	0	0	0	0
40	7471628	1344893	1065919	552146	6919482
50	0	0	0	0	0
60	1297644	233576	189847	122983	1174662
70	408606	73549	58595	42821	365784
80	436050	78489	61382	50260	385790
90	406550	73179	57284	52232	354318
100	0	0	0	0	0
110	233094	41957	33793	33793	199301
120	160594	28907	23597	23597	136997
130	268967	48414	40379	40379	228588
140	0	0	0	0	0
150	0	0	0	0	0
Total	391,492,161	70,468,599	12,885,098	5,429,337	386,062,884

APPENDIX TABLE 7. continued.

YEAR = 1972

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	222926657	40126799	4069045	1439628	221487020
20	0	0	0	0	0
25	0	0	0	0	0
30	29937372	5388727	3874419	1737677	28199696
35	0	0	0	0	0
40	2283555	411040	324662	168175	2115381
50	0	0	0	0	0
60	900017	162003	128121	82997	817020
70	904783	162861	125427	91662	813121
80	1217467	219144	168262	137773	1079694
90	939261	169067	128336	117017	822244
100	0	0	0	0	0
110	2155833	388050	320108	320108	1835725
120	2022094	363977	301283	301283	1720811
130	2117000	381060	316647	316647	1800353
140	0	0	0	0	0
150	0	0	0	0	0
Total	265,404,039	47,772,728	9,756,310	4,712,967	260,691,065

YEAR = 1973

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	2327011	418862	24045	7803	2319209
15	22409994	4033799	365750	129402	22280595
20	35745413	6434175	2940010	1128964	34616456
25	20966814	3774027	2708369	1126140	19840680
30	21102860	3798514	2735303	1226783	19876074
35	0	0	0	0	0
40	16155627	2908013	2319276	1201385	14954242
50	5677389	1021930	857556	488635	5188753
60	0	0	0	0	0
70	1844928	332087	275185	201105	1643822
80	0	0	0	0	0
90	1163122	209362	164788	150254	1012869
100	0	0	0	0	0
110	0	0	0	0	0
120	1076672	193801	148853	148853	927819
130	0	0	0	0	0
140	789728	142151	114434	114434	675294
150	0	0	0	0	0
Total	129,259,558	23,266,721	12,653,569	5,923,758	123,335,813

APPENDIX TABLE 7. continued.

YEAR = 1974

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	4589528	826115	84853	27535	4561993
15	76689746	13804152	1415416	500774	76188969
20	88995092	16019120	7457058	2863510	86131589
25	48703858	8766695	6321865	2628632	46075225
30	31351514	5643272	4061652	1821651	29529862
35	0	0	0	0	0
40	22233498	4002029	3187713	1651235	20582263
50	6260167	1126830	942094	536805	5723362
60	0	0	0	0	0
70	2341617	421491	343056	250705	2090911
80	0	0	0	0	0
90	1702628	306473	236413	215561	1487066
100	0	0	0	0	0
110	0	0	0	0	0
120	1339789	241162	190681	190681	1149108
130	0	0	0	0	0
140	549544	98918	80985	80985	468559
150	295711	53228	44896	44896	250815
Total	285,052,692	51,309,485	24,366,682	10,812,970	274,239,722

YEAR = 1975

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	20033	3606	207	67	19966
15	224950	40491	3769	1333	223617
20	4499344	809882	353343	135684	4363661
25	5788461	1041923	715031	297310	5491151
30	7755400	1395972	964008	432358	7323042
35	0	0	0	0	0
40	7309312	1315676	1036739	537031	6772281
50	4224389	760390	621361	354052	3870338
60	0	0	0	0	0
70	3050756	549136	441438	322603	2728153
80	0	0	0	0	0
90	3395333	611160	465471	424416	2970917
100	0	0	0	0	0
110	0	0	0	0	0
120	1211317	218037	165965	165965	1045352
130	0	0	0	0	0
140	100217	18039	14223	14223	85994
150	0	0	0	0	0
Total	37,579,512	6,764,312	4,781,555	2,685,042	34,894,472

APPENDIX TABLE 7. continued.

YEAR = 1976

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	24711	4448	374	121	24590
15	431767	77718	5571	1971	429796
20	2396261	431327	199569	76634	2319626
25	3781511	680672	489406	203495	3578016
30	3002945	540530	388926	174433	2828511
35	0	0	0	0	0
40	1846412	332354	264157	136833	1709577
50	939089	169036	140333	79962	859127
60	0	0	0	0	0
70	646678	116402	91022	66519	580159
80	0	0	0	0	0
90	1281183	230613	173994	158648	1122535
100	0	0	0	0	0
110	0	0	0	0	0
120	388461	69923	52538	52538	335923
130	0	0	0	0	0
140	84278	15170	11495	11495	72783
150	0	0	0	0	0
Total	14,823,296	2,668,193	1,817,385	962,649	13,860,643

YEAR = 1977

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	28767	5178	297	96	28670
15	328856	59194	3358	1188	327667
20	339345	61082	28492	10941	328404
25	1074089	193336	139927	58182	1015907
30	608300	109494	79244	35541	572759
35	349972	62995	50331	24300	325672
40	45900	8262	6443	3337	42563
50	642228	115601	97232	55403	586825
60	173289	31192	26050	16875	156414
70	107583	19365	14905	10893	96691
80	80100	14418	11004	9010	71090
90	240144	43226	32322	29471	210673
100	208189	37474	27534	27259	180930
110	139578	25124	18424	18424	121154
120	234428	42197	31699	31699	202729
130	35478	6386	4656	4656	30822
140	95244	17144	13001	13001	82243
150	5717	1029	868	868	4849
Total	4,737,207	852,697	585,787	351,144	4,386,062

APPENDIX TABLE 7. continued.

YEAR = 1978

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	1774367	319386	9451	3344	1771022
20	2753583	495645	107094	41124	2712459
25	1630827	293549	127721	53106	1577722
30	6511928	1172147	534580	239759	6272168
35	2200289	396052	287187	138654	2061635
40	1505028	270905	196795	101940	1403088
50	3201033	576186	410795	234071	2966962
60	683850	123093	87823	56892	626958
70	750311	135056	96239	70331	679980
80	2229245	401264	290114	237545	1991699
90	2352683	423483	304164	277337	2075346
100	1876744	337814	240725	238318	1638427
110	1342617	241671	171190	171190	1171427
120	1183489	213028	149275	149275	1034214
130	342706	61687	43496	43496	299210
140	375439	67579	47687	47687	327752
150	265789	47842	34045	34045	231744
Total	30,979,928	5,576,387	3,138,381	2,138,114	28,841,813

YEAR = 1979

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	865772	155839	12122	4289	861483
20	4248006	764641	238168	91457	4156549
25	4020256	723646	397479	165272	3854984
30	2479422	446296	200304	89836	2389586
35	3864439	695599	524269	253117	3611322
40	691067	124392	94667	49038	642029
50	3859006	694621	500347	285098	3573908
60	1384383	249189	181145	117346	1267038
70	732222	131800	94049	68731	663491
80	623183	112173	82246	67343	555840
90	686989	123658	89706	81794	605195
100	710450	127881	93319	92386	618064
110	467633	84174	60739	60739	406894
120	204756	36856	26587	26587	178169
130	163578	29444	21347	21347	142231
140	75567	13602	9789	9789	65778
150	75200	13536	9726	9726	65474
Total	25,151,929	4,527,347	2,636,009	1,493,895	23,658,035

APPENDIX TABLE 7. continued.

YEAR = 1980

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	57300	10314	319	96	57204
10	0	0	0	0	0
15	192606	34669	1399	495	192111
20	6730216	1211439	352580	135391	6594826
25	4431556	797680	431924	179594	4251962
30	3614066	650532	353711	158639	3455427
35	2485583	447405	334953	161715	2323868
40	544550	98019	71606	37092	507458
50	4207534	757356	569150	324302	3883232
60	1604283	288771	210874	136604	1467679
70	361267	65028	46959	34318	326949
80	270889	48760	35095	28736	242153
90	547439	98539	72295	65919	481520
100	380878	68558	50588	50082	330796
110	414189	74554	54589	54589	359600
120	162811	29306	21652	21652	141159
130	94950	17091	12458	12458	82492
140	18528	3335	2410	2410	16118
150	23006	4141	3051	3051	19955
Total	26,141,651	4,705,497	2,625,613	1,407,143	24,734,509

YEAR = 1981

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	1423517	256233	30091	10646	1412871
20	1213189	218374	113008	43395	1169794
25	718278	129290	94087	39121	679156
30	670311	120656	88111	39518	630793
35	286789	51622	42048	20301	266488
40	613972	110515	87284	45213	568759
50	1267461	228143	183737	104693	1162768
60	953200	171576	127972	82900	870300
70	511067	91992	67653	49441	461626
80	405494	72989	51685	42320	363175
90	434272	78169	55796	50875	383397
100	550328	99059	71327	70614	479714
110	284122	51142	36856	36856	247266
120	163194	29375	21073	21073	142121
130	57744	10394	7536	7536	50208
140	20928	3767	2720	2720	18208
150	15917	2865	2006	2006	13911
Total	9,589,783	1,726,161	1,082,990	669,228	8,920,555

APPENDIX TABLE 7. continued.

YEAR = 1982

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
20	1118550	201339	85905	32988	1085562
25	746945	134450	89825	37349	709595
30	1007711	181388	120239	53927	953784
35	548283	98691	77257	37300	510984
40	254044	45728	36218	18761	235284
50	1106639	199195	158865	90521	1016118
60	280744	50534	39618	25665	255080
70	282283	50811	38496	28133	254150
80	259206	46657	33737	27624	231582
90	545111	98120	69886	63722	481389
100	534606	96229	67689	67012	467593
110	569906	102583	72178	72178	497728
120	249639	44935	31568	31568	218071
130	123617	22251	15528	15528	108089
140	59217	10659	7453	7453	51764
150	11450	2061	1465	1465	9985
Total	7,697,951	1,385,631	945,927	611,194	7,086,758

YEAR = 1983

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	578467	104124	7619	2696	575771
20	175606	31609	9716	3731	171875
25	67017	12063	6419	2669	64348
30	104561	18821	10734	4814	99747
35	27806	5005	3831	1850	25956
40	22817	4107	3131	1622	21195
50	81033	14586	11386	6488	74546
60	53894	9701	7572	4905	48989
70	111117	20001	15504	11330	99786
80	54039	9727	6969	5706	48333
90	101311	18236	13445	12259	89052
100	79233	14262	10417	10313	68921
110	60911	10964	7928	7928	52983
120	73689	13264	10001	10001	63688
130	16783	3021	2315	2315	14468
140	6950	1251	921	921	6029
150	3922	706	521	521	3401
Total	1,619,156	291,448	128,429	90,069	1,529,088

APPENDIX TABLE 7. continued.

YEAR = 1984

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	814883	146679	3439	1116	813767
15	11464028	2063525	52762	18667	11445360
20	17253451	3105621	506249	194400	17059052
25	12379489	2228308	873026	363004	12016485
30	8914311	1604576	622739	279299	8635012
35	10383895	1869101	1322493	638500	9745396
40	5378211	968078	684652	354650	5023561
50	8354956	1503892	1037904	591398	7763558
60	3935689	708424	488849	316676	3619012
70	1786284	321531	222979	162953	1623330
80	1021967	183954	128386	105122	916844
90	1212689	218284	155437	141727	1070961
100	741833	133530	95670	94713	647120
110	518583	93345	67050	67050	451533
120	294400	52992	38156	38156	256244
130	89433	16098	11503	11503	77930
140	44306	7975	5642	5642	38664
150	34917	6285	4489	4489	30428
Total	84,623,325	15,232,198	6,321,425	3,389,065	81,234,257

YEAR = 1985

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	893856	160894	14121	4996	888860
20	7160417	1288875	485879	186578	6973839
25	11224100	2020338	1295951	538856	10685243
30	6659728	1198751	749157	335997	6323731
35	3536122	636502	490509	236818	3299304
40	767561	138161	106286	55056	712505
50	2814950	506691	403563	229950	2585000
60	592044	106568	84778	54919	537125
70	404694	72845	57790	42233	362462
80	419806	75565	58969	48284	371522
90	257806	46405	35911	32744	225062
100	538822	96988	75234	74482	464341
110	395906	71263	55324	55324	340582
120	274361	49385	38073	38073	236288
130	166006	29881	23066	23066	142940
140	77328	13919	10870	10870	66458
150	22039	3967	3072	3072	18967
Total	36,205,546	6,516,998	3,988,553	1,971,318	34,234,229

APPENDIX TABLE 7. continued.

YEAR = 1986

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	6120450	1101681	36033	12748	6107701
20	25302094	4554377	1685282	647148	24654946
25	21324947	3838491	2237886	930513	20394435
30	44987517	8097753	5297167	2375779	42611734
35	17365744	3125834	2441115	1178571	16187174
40	5129550	923319	724437	375258	4754292
50	5552711	999488	808042	460422	5092289
60	1247633	224574	180521	116942	1130692
70	734022	132124	105708	77251	656771
80	390178	70232	55061	45084	345094
90	650422	117076	91604	83525	566898
100	445972	80275	62071	61450	384522
110	405767	73038	55395	55395	350372
120	189594	34127	26419	26419	163175
130	52372	9427	7183	7183	45189
140	23344	4202	3317	3317	20027
150	3150	567	423	423	2727
Total	129,925,467	23,386,585	13,817,664	6,457,428	123,468,038

APPENDIX TABLE 8. CHINOOK SALMON ENTRAINMENT LOSSES BY LENGTH GROUP AT THE STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 75%.

<u>Length Group*</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
Year = 1968					
1	133300	33325	24845	24348	108952
2	58676	14669	10528	10528	48148
TOTAL	191,976	47,994	35,373	34,876	157,100
Year = 1969					
1	89972	22493	16776	16440	73532
2	171,276	42,819	30,080	30,080	141,196
TOTAL	261,248	65,312	46,856	46,520	214,728
Year = 1970					
1	45172	11293	8517	8347	36825
2	241592	60398	42914	42914	198678
TOTAL	286,764	71,691	51,431	51,261	235,503
Year = 1971					
1	69548	17387	12610	12358	57190
2	34440	8610	6038	6038	28402
TOTAL	103,988	25,997	18,648	18,396	85,592
Year = 1972					
1	387100	96775	71581	70149	316951
2	148424	37106	26006	26006	122418
TOTAL	535,524	133,881	97,587	96,155	439,369

* Length Group 1 <= 100 MM
 Length Group 2 > 100 MM

APPENDIX TABLE 8. continued.

<u>Length Group</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
Year = 1973					
1	177,768	44,442	33,033	32,372	145,396
2	50980	12745	9194	9194	41786
TOTAL	228,748	57,187	42,227	41,566	187,182
Year = 1974					
1	593748	148437	108601	106429	487319
2	191408	47852	33202	33202	158206
TOTAL	785,156	196,289	141,803	139,631	645,525
Year = 1975					
1	117900	29475	22057	21616	96284
2	92112	23028	16416	16416	75696
TOTAL	210,012	52,503	38,473	38,032	171,980
Year = 1976					
1	66156	16539	12309	12063	54093
2	109,560	27,390	19,572	19,572	89,988
TOTAL	175,716	43,929	31,881	31,635	144,081
Year = 1977					
1	39420	9855	7461	7312	32108
2	113036	28259	20878	20878	92158
TOTAL	152,456	38,114	28,339	28,190	124,266
Year = 1978					
1	30752	7688	5904	5786	24966
2	573028	143257	108519	108519	464509
TOTAL	603,780	150,945	114,423	114,305	489,475
Year = 1979					
1	420308	105077	80716	79102	341206
2	226876	56719	41718	41718	185158
TOTAL	647,184	161,796	122,434	120,820	526,364

APPENDIX TABLE 8. continued.

<u>Length Group</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
Year = 1980					
1	50,848	12,712	9,596	9,404	41,444
2	397292	99323	70411	70411	326881
TOTAL	448,140	112,035	80,007	79,815	368,325
Year = 1981					
1	293244	73311	57427	56278	236966
2	237344	59336	44119	44119	193225
TOTAL	530,588	132,647	101,546	100,397	430,191
Year = 1982					
1	283532	70883	54581	53489	230043
2	1256252	314063	234253	234253	1021999
TOTAL	1,539,784	384,946	288,834	287,742	1,252,042
Year = 1983					
1	84588	21147	16507	16177	68411
2	284,452	71,113	52,427	52,427	232,025
TOTAL	369,040	92,260	68,934	68,604	300,436
Year = 1984					
1	362420	90605	73188	71724	290696
2	375064	93766	71863	71863	303201
TOTAL	737,484	184,371	145,051	143,587	593,897
Year = 1985					
1	577628	144407	107261	105116	472512
2	190188	47547	33480	33480	156708
TOTAL	767,816	191,954	140,741	138,596	629,220
Year = 1986					
1	1412088	353022	270244	264839	1147249
2	901264	225316	164987	164987	736277
TOTAL	2,313,352	578,338	435,231	429,826	1,883,526

APPENDIX TABLE 5. continued.

