SCOMM
74.31

from Data Processing

FIRST CLASS MAIL

to Ginnie Jay
Rm 11, Capitol

FLOPPY DISK MAILER

Do not bend or fold. Avoid exposure to all magnetic fields.
For 5¼" MINI FLOPPY DISK

FAX TRANSMITTAL SHEET

FROM: Mark Herrmann

SCHOOL OF MANAGEMENT
UNIVERSITY OF ALASKA FAIRBANKS
101 BUNNELL BUILDING
FAIRBANKS, ALASKA 99775-1070

TELEPHONE: (907) 474-7461
FAX: (907) 474-5219
John A. Lehman, Acting Dean

TRANSMITTED TO: Ginny Fay

DATE: Dec 16 TIME: 9:10 AM PAGES (INCLUDING THIS PAGE): 4

MESSAGE:

SIMNLIN Procedure
Simultaneous Simulation

Solution Range T = 9 To 43

Descriptive Statistics

Variable	Nobs	N	Actual Mean	Actual Std	Predicted Mean	Predicted Std
NXQUSA	Norw exp Q USA		4.0069	2.2509	3.9513	2.1754
NXPUSA	Norw exp P USA		21.9871	2.9363	22.2632	3.3385
NXPEEC	Norw exp P EEC		19.7802	3.0037	19.7344	3.2799
NXQJAP	Norw exp Q JAP		1.2401	1.2306	1.2139	1.2256
NXPJAP	Norw exp P JAP		21.5489	2.8177	21.5632	3.1270
NPHX	N.A. wh exp P		2.4373	0.6190	2.4815	0.7018
NPHXJ	NA P H-V sal-Jpn		2.4657	0.6666	2.5323	0.7713
NXQEEC	NA Q H-V sal-EEC		27.4308	23.0370	27.5126	22.7056
NPHXE	NA P H-V sal-EEC		2.3924	0.5769	2.4115	0.5574
NHTSUP	Tot beg H-V Supp		131.5584	136.7795	131.1849	136.6855
NHZINVE	Tot end H-V Inv		23.8234	16.9948	23.8685	17.3264
NQHXJ	NA Q H-V sal-Jpn		46.5171	63.6166	46.2489	63.5907
NHEXP	Tot NA H-V export		54.5437	68.9716	54.0954	68.8298
NQHXE	NA Q H-V sal-Jpn		8.0266	5.9285	7.8465	6.9924
JINVZE	Tot end Jpn Inv		103.4069	42.3828	101.6850	42.4151
NPLXE	NA P L-V sal-EEC		1.4303	0.3533	1.3727	0.3837
NQLXE	NA Q L-V sal-EEC		13.0180	15.9128	13.8160	15.2647
NQLXJ	NA Q L-V sal-JPN		5.6120	2.9659	5.7017	2.9031
NPLXJ	NA P L-V sal-JPN		1.4748	0.3243	1.4130	0.3325
JINVTE	Tot end Jpn Inv		156.0483	54.1726	158.4135	61.5247
NPLX	N.A. wh exp P		1.4190	0.3180	1.3658	0.3627
NLTSUP	Tot beg H-V Supp		144.2762	166.1618	145.1019	165.1933
NLZINVE	Tot end H-V Inv		29.5918	18.6374	31.0904	21.1642
HCANP	H-V NA can exp P		3.0955	0.6937	2.9819	0.2970
LCANQ	L-V NA exp can Q		8.8026	4.7669	8.6817	4.4092
LCANP	L-V NA exp can P		2.1292	0.6547	2.1778	0.6197
ULBINVE	Tot end L-V Inv Can		68.6657	43.6838	67.4633	35.6399
NLTSUPC	Tot beg H-V Supp Can		250.6330	147.6046	251.0246	148.4074
NAPHEX	Exvessel H-V		1.7297	0.7349	1.7540	0.7582
NAPLEX	Exvessel H-V		0.4931	0.2250	0.4858	0.1979