YEAR = 1970

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	31269743	26579286	2667589	943793	30325948
20	0	0	0	0	0
25	0	0	0	0	0
30	6293662	5349613	3834120	1719603	4574059
35	0	0	0	0	0
40	5586304	4748358	3779659	1957864	3628440
50	0	0	0	0	0
60	2698611	2293819	1911270	1238121	1460490
70	1996853	1697325	1408312	1029194	967659
80	552486	469613	378540	309949	242537
90	223434	189919	150727	137433	86001
100	0	0	0	0	0
110	89901	76416	60586	60586	29315
120	12049	10242	7773	7773	4276
130	10699	9094	6947	6947	3752
140	902	767	596	596	306
150	0	0	0	0	0
Total	48,734,644	41,424,452	14,206,119	7,411,859	41,322,783

YEAR = 1971

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	72010629	61209042	6138106	2171662	69838967
20	0	0	0	0	0
25	0	0	0	0	0
30	8631286	7336593	5216196	2339464	6291822
35	0	0	0	0	0
40	1582227	1344893	1065919	552146	1030081
50	0	0	0	0	0
60	274795	233576	189847	122983	151812
70	86528	73549	58595	42821	43707
80	92340	78489	61382	50260	42080
90	86093	73179	57284	52232	33861
100	0	0	0	0	0
110	49361	41957	33793	33793	15568
120	34008	28907	23597	23597	10411
130	56958	48414	40379	40379	16579
140	0	0	0	0	0
150	0	0	0	0	0
Total	82,904,225	70,468,599	12,885,098	5,429,337	77,474,888

APPENDIX TABLE 5. continued.

YEAR = 1972

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	47207993	40126799	4069045	1439628	45768366
20	0	0	0	0	0
25	0	0	0	0	0
30	6339679	5388727	3874419	1737677	4602002
35	0	0	0	0	0
40	483576	411040	324662	168175	315402
50	0	0	0	0	0
60	190592	162003	128121	82997	107595
70	191601	162861	125427	91662	99939
80	257816	219144	168262	137773	120044
90	198902	169067	128336	117017	81886
100	0	0	0	0	0
110	456529	388050	320108	320108	136421
120	428208	363977	301283	301283	126925
130	448306	381060	316647	316647	131659
140	0	0	0	0	0
150	0	0	0	0	0
Total	56,203,202	47,772,728	9,756,310	4,712,967	51,490,239

YEAR = 1973

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	492779	418862	24045	7803	484976
15	4745646	4033799	365750	129402	4616244
20	7569617	6434175	2940010	1128964	6440654
25	4440032	3774027	2708369	1126140	3313892
30	4468840	3798514	2735303	1226783	3242057
35	0	0	0	0	0
40	3421192	2908013	2319276	1201385	2219807
50	1202271	1021930	857556	488635	713635
60	0	0	0	0	0
70	390691	332087	275185	201105	189585
80	0	0	0	0	0
90	246308	209362	164788	150254	96055
100	0	0	0	0	0
110	0	0	0	0	0
120	228001	193801	148853	148853	79148
130	0	0	0	0	0
140	167236	142151	114434	114434	52802
150	0	0	0	0	0
Total	27,372,613	23,266,721	12,653,569	5,923,758	21,448,855

APPENDIX TABLE 5. continued.

YEAR = 1974

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	971900	826115	84853	27535	944365
15	16240184	13804152	1415416	500774	15739405
20	18846024	16019120	7457058	2863510	15982514
25	10313759	8766695	6321865	2628632	7685127
30	6639144	5643272	4061652	1821651	4817492
35	0	0	0	0	0
40	4708269	4002029	3187713	1651235	3057034
50	1325682	1126830	942094	536805	788877
60	0	0	0	0	0
70	495872	421491	343056	250705	245166
80	0	0	0	0	0
90	360556	306473	236413	215561	144995
100	0	0	0	0	0
110	0	0	0	0	0
120	283720	241162	190681	190681	93039
130	0	0	0	0	0
140	116374	98918	80985	80985	35389
150	62621	53228	44896	44896	17725
Total	60,364,105	51,309,485	24,366,682	10,812,970	49,551,128

YEAR = 1975

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	4242	3606	207	67	4175
15	47636	40491	3769	1333	46303
20	952802	809882	353343	135684	817119
25	1225792	1041923	715031	297310	928482
30	1642320	1395972	964008	432358	1209962
35	0	0	0	0	0
40	1547854	1315676	1036739	537031	1010823
50	894576	760390	621361	354052	540525
60	0	0	0	0	0
70	646042	549136	441438	322603	323439
80	0	0	0	0	0
90	719012	611160	465471	424416	294595
100	0	0	0	0	0
110	0	0	0	0	0
120	256514	218037	165965	165965	90549
130	0	0	0	0	0
140	21222	18039	14223	14223	6999
150	0	0	0	0	0
Total	7,958,012	6,764,312	4,781,555	2,685,042	5,272,971

APPENDIX TABLE 5. continued.

YEAR = 1976

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	5233	4448	374	121	5112
15	91433	77718	5571	1971	89462
20	507444	431327	199569	76634	430809
25	800791	680672	489406	203495	597296
30	635918	540530	388926	174433	461484
35	0	0	0	0	0
40	391005	332354	264157	136833	254171
50	198866	169036	140333	79962	118904
60	0	0	0	0	0
70	136944	116402	91022	66519	70425
80	0	0	0	0	0
90	271309	230613	173994	158648	112662
100	0	0	0	0	0
110	0	0	0	0	0
120	82262	69923	52538	52538	29724
130	0	0	0	0	0
140	17847	15170	11495	11495	6352
150	0	0	0	0	0
Total	3,139,052	2,668,193	1,817,385	962,649	2,176,401

YEAR = 1977

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	6092	5178	297	96	5995
15	69640	59194	3358	1188	68452
20	71861	61082	28492	10941	60920
25	227454	193336	139927	58182	169273
30	128816	109494	79244	35541	93276
35	74112	62995	50331	24300	49812
40	9720	8262	6443	3337	6383
50	136001	115601	97232	55403	80598
60	36696	31192	26050	16875	19821
70	22782	19365	14905	10893	11890
80	16962	14418	11004	9010	7952
90	50854	43226	32322	29471	21383
100	44087	37474	27534	27259	16828
110	29558	25124	18424	18424	11134
120	49644	42197	31699	31699	17945
130	7513	6386	4656	4656	2857
140	20169	17144	13001	13001	7168
150	1211	1029	868	868	343
Total	1,003,172	852,697	585,787	351,144	652,030

APPENDIX TABLE 5. continued.

YEAR = 1978

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	375748	319386	9451	3344	372405
20	583112	495645	107094	41124	541988
25	345352	293549	127721	53106	292245
30	1378996	1172147	534580	239759	1139237
35	465944	396052	287187	138654	327290
40	318712	270905	196795	101940	216772
50	677866	576186	410795	234071	443795
60	144815	123093	87823	56892	87924
70	158889	135056	96239	70331	88558
80	472075	401264	290114	237545	234530
90	498215	423483	304164	277337	220879
100	397428	337814	240725	238318	159110
110	284319	241671	171190	171190	113129
120	250621	213028	149275	149275	101346
130	72573	61687	43496	43496	29077
140	79505	67579	47687	47687	31818
150	56285	47842	34045	34045	22240
Total	6,560,455	5,576,387	3,138,381	2,138,114	4,422,343

YEAR = 1979

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	183340	155839	12122	4289	179051
20	899578	764641	238168	91457	808121
25	851348	723646	397479	165272	686076
30	525054	446296	200304	89836	435218
35	818352	695599	524269	253117	565235
40	146344	124392	94667	49038	97306
50	817201	694621	500347	285098	532103
60	293164	249189	181145	117346	175818
70	155059	131800	94049	68731	86328
80	131968	112173	82246	67343	64625
90	145480	123658	89706	81794	63686
100	150448	127881	93319	92386	58062
110	99028	84174	60739	60739	38289
120	43360	36856	26587	26587	16773
130	34640	29444	21347	21347	13293
140	16002	13602	9789	9789	6213
150	15925	13536	9726	9726	6199
Total	5,326,291	4,527,347	2,636,009	1,493,895	3,832,396

APPENDIX TABLE 5. continued.

YEAR = 1980

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	12134	10314	319	96	12038
10	0	0	0	0	0
15	40787	34669	1399	495	40292
20	1425222	1211439	352580	135391	1289832
25	938447	797680	431924	179594	758853
30	765332	650532	353711	158639	606692
35	526359	447405	334953	161715	364644
40	115316	98019	71606	37092	78225
50	891007	757356	569150	324302	566705
60	339731	288771	210874	136604	203126
70	76504	65028	46959	34318	42186
80	57365	48760	35095	28736	28629
90	115928	98539	72295	65919	50010
100	80656	68558	50588	50082	30574
110	87711	74554	54589	54589	33122
120	34478	29306	21652	21652	12826
130	20107	17091	12458	12458	7649
140	3924	3335	2410	2410	1514
150	4872	4141	3051	3051	1821
Total	5,535,880	4,705,497	2,625,613	1,407,143	4,128,738

YEAR = 1981

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	301451	256233	30091	10646	290804
20	256911	218374	113008	43395	213516
25	152106	129290	94087	39121	112985
30	141948	120656	88111	39518	102430
35	60732	51622	42048	20301	40431
40	130018	110515	87284	45213	84805
50	268404	228143	183737	104693	163710
60	201854	171576	127972	82900	118954
70	108226	91992	67653	49441	58785
80	85869	72989	51685	42320	43550
90	91964	78169	55796	50875	41089
100	116540	99059	71327	70614	45926
110	60167	51142	36856	36856	23311
120	34559	29375	21073	21073	13486
130	12228	10394	7536	7536	4692
140	4432	3767	2720	2720	1712
150	3371	2865	2006	2006	1365
Total	2,030,780	1,726,161	1,082,990	669,228	1,361,551

APPENDIX TABLE 5. continued.

YEAR = 1982

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	0	0	0	0	0
20	236869	201339	85905	32988	203882
25	158176	134450	89825	37349	120827
30	213398	181388	120239	53927	159470
35	116107	98691	77257	37300	78807
40	53798	45728	36218	18761	35037
50	234347	199195	158865	90521	143826
60	59452	50534	39618	25665	33787
70	59778	50811	38496	28133	31645
80	54891	46657	33737	27624	27267
90	115435	98120	69886	63722	51713
100	113211	96229	67689	67012	46198
110	120686	102583	72178	72178	48508
120	52865	44935	31568	31568	21297
130	26178	22251	15528	15528	10650
140	12540	10659	7453	7453	5087
150	2425	2061	1465	1465	960
Total	1,630,156	1,385,631	945,927	611,194	1,018,961

YEAR = 1983

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	122499	104124	7619	2696	119803
20	37187	31609	9716	3731	33456
25	14192	12063	6419	2669	11523
30	22142	18821	10734	4814	17328
35	5888	5005	3831	1850	4039
40	4832	4107	3131	1622	3210
50	17160	14586	11386	6488	10672
60	11413	9701	7572	4905	6508
70	23531	20001	15504	11330	12200
80	11444	9727	6969	5706	5737
90	21454	18236	13445	12259	9195
100	16779	14262	10417	10313	6466
110	12899	10964	7928	7928	4971
120	15605	13264	10001	10001	5604
130	3554	3021	2315	2315	1239
140	1472	1251	921	921	551
150	831	706	521	521	310
Total	342,882	291,448	128,429	90,069	252,812

APPENDIX TABLE 5. continued.

YEAR = 1984

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	172564	146679	3439	1116	171448
15	2427677	2063525	52762	18667	2409010
20	3653672	3105621	506249	194400	3459272
25	2621539	2228308	873026	363004	2258534
30	1887736	1604576	622739	279299	1608438
35	2198942	1869101	1322493	638500	1560443
40	1138915	968078	684652	354650	784266
50	1769285	1503892	1037904	591398	1177887
60	833440	708424	488849	316676	516764
70	378272	321531	222979	162953	215319
80	216416	183954	128386	105122	111294
90	256805	218284	155437	141727	115077
100	157094	133530	95670	94713	62381
110	109818	93345	67050	67050	42768
120	62344	52992	38156	38156	24188
130	18939	16098	11503	11503	7436
140	9382	7975	5642	5642	3740
150	7394	6285	4489	4489	2905
Total	17,920,234	15,232,198	6,321,425	3,389,065	14,531,170

YEAR = 1985

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	189287	160894	14121	4996	184291
20	1516324	1288875	485879	186578	1329746
25	2376869	2020338	1295951	538856	1838012
30	1410295	1198751	749157	335997	1074298
35	748826	636502	490509	236818	512008
40	162542	138161	106286	55056	107486
50	596107	506691	403563	229950	366157
60	125374	106568	84778	54919	70455
70	85700	72845	57790	42233	43467
80	88900	75565	58969	48284	40616
90	54594	46405	35911	32744	21850
100	114104	96988	75234	74482	39622
110	83839	71263	55324	55324	28515
120	58100	49385	38073	38073	20027
130	35154	29881	23066	23066	12088
140	16375	13919	10870	10870	5505
150	4667	3967	3072	3072	1595
Total	7,667,057	6,516,998	3,988,553	1,971,318	5,695,738

APPENDIX TABLE 5. continued.

YEAR = 1986

<u>Length Group</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
5	0	0	0	0	0
10	0	0	0	0	0
15	1296095	1101681	36033	12748	1283347
20	5358091	4554377	1685282	647148	4710942
25	4515872	3838491	2237886	930513	3585359
30	9526769	8097753	5297167	2375779	7150988
35	3677452	3125834	2441115	1178571	2498881
40	1086258	923319	724437	375258	710999
50	1175868	999488	808042	460422	715446
60	264205	224574	180521	116942	147263
70	155440	132124	105708	77251	78189
80	82626	70232	55061	45084	37542
90	137736	117076	91604	83525	54212
100	94441	80275	62071	61450	32991
110	85927	73038	55395	55395	30532
120	40149	34127	26419	26419	13730
130	11091	9427	7183	7183	3908
140	4944	4202	3317	3317	1627
150	667	567	423	423	244
Total	27,513,631	23,386,585	13,817,664	6,457,428	21,056,200

APPENDIX TABLE 3. continued.

YEAR = 1978

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	4319256	777466	544432	517026	3802230
2	1536561	276581	192124	185617	1350944
3	39250	7065	4977	4876	34374
4	418	75	58	57	361
5	1505	271	204	204	1301
6	5625051	1012509	531346	261165	5363886
7	9048761	1628777	992861	516316	8532444
8	2017978	363236	241849	154744	1863235
9	99143	17846	12620	9768	89374
10	1312206	236197	170103	154317	1157890
11	1266145	227906	169603	145573	1120572
12	1185705	213427	161659	143983	1041721
Total	26,451,979	4,761,356	3,021,836	2,093,646	24,358,332

YEAR = 1979

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	246090	44296	33804	30903	215187
2	57444	10340	7981	7138	50304
3	4168	750	580	545	3621
4	3567	642	464	457	3110
5	115928	20867	11593	8096	107833
6	5188882	933999	681998	328462	4860422
7	9632966	1733934	1041404	545535	9087433
8	2410306	433855	297867	190727	2219578
9	65395	11771	8076	6449	58945
10	337627	60773	45552	39719	297909
11	877955	158032	115821	105878	772077
12	1097823	197608	140579	134238	963585
Total	20,038,151	3,606,867	2,385,719	1,398,147	18,640,004

APPENDIX TABLE 3. continued.

YEAR = 1980

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	252406	45433	31446	29981	222423
2	53345	9602	6725	6266	47080
3	2378	428	337	322	2057
4	1672	301	233	233	1439
5	0	0	0	0	0
6	3118190	561274	324662	143388	2974801
7	10140477	1825286	1186259	592470	9548008
8	3513948	632511	450116	266358	3247591
9	662906	119323	81866	53898	609008
10	63328	11399	8441	6993	56335
11	451844	81332	62038	58716	393129
12	901034	162186	119192	112537	788497
Total	19,161,528	3,449,075	2,271,315	1,271,162	17,890,368

YEAR = 1981

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	448732	80772	58868	55865	392868
2	135467	24384	18404	17204	118263
3	30576	5504	4068	3807	26770
4	3116	561	405	381	2735
5	221060	39791	30342	14241	206820
6	1721429	309857	256281	124654	1596773
7	2166340	389941	296695	177177	1989162
8	1398305	251695	167427	121180	1277126
9	46755	8416	5887	4900	41855
10	27902	5022	3675	3196	24704
11	277556	49960	37204	34637	242917
12	475839	85651	60635	57941	417899
Total	6,953,077	1,251,554	939,891	615,183	6,337,892

APPENDIX TABLE 3. continued.

YEAR = 1982

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	392445	70640	51090	47579	344866
2	220112	39620	27554	25755	194357
3	97643	17576	11923	11636	86007
4	25948	4671	3221	2963	22987
5	12061	2171	1437	638	11422
6	38655	6958	6104	2797	35858
7	1804215	324759	250795	124242	1679975
8	2034162	366149	259915	139426	1894735
9	236984	42657	30325	19082	217901
10	170377	30668	22768	18965	151413
11	208915	37605	28027	25356	183561
12	1337878	240818	166863	159766	1178113
Total	6,579,395	1,184,292	860,022	578,205	6,001,195

YEAR = 1983

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	111917	20145	12982	12131	99787
2	48462	8723	6130	5963	42498
3	2732	492	367	347	2385
4	0	0	0	0	0
5	333	60	46	19	314
6	86033	15486	8084	3474	82559
7	141195	25415	17935	9554	131640
8	272638	49075	37282	26490	246150
9	18128	3263	2409	1235	16892
10	2249	405	341	254	1996
11	42420	7636	5731	4974	37446
12	138973	25015	19787	19202	119771
Total	865,080	155,715	111,094	83,643	781,438

APPENDIX TABLE 3. continued.

YEAR = 1984

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	6333	1140	891	829	5504
2	7243	1304	968	878	6366
3	2862	515	377	369	2493
4	6462	1163	805	763	5698
5	91917	16545	7165	4517	87399
6	25472538	4585057	2187920	1017351	24455187
7	26050695	4689125	3117220	1759071	24291622
8	802159	144389	98697	67050	735110
9	100066	18012	13532	11616	88451
10	653074	117553	83436	79095	573979
11	967704	174187	129320	121925	845780
12	929904	167383	118644	111418	818487
Total	55,090,957	9,916,373	5,758,975	3,174,882	51,916,076

YEAR = 1985

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	111526	20075	14525	13483	98043
2	63750	11475	8464	7609	56142
3	19890	3580	2810	2581	17309
4	8478	1526	1146	1126	7352
5	2508702	451566	324432	139687	2369014
6	16005965	2881074	1937189	902807	15103159
7	7109856	1279774	878643	438625	6671230
8	776166	139710	105959	67254	708912
9	104367	18786	14913	12557	91811
10	33516	6033	4579	4053	29462
11	714960	128693	99565	97281	617681
12	694095	124937	96328	92688	601408
Total	28,151,271	5,067,229	3,488,553	1,779,751	26,371,523

APPENDIX TABLE 3. continued.

YEAR = 1986

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	249589	44926	34854	32705	216884
2	77645	13976	11003	10328	67318
3	7356	1324	1050	1008	6346
4	567	102	79	79	488
5	297917	53625	34165	14345	283572
6	49859152	8974649	5703389	2569332	47289828
7	43398906	7811802	5672152	2703542	40695356
8	2377122	427882	326422	192297	2184825
9	873416	157215	126121	101098	772318
10	448361	80705	64676	56517	391844
11	471800	84924	63310	59647	412154
12	441095	79397	59128	56637	384458
Total	98,502,926	17,730,527	12,096,349	5,797,535	92,705,391

APPENDIX TABLE 4. CHINOOK SALMON ENTRAINMENT LOSSES AT STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 75%.

YEAR = 1968

Month	Entrained into CCF*	Encountering the Screens	Salvaged	Released Alive	System Loss
1	0	0	0	0	0
2	0	0	0	0	0
3	18768	4692	3466	3431	15337
4	56944	14236	10548	10360	46584
5	75408	18852	13979	13751	61657
6	9364	2341	1632	1601	7763
7	684	171	120	118	566
8	0	0	0	0	0
9	0	0	0	0	0
10	1824	456	300	300	1524
11	15244	3811	2772	2759	12485
12	13740	3435	2556	2556	11184
Total	191,976	47,994	35,373	34,876	157,100

YEAR = 1969

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	19032	4758	3421	3412	15620
2	1396	349	275	270	1126
3	1536	384	284	281	1255
4	83204	20801	14868	14787	68417
5	132924	33231	24124	23910	109014
6	20416	5104	3394	3374	17042
7	1244	311	212	209	1035
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	1496	374	278	278	1218
Total	261,248	65,312	46,856	46,521	214,727

CCF = Clifton Court Forebay

APPENDIX TABLE 4. continued.

YEAR = 1970

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	6084	1521	1093	1091	4993
2	7972	1993	1574	1543	6429
3	6448	1612	1189	1178	5270
4	60912	15228	10831	10790	50122
5	70896	17724	12764	12687	58209
6	38072	9518	6220	6213	31859
7	0	0	0	0	0
8	3200	800	540	540	2660
9	0	0	0	0	0
10	0	0	0	0	0
11	17636	4409	3168	3168	14468
12	75544	18886	14052	14052	61492
Total	286,764	71,691	51,431	51,262	235,502

YEAR = 1971

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	3900	975	696	696	3204
2	0	0	0	0	0
3	7960	1990	1431	1431	6529
4	30576	7644	5528	5475	25101
5	20772	5193	3892	3814	16958
6	34704	8676	6013	5910	28794
7	4436	1109	776	760	3676
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	1640	410	312	309	1331
Total	103,988	25,997	18,648	18,395	85,593

APPENDIX TABLE 4. continued.

YEAR = 1972

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	3068	767	548	548	2520
2	0	0	0	0	0
3	25960	6490	4823	4764	21196
4	72872	18218	13520	13272	59600
5	231712	57928	43386	42530	189182
6	114412	28603	19540	19279	95133
7	0	0	0	0	0
8	0	0	0	0	0
9	2164	541	385	377	1787
10	8552	2138	1407	1407	7145
11	47808	11952	8588	8588	39220
12	28976	7244	5390	5390	23586
Total	535,524	133,881	97,587	96,155	439,369

YEAR = 1973

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	9052	2263	1648	1636	7416
2	3532	883	667	667	2865
3	10012	2503	1814	1809	8203
4	35276	8819	6534	6418	28858
5	119488	29872	22334	21907	97581
6	22364	5591	3917	3839	18525
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	4152	1038	699	694	3458
11	8128	2032	1463	1462	6666
12	16744	4186	3151	3135	13609
Total	228,748	57,187	42,227	41,567	187,181

APPENDIX TABLE 4. continued.

YEAR = 1974

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	5080	1270	907	907	4173
2	4808	1202	928	919	3889
3	21988	5497	4008	3987	18001
4	70928	17732	13107	12884	58044
5	363612	90903	67567	66410	297202
6	259176	64794	44661	43959	215217
7	20948	5237	3597	3543	17405
8	0	0	0	0	0
9	8	2	1	1	7
10	540	135	91	91	449
11	25124	6281	4528	4522	20602
12	12944	3236	2408	2408	10536
Total	785,156	196,289	141,803	139,631	645,525

YEAR = 1975

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	9764	2441	1743	1743	8021
2	8688	2172	1650	1645	7043
3	23608	5902	4403	4343	19265
4	29828	7457	5507	5415	24413
5	81712	20428	15161	14909	66803
6	3836	959	664	653	3183
7	0	0	0	0	0
8	0	0	0	0	0
9	2312	578	402	397	1915
10	15152	3788	2516	2509	12643
11	19796	4949	3569	3564	16232
12	15316	3829	2858	2854	12462
Total	210,012	52,503	38,473	38,032	171,980

APPENDIX TABLE 4. continued.

YEAR = 1976

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	5384	1346	961	961	4423
2	5312	1328	1005	1004	4308
3	57028	14257	10288	10275	46753
4	16784	4196	3040	3009	13775
5	74596	18649	13687	13513	61083
6	9380	2345	1602	1581	7799
7	652	163	114	112	540
8	1448	362	252	249	1199
9	136	34	24	24	112
10	832	208	138	138	694
11	712	178	128	128	584
12	3452	863	642	642	2810
Total	175,716	43,929	31,881	31,636	144,080

YEAR = 1977

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	12456	3114	2224	2224	10232
2	5192	1298	984	982	4210
3	3248	812	592	589	2659
4	388	97	69	69	319
5	24284	6071	4522	4441	19843
6	3540	885	611	601	2939
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	1496	374	269	269	1227
12	101852	25463	19068	19015	82837
Total	152,456	38,114	28,339	28,190	124,266

APPENDIX TABLE 4. continued.

YEAR = 1978

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	235788	58947	45618	45607	190181
2	34680	8670	6670	6670	28010
3	2724	681	506	506	2218
4	108	27	18	18	90
5	17552	4388	3192	3187	14365
6	62120	15530	11531	11441	50679
7	3464	866	636	630	2834
8	0	0	0	0	0
9	112	28	20	20	92
10	223180	55795	41845	41845	181335
11	3544	886	653	647	2897
12	20508	5127	3734	3734	16774
Total	603,780	150,945	114,423	114,305	489,475

YEAR = 1979

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	13368	3342	2401	2401	10967
2	6652	1663	1180	1179	5473
3	12900	3225	2302	2300	10600
4	149728	37432	28993	28641	121087
5	316552	79138	59787	58791	257761
6	51332	12833	9534	9377	41955
7	28632	7158	5644	5542	23090
8	1828	457	360	356	1472
9	368	92	70	70	298
10	8680	2170	1518	1518	7162
11	29200	7300	5392	5392	23808
12	27944	6986	5253	5253	22691
Total	647,184	161,796	122,434	120,820	526,364

APPENDIX TABLE 4. continued.

YEAR = 1980

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	30644	7661	5962	5936	24708
2	1976	494	384	384	1592
3	1044	261	189	186	858
4	105168	26292	18667	18603	86565
5	156212	39053	27044	27015	129197
6	126332	31583	22838	22773	103559
7	3964	991	726	721	3243
8	128	32	23	23	105
9	4904	1226	932	932	3972
10	5280	1320	965	965	4315
11	4492	1123	809	809	3683
12	7996	1999	1468	1468	6528
Total	448,140	112,035	80,007	79,815	368,325

YEAR = 1981

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	9524	2381	1761	1761	7763
2	18844	4711	3504	3504	15340
3	33660	8415	6324	6299	27361
4	283556	70889	55053	54257	229299
5	99148	24787	19119	18797	80351
6	2148	537	351	346	1802
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	2272	568	397	397	1875
11	15936	3984	2941	2941	12995
12	65500	16375	12096	12096	53404
Total	530,588	132,647	101,546	100,398	430,190

APPENDIX TABLE 4. continued.

YEAR = 1982

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	36512	9128	6704	6700	29812
2	137220	34305	26819	26707	110513
3	117228	29307	22978	22943	94285
4	145032	36258	28732	28596	116436
5	649220	162305	117775	117217	532003
6	149060	37265	26915	26668	122392
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	33232	8308	6085	6085	27147
12	272280	68070	52826	52826	219454
Total	1,539,784	384,946	288,834	287,742	1,252,042

YEAR = 1983

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	64628	16157	12509	12480	52148
2	65388	16347	12752	12627	52761
3	25328	6332	4796	4732	20596
4	0	0	0	0	0
5	7252	1813	1136	1132	6120
6	204792	51198	37445	37339	167453
7	756	189	134	132	624
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	896	224	162	162	734
12	0	0	0	0	0
Total	369,040	92,260	68,934	68,604	300,436

APPENDIX TABLE 4. continued.

YEAR = 1984

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	0	0	0	0	0
2	404	101	78	77	327
3	8968	2242	1673	1667	7301
4	137884	34471	27258	26932	110952
5	203292	50823	40079	39661	163631
6	229136	57284	46134	45420	183716
7	12	3	2	2	10
8	2944	736	575	575	2369
9	0	0	0	0	0
10	54520	13630	10511	10511	44009
11	48560	12140	8857	8857	39703
12	51764	12941	9884	9884	41880
Total	737,484	184,371	145,051	143,586	593,898

YEAR = 1985

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	636	159	121	121	515
2	4472	1118	852	841	3631
3	12452	3113	2264	2248	10204
4	150896	37724	28264	27817	123079
5	527684	131921	96277	94750	432934
6	48372	12093	8768	8634	39738
7	2196	549	408	400	1796
8	0	0	0	0	0
9	104	26	18	18	86
10	3980	995	717	714	3266
11	6016	1504	1101	1101	4915
12	11008	2752	1951	1951	9057
Total	767,816	191,954	140,741	138,595	629,221

APPENDIX TABLE 4. continued.

YEAR = 1986

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	9296	2324	1639	1639	7657
2	73024	18256	13424	13163	59861
3	103460	25865	18900	18531	84929
4	706120	176530	133773	131996	574124
5	937600	234400	176554	174278	763322
6	480028	120007	90239	89516	390512
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	828	207	152	152	676
12	2996	749	550	550	2446
Total	2,313,352	578,338	435,231	429,825	1,883,527

APPENDIX TABLE 5. STRIPED BASS ENTRAINMENT LOSSES BY LENGTH GROUP AT THE STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 15%.

YEAR = 1968

Length Group*	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	40294	34250	2880	935	39360
15	13614672	11572467	1177713	416675	13197993
20	751147	638475	296649	113913	637234
25	5626	4782	3297	1371	4255
30	1221233	1038048	746290	334711	886522
35	93020	79067	63113	30471	62549
40	308227	261993	208936	108229	199998
50	47972	40776	33741	19226	28746
60	99814	84842	70958	45967	53848
70	64652	54954	44641	32624	32028
80	140558	119474	96335	78879	61679
90	128449	109182	86584	78947	49502
100	5436	4621	3534	3499	1938
110	223416	189904	151588	151588	71828
120	84771	72055	57243	57243	27528
130	75871	64490	51512	51512	24359
140	46327	39378	32464	32464	13863
150	0	0	0	0	0
Total	16,951,485	14,408,758	3,127,478	1,558,254	15,393,230

YEAR = 1969

Length Group	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
5	0	0	0	0	0
10	0	0	0	0	0
15	1640551	1394469	117309	41504	1599048
20	0	0	0	0	0
25	0	0	0	0	0
30	1252727	1064818	750746	336710	916017
35	0	0	0	0	0
40	498161	423437	333210	172603	325558
50	0	0	0	0	0
60	300484	255411	210553	136396	164087
70	99224	84340	68050	49731	49493
80	44798	38078	30155	24691	20107
90	40069	34059	26606	24259	15810
100	3161	2687	2053	2032	1129
110	27002	22952	17757	17757	9245
120	11895	10111	7809	7809	4086
130	8661	7362	5692	5692	2969
140	1998	1698	1297	1297	701
150	0	0	0	0	0
Total	3,928,731	3,339,422	1,571,237	820,481	3,108,250

* End point of length group

APPENDIX TABLE 1. continued.

YEAR = 1986

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	52853	44926	34854	32705	20150
2	16442	13976	11003	10328	6115
3	1558	1324	1050	1008	550
4	120	102	79	79	41
5	63088	53625	34165	14345	48744
6	10558411	8974649	5703389	2569332	7989079
7	9190356	7811802	5672152	2703542	6486812
8	503390	427882	326422	192297	311093
9	184957	157215	126121	101098	83861
10	94945	80705	64676	56517	38428
11	99910	84924	63310	59647	40264
12	93408	79397	59128	56637	36772
Total	20,859,438	17,730,527	12,096,349	5,797,535	15,061,909

APPENDIX TABLE 2. CHINOOK SALMON ENTRAINMENT LOSSES AT STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 15%.

YEAR = 1968

Month	Entrained into CCF*	Encountering the Screens	Salvaged	Released Alive	System Loss
1	0	0	0	0	0
2	0	0	0	0	0
3	5520	4692	3466	3431	2089
4	16749	14236	10548	10360	6388
5	22179	18852	13979	13751	8428
6	2754	2341	1632	1601	1153
7	201	171	120	118	84
8	0	0	0	0	0
9	0	0	0	0	0
10	536	456	300	300	236
11	4483	3811	2772	2759	1724
12	4041	3435	2556	2556	1485
Total	56,463	47,994	35,373	34,876	21,587

YEAR = 1969

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	5598	4758	3421	3412	2186
2	410	349	275	270	140
3	452	384	284	281	171
4	24472	20801	14868	14787	9685
5	39095	33231	24124	23910	15186
6	6004	5104	3394	3374	2631
7	366	311	212	209	156
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	440	374	278	278	162
Total	76,837	65,312	46,856	46,521	30,317

CCF = Clifton Court Forebay

APPENDIX TABLE 2. continued.

YEAR = 1970

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	1789	1521	1093	1091	699
2	2345	1993	1574	1543	802
3	1897	1612	1189	1178	719
4	17915	15228	10831	10790	7125
5	20852	17724	12764	12687	8165
6	11198	9518	6220	6213	4985
7	0	0	0	0	0
8	941	800	540	540	401
9	0	0	0	0	0
10	0	0	0	0	0
11	5187	4409	3168	3168	2019
12	22219	18886	14052	14052	8167
Total	84,343	71,691	51,431	51,262	33,082

YEAR = 1971

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	1147	975	696	696	451
2	0	0	0	0	0
3	2341	1990	1431	1431	910
4	8993	7644	5528	5475	3517
5	6109	5193	3892	3814	2295
6	10207	8676	6013	5910	4297
7	1305	1109	776	760	544
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	482	410	312	309	173
Total	30,584	25,997	18,648	18,395	12,187

APPENDIX TABLE 2. continued.

YEAR = 1972

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	902	767	548	548	354
2	0	0	0	0	0
3	7635	6490	4823	4764	2872
4	21433	18218	13520	13272	8161
5	68151	57928	43386	42530	25621
6	33650	28603	19540	19279	14371
7	0	0	0	0	0
8	0	0	0	0	0
9	636	541	385	377	259
10	2515	2138	1407	1407	1108
11	14061	11952	8588	8588	5473
12	8522	7244	5390	5390	3132
Total	157,505	133,881	97,587	96,155	61,351

YEAR = 1973

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	2662	2263	1648	1636	1026
2	1039	883	667	667	372
3	2945	2503	1814	1809	1136
4	10375	8819	6534	6418	3957
5	35144	29872	22334	21907	13237
6	6578	5591	3917	3839	2739
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	1221	1038	699	694	527
11	2391	2032	1463	1462	929
12	4924	4186	3151	3135	1789
Total	67,279	57,187	42,227	41,567	25,712

APPENDIX TABLE 2. continued.

YEAR = 1974

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	1494	1270	907	907	587
2	1414	1202	928	919	495
3	6467	5497	4008	3987	2480
4	20861	17732	13107	12884	7976
5	106945	90903	67567	66410	40535
6	76228	64794	44661	43959	32269
7	6161	5237	3597	3543	2618
8	0	0	0	0	0
9	2	2	1	1	1
10	159	135	91	91	68
11	7389	6281	4528	4522	2867
12	3807	3236	2408	2408	1399
Total	230,927	196,289	141,803	139,631	91,295

YEAR = 1975

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	2872	2441	1743	1743	1129
2	2555	2172	1650	1645	910
3	6944	5902	4403	4343	2601
4	8773	7457	5507	5415	3358
5	24033	20428	15161	14909	9124
6	1128	959	664	653	475
7	0	0	0	0	0
8	0	0	0	0	0
9	680	578	402	397	284
10	4457	3788	2516	2509	1947
11	5822	4949	3569	3564	2258
12	4504	3829	2858	2854	1650
Total	61,768	52,503	38,473	38,032	23,736

APPENDIX TABLE 2. continued.