SAS

SIMNLIN Procedure
Simultaneous Simulation

Solution Range T = 9 To 43

Statistics of Fit

Variable	N	Mean Error	Mean % Error	Mean Abs Error	Mean Abs % Error
NXQUSA	35	-0.0556	5.9371	0.4010	17.77905
NXPUSA	35	0.2761	1.5334	1.7103	8.15393
NXPEEC	35	-0.0458	0.1303	1.7233	8.82741
NXQJAP	35	-0.0263	6.0744	0.3336	25.49316
NXPJAP	35	0.0144	0.5542	2.0362	9.74573
NPHX	35	0.0442	3.2964	0.4203	18.86219
NPHXJ	35	0.0665	4.6108	0.4874	21.74561
NXQEEC	35	0.0819	1.?119	0.6366	3.04369
NPHXE	35	0.0191	2.8543	0.3780	16.69246
NHTSUP	35	-0.3735	1.1544	5.0035	10.65467
NHZINVE	35	0.0451	3.1679	5.4221	24.51783
NQHXJ	35	-0.2683	7.5652	5.2357	30.81754
NHEXP	35	-0.4483	1.5198	4.6495	20.90141
NQHXE	35	-0.1800	4.3557	2.5536	36.81190
JINVZE	35	-1.7219	2.8167	18.7556	22.76753
NPLXE	35	-0.0577	-3.5583	0.2220	16.60730
NQLXE	35	0.7980	24.8097	4.4942	44.88275
NQLXJ	35	0.0896	9.0240	1.1887	27.80592
NPLXJ	35	-0.0617	-3.7588	0.1601	11.27363
JINVTE	35	2.3652	3.9132	26.3101	18.39993
NPLX	35	-0.0532	-3.8725	0.1901	14.29884
NLTSUP	35	0.8257	2.9972	5.1698	8.93675
NLZINVE	35	1.4986	5.8455	5.8427	19.40417
HCANP	35	-0.1135	0.8122	0.5989	19.77807
LCANQ	35	-0.1209	6.0660	1.6644	24.03509
LCANP	35	0.0486	4.9438	0.4344	20.90294
ULBINVE	35	-1.2024	14.6453	16.1274	33.78358
NLTSUPC	35	0.3916	1.3187	22.2858	11.84294
NAPHEX	35	0.0242	3.4049	0.2241	14.01889
NAPLEX	35	-0.007348	2.0515	0.0813	16.76242

SAS

SIMKLIN Procedure
Simultaneous Simulation

Solution Range T = 9 To 43

Statistics of Fit

Variable	RMS Error	RMS % Error
NXQUSA	0.4932	36.3555
NXPUSA	2.2256	10.9613
NXPEEC	2.0516	10.6907
NXQJAP	0.6044	34.3097
NXPJAP	2.4552	11.9235
NPHX	0.5614	26.3001
NPHXJ	0.6344	29.6726
NXQEEC	0.8618	3.9085
NPHXE	0.4840	22.1572
NHTSUP	7.2255	17.5745
NHZINVE	7.6381	29.6371
NQHXJ	7.4445	45.0224
NHEXP	6.3986	29.7228
NQHXE	3.8821	51.2270
JINVZE	23.4826	30.8980
NPLXE	0.2819	21.4445
NQLXE	8.4043	62.7209
NQLXJ	1.5310	37.0747
NPLXJ	0.1954	13.8841
JINVTE	33.2171	24.0762
NPLX	0.2253	17.6895
NLTSUP	7.4146	12.9263
NLZINVE	8.4158	23.6761
HCANP	0.7179	24.2040
LCANQ	1.9719	31.8355
LCANP	0.5449	25.8759
ULBINVE	19.3088	47.8222
NLTSUPC	26.3965	15.2242
NAPHEX	0.2997	18.1398
NAPLEX	0.1076	21.0015

UNIVERSITY OF ALASKA FAIRBANKS
School of Management
Fairbanks, Alaska 99775-1070

DATE: **December 16, 1992**

TO: **Ginny Fay**

FROM **Mark Herrmann**

Re. **Salmon Project**

I have enclosed the final executive summary report for the demand portion of the salmon grant. I have type it in double space and cleaned up a few errors. Otherwise, it is nearly identical to the DRAFT version.

I have also enclosed the hard copy of the salmon prices used for the "average" price runs for every scenario as well as the Goodness-Of-Fit statistics requested.

Also enclosed are the files that will run the base scenario.

After Jeff has been able to reproduce the base scenario I will give him the rest of the data to run the 11 simulations. I rather hold off on this data now because it will only confuse things. Once Jeff has fooled around with the base scenario, he will have more understanding on how to run the rest of the scenarios. At that point, it might be easier for me to guide him through the rest of the process over the phone, at some predetermined time.