YEAR = 1976

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	1584	1346	961	961	623
2	1563	1328	1005	1004	559
3	16773	14257	10288	10275	6498
4	4936	4196	3040	3009	1927
5	21940	18649	13687	13513	8427
6	2759	2345	1602	1581	1178
7	192	163	114	112	80
8	426	362	252	249	176
9	40	34	24	24	16
10	245	208	138	138	107
11	209	178	128	128	81
12	1015	863	642	642	373
Total	51,682	43,929	31,881	31,636	20,045

YEAR = 1977

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	3664	3114	2224	2224	1440
2	1527	1298	984	982	544
3	955	812	592	589	366
4	114	97	69	69	46
5	7143	6071	4522	4441	2702
6	1041	885	611	601	440
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	440	374	269	269	171
12	29957	25463	19068	19015	10942
Total	44,841	38,114	28,339	28,190	16,651

APPENDIX TABLE 2. continued.

YEAR = 1978

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	69350	58947	45618	45607	23742
2	10200	8670	6670	6670	3530
3	801	681	506	506	295
4	31	27	18	18	14
5	5163	4388	3192	3187	1976
6	18270	15530	11531	11441	6829
7	1019	866	636	630	390
8	0	0	0	0	0
9	33	28	20	20	13
10	65641	55795	41845	41845	23796
11	1042	886	653	647	395
12	6032	5127	3734	3734	2298
Total	177,582	150,945	114,423	114,305	63,278

YEAR = 1979

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	3932	3342	2401	2401	1531
2	1956	1663	1180	1179	778
3	3794	3225	2302	2300	1494
4	44038	37432	28993	28641	15397
5	93103	79138	59787	58791	34312
6	15098	12833	9534	9377	5721
7	8422	7158	5644	5542	2880
8	538	457	360	356	181
9	108	92	70	70	38
10	2553	2170	1518	1518	1035
11	8588	7300	5392	5392	3196
12	8219	6986	5253	5253	2966
Total	190,349	161,796	122,434	120,820	69,529

APPENDIX TABLE 2. continued.

YEAR = 1980

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	9013	7661	5962	5936	3077
2	581	494	384	384	197
3	307	261	189	186	121
4	30932	26292	18667	18603	12329
5	45945	39053	27044	27015	18929
6	37157	31583	22838	22773	14384
7	1165	991	726	721	444
8	38	32	23	23	15
9	1442	1226	932	932	510
10	1553	1320	965	965	588
11	1321	1123	809	809	512
12	2352	1999	1468	1468	884
Total	131,806	112,035	80,007	79,815	51,990

YEAR = 1981

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	2801	2381	1761	1761	1040
2	5542	4711	3504	3504	2038
3	9900	8415	6324	6299	3601
4	83399	70889	55053	54257	29142
5	29161	24787	19119	18797	10364
6	632	537	351	346	286
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	668	568	397	397	271
11	4687	3984	2941	2941	1746
12	19265	16375	12096	12096	7169
Total	156,055	132,647	101,546	100,398	55,657

APPENDIX TABLE 2. continued.

YEAR = 1982

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	10739	9128	6704	6700	4039
2	40359	34305	26819	26707	13652
3	34479	29307	22978	22943	11535
4	42656	36258	28732	28596	14060
5	190947	162305	117775	117217	73731
6	43841	37265	26915	26668	17174
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	9774	8308	6085	6085	3689
12	80082	68070	52826	52826	27256
Total	452,877	384,946	288,834	287,742	165,136

YEAR = 1983

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	19008	16157	12509	12480	6528
2	19232	16347	12752	12627	6604
3	7449	6332	4796	4732	2717
4	0	0	0	0	0
5	2133	1813	1136	1132	1001
6	60233	51198	37445	37339	22894
7	222	189	134	132	90
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	264	224	162	162	102
12	0	0	0	0	0
Total	108,541	92,260	68,934	68,604	39,936

APPENDIX TABLE 2. continued.

YEAR = 1984

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	0	0	0	0	0
2	119	101	78	77	42
3	2638	2242	1673	1667	970
4	40555	34471	27258	26932	13622
5	59791	50823	40079	39661	20130
6	67393	57284	46134	45420	21973
7	4	3	2	2	2
8	866	736	575	575	291
9	0	0	0	0	0
10	16035	13630	10511	10511	5524
11	14282	12140	8857	8857	5425
12	15225	12941	9884	9884	5341
Total	216,908	184,371	145,051	143,586	73,320

YEAR = 1985

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	187	159	121	121	66
2	1315	1118	852	841	474
3	3663	3113	2264	2248	1415
4	44381	37724	28264	27817	16564
5	155201	131921	96277	94750	60450
6	14227	12093	8768	8634	5593
7	646	549	408	400	246
8	0	0	0	0	0
9	31	26	18	18	13
10	1170	995	717	714	456
11	1769	1504	1101	1101	668
12	3238	2752	1951	1951	1287
Total	225,828	191,954	140,741	138,595	87,232

APPENDIX TABLE 2. continued.

YEAR = 1986

<u>Month</u>	<u>Entrained into CCF</u>	<u>Encountering the Screens</u>	<u>Salvaged</u>	<u>Released Alive</u>	<u>System Loss</u>
1	2734	2324	1639	1639	1095
2	21477	18256	13424	13163	8314
3	30429	25865	18900	18531	11898
4	207682	176530	133773	131996	75686
5	275765	234400	176554	174278	101487
6	141185	120007	90239	89516	51669
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	244	207	152	152	92
12	881	749	550	550	331
Total	680,397	578,338	435,231	429,825	250,572

APPENDIX TABLE 3. STRIPED BASS (21 - 150 MM) ENTRAINMENT LOSSES AT THE STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 82%.

YEAR = 1968

Month	Entrained into CCF*	Encountering the Screens	Salvaged	Released Alive	System Loss
1	0	0	0	0	0
2	0	0	0	0	0
3	157867	28416	21532	20323	137544
4	411133	74004	57495	52457	358676
5	1226993	220859	167670	154371	1072624
6	5002693	900485	682244	410631	4592065
7	4225578	760604	584751	293504	3932073
8	422206	75997	56451	30868	391338
9	216330	38939	31319	21046	195283
10	69262	12467	10358	8647	60614
11	139429	25097	19003	16931	122499
12	148323	26698	19413	17955	130367
Total	12,019,814	2,163,566	1,650,236	1,026,733	10,993,083

YEAR = 1969

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	279967	50394	38504	35645	244321
2	17879	3218	2296	2053	15825
3	3751	675	511	483	3270
4	9906	1783	1385	1337	8569
5	82027	14765	11391	10873	71155
6	14361	2585	2053	1460	12901
7	5482450	986841	737443	356119	5126332
8	4727715	850989	634249	351410	4376305
9	63529	11435	9325	6472	57055
10	27017	4863	4054	3358	23659
11	18100	3258	2473	2002	16100
12	78594	14147	10244	7770	70826
Total	10,805,296	1,944,953	1,453,928	778,982	10,026,318

* CCF = Clifton Court Forebay

APPENDIX TABLE 3. continued.

YEAR = 1970

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	122889	22120	16898	13242	109645
2	27628	4973	3547	2943	24686
3	0	0	0	0	0
4	12783	2301	1788	1627	11156
5	4189	754	582	477	3712
6	7067767	1272198	932669	428955	6638812
7	54249083	9764835	7634407	4097267	50151818
8	15537572	2796763	2165811	1346677	14190896
9	2917911	525224	426116	299065	2618847
10	1221889	219940	180397	127211	1094677
11	836666	150600	114183	97874	738793
12	474766	85458	62132	52728	422037
Total	82,473,143	14,845,166	11,538,530	6,468,066	76,005,079

YEAR = 1971

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	173716	31269	23891	20815	152902
2	103411	18614	13273	11522	91889
3	164372	29587	22336	19180	145192
4	130650	23517	18273	15362	115288
5	52062	9371	7205	5565	46497
6	787439	141739	115015	88732	698706
7	37043691	6667864	4897081	2261559	34782133
8	11595389	2087170	1456992	704941	10890448
9	743250	133785	103492	60521	682730
10	239134	43044	35677	27915	211217
11	150955	27172	20328	16174	134782
12	257918	46425	33429	25389	232528
Total	51,441,987	9,259,557	6,746,992	3,257,675	48,184,312

APPENDIX TABLE 3. continued.

YEAR = 1972

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	161928	29147	22246	16383	145546
2	453333	81600	58237	44877	408456
3	686755	123616	93622	73187	613568
4	336800	60624	47081	37639	299161
5	1261662	227099	166916	136964	1124696
6	30291321	5452438	4050887	2251469	28039853
7	4867850	876213	653746	311476	4556375
8	2040938	367369	268347	141967	1898971
9	730298	131454	102414	62942	667356
10	377006	67861	56371	46506	330502
11	222961	40133	30442	28210	194751
12	1046529	188375	136956	121720	924809
Total	42,477,381	7,645,929	5,687,265	3,273,340	39,204,044

YEAR = 1973

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	497749	89595	68455	64354	433397
2	162956	29332	20513	18633	144323
3	34889	6280	4759	4618	30270
4	11166	2010	1562	1334	9832
5	806943	145250	88454	44597	762348
6	45424173	8176351	6095039	2847504	42576671
7	17635835	3174450	2471921	1290358	16345476
8	2629649	473337	357985	196726	2432922
9	232829	41909	33706	21012	211818
10	210356	37864	31557	27225	183131
11	327029	58865	44652	40419	286611
12	803566	144642	105161	100809	702756
Total	68,777,140	12,379,885	9,323,764	4,657,589	64,119,555

APPENDIX TABLE 3. continued.

YEAR = 1974

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	474934	85488	65314	62464	412470
2	152372	27427	19559	18812	133560
3	61839	11131	8434	7784	54056
4	16617	2991	2323	2156	14462
5	323172	58171	44879	41662	281510
6	65308122	11755462	8609840	3870880	61437240
7	38992765	7018697	5384630	2662726	36330041
8	7697333	1385520	1039618	558785	7138548
9	296874	53437	42917	27918	268956
10	49967	8994	7462	5933	44034
11	105916	19065	14461	12738	93179
12	1298416	233715	169918	149298	1149117
Total	114,778,327	20,660,098	15,409,355	7,421,156	107,357,173

YEAR = 1975

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	1584939	285289	217969	199256	1385684
2	597555	107560	76703	71853	525702
3	250165	45030	34122	31732	218433
4	40734	7332	5697	5369	35366
5	33794	6083	4692	4352	29443
6	1111844	200132	147381	66984	1044861
7	7817349	1407123	1061312	502731	7314618
8	16765623	3017812	2226010	1161024	15604598
9	1973911	355304	284309	178736	1795175
10	497134	89484	74580	67533	429600
11	1498562	269741	204622	181585	1316976
12	663572	119443	86839	76800	586771
Total	32,835,182	5,910,333	4,424,236	2,547,955	30,287,227

APPENDIX TABLE 3. continued.

YEAR = 1976

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	1125850	202653	154832	137668	988183
2	434978	78296	55834	50553	384425
3	98456	17722	13384	11586	86872
4	19045	3428	2665	2265	16780
5	116317	20937	15268	10965	105352
6	4554100	819738	597980	261235	4292866
7	4119518	741513	567596	280213	3839303
8	1040367	187266	141389	75752	964615
9	75351	13563	10836	8134	67217
10	11406	2053	1697	1322	10084
11	227522	40954	31064	27786	199737
12	147650	26577	19326	16445	131205
Total	11,970,560	2,154,700	1,611,871	883,924	11,086,639

YEAR = 1977

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	404698	72846	55649	51330	353369
2	75694	13625	9717	8948	66745
3	33957	6112	4631	4135	29822
4	0	0	0	0	0
5	8556	1540	1188	1136	7420
6	245433	44178	32009	13804	231629
7	2577922	464026	357521	174892	2403030
8	85127	15323	12288	8082	77047
9	4549	819	666	423	4127
10	0	0	0	0	0
11	157283	28311	21471	19641	137643
12	447017	80463	58500	56529	390490
Total	4,040,236	727,243	553,640	338,920	3,701,322

SWP Facility	Case 1	Case 2
Striped Bass <20mm	51,909,361	51,909,361
Striped Bass >20mm	15,061,909	92,705,391
Total	66,971,270	144,614,752

CVP Facility	Case 1	Case 2
Striped Bass <20mm	47,813,048	47,813,048
Striped Bass >20mm	4,932,410	4,932,410
Total	52,745,458	52,745,458

Similarly, the combined losses for chinook salmon in 1986 were:

Facility	Case 1	Case 2
SWP	250,572	1,883,526
CVP	451,631	451,631
Total	702,203	2,335,157

The Case 1 analysis for the CVP represents our best estimate of the magnitude of losses associated with this facility. The SWP Case 1 analysis is only valid for the 1968 and 1969 estimates, since it ignores the measured pre-screening loss estimates in the Forebay. As we have discussed earlier, the estimates of CVP losses are based on a series of assumptions about the Tracy Facility, which are unverified.

The Case 2 analysis for the SWP is based on the measured pre-screening loss estimates in the Forebay. The loss estimates are high, and have not been substantiated by analyses of the relative numbers of fish salvaged at the Skinner and Tracy facilities. Many biologists associated with the problem are skeptical of their general applicability. This has presented a dilemma, and we are conducting additional evaluations to verify or modify the loss estimates. Potential biases include marked fish leaving the Forebay through the radial gates and marked fish behaving differently than the unmarked fish. We believe that these two cases bracket the range of potential losses, and are suitable for the purposes of assessing the range of potential impacts.

The information presented supports the point that entrainment losses at the SWP and CVP facilities are substantial, and vary greatly from year to year. It is important to note that the actual losses at the two facilities depend greatly on the timing of the fish occurrence, their abundance and distribution, hydrologic conditions in the Delta and the operations of the SWP and CVP. Any analysis of this information must take all of the

factors into account, since without them one cannot correctly assess the impact of the losses.

LITERATURE CITED

- Baracco, Alan. MS. A procedure for estimating losses of striped bass and chinook salmon caused by State Water Project export operations in the south Delta, 1986-1980. Memorandum to Bay-Delta Project Files dated 4-4-84. Calif. Dept. of Fish and Game. 24 p.
- Bates, Daniel W., Orren Logan and Everett A. Pesonen. 1960. Efficiency evaluation. Tracy Fish Collecting Facility. Central Valley Project, California. U.S. Dept. of Interior. 70 p.
- Bates, Daniel W., and R. Vinsonhaler. 1956. Use of louvers for guiding fish. Trans. Amer. Fish. Soc., 86:38-57.
- California Departments of Water Resources and Fish and Game. 1973. Evaluation testing program report for Delta Fish Protective Facility, State Water Facilities, California Aqueduct, North San Joaquin Division. Memorandum Report. 198 p.
- Decoto, R.J. 1978. 1974 Evaluation of the Glenn-Colusa Irrigation District Fish Screen. Calif. Dept. Fish and Game, Anad. Fish. Br. Admin. Rept. 78-20. 18 p.
- Fusfeld, Alice and Lee W. Miller. MS. Final Report 1984 egg and larva survey in the Sacramento-San Joaquin Estuary. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Technical Report 11. 73p.
- Hall, F.A. Jr. 1979. An evaluation of downstream migrant chinook salmon, Oncorhynchus tshawytscha, losses at Hallwood-Cordua Fish Screen. Calif. Dept. Fish and Game, Anad. Fish. Br. Admin. Rept. 79-5. 17 p.
- Hall, F.A. Jr. 1980. Evaluation of downstream migrant chinook salmon, Oncorhynchus tshawytscha, losses in Clifton Court Forebay, Contra Costa County, Calif. Calif. Dept. of Fish and Game, Anad. Fish. Br. Admin. Rept. 80-4. 15 p.
- Hallock, R.J., R.A. Iselin, and D.H. Fry, Jr. 1968. Efficiency tests of the primary louver system, Tracy Fish Screen, 1966-1967. Calif. Dept. of Fish and Game. Marine Res. Br. Admin. Dept. 68-7. 36 p.
- Heubach W. MSa. Effects of Clifton Court Forebay on the densities and entrainment time of various fishes at the Delta Fish Protective Facility. Unpublished Office Report. Calif. Dept. of Fish and Game. 1972. 13 p.

- Heubach W. MSb. Further observation of the densities of king salmon, striped bass, and white catfish collected at the federal and state facilities. Unpublished Office Report. Calif. Dept. of Fish and Game. 1973. 11 p.
- Heubach W. and J.E. Skinner. 1978. 1973 Evaluation of the federal fish collecting facility at Tracy, California. Office Report. Calif. Dept. of Fish and Game. 25 p.
- Kano, Robert M. 1985a. 1984 Clifton Court Forebay evaluations of predation losses to juvenile chinook salmon and striped bass. Memorandum to Clifton Court Forebay Files dated 3-18-85. Calif. Dept. of Fish and Game. 1985. 9 p.
- Kano, Robert M. 1985b. 1985 Clifton Court Forebay evaluation of predation losses to juvenile chinook salmon. Memorandum to Clifton Court Forebay Files dated 9-20-85. Calif. Dept. of Fish and Game. 5 p.
- Kano, Robert M. 1986. 1986 Evaluation of Clifton Court Forebay losses to juvenile striped bass. Memorandum to Clifton Court Forebay File dated 8-28-86. Calif. Dept. of Fish and Game. 5 p.
- Kano, Robert M. MS. Evaluations of the effects of trashrack and bypass design and predator control on predation losses of juvenile chinook salmon (Oncorhynchus tshawytscha) at Hallwood-Cordua fish screen. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Technical Report 14. 21 p.
- Menchen, R.S. 1980. A Tracy trucking study of the effects of handling procedures on juvenile chinook salmon (Oncorhynchus tshawytscha) collected at U.S. Water and Power Resources Service Tracy Fish Collecting Facility. Office Report. Calif. Dept. of Fish and Game. 9 p.
- Raquel, Paul F. MS. Estimated entrainment of striped bass eggs and larvae at State Water Project and Central Valley Project facilities in the Sacramento-San Joaquin Delta, California, 1985 and 1986. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Technical Report 13. 36 p.

APPENDIX TABLE 1. STRIPED BASS (21 - 150 MM) ENTRAINMENT LOSSES AT THE STATE WATER PROJECT BASED ON A PRE-SCREENING LOSS RATE OF 15%.

YEAR = 1968

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	0	0	0	0	0
2	0	0	0	0	0
3	33430	28416	21532	20323	13106
4	87063	74004	57495	52457	34605
5	259835	220859	167670	154371	105464
6	1059393	900485	682244	410631	648765
7	894829	760604	584751	293504	601323
8	89409	75997	56451	30868	58540
9	45811	38939	31319	21046	24765
10	14667	12467	10358	8647	6021
11	29526	25097	19003	16931	12595
12	31411	26698	19413	17955	13456
Total	2,545,374	2,163,566	1,650,236	1,026,733	1,518,640

YEAR = 1969

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	59286	50394	38504	35645	23642
2	3785	3218	2296	2053	1731
3	793	675	511	483	311
4	2097	1783	1385	1337	760
5	17371	14765	11391	10873	6498
6	3042	2585	2053	1460	1581
7	1160989	986841	737443	356119	804871
8	1001163	850989	634249	351410	649755
9	13453	11435	9325	6472	6981
10	5720	4863	4054	3358	2364
11	3834	3258	2473	2002	1833
12	16643	14147	10244	7770	8875
Total	2,288,176	1,944,953	1,453,928	778,982	1,509,202

CCF = Clifton Court Forebay

APPENDIX TABLE 1. continued.

YEAR = 1970

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	26024	22120	16898	13242	12781
2	5850	4973	3547	2943	2908
3	0	0	0	0	0
4	2706	2301	1788	1627	1079
5	887	754	582	477	411
6	1496704	1272198	932669	428955	1067749
7	11488041	9764835	7634407	4097267	7390775
8	3290309	2796763	2165811	1346677	1943632
9	617912	525224	426116	299065	318845
10	258753	219940	180397	127211	131542
11	177175	150600	114183	97874	79301
12	100539	85458	62132	52728	47811
Total	17,464,900	14,845,166	11,538,530	6,468,066	10,996,834

YEAR = 1971

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	36786	31269	23891	20815	15971
2	21899	18614	13273	11522	10377
3	34809	29587	22336	19180	15627
4	27667	23517	18273	15362	12306
5	11025	9371	7205	5565	5462
6	166752	141739	115015	88732	78021
7	7844546	6667864	4897081	2261559	5582987
8	2455495	2087170	1456992	704941	1750554
9	157395	133785	103492	60521	96874
10	50639	43044	35677	27915	22725
11	31966	27172	20328	16174	15792
12	54617	46425	33429	25389	29228
Total	10,893,596	9,259,557	6,746,992	3,257,675	7,635,924

APPENDIX TABLE 1. continued.

YEAR = 1972

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	34290	29147	22246	16383	17908
2	96000	81600	58237	44877	51122
3	145430	123616	93622	73187	72243
4	71322	60624	47081	37639	33684
5	267175	227099	166916	136964	130211
6	6414633	5452438	4050887	2251469	4163164
7	1030838	876213	653746	311476	719363
8	432199	367369	268347	141967	290232
9	154651	131454	102414	62942	91709
10	79836	67861	56371	46506	33332
11	47214	40133	30442	28210	19005
12	221618	188375	136956	121720	99898
Total	8,995,206	7,645,929	5,687,265	3,273,340	5,721,871

YEAR = 1973

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	105405	89595	68455	64354	41053
2	34508	29332	20513	18633	15875
3	7389	6280	4759	4618	2770
4	2364	2010	1562	1334	1030
5	170882	145250	88454	44597	126285
6	9619237	8176351	6095039	2847504	6771733
7	3734648	3174450	2471921	1290358	2444289
8	556868	473337	357985	196726	360140
9	49304	41909	33706	21012	28292
10	44546	37864	31557	27225	17321
11	69253	58865	44652	40419	28835
12	170167	144642	105161	100809	69356
Total	14,564,571	12,379,885	9,323,764	4,657,589	9,906,979

APPENDIX TABLE 1. continued.

YEAR = 1974

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	100573	85488	65314	62464	38111
2	32267	27427	19559	18812	13454
3	13096	11131	8434	7784	5312
4	3518	2991	2323	2156	1363
5	68437	58171	44879	41662	26775
6	13829958	11755462	8609840	3870880	9959078
7	8257289	7018697	5384630	2662726	5594565
8	1630023	1385520	1039618	558785	1071238
9	62866	53437	42917	27918	34950
10	10581	8994	7462	5933	4650
11	22430	19065	14461	12738	9693
12	274959	233715	169918	149298	125660
Total	24,305,997	20,660,098	15,409,355	7,421,156	16,884,849

YEAR = 1975

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	335633	285289	217969	199256	136377
2	126541	107560	76703	71853	54688
3	52977	45030	34122	31732	21245
4	8626	7332	5697	5369	3258
5	7157	6083	4692	4352	2805
6	235449	200132	147381	66984	168466
7	1655439	1407123	1061312	502731	1152706
8	3550367	3017812	2226010	1161024	2389342
9	418004	355304	284309	178736	239267
10	105276	89484	74580	67533	37741
11	317343	269741	204622	181585	135757
12	140521	119443	86839	76800	63721
Total	6,953,333	5,910,333	4,424,236	2,547,955	4,405,373

APPENDIX TABLE 1. continued.

YEAR = 1976

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	238416	202653	154832	137668	100748
2	92112	78296	55834	50553	41559
3	20851	17722	13384	11586	9264
4	4032	3428	2665	2265	1769
5	24631	20937	15268	10965	13665
6	964397	819738	597980	261235	703163
7	872368	741513	567596	280213	592156
8	220313	187266	141389	75752	144560
9	15958	13563	10836	8134	7822
10	2416	2053	1697	1322	1092
11	48180	40954	31064	27786	20395
12	31268	26577	19326	16445	14824
Total	2,534,942	2,154,700	1,611,871	883,924	1,651,017

YEAR = 1977

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	85702	72846	55649	51330	34371
2	16030	13625	9717	8948	7081
3	7190	6112	4631	4135	3055
4	0	0	0	0	0
5	1812	1540	1188	1136	676
6	51974	44178	32009	13804	38171
7	545915	464026	357521	174892	371022
8	18027	15323	12288	8082	9946
9	963	819	666	423	541
10	0	0	0	0	0
11	33307	28311	21471	19641	13669
12	94662	80463	58500	56529	38133
Total	855,582	727,243	553,640	338,920	516,665

APPENDIX TABLE 1. continued.

YEAR = 1978

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	914665	777466	544432	517026	397639
2	325389	276581	192124	185617	139774
3	8313	7065	4977	4876	3436
4	88	75	58	57	31
5	319	271	204	204	115
6	1191187	1012509	531346	261165	930022
7	1916207	1628777	992861	516316	1399894
8	427337	363236	241849	154744	272593
9	20996	17846	12620	9768	11225
10	277879	236197	170103	154317	123562
11	268124	227906	169603	145573	122552
12	251091	213427	161659	143983	107108
Total	5,601,595	4,761,356	3,021,836	2,093,646	3,507,951

YEAR = 1979

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	52114	44296	33804	30903	21209
2	12167	10340	7981	7138	5027
3	883	750	580	545	338
4	756	642	464	457	298
5	24551	20867	11593	8096	16453
6	1098821	933999	681998	328462	770362
7	2039923	1733934	1041404	545535	1494388
8	510418	433855	297867	190727	319691
9	13848	11771	8076	6449	7398
10	71498	60773	45552	39719	31779
11	185920	158032	115821	105878	80041
12	232480	197608	140579	134238	98243
Total	4,243,379	3,606,867	2,385,719	1,398,147	2,845,227

APPENDIX TABLE 1. continued.

YEAR = 1980

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	53450	45433	31446	29981	23469
2	11298	9602	6725	6266	5031
3	504	428	337	322	182
4	354	301	233	233	122
5	0	0	0	0	0
6	660324	561274	324662	143388	516935
7	2147395	1825286	1186259	592470	1554925
8	744130	632511	450116	266358	477774
9	140379	119323	81866	53898	86483
10	13411	11399	8441	6993	6417
11	95684	81332	62038	58716	36966
12	190806	162186	119192	112537	78270
Total	4,057,735	3,449,075	2,271,315	1,271,162	2,786,574

YEAR = 1981

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	95025	80772	58868	55865	39161
2	28687	24384	18404	17204	11482
3	6475	5504	4068	3807	2669
4	661	561	405	381	279
5	46813	39791	30342	14241	32572
6	364537	309857	256281	124654	239883
7	458755	389941	296695	177177	281578
8	296112	251695	167427	121180	174929
9	9900	8416	5887	4900	5000
10	5908	5022	3675	3196	2711
11	58777	49960	37204	34637	24140
12	100765	85651	60635	57941	42825
Total	1,472,415	1,251,554	939,891	615,183	857,229

APPENDIX TABLE 1. continued.

YEAR = 1982

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	83106	70640	51090	47579	35527
2	46612	39620	27554	25755	20856
3	20678	17576	11923	11636	9041
4	5497	4671	3221	2963	2533
5	2554	2171	1437	638	1915
6	8186	6958	6104	2797	5388
7	382070	324759	250795	124242	257828
8	430763	366149	259915	139426	291336
9	50185	42657	30325	19082	31102
10	36081	30668	22768	18965	17115
11	44242	37605	28027	25356	18888
12	283314	240818	166863	159766	123549
Total	1,393,288	1,184,292	860,022	578,205	815,078

YEAR = 1983

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	23699	20145	12982	12131	11570
2	10262	8723	6130	5963	4300
3	578	492	367	347	231
4	0	0	0	0	0
5	71	60	46	19	51
6	18220	15486	8084	3474	14745
7	29901	25415	17935	9554	20345
8	57738	49075	37282	26490	31247
9	3839	3263	2409	1235	2603
10	477	405	341	254	224
11	8984	7636	5731	4974	4009
12	29431	25015	19787	19202	10229
Total	183,200	155,715	111,094	83,643	99,554

APPENDIX TABLE 1. continued.

YEAR = 1984

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	1340	1140	891	829	513
2	1534	1304	968	878	656
3	606	515	377	369	237
4	1369	1163	805	763	605
5	19465	16545	7165	4517	14947
6	5394186	4585057	2187920	1017351	4376832
7	5516617	4689125	3117220	1759071	3757545
8	169867	144389	98697	67050	102819
9	21189	18012	13532	11616	9573
10	138296	117553	83436	79095	59202
11	204925	174187	129320	121925	83000
12	196922	167383	118644	111418	85505
Total	11,666,316	9,916,373	5,758,975	3,174,882	8,491,434

YEAR = 1985

Month	Entrained into CCF	Encountering the Screens	Salvaged	Released Alive	System Loss
1	23618	20075	14525	13483	10135
2	13501	11475	8464	7609	5891
3	4211	3580	2810	2581	1633
4	1795	1526	1146	1126	669
5	531255	451566	324432	139687	391569
6	3389499	2881074	1937189	902807	2486692
7	1505617	1279774	878643	438625	1066992
8	164366	139710	105959	67254	97113
9	22102	18786	14913	12557	9544
10	7095	6033	4579	4053	3045
11	151404	128693	99565	97281	54123
12	146985	124937	96328	92688	54296
Total	5,961,448	5,067,229	3,488,553	1,779,751	4,181,702

TABLE 7. STRIPED BASS HANDLING AND TRUCKING 1984/85 EVALUATION AT THE JOHN E. SKINNER FISH PROTECTIVE FACILITY. RESULTS BASED ON TEST WHICH CONTAINED AT LEAST FIFTEEN STRIPED BASS.

MONTH	MEAN FORK LENGTH (MM)	MEAN MORTALITY (%)		Trucking Results minus Handling Results
		Handling Tests	Trucking Tests	
JAN	86.99	1.90	2.79	0.90
FEB	82.97	3.92	3.13	-0.80
MAR	89.00			0.00
APR	98.00			0.00
MAY	16.41	31.16	66.80	35.64
JUN	32.80	45.94	66.51	20.57
JUL	48.66	17.33	38.05	20.73
AUG	51.92	24.77	61.67	36.90
SEP	76.15	21.58	28.09	6.50
OCT	82.61	11.35	4.71	-6.64
NOV	83.46	2.85	4.60	1.75
DEC	87.00	1.47	10.23	8.76

Data used in regression equations to develop the relationships between handling rate and size of fish and between trucking loss rate and size of fish.

MONTH	MEAN FORK LENGTH (MM)	MEAN MORTALITY (%)	
		Handling Loss Rates	Trucking Loss Rates
MAY	16.41	31.16	35.64
JUN	32.80	45.94	20.57
JUL	48.66	17.33	20.73
AUG	51.92	24.77	36.90
SEP	76.15	21.58	6.50
OCT	82.61	11.35	0.00
NOV	83.46	2.85	1.75
DEC	87.00	1.47	8.76
JAN	86.99	1.90	0.90
FEB	82.97	3.92	0.00

Regression Equations:

$$\text{Handling Loss (H)} = 48.62461 - 0.49922 * \text{FL(mm)} \quad r^2 = 0.74$$

$$\text{Trucking Loss (T)} = 44.89634 - 0.48880 * \text{FL(mm)} \quad r^2 = 0.75$$

striped bass. These equations were then used to calculate the actual handling and trucking loss rates for the mid-point of each of the length groups of striped bass. Handling losses for chinook salmon were very low, about 0.02, and trucking losses were essentially zero. These numbers are used for young-of-the-year chinook salmon in the calculation process. Handling and trucking losses for yearling chinook salmon were assumed to be zero.

The number of fish released alive is calculated by multiplying the number of fish salvaged by the survival rates for the handling (1 - H), and trucking (1 - T) operations. This can be expressed as:

$$\text{No. Released Alive} = \text{No. Salvaged} * (1 - H) * (1 - T)$$

The final step in the calculation process is to subtract the number of fish released alive from the number entering the forebay. This can be expressed as:

$$\text{System Loss} = \text{No. Entrained} - \text{No. Released Alive}$$

The calculation process is rather simple, but is cumbersome, both because of the number of time intervals, and the number of size groups and species of fish involved. Each calculation is carried out separately and summed at the end, to allow the generation of loss estimates for specific species and size groups. As noted earlier, we delete the loss estimates for striped bass up to 20 mm from the results, since they are accounted for in the egg and larval loss estimate.

CVP Entrainment Loss Estimates

The estimates of entrainment losses for the CVP facilities have been generated from the SWP data, using the fish salvage records from Tracy Facility as part of the calculation. We used two separate processes to develop the CVP estimates, one for the period from 1968 to 1986, when records from the Skinner Facility are available, and the other for the period from 1957 to 1967, before the SWP facilities were operating in the Delta.

1968-1986 CVP Loss Estimates

The procedure to estimate losses of striped bass larger than 20 mm, and all chinook salmon is based on the assumption that the loss rate at the CVP would be the same as that for the SWP facilities in the absence of the Forebay. Therefore, monthly losses for the SWP were calculated using a pre-screening loss rate (P = 0.15) for the intake structure (i.e., without a Forebay). All other factors were assumed to be the same at the two installations. To generate a system loss estimate for the CVP facilities, the ratios of monthly system loss to total monthly salvage at the Skinner Facility were multiplied by the total

monthly salvage at Tracy Facility. The calculation can be described by:

$$\text{CVP Loss} = (\text{SWP Loss} / \text{SWP Salvage}) * \text{CVP Salvage}$$

Occasionally during this period the SWP was not operating during a given month, or was operating at such a reduced level that very few fish were salvaged. In such cases, CVP losses were calculated by multiplying the CVP salvage by the appropriate monthly mean SWP ratio of system loss to salvage from the 1968-86 period. If no fish were salvaged at the CVP facility during a month, then the loss of fish was assumed to be zero.

1957-1967 CVP Loss Estimates

Since the SWP was not in operation prior to 1968, the monthly CVP losses from 1957 to 1967 were estimated by multiplying the monthly CVP salvage estimates from Tracy Facility by the monthly mean ratio of system loss to salvage from the SWP from the 1968-86 period. As before, if no fish were salvaged at Tracy Facility, system loss was assumed to be zero. The calculation can be represented by the equation:

$$\text{CVP Loss} = \text{CVP Salvage} * (1968-86 \text{ mean } (\text{SWP Loss} / \text{SWP Salvage}))$$

These loss estimates are then tabulated, and summarized by year, month, species and size classes. As with the SWP calculation, the estimates of striped bass up to 20 mm lost are deleted from the totals, since the CVP egg and larval estimates are used for these smaller size groups.

The losses of striped bass greater than 20 mm and all chinook salmon are probably underestimated because we do not believe screening efficiencies to be as high at the Tracy Facility, due to their inability to control approach velocities throughout the tidal cycle, the longer louver array, and the handling and trucking loss rates which are probably higher due to the debris loads in the holding tanks and trucks. Menchen (1980) reported handling and trucking mortalities averaging about 0.50 for chinook salmon at this facility, although the data was based on ocean recoveries of the marked fish.

The computation process described for both the SWP and CVP provides an estimate of system losses for striped bass up to 150 mm in length, and all chinook salmon. We have restricted the striped bass loss estimates to fish no larger than 150 mm because the model and the associated parameters were developed with these fish in mind, and information on the larger fish is lacking. Further, the larger fish become predators at the facilities, screening efficiency is relatively high for these fish, and they can withstand the rigors of handling and trucking better than the smaller fish.