For instructions on how to run the base scenario please see the instructions I sent with the last correspondence. Again, I am rewriting the entire program to improve the forecasting and simulation ability. The results I sent you will likely be somewhat different than the results I have in three months (the same with the program). Early indications are the results for sockeye, chinook, and coho will remain virtually unchanged, but the results for pink salmon may have been too generous in out initial study, i.e., I believe that I may be high on the predicted future pink prices.

I believe this satisfies the demand portion of the grant with the exception of the large report which I will get to you by mid--February. Having Ben and Kurt's comments will be very useful-please thank them for me. I would appreciate it if you would let us know when the project is signed

off on so we can send the executive summaries to interest parties. I got a call today from Chile requesting it!

Josh and I have both enjoyed working with you Ginny. I found your comments on the project, at all stages, to be very useful. If you have any questions about the project in the future please do not hesitate to call. Maybe we will work together again.

CASE 1 -- BASE SCENARIO

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22507	0.92426
95	1.40388	1.22630	1.20973	1.28859	0.96968
96	1.44636	1.25872	1.24595	1.32915	0.99914
97	1.51027	1.30749	1.30044	1.39015	1.04346
98	1.56688	1.35070	1.34870	1.44419	1.08272
99	1.59961	1.37568	1.37661	1.47544	1.10542
100	1.63307	1.40122	1.40514	1.50738	1.12863
101	1.66577	1.42617	1.43302	1.53860	1.15130
102	1.70827	1.45861	1.46926	1.57917	1.18078
103	1.75406	1.49356	1.50830	1.62289	1.21253
104	1.80348	1.53128	1.55043	1.67006	1.24681
105	1.84930	1.56624	1.58949	1.71380	1.27858
106	1.89847	1.60377	1.63142	1.76074	1.31268

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27166	0.26703
97	0.27015	0.23955	0.26104	0.28175	0.27517
98	0.26824	0.23808	0.25918	0.27985	0.27364
99	0.27306	0.24179	0.26385	0.28461	0.27748
100	0.28203	0.24870	0.27253	0.29347	0.28463
101	0.29736	0.26051	0.28737	0.30860	0.29685
102	0.29803	0.26102	0.28801	0.30927	0.29738
103	0.29570	0.25923	0.28576	0.30696	0.29553
104	0.32187	0.27939	0.31108	0.33280	0.31638
105	0.34137	0.29441	0.32996	0.35206	0.33192
106	0.35749	0.30682	0.34555	0.36796	0.34476

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38690	0.40140	0.34588	0.45026	0.33002
97	0.39822	0.40866	0.35848	0.46196	0.33499
98	0.39609	0.40730	0.35611	0.45976	0.33406
99	0.40143	0.41072	0.36206	0.46528	0.33641
100	0.41137	0.41710	0.37311	0.47555	0.34077
101	0.42833	0.42798	0.39200	0.49310	0.34823
102	0.42908	0.42846	0.39282	0.49387	0.34856
103	0.42650	0.42680	0.38995	0.49120	0.34743
104	0.45547	0.44539	0.42219	0.52115	0.36016
105	0.47706	0.45924	0.44622	0.54348	0.36966

106	0.49490	0.47069	0.46608	0.56192	0.37750

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.85971	0.65834	0.68630	1.14653	0.69134
97	0.89187	0.68109	0.70428	1.19456	0.71709
98	0.92036	0.70124	0.72021	1.23711	0.73990
99	0.93683	0.71289	0.72941	1.26172	0.75309
100	0.95366	0.72480	0.73883	1.28686	0.76657
101	0.97012	0.73644	0.74803	1.31144	0.77975
102	0.99151	0.75157	0.75998	1.34338	0.79687
103	1.01455	0.76787	0.77286	1.37780	0.81532
104	1.03942	0.78546	0.78677	1.41494	0.83524
105	1.06247	0.80_77	0.79965	1.44938	0.85370
106	1.08721	0.81927	0.81349	1.48634	0.87351