RESULTS

Loss estimates for the SWP and CVP facilities in the south Delta are presented below. We have combined two methods, one for striped bass up to 20 mm in length, and one for all other fish. We have chosen to provide two estimates of fish losses associated with the two facilities. The first estimate (Case 1), is intended to represent pre-screening losses in the absence of a Forebay and is based on an assumed pre-screening loss rate for the headworks of the two intake facilities. We have used a figure of 0.15 to account for the losses of fish associated with trashracks and the associated intake structures. The second (Case 2), is based on the averages of measured pre-screening loss rates in the Forebay for chinook salmon (0.75), and striped bass (0.82), and an assumed pre-screening loss rate at the headworks to the CVP facility of 0.15, as in Case 1. We believe that these two cases bracket the magnitude of the problem, and are consistent with the available data.

Striped Bass Eggs and Larvae

The results of the two years of sampling are presented in Table 8 and Table 9. Estimates of losses are shown for each year, facility, and size class of striped bass.

The 1985 entrainment loss estimate for striped bass up to 20 mm at the SWP is 441,142,942, and for the CVP is 352,460,422. The grand total for 1985 is 793,603,364 striped bass up to 20 mm.

The 1986 entrainment estimate for striped bass up to 20 mm at the SWP is 51,909,361 and for the CVP is 47,813,048. The grand total for 1986 is 99,722,409 striped bass up to 20 mm.

Juvenile Striped Bass (>20 mm) and Chinook Salmon

The results of our Case 1 analysis for striped bass (Table 10) and for chinook salmon (Table 11) show the losses at the two facilities for the period from 1957 to 1986. The Case 2 analysis for striped bass (Table 12) and for chinook salmon (Table 13) show the estimated magnitude of system losses with the higher SWP Forebay loss rate. There is no difference in the estimates for the CVP facilities because the same assumptions are used in both cases.

Appendix Tables 1 and 2 show the monthly distribution of striped bass and chinook salmon salvage and system loss estimates at the Skinner Facility for the Case 1 analysis. Appendix Tables 3 and 4 show the same results for the Case 2 analysis of striped bass and chinook salmon respectively.

TABLE 8. STRIPED BASS EGG AND LARVAL 1985 AND 1986 ENTRAINMENT ESTIMATES FOR THE SWP INTAKE.

1985 ENTRAINMENT

Bi-Monthly Period	SIZE GROUPS					
	EGGS	3-6 mm	7-10 mm	11-14 mm	15-18 mm	19-20 mm
APR 8	3161003	38461069	4289227	0	0	0
MAY 9	72754238	69328241	13288904	0	0	0
10	9186982	133014715	2281900	337231	0	0
JUN 11	776332	42792309	8809719	0	0	0
12	0	23174110	15141675	1919412	0	0
JUL 13	0	455787	1090896	879193	0	0
TOTAL	85878556	307226231	44902321	3135835	0	0
GRAND TOTAL						441,142,942

1986 ENTRAINMENT

Bi-Monthly Period	SIZE GROUPS					
	EGGS	3-6 mm	7-10 mm	11-14 mm	15-18 mm	19-20 mm
APR 8	232944	0	0	0	0	0
MAY 9	2925636	4700959	1701729	0	0	0
10	535473	20319317	6024493	622261	0	0
JUN 11	78070	1278781	6191257	3839482	695104	0
12	0	0	0	131636	0	0
JUL 13	0	771049	296738	1022474	188306	353651
TOTAL	3772123	27070106	14214217	5615853	883410	353651
GRAND TOTAL						51,909,361

TABLE 9. STRIPED BASS EGG AND LARVAL 1985 AND 1986 ENTRAINMENT ESTIMATES FOR THE CVP INTAKE.

1985 ENTRAINMENT

Bi-Monthly Period	SIZE GROUPS					
	EGGS	3-6 mm	7-10 mm	11-14 mm	15-18 mm	19-20 mm
APR 8	1441386	36453707	5358129	0	0	0
MAY 9	53133878	50714312	5878537	0	0	0
10	30287795	107676719	2467556	0	0	0
JUN 11	0	42307228	1475222	0	0	0
12	0	6977666	6392579	0	0	0
JUL 13	0	0	1008369	887339	0	0
TOTAL	84863059	244129632	22580392	887339	0	0
GRAND TOTL						352,460,42242

1986 ENTRAINMENT

Bi-Monthly Period	SIZE GROUPS					
	EGGS	3-6 mm	7-10 mm	11-14 mm	15-18 mm	19-20 mm
APR 8	887433	0	0	0	0	0
MAY 9	781887	307790	73543	73543	0	0
10	7368537	11917849	8468814	3389458	631474	0
JUN 11	234260	937747	4031236	2458346	372145	0
12	0	347403	1452850	1272731	397805	527523
JUL 13	0	283243	1245136	0	135265	217030
TOTAL	9272117	13794033	15271579	7194078	1536689	744553
GRAND TOTAL						47,813,048

TABLE 10. CASE 1 : STRIPED BASS (21-150 MM) LOSS ESTIMATES FOR THE SWP AND CVP. *

Year	SWP Loss Estimate	CVP Loss Estimate	Total Loss Estimate
57	0	1,620,508	1,620,508
58	0	595,627	595,627
59	0	7,588,785	7,588,785
60	0	9,543,995	9,543,995
61	0	14,914,267	14,914,267
62	0	14,557,809	14,557,809
63	0	22,821,772	22,821,772
64	0	25,964,402	25,964,402
65	0	12,595,642	12,595,642
66	0	33,904,832	33,904,832
67	0	5,001,933	5,001,933
68	1,518,640	14,009,333	15,527,973
69	1,509,202	8,329,794	9,838,996
70	10,996,834	18,717,177	29,714,011
71	7,635,924	8,459,477	16,095,401
72	5,721,871	9,133,657	14,855,528
73	9,906,979	8,547,806	18,454,785
74	16,884,849	5,935,344	22,820,193
75	4,405,373	6,192,385	10,597,758
76	1,651,017	4,403,134	6,054,151
77	516,665	613,848	1,130,513
78	3,507,951	3,332,958	6,840,909
79	2,845,227	2,409,101	5,254,328
80	2,786,574	1,292,981	4,079,555
81	857,229	5,746,690	6,603,919
82	815,078	1,367,483	2,182,561
83	99,554	353,605	453,159
84	8,491,434	5,654,189	14,145,623
85	4,181,702	1,699,364	5,881,066
86	15,061,909	4,932,410	19,994,319

* SWP losses are based on a 15% pre-screening loss rate, and CVP losses are based on a 15% pre-screening loss rate.

TABLE 11. CASE 1 : CHINOOK SALMON LOSS ESTIMATES FOR THE SWP AND CVP. *

Year	SWP Loss Estimate	CVP Loss Estimate	Total Loss Estimate
57	0	133,583	133,583
58	0	327	327
59	0	61,569	61,569
60	0	44,206	44,206
61	0	44,313	44,313
62	0	57,745	57,745
63	0	14,438	14,438
64	0	82,727	82,727
65	0	209,633	209,633
66	0	72,985	72,985
67	0	36,221	36,221
68	21,587	106,014	127,601
69	30,317	42,225	72,542
70	33,082	295,085	328,167
71	12,187	280,505	292,692
72	61,351	183,002	244,353
73	25,712	140,973	166,685
74	91,295	168,417	259,712
75	23,736	70,226	93,962
76	20,045	74,142	94,187
77	16,651	8,059	24,710
78	63,278	26,732	90,010
79	69,529	60,217	129,746
80	51,990	111,163	163,153
81	55,657	42,029	97,686
82	165,136	128,813	293,949
83	39,936	156,848	196,784
84	73,320	104,086	177,406
85	87,232	83,456	170,688
86	250,572	451,631	702,203

* SWP losses are based on a 15% pre-screening loss Rate, and CVP losses are based on a 15% pre-screening loss rate.

TABLE 12. CASE 2 : STRIPED BASS (21-150 MM) LOSS ESTIMATES
FOR THE SWP AND CVP. *

Year	SWP Loss Estimate	CVP Loss Estimate	Total Loss Estimate
57	0	1,620,508	1,620,508
58	0	595,627	595,627
59	0	7,588,785	7,588,785
60	0	9,543,995	9,543,995
61	0	14,914,267	14,914,267
62	0	14,557,809	14,557,809
63	0	22,821,772	22,821,772
64	0	25,964,402	25,964,402
65	0	12,595,642	12,595,642
66	0	33,904,832	33,904,832
67	0	5,001,933	5,001,933
68	1,518,640	14,009,334	15,527,974
69	1,509,202	8,329,794	9,838,996
70	76,005,080	18,717,177	94,722,258
71	48,184,312	8,459,477	56,643,788
72	39,204,045	9,133,657	48,337,702
73	64,119,553	8,547,806	72,667,359
74	107,357,172	5,935,344	113,292,516
75	30,287,227	6,192,385	36,479,612
76	11,086,632	4,403,134	15,489,766
77	3,701,321	613,848	4,315,168
78	24,358,330	3,332,958	27,691,288
79	18,640,004	2,399,012	21,039,016
80	17,890,368	1,278,896	19,169,264
81	6,337,891	5,746,387	12,084,278
82	6,001,194	1,368,322	7,369,517
83	781,441	162,844	944,285
84	51,916,079	5,640,468	57,556,547
85	26,371,527	1,699,641	28,071,168
86	92,705,391	4,932,410	97,637,802

* SWP losses are based on a 82% pre-screening loss rate (in 1968 and 1969 losses are based on a 15% pre-screening loss rate).
CVP losses are based on a 15% pre-screening loss rate.

TABLE 13. CASE 2 : CHINOOK SALMON LOSS ESTIMATES FOR THE SWP AND CVP. *

Year	SWP Loss Estimate	CVP Loss Estimate	Total Loss Estimate
57	0	133,583	133,583
58	0	327	327
59	0	61,569	61,569
60	0	44,206	44,206
61	0	44,313	44,313
62	0	57,745	57,745
63	0	14,438	14,438
64	0	82,727	82,727
65	0	209,633	209,633
66	0	72,985	72,985
67	0	36,221	36,221
68	21,587	106,014	127,601
69	30,317	42,225	72,542
70	235,503	295,085	530,588
71	85,592	280,505	366,097
72	439,369	183,002	622,370
73	187,182	140,973	328,155
74	645,525	168,417	813,942
75	171,980	70,226	242,207
76	144,081	74,142	218,223
77	124,266	8,059	132,325
78	489,475	26,732	516,207
79	526,364	60,217	586,582
80	368,325	111,163	479,488
81	430,191	42,029	472,219
82	1,252,042	128,813	1,380,855
83	300,436	156,848	457,284
84	593,897	104,086	697,983
85	629,220	83,456	712,677
86	1,883,526	451,631	2,335,157

* SWP losses are based on a 75% pre-screening loss rate (in 1968 and 1969 losses are based on a 15% pre-screening loss rate).
CVP losses are based on a 15% pre-screening loss rate.

Appendix Tables 5 and 6 show the same information, by size groups, for the Case 1 analysis of striped bass and chinook salmon respectively. Appendix Tables 7 and 8 show the same information for Case 2, again for striped bass and chinook salmon respectively.

As before, caution must be used in the interpretation of these numbers, since they represent the total for all size classes, and each size class has a different survival rate.

DISCUSSION

The estimates of striped bass losses associated with the entrainment of eggs and larvae are based on the egg and larval sampling program, and the assumption that all of these fish are lost. While this assumption may not be entirely correct, it probably does not bias the result significantly, since the louver efficiency for these small fish is quite low, and those salvaged are subjected to high collection, handling and trucking mortality rates. Furthermore, we believe many settle out in the Forebay. We are presenting the estimates separately, and the Appendix Tables have estimates from the fish salvage estimation process for the smaller size classes which could be used to generate another estimate. Unfortunately, the facility operators cannot identify the smaller size classes reliably, making these estimates suspect.

The two cases presented for analysis represent our best estimate of the range of entrainment losses for striped bass (1-150 mm) and chinook salmon at the SWP and CVP facilities. Case 1 represents a condition where there is no Forebay at the SWP facilities, and a baseline loss estimate is used to reflect losses associated with the trashrack and intake structure at both facilities. We then used the model described earlier to develop our loss estimates for the SWP facility, and calculate a loss for the CVP facility from the SWP data. The same pre-screening loss estimate of 0.15 is used for striped bass and chinook salmon. Case 2 is based on the results of our evaluations of Forebay losses. This approach uses a pre-screening loss estimate of 0.82 for striped bass, and 0.75 for chinook salmon at the SWP facility, after the Forebay became operational in 1970. The baseline numbers (0.15) were used for the 1968 and 1969 estimates at the SWP facility in Case 2. The estimate of pre-screening loss at the trashrack and intake structure remains the same for the CVP facility (0.15).

Case 1 the losses at the two facilities are substantial, even without the Forebay. However, Case 2 shows that the losses could be much larger at the SWP facilities depending on the level of pre-screening losses incurred by fish as they traverse the Forebay. For example, the combined losses for striped bass in 1986 were:

Facility. These records can be divided into two time periods, 1968 to 1977, and 1978 to 1986. For the earlier time period, we have only estimates of the average operations of the facility on a monthly basis. This is important, since facility operations change frequently and control the efficiency of fish salvage. Therefore, all we can do for this earlier period is assume that the facility was operated optimally for the amount of water being exported. Since 1978, however, we have collected operational information on factors which affect the actual efficiency of the fish salvage process. This information, along with the fish salvage records, are then used to generate the estimates of entrainment losses for the SWP facility. It will be easier to follow the methodology if the second time period (1978-86) is considered first.

1978-1986 SWP Loss Estimates

The fish facility monitoring program produces monthly reports of length frequency and fish salvage and loss estimates, from information collected at the facility by employees of DWR, under the oversight of DFG employees. These reports include salvage information for all species encountered, information on the actual operation of the Skinner Facility, and screen loss estimates for chinook salmon, striped bass, steelhead rainbow trout (steelhead), American shad, threadfin shad and white catfish. The screen loss information is limited to these species because they are the only species of fish for which screen (louver) efficiency information is available.

The factors which affect the efficiency of the louver screens include the species of fish, the size of the fish, the velocity of the water passing through the primary screens, and the primary bypass ratio. These same conditions also affect losses in the secondary, and are included in the calculation process.

Regression equations predicting screening efficiencies of different species and sizes of fish, based on the primary channel velocity (feet per second - fps) have been developed from data collected in the field testing program at the Skinner Facility in 1970-71 (Baracco 1984, California Departments of Water Resources and Fish and Game 1973). The efficiency relationships are presented in Table 1.

The number of fish of each species, in each length group, salvaged during each sampling period (typically two hours), is Table 1 calculated using the bi-monthly relative length frequency for that group and the salvage information collected by the operators. This information, along with the primary channel velocities for each sampling period (obtained from the records collected at the facility) and the screen efficiencies, is used to calculate screen losses during each sampling period. The number of fish lost through the screens for each species and length group is

TABLE 1. LENGTH GROUPS AND SCREENING EFFICIENCY EQUATIONS USED IN BI-MONTHLY LENGTH-FREQUENCY AND SALVAGE/LOSS REPORTS PRODUCED FOR THE JOHN E. SKINNER DELTA FISH PROTECTIVE FACILITY.

Striped Bass

Length Interval (mm)

A) 1 - 15	Eff(A) = 0.168 - (0.0457 x Velocity)
B) 16 - 20	Eff(B) = 0.656 - (0.133 x Velocity)
C) 21 - 30	Eff(C) = 0.935 - (0.149 x Velocity)
D) 31 - 40	Eff(D) = 0.806 - (0.0431 x Velocity)
E) ≥ 51	Eff(E) = 0.945 - (0.0717 x Velocity)

Chinook Salmon and Steelhead

Length Interval (mm)

A) 1 - 100	Eff(A) = 0.630 + (0.0494 x Velocity)
B) ≥ 101	Eff(B) = 0.568 + (0.0579 x Velocity)

White Catfish

Length Interval (mm)

A) all lengths	Eff(A) = -11.6 + (0.999 x length)
----------------	-----------------------------------

American Shad and Threadfin Shad

Length Interval (mm)

A) 1 - 50	Eff(A) = -65.8 - (0.0539 x [length x length]) + (5.43 x length)
B) ≥ 51	Eff(B) = 0.71

calculated by sample period from the salvage estimates and screening efficiencies as follows:

$$\text{No. Lost} = (\text{No. Salvaged} / \text{Efficiency}) - \text{No. Salvaged}$$

The numbers of fish salvaged and lost through the screens during each sample period are summed for each bi-monthly period, by species and size classes, to estimate the number of fish encountering the screens.

1968-1977 SWP Loss Estimates

The method described above, used to calculate the number of fish lost through the screens at the Skinner Facility for the period from 1978 to 1986, cannot be used for the earlier years because of the lack of accurate operational records from the Skinner Facility. Therefore, calculated average monthly operational conditions were used to estimate primary channel velocities.

The estimates of channel velocities were developed by Baracco (1984) for the 1968-80 period from the on-peak and off-peak power consumption records of the Banks Pumping Plant, and records of total exports. Exports were apportioned into the two time periods using the power consumption records, and converted to channel velocities using the average depth of the primary channel and the width of the facility. Again, no information on the number of intake channels actually in use was available, so we assumed that the facility was operated to the criteria which would optimize salvage. This information was then applied to the screen efficiency relationships to generate the screening efficiencies and loss estimates for each species and size group. Tables 2 to 4 summarize the operational information used for this analysis. Finally, during the 1968-77 period, the number of fish in each species and length group encountering the screens during each bi-monthly period was estimated by adding the number salvaged and the number lost through the screens. The number of fish lost through the screens for each bi-monthly period was then calculated in the same manner already discussed for the 1978-86 period.

This methodology probably underestimates losses during this earlier period, since the facility was not always operated to the appropriate criteria.

SWP Entrainment Loss Estimates

Losses due to entrainment into the SWP intakes in the south Delta are estimated for striped bass (1 to 150 mm) and for all Table 2 chinook salmon. Losses occur both before and after the fish are collected in the holding tanks where they are counted. Losses are estimated from the time the fish enter the Forebay until they are released back into the Delta. There are two sources of losses

TABLE 2. AVERAGE 1968-1980 STATE WATER PROJECT OPERATIONS AT THE HARVEY O. BANKS PUMPING PLANT AND ESTIMATED WATER VELOCITIES IN THE PRIMARY CHANNEL AT THE JOHN E. SKINNER DELTA FISH PROTECTIVE FACILITY.

Bi-Monthly Period	Proportion of Water Pumped		Primary Channel Velocity	
	Off-Peak	On-Peak	Off-Peak	On-Peak
JAN 1	0.62	0.38	2.60	2.40
JAN 2	0.62	0.38	2.60	2.40
FEB 3	0.66	0.34	3.20	3.30
FEB 4	0.66	0.34	3.20	3.30
MAR 5	0.73	0.27	2.80	2.10
MAR 6	0.73	0.27	2.80	2.10
APR 7	0.84	0.16	2.60	1.00
APR 8	0.84	0.16	2.60	1.00
MAY 9	0.80	0.20	2.70	1.30
MAY 10	0.80	0.20	2.70	1.30
JUN 11	0.81	0.19	1.60	0.70
JUN 12	0.81	0.19	1.60	0.70
JUL 13	0.72	0.28	1.50	1.20
JUL 14	0.72	0.28	1.50	1.20
AUG 15	0.72	0.28	2.20	0.90
AUG 16	0.72	0.28	2.20	0.90
SEP 17	0.72	0.28	1.90	1.00
SEP 18	0.72	0.28	1.90	1.00
OCT 19	0.76	0.24	1.70	1.10
OCT 20	0.76	0.24	1.70	1.10
NOV 21	0.75	0.25	2.60	2.60
NOV 22	0.75	0.25	2.60	2.60
DEC 23	0.70	0.30	2.80	3.60
DEC 24	0.70	0.30	2.80	3.60

TABLE 3. AVERAGE 1968-1980 SCREENING EFFICIENCIES FOR STRIPED BASS AT THE JOHN E. SKINNER DELTA FISH PROTECTIVE FACILITY.

Bi-Monthly Period	Length Intervals				
	1-15 mm	16-20 mm	21-30 mm	31-40 mm	>40 mm
JAN 1	0.0527	0.3203	0.5589	0.7512	0.7640
JAN 2	0.0527	0.3203	0.5589	0.7512	0.7640
FEB 3	0.0202	0.2259	0.4531	0.7206	0.7131
FEB 4	0.0202	0.2259	0.4531	0.7206	0.7131
MAR 5	0.0487	0.3087	0.5460	0.7475	0.7578
MAR 6	0.0487	0.3087	0.5460	0.7475	0.7578
APR 7	0.0609	0.3442	0.5857	0.7590	0.7769
APR 8	0.0609	0.3442	0.5857	0.7590	0.7769
MAY 9	0.0574	0.3341	0.5744	0.7557	0.7715
MAY 10	0.0574	0.3341	0.5744	0.7557	0.7715
JUN 11	0.1027	0.4659	0.7221	0.7984	0.8425
JUN 12	0.1027	0.4659	0.7221	0.7984	0.8425
JUL 13	0.1033	0.4677	0.7240	0.7990	0.8435
JUL 14	0.1033	0.4677	0.7240	0.7990	0.8435
AUG 15	0.0841	0.4118	0.6614	0.7809	0.8134
AUG 16	0.0841	0.4118	0.6614	0.7809	0.8134
SEP 17	0.0927	0.4368	0.6894	0.7890	0.8268
SEP 18	0.0927	0.4368	0.6894	0.7890	0.8268
OCT 19	0.0969	0.4491	0.7032	0.7929	0.8334
OCT 20	0.0969	0.4491	0.7032	0.7929	0.8334
NOV 21	0.0492	0.3102	0.5476	0.7479	0.7586
NOV 22	0.0492	0.3102	0.5476	0.7479	0.7586
DEC 23	0.0291	0.2517	0.4820	0.7290	0.7270
DEC 24	0.0291	0.2517	0.4820	0.7290	0.7270

TABLE 4. AVERAGE 1968-1980 SCREENING EFFICIENCIES FOR CHINOOK SALMON AND STEELHEAD AT THE JOHN E. SKINNER DELTA FISH PROTECTIVE FACILITY.

Bi-Monthly Period	Chinook Salmon		Steelhead	
	1-100 mm	>100 mm	1-100 mm	>100 mm
JAN 1	0.7547	0.7141	0.7547	0.7141
JAN 2	0.7547	0.7141	0.7547	0.7141
FEB 3	0.7898	0.7552	0.7898	0.7552
FEB 4	0.7898	0.7552	0.7898	0.7552
MAR 5	0.7590	0.7192	0.7590	0.7192
MAR 6	0.7590	0.7192	0.7590	0.7192
APR 7	0.7458	0.7037	0.7458	0.7037
APR 8	0.7458	0.7037	0.7458	0.7037
MAY 9	0.7495	0.7081	0.7495	0.7081
MAY 10	0.7495	0.7081	0.7495	0.7081
JUN 11	0.7006	0.6507	0.7006	0.6507
JUN 12	0.7006	0.6507	0.7006	0.6507
JUL 13	0.7000	0.6500	0.7000	0.6500
JUL 14	0.7000	0.6500	0.7000	0.6500
AUG 15	0.7207	0.6743	0.7207	0.6743
AUG 16	0.7207	0.6743	0.7207	0.6743
SEP 17	0.7114	0.6634	0.7114	0.6634
SEP 18	0.7114	0.6634	0.7114	0.6634
OCT 19	0.7069	0.6581	0.7069	0.6581
OCT 20	0.7069	0.6581	0.7069	0.6581
NOV 21	0.7584	0.7185	0.7584	0.7185
NOV 22	0.7584	0.7185	0.7584	0.7185
DEC 23	0.7802	0.7440	0.7802	0.7440
DEC 24	0.7802	0.7440	0.7802	0.7440

before the fish are counted in the holding tanks. The first occurs in the Forebay (P), and the second is associated with losses at the fish screens. After the fish have been collected, they can die either from handling (H) or in the trucking operation (T). Further losses probably occur after the fish are returned to the Delta, due to stress and predation, but are not accounted for in this process since adequate information is not available for this purpose.

Estimation Process

Using bi-monthly abundance and length frequency distributions, loss estimates are generated for each time interval. These are summed over time to provide monthly and annual loss estimates. The estimation process begins with the salvage numbers, which are used to calculate the number of fish encountering the screens, as described in the previous sections. This can be simply expressed as:

$$\text{No. Encountering Screens} = \text{No. Salvaged} / \text{Screen Efficiency}$$

Of course, screen efficiency varies for each time interval, and the calculation is the grand sum of a series of these calculations.

The number of fish entrained by the SWP is calculated by dividing the number of fish encountering the screens by the proportion of fish which survive entrainment to reach the screens (1-P). The calculation can be summarized by the expression:

$$\text{No. Entrained} = \text{No. Encountering Screen} / (1 - P)$$

Estimates of survival for fish crossing the Forebay are available for juvenile chinook salmon and striped bass, based on mark-recapture experiments within the Forebay conducted over the past several years.

We have chosen to use two sets of pre-screening loss estimates for this report. The first, a baseline level of 0.15 for both chinook salmon and striped bass, is based on experimental evidence from a number of installations with intake structures and trashracks, which we believe to be a baseline number for any installation (Table 5). The second, 0.75 for chinook salmon, and 0.82 for striped bass, is based on the results of studies in the Forebay which are presented in Table 6.

Handling and trucking loss rates were developed from data collected during 1984 and 1985 by DFG at the Skinner Facility, using the equipment at the facility. Monthly mean handling and trucking loss rates (Table 7) were developed for striped bass. Linear regressions were used to develop the relationships between handling and trucking loss rates and the various size groups of

TABLE 5. Loss estimates for chinook salmon (Oncorhynchus tshawytscha) at trashracks and intake structures associated with water diversion facilities.

Glenn-Colusa Fish Screen (Decoto 1978)

	Release Site	Result
Bypass Recoveries	Inside Trashrack	0.196
	Outside Trashrack	0.156
	Difference	0.040
Culvert Recoveries	Inside Trashrack	0.301
	Outside Trashrack	0.377
	Difference	0.077
Mean Loss at this Installation (0.040 + 0.077 / 2)		0.058

Hallwood-Cordua Fish Screen (Kano MS)

	Release Site	Result
Bypass Recoveries	Inside Trashrack	0.740
	Upstream of Trashrack	0.498
	Upstream of Screen	0.541
	Difference	0.520
Loss at this Installation (0.740 - 0.520)		0.220

Clifton Court Forebay (Hall 1980)

Trashboom Release, Calculated Loss	0.150
------------------------------------	-------

Hallwood-Cordua (Kano MS)

	Release Site	Result
Bypass Recoveries	Trashrack Day (6")	0.230
	Trashrack Night (6")	0.170
	Average Loss	0.200
	Trashrack Day (12")	0.120
	Trashrack Night (12")	0.070
	Average Loss	0.100
Average Loss at this Installation		0.150

TABLE 6. Summary of Clifton Court Forebay loss estimates for juvenile chinook salmon (Oncorhynchus tshawytscha) and striped bass (Morone saxatilis).

Chinook Salmon Studies -

		Result	Mean
1978 (Hall 1980)	Fingerlings	0.86	
1984 (Kano 1985a)	Smolts	0.63	0.75
1985 (Kano 1985b)	Fry	0.75	

Striped Bass Studies -

		Result	Mean
1984 (Kano 1985 a)	Fry	0.94	
1985 (Kano 1986)	Fry	0.70	0.82

State of California
THE RESOURCES AGENCY
Department of Fish and Game
Bay-Delta Project

Estimates of Fish Entrainment Losses
Associated with the State Water Project
and Federal Central Valley Project
Facilities in the South Delta

July 1987

TABLE OF CONTENTS

	<u>Page</u>
List of Tables	ii
List of Figures	iv
List of Appendices	v
Introduction	1
Methods	5
Striped Bass Egg and Larval Survey Methodology	6
Salvage Records Estimates Methodology	6
1978-1986 SWP Loss Estimates	8
1968-1977 SWP Loss Estimates	10
SWP Entrainment Loss Estimates	10
Estimation Process	14
CVP Entrainment Loss Estimates	18
1968-1986 CVP Loss Estimates	18
1957-1967 CVP Loss Estimates	19
Results	20
Striped Bass Eggs and Larvae	20
Juvenile Striped Bass (> 20 mm) and Chinook Salmon	20
Discussion	27
Literature Cited	30
Appendices	A-1

LIST OF TABLES

		<u>Page</u>
Table 1	Length groups and screening efficiency equations used in bi-monthly length-frequency and salvage/loss reports produced for the John E. Skinner Delta Fish Protective Facility.	9
Table 2	Average 1968-1980 State Water Project operations at the Harvey O. Banks pumping plant and estimated water velocities in the primary channel at the John E. Skinner Delta Fish Protective Facility.	11
Table 3	Average 1968-1980 screening efficiencies for striped bass at the John E. Skinner Delta Fish Protective Facility.	12
Table 4	Average 1968-1980 screening efficiencies for chinook salmon and steelhead at the John E. Skinner Delta Fish Protective Facility.	13
Table 5	Loss estimates for chinook salmon (<u>Oncorhynchus tshawytscha</u>) at trashracks and intake structures associated with water diversion facilities.	15
Table 6	Summary of Clifton Court Forebay loss estimates for juvenile chinook salmon (<u>Oncorhynchus tshawytscha</u>) and striped bass (<u>Morone saxatilis</u>).	16
Table 7	Striped bass handling and trucking 1984/85 evaluation at the John E. Skinner Fish Protective Facility. Results based on test which contained at least fifteen striped bass.	17
Table 8	Striped bass egg and larval 1985 and 1986 entrainment estimates for the SWP intake.	21
Table 9	Striped bass egg and larval 1985 and 1986 entrainment estimates for the CVP intake.	22
Table 10	Case 1: Striped bass (21-150 mm) loss estimates for the SWP and CVP.	23
Table 11	Case 1: Chinook salmon loss estimates for the SWP and CVP.	24

Table 12	Case 2: Striped bass (21-150 mm) loss estimates for the SWP and CVP.	25
Table 13	Case 2: Chinook salmon loss estimates for the SWP and CVP.	26

LIST OF FIGURES

	<u>Page</u>
Figure 1 Aerial photograph of the Tracy Fish Collecting Facility.	2
Figure 2 Schematic diagram of John E. Skinner Delta Fish Protective Facility.	3
Figure 3 Schematic diagram of the entrainment loss . . . calculation process at the State Water Project facilities in the south Delta.	7

LIST OF APPENDICES

	<u>Page</u>
Appendix Table 1. Striped bass (21-150 mm) entrainment losses at the State Water Project based on a pre-screening loss rate of 15%.	A-1
Appendix Table 2. Chinook salmon entrainment losses at State Water Project bases on a pre-screening loss rate of 15%.	A-11
Appendix Table 3. Striped bass (21-150 mm) entrainment losses at the State Water Project based on a pre-screening loss rate of 82%.	A-21
Appendix Table 4. Chinook salmon entrainment losses at State Water Project based on a pre-screening loss rate of 75%.	A-31
Appendix Table 5. Striped bass entrainment losses by length group at the State Water Project based on a pre-screening loss rate of 15%.	A-41
Appendix Table 6. Chinook salmon entrainment losses by length group at the State Water Project based on a pre-screening loss rate of 15%.	A-51
Appendix Table 7. Striped bass entrainment losses by length group at the State Water Project based on a pre-screening loss rate of 82%.	A-54
Appendix Table 8. Chinook salmon entrainment losses by length group at the State Water Project based on a pre-screening loss rate of 75%.	A-64

ESTIMATES OF FISH ENTRAINMENT LOSSES ASSOCIATED WITH THE
STATE WATER PROJECT AND FEDERAL CENTRAL VALLEY PROJECT
FACILITIES IN THE SOUTH DELTA

INTRODUCTION

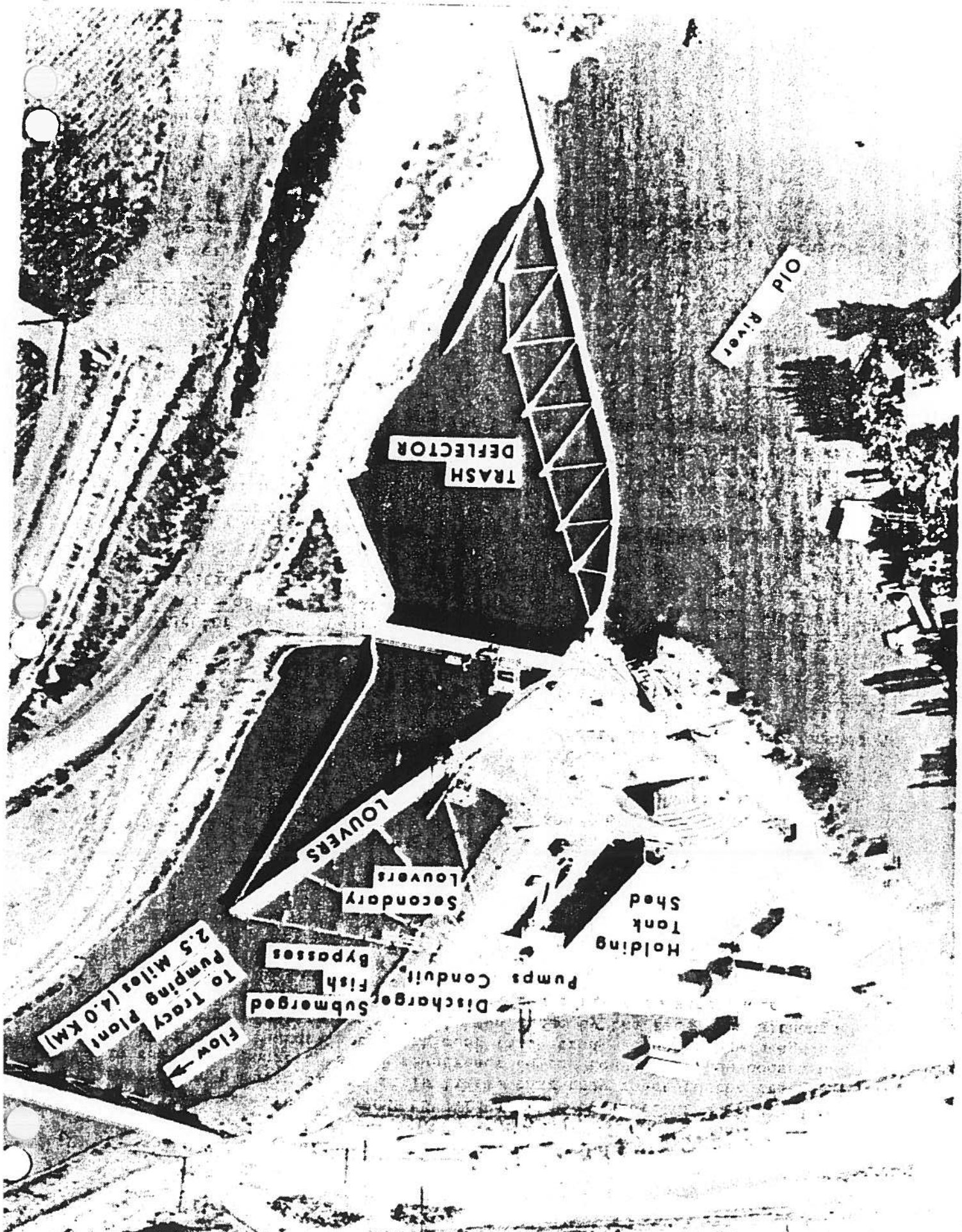
The fish salvage facilities in the south Delta, operated by the California Department of Water Resources' (DWR) State Water Project (SWP) and the U.S. Bureau of Reclamation's (USBR) Central Valley Project (CVP), are known as the John E. Skinner Delta Fish Protective Facility and the Tracy Fish Collecting Facility, respectively. These two installations are among the largest fish protective facilities in the United States, and they are the largest in the State of California. Both utilize louver fish screens to separate the fish from the water being exported.