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59658	1.13720	1.02164	2.27151	1.37220
94	1.56030	1.12702	1.01250	2.24669	1.35600
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66375	1.15604	1.03857	2.31774	1.40221
97	1.72498	1.17321	1.05400	2.35978	1.42956
98	1.77921	1.18843	1.06766	2.39703	1.45379
99	1.81058	1.19722	1.07556	2.41857	1.46780
100	1.84263	1.20621	1.08364	2.44059	1.48212
101	1.87396	1.21500	1.09153	2.46210	1.49611
102	1.91468	1.22642	1.10179	2.49007	1.51430
103	1.95855	1.23873	1.11285	2.52020	1.53390
104	2.00590	1.25201	1.12478	2.55271	1.55505
105	2.04980	1.26432	1.13584	2.58285	1.57466
106	2.09691	1.27754	1.14771	2.61521	1.59570

CASE 2 -- WISH LIST

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.28421	1.13497	1.10770	1.17435	0.88669
93	1.35656	1.19018	1.16939	1.24342	0.93687
94	1.32995	1.16988	1.14670	1.21802	0.91841
95	1.39646	1.22064	1.20341	1.28152	0.96454
96	1.44365	1.25665	1.24364	1.32656	0.99726
97	1.50278	1.30178	1.29406	1.38301	1.03827
98	1.55916	1.34481	1.34213	1.43683	1.07737
99	1.57114	1.35395	1.35234	1.44826	1.08568
100	1.59915	1.37533	1.37622	1.47500	1.10510
101	1.62876	1.39793	1.40146	1.50327	1.12564

102	1.66036	1.42205	1.42841	1.53343	1.14755
103	1.61556	1.38786	1.39021	1.49067	1.11649
104	1.66011	1.42185	1.42819	1.53319	1.14738
105	1.70320	1.45474	1.46493	1.57433	1.17726
106	1.75018	1.49060	1.50499	1.61918	1.20984

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27536	0.24356	0.26608	0.28689	0.27932
93	0.26778	0.23773	0.25875	0.27941	0.27328
94	0.27027	0.23964	0.26115	0.28186	0.27526
95	0.24813	0.22259	0.23973	0.26001	0.25762
96	0.24904	0.22329	0.24061	0.26090	0.25834
97	0.25880	0.23081	0.25005	0.27053	0.26612
98	0.25494	0.22784	0.24632	0.26673	0.26305
99	0.25975	0.23154	0.25097	0.27147	0.26688
100	0.26824	0.23808	0.25919	0.27986	0.27365
101	0.28530	0.25122	0.27570	0.29670	0.28724
102	0.28486	0.25088	0.27527	0.29626	0.28689
103	0.27906	0.24641	0.26966	0.29054	0.28227
104	0.30488	0.26630	0.29465	0.31603	0.30285
105	0.32515	0.28192	0.31426	0.33604	0.31900
106	0.34134	0.29438	0.32992	0.35202	0.33189

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40398	0.41236	0.36489	0.46792	0.33753
93	0.39559	0.40698	0.35556	0.45925	0.33384
94	0.39834	0.40874	0.35862	0.46209	0.33505
95	0.37384	0.39302	0.33135	0.43675	0.32427
96	0.37484	0.39366	0.33246	0.43779	0.32471
97	0.38564	0.40059	0.34448	0.44896	0.32946
98	0.38137	0.39785	0.33973	0.44454	0.32759
99	0.38670	0.40127	0.34565	0.45005	0.32993
100	0.39610	0.40730	0.35612	0.45977	0.33406
101	0.41499	0.41942	0.37714	0.47930	0.34237
102	0.41449	0.41910	0.37659	0.47879	0.34215
103	0.40808	0.41498	0.36945	0.47215	0.33933
104	0.43667	0.43333	0.40127	0.50171	0.35190
105	0.45910	0.44772	0.42624	0.52491	0.36176
106	0.47702	0.45922	0.44618	0.54344	0.36964

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.77812	0.60062	0.64069	1.02465	0.62600
93	0.81452	0.62637	0.66104	1.07903	0.65515
94	0.80113	0.61690	0.65356	1.05903	0.64443
95	0.83460	0.64058	0.67227	1.10903	0.67123
96	0.85835	0.65737	0.68554	1.14449	0.69025
97	0.88810	0.67842	0.70218	1.18894	0.71407
98	0.91647	0.69849	0.71804	1.23131	0.73679
99	0.92250	0.70275	0.72140	1.24031	0.74162
100	0.93660	0.71273	0.72929	1.26137	0.75290
101	0.95149	0.72326	0.73761	1.28362	0.76483