The purpose of this testimony is to present estimates of the number of striped bass and chinook salmon lost at the two facilities. The effects of the losses on striped bass and chinook salmon populations in the Sacramento-San Joaquin Estuary will be discussed in separate testimony.

The USBR-Tracy Fish Collecting Facility (Tracy Facility) is the oldest of the two facilities (Figure 1). It was completed in the middle 1950's, and screens up to 4600 cubic feet per second of water (cfs) through a set of primary louvers. The fish are diverted from the primary to tandem secondary louvers, which in turn divert the salvaged fish into circular holding tanks. The fish are then regularly removed from the holding tanks and trucked to release points in the western Delta, beyond the immediate influence of the pumps. The California Department of Fish and Game (DFG) developed the louver screen concept and did limited testing in the late 1940's. After additional evaluations were conducted by the U.S. Fish and Wildlife Service and Bureau of Reclamation in the early 1950's (Bates and Vinsonhalter 1956), the Tracy Facility was completed in 1957. Field evaluations of the completed Tracy Facility were conducted in the late 1950's (Bates, Logan and Pesonen 1960), and again in the mid-1960's (Hallock, Iselin and Fry 1968). These limited evaluations, which were primarily of the secondary system, showed that the louver screen was effective for fish large enough to detect and avoid the screen. This type of screen is a behavioral barrier, since it requires fish to detect and react to the fish screen to avoid being lost through the louvers.

The DWR-John E. Skinner Delta Fish Protective Facility (Skinner Facility) was completed in 1968, and benefitted from the operational experience and testing of the earlier facility (Figure 2). The most significant change was the folding of the primary louvers into a "sawtooth" array, to reduce the overall length of the facility. This in turn reduced the exposure of any fish to the primary screen, improving salvage. The facility was

FIGURE 1. Aerial photograph of the Tracy Fish Collecting Facility.



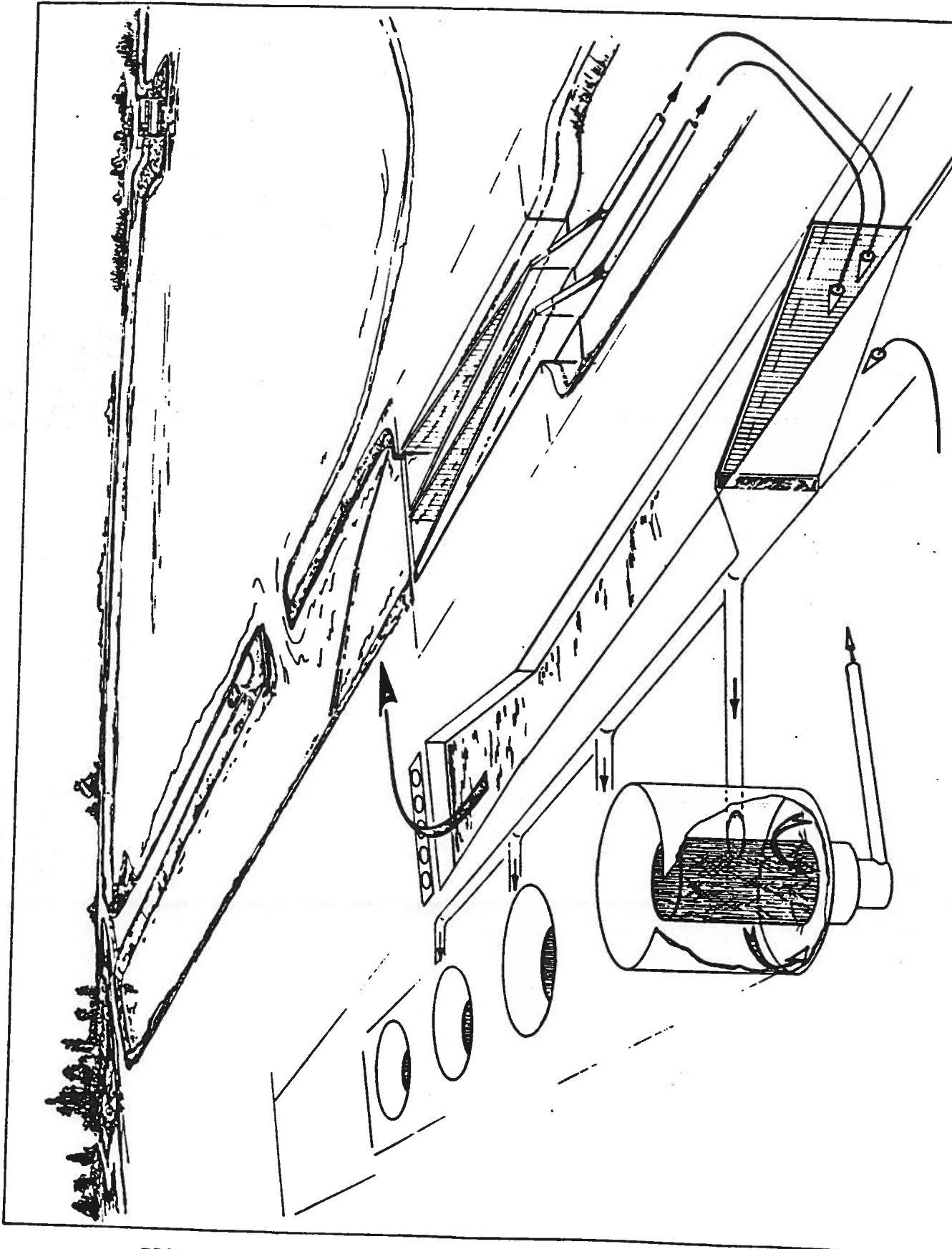


FIGURE 2. Schematic diagram of John E. Skinner Delta Fish Protective Facility.

originally intended to screen the full 10300 cfs export capacity of the Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant), making it more than twice as large as the CVP facility. As with the Tracy Facility, fish are screened from the export water by the primary louvers, screened again in the secondary channel, and are then diverted into the holding tanks. From there the fish are trucked to the western Delta, beyond the immediate influence of the pumps. A full scale evaluation of this screen was completed in 1972, and showed that while these screens continued to be relatively efficient for larger fish, they had little or no ability to save the smaller fish (less than about 38mm), whose presence at the diversions was assured by their location in the Delta nursery area (California Departments of Water Resources and Fish and Game 1973). This work led to a re-evaluation of the Tracy Facility, in which the estimated efficiency of the older facility was reported, based on the more recent information from the Skinner Facility but no additional field testing (Heubach and Skinner 1978).

The Skinner Facility differs from the Tracy Facility in that it is preceded by Clifton Court Forebay (Forebay), which isolates the exports from the tidal fluctuations in the adjacent Delta channels. This feature was added in 1969, and changes in the patterns of fish salvage following the addition were noted by Heubach as early as 1972 (Heubach MSa, MSb). The Forebay has proven to be a mixed blessing, eliminating undesirable hydraulic conditions which occur at low tides at the Tracy Facility, but presenting an opportunity for increased losses before the fish get to the fish screen.

The export operations of the CVP and SWP draw water and fish out of the central and southern Delta, to the two intakes in the south Delta, which are located less than a mile apart. We use the term "entrainment" to define the fish that have entered the project's facility, and become subject to the fish salvage process. In the case of the CVP, fish are entrained when they approach the log boom and trashrack, and are drawn into the system. At the SWP facilities, the entrainment begins when fish enter the Forebay. The term "loss" is used to identify those fish which do not survive the entrainment and salvage process.

Records of fish salvage have been kept at the two facilities since they were constructed. The early records from the Tracy Facility are quite rudimentary, and of limited value. As time went on, the accuracy and the value have improved. Today, all of the data from the Skinner Facility, and data from Tracy Facility back to 1979 is on edited computer files and available for analysis. Records for the Tracy Facility are available back to 1957, but are hand tabulated and have neither been verified to the same level of accuracy as the other records, nor do they include identification of all fish species. It is important to keep in mind that these records vary in quality over time. Today, the fish salvage process is designed to provide an estimate of total fish salvage

(with a probability of 0.80) of plus or minus 50% when daily fish salvage exceeds 10,000, and plus or minus 100% when daily fish salvage is less than 10,000. Species composition and size distribution information is less precise. Data on these two items is collected twice a day: 0500 and 1700 at the Tracy Facility, 0100 and 1300 at the Skinner Facility.

In 1982, after the decision to reject the Peripheral Canal as an alternative to solve the issues associated with the transfer of water across the Delta, new evaluations of the existing SWP facilities began. This work included studies on the losses of fish in the Forebay and at the trashrack structure, as well as evaluations of losses associated with the secondary fish screens, the holding tanks, and the handling and trucking process.

No comparable studies have been done at the CVP facilities, and this requires us to generate loss estimates for the CVP operations based on the data gathered at the SWP installation. Thus, these estimates of losses are based on a number of assumptions, which include both the adequacy of the fish salvage data and the factors which are affecting the numbers of fish lost. We will outline the available information, and the assumptions, as we proceed through this report. Despite these limitations, we believe that the information is sufficient to estimate the general magnitude of losses at the two facilities. The impact of such losses on striped bass and chinook salmon populations will be considered in separate testimony on those species.

METHODS

The calculation of losses associated with the entrainment of fish to the CVP and SWP facilities in the south Delta is based on several methodologies. These account for the different sizes of fish, the different species, and the different levels of information available about the two facilities over their period of operation.

The calculation process involves two basic approaches. The first, for striped bass eggs and larvae (striped bass up to 20 mm), is based on sampling done in the south Delta immediately before the striped bass are entrained. This information is available only for 1985 and 1986. The second approach, which calculates loss estimates for striped bass greater than 20 mm and all chinook salmon, is a model simulation of entrainment losses. The model utilizes as input data, the salvage records collected at the Tracy Facility and the Skinner Facility. These records are available for the Tracy Facility since February 1957, and from the Skinner Facility since March 1968.

The model depends on operational information about the manner in which exports affect facility operation, and mortality estimates associated with both entrainment, and the handling and trucking

process. These have been developed only for the Skinner Facility. Thus, we are forced to estimate the losses at the Tracy Facility by comparing the ratio of system loss to salvage at the Skinner Facility, and multiplying this ratio by the salvage at the Tracy Facility for the years from 1968 to 1986. We then estimate system losses for the period from 1957 to 1968 at the Tracy Facility by developing an average monthly ratio of loss to salvage at the Skinner Facility for the 1968 to 1986 period, and apply it to the Tracy Facility salvage records from 1957 to 1968. This is done on a monthly basis.

The results of both the striped bass egg and larval approach, and the simulation model approach are combined to provide an estimate of the total system loss for each of the two facilities. To avoid double counting fish, we eliminate all losses of striped bass up to 20 mm from the simulation model calculation when presenting results. Figure 3 presents a schematic diagram of the process.

Striped Bass Egg and Larval Survey Methodology

The densities of striped bass eggs and larvae are estimated by sampling in West Canal (just downstream of the intake to the Forebay), and in Old River (approximately 1/4 mile downstream of the CVP intake). Sampling is done during the striped bass spawning period (mid-April to mid-July). During 1985 and 1986, the survey was conducted in conjunction with a Delta wide survey. Methods are the same as used in the Delta egg and larval survey (Fusfeld and Miller MS, Raquel MS).

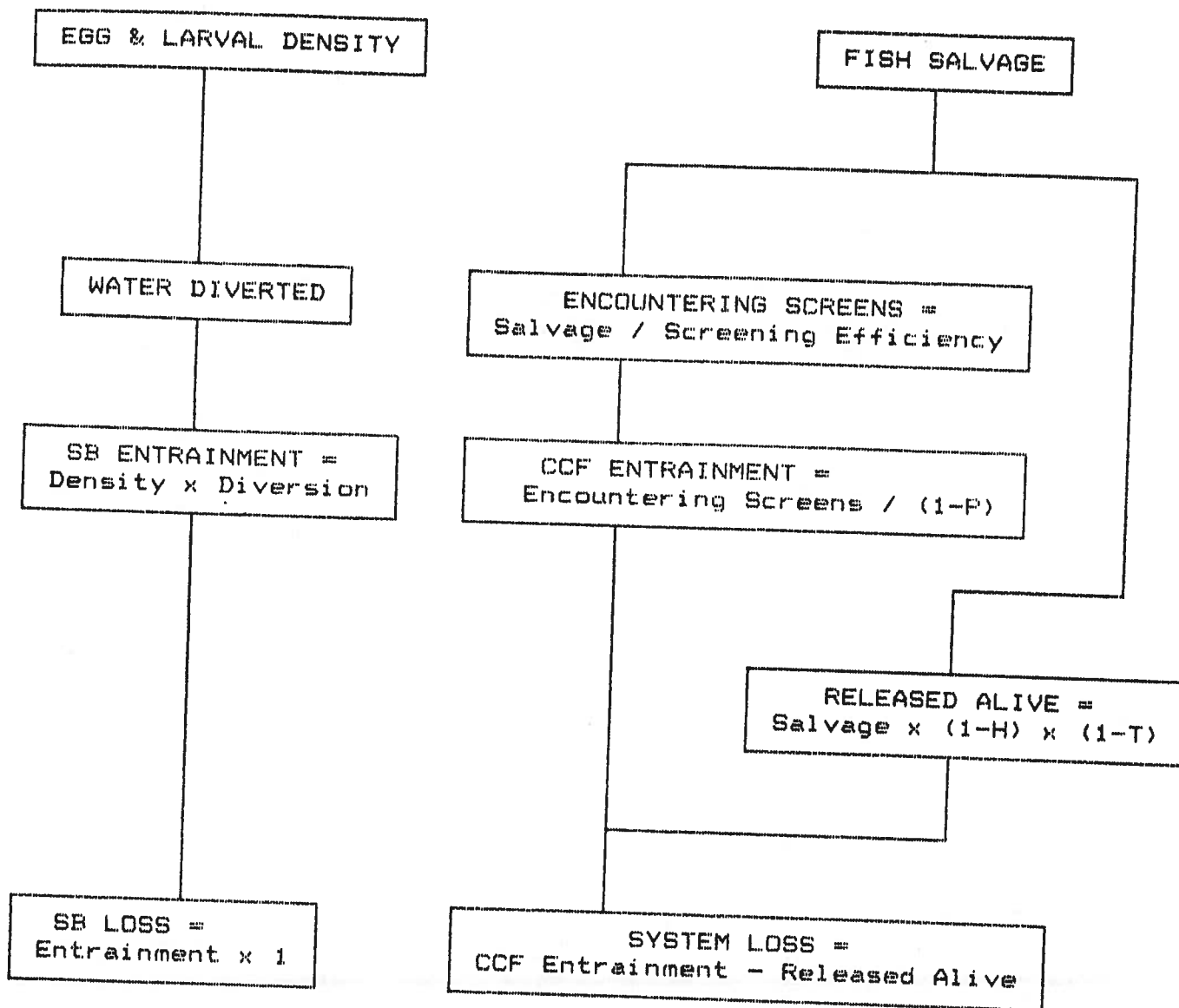
The densities from the sampling are used to estimate the numbers of eggs and larvae entrained into the SWP and CVP facilities, based on the assumption that the mean densities sampled in the West Canal (SWP entrainment) and Old River (CVP entrainment) sampling stations are representative of the densities in the water which is drawn into the intake of each facility. All eggs and larvae drawn into the intakes are assumed to be lost. This assumption is based on the low louver efficiencies for the smaller fish, the fact that the cylinder screens in the holding Figure 3 tanks will both allow the smaller eggs and larvae to pass through the screen and will impinge the larger eggs and larvae on the screens, and low survivals of these small fish in the trucking and handling operation.

We present information for 1985 and 1986 in this report. The information for 1987 may be available before Phase I of the hearings are over.

Salvage Record Estimates Methodology

The losses of striped bass larger than 20 mm, and all chinook salmon, are based on the salvage records collected at the Skinner

STRIPED BASS (1-20 MM)

STRIPED BASS (21-150 MM)
ALL CHINOOK SALMON

P = Clifton Court Forebay loss rate
 H = Handling loss rate at the Skinner Facility
 T = Trucking loss rate at the Skinner Facility

FIGURE 3. Schematic diagram of the entrainment loss calculation process at the State Water Project facilities in the south Delta.

Summary of Testimony
Harold K. Chadwick
Department of Fish and Game

Summary of Qualifications

DFG Exhibit 8

Agreement Between the Department of Water Resources
and the Department of Fish and Game to Offset the
Direct Fish Losses in Relation to the Harvey O. Banks
Delta Pumping Plant

This testimony will describe the history of actions leading to the agreement. The agreement is being submitted in the hearing as DWR Exhibit 560. The testimony will briefly summarize the major features of the agreement, highlighting what the Department of Fish and Game expects to accomplish through the agreement.

The steps being taken jointly to implement the agreement will be described by Randall Brown of the Department of Water Resources in separate testimony.

Summary of Testimony

Harold K. Chadwick

Department of Fish and Game

Summary of Qualification

DFG Exhibit 8

Salmon Management in Relation to the
Sacramento-San Joaquin Estuary

This testimony will:

A. Present Department of Fish and Game comments on the Fish and Wildlife Service's testimony on behalf of the Interagency Program. The testimony will be based on Fish and Wildlife Service Exhibit 31.

B. Relate testimony on management needs in the Estuary to testimony on salmon presented during the topic: Uses Upstream of the Estuary.

C. Describe preliminary recommendations on measures to protect salmon residing in and migrating through the Estuary.