102	0.96740	0.73451	0.74650	1.30737	0.77757
103	0.94485	0.71857	0.73390	1.27370	0.75952
104	0.96727	0.73442	0.74643	1.30718	0.77746
105	0.98896	0.74976	0.75856	1.33957	0.79483
106	1.01259	0.76649	0.77177	1.37488	0.81376

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.50840	1.11246	0.99942	2.21105	1.33281
93	1.57771	1.13191	1.01689	2.25865	1.36378
94	1.55222	1.12476	1.01047	2.24114	1.35239
95	1.61595	1.14263	1.02652	2.28491	1.38085
96	1.66115	1.15531	1.03791	2.31595	1.40105
97	1.71781	1.17120	1.05219	2.35486	1.42636
98	1.77183	1.18635	1.06580	2.39196	1.45049
99	1.78330	1.18957	1.06869	2.39984	1.45561
100	1.81014	1.19710	1.07545	2.41827	1.46760
101	1.83850	1.20505	1.08260	2.43775	1.48027
102	1.86878	1.21355	1.09023	2.45854	1.49380
103	1.83586	1.20151	1.07941	2.42907	1.47463
104	1.86854	1.21348	1.09017	2.45837	1.49369
105	1.90983	1.22506	1.10057	2.48673	1.51213
106	1.95484	1.23769	1.11191	2.51764	1.53224

CASE 3 -- SALMON ENHANCEMENT PROGRAM IS ELIMINATED

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37529	1.20448	1.18535	1.26130	0.94985
94	1.33757	1.17569	1.15320	1.22529	0.92370
95	1.41029	1.23119	1.21520	1.29472	0.97413
96	1.48124	1.28534	1.27569	1.36244	1.02333
97	1.62979	1.39871	1.40234	1.50425	1.12635
98	1.72768	1.47343	1.48581	1.59770	1.19424
99	1.77755	1.51148	1.52832	1.64530	1.22882
100	1.82675	1.54903	1.57027	1.69227	1.26294
101	1.85131	1.56778	1.59121	1.71572	1.27998
102	1.90895	1.61177	1.64035	1.77074	1.31995
103	1.96692	1.65601	1.68978	1.82608	1.36015
104	2.02623	1.70128	1.74035	1.88270	1.40128
105	2.07731	1.74026	1.78289	1.93146	1.43670
106	2.13953	1.78775	1.83694	1.99086	1.47985

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26133	0.23276	0.25250	0.27303	0.26814
94	0.27137	0.24049	0.26222	0.28295	0.27614
95	0.38941	0.33141	0.37645	0.39948	0.37021
96	0.41403	0.35037	0.40027	0.42379	0.38982
97	0.48671	0.40635	0.47060	0.49554	0.44774
98	0.51052	0.42469	0.49364	0.51905	0.46672
99	0.52626	0.43680	0.50886	0.53456	0.47924

100	0.53877	0.44645	0.52099	0.54694	0.48923
101	0.54737	0.45307	0.52930	0.55542	0.49608
102	0.55905	0.46207	0.54061	0.56696	0.50539
103	0.56213	0.46444	0.54359	0.56999	0.50784
104	0.57665	0.47562	0.55764	0.58433	0.51941
105	0.58662	0.48330	0.56728	0.59417	0.52736
106	0.60666	0.49874	0.58668	0.61396	0.54333

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.38845	0.40239	0.34760	0.45186	0.33069
94	0.39956	0.40952	0.35997	0.46335	0.33558
95	0.53024	0.49336	0.50542	0.59847	0.39304
96	0.55749	0.51085	0.53574	0.62664	0.40502
97	0.63795	0.56247	0.62529	0.70984	0.44040
98	0.66431	0.57938	0.65463	0.73709	0.45199
99	0.68172	0.59054	0.67400	0.75509	0.45964
100	0.69559	0.59945	0.68944	0.76943	0.46574
101	0.70511	0.60555	0.70003	0.77927	0.46993
102	0.71804	0.61385	0.71442	0.79264	0.47561
103	0.72145	0.61603	0.71822	0.79616	0.47711
104	0.73752	0.62635	0.73611	0.81279	0.48418
105	0.74856	0.63343	0.74839	0.82420	0.48903
106	0.77075	0.64767	0.77309	0.84714	0.49879

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82395	0.63304	0.66631	1.09311	0.66270
94	0.80497	0.61961	0.65570	1.06476	0.64750
95	0.84156	0.64550	0.67616	1.11942	0.67680
96	0.87726	0.67075	0.69611	1.17274	0.70539
97	0.95201	0.72363	0.73790	1.28439	0.76525
98	1.00127	0.75848	0.76544	1.35797	0.80469
99	1.02636	0.77623	0.77947	1.39545	0.82479
100	1.05112	0.79374	0.79331	1.43243	0.84461
101	1.06348	0.80248	0.80022	1.45089	0.85451
102	1.09249	0.82300	0.81644	1.49422	0.87773
103	1.12166	0.84364	0.83274	1.53779	0.90109
104	1.15150	0.86475	0.84943	1.58236	0.92499
105	1.17720	0.88293	0.86380	1.62075	0.94557
106	1.20851	0.90508	0.88130	1.66752	0.97064

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59566	1.13694	1.02141	2.27097	1.37179
94	1.55952	1.12680	1.01231	2.24616	1.35565
95	1.62919	1.14635	1.02986	2.29401	1.38677
96	1.69716	1.16541	1.04699	2.34068	1.41713
97	1.83949	1.20533	1.08285	2.43843	1.48071
98	1.93328	1.23164	1.10648	2.50284	1.52261

99	1.98105	1.24504	1.11852	2.53564	1.54395
100	2.02819	1.25826	1.13040	2.56802	1.56501
101	2.05173	1.26486	1.13633	2.58418	1.57552
102	2.10695	1.28035	1.15024	2.62210	1.60019
103	2.16249	1.29593	1.16423	2.66025	1.62500
104	2.21931	1.31187	1.17855	2.69927	1.65038
105	2.26825	1.32559	1.19088	2.73288	1.67224
106	2.32786	1.34232	1.20590	2.77382	1.69887

CASE 4A -- SALMON PRODUCTION FROM ENHANCEMENT PROGRAM IS INCREASED BY 15%

YR	PWRZ	C	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37639	1.20532	1.18630	1.26236	0.95062
94	1.33850	1.17640	1.15399	1.22619	0.92435
95	1.40331	1.22587	1.20925	1.28805	0.96929
96	1.44121	1.25479	1.24156	1.32423	0.99557
97	1.49531	1.29608	1.28769	1.37588	1.03309
98	1.54486	1.33390	1.32993	1.42318	1.06746
99	1.57654	1.35807	1.35694	1.45342	1.08942
100	1.60937	1.38313	1.38493	1.48476	1.11219
101	1.64187	1.40793	1.41264	1.51578	1.13473
102	1.68369	1.43985	1.44830	1.55571	1.16373
103	1.72695	1.47287	1.48518	1.59700	1.19373
104	1.77688	1.51098	1.52775	1.64467	1.22836
105	1.82103	1.54467	1.56539	1.68681	1.25897
106	1.86767	1.58027	1.60516	1.73134	1.29132

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26626	0.23655	0.25727	0.27790	0.27207
94	0.27726	0.24503	0.26792	0.28876	0.28083
95	0.23266	0.21068	0.22476	0.24473	0.24529
96	0.23852	0.21519	0.23043	0.25052	0.24996
97	0.23766	0.21453	0.22960	0.24967	0.24928
98	0.23265	0.21067	0.22475	0.24472	0.24528
99	0.23427	0.21191	0.22631	0.24632	0.24657
100	0.24182	0.21773	0.23362	0.25377	0.25259
101	0.26145	0.23285	0.25261	0.27315	0.26823
102	0.26054	0.23215	0.25174	0.27226	0.26751
103	0.25690	0.22971	0.24821	0.26866	0.26461
104	0.28501	0.251	0.27542	0.29642	0.28701
105	0.30371	0.26540	0.29351	0.31487	0.30191
106	0.32020	0.27810	0.30947	0.33116	0.31505

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39391	0.40589	0.35368	0.45750	0.33310
94	0.40609	0.41371	0.36723	0.47010	0.33845
95	0.35671	0.38203	0.31228	0.41904	0.31674

96	0.36320	0.38619	0.31951	0.42575	0.31960
97	0.36225	0.38558	0.31844	0.42477	0.31918
98	0.35670	0.38202	0.31227	0.41903	0.31674
99	0.35849	0.38317	0.31426	0.42088	0.31752
100	0.36685	0.38853	0.32357	0.42953	0.32120
101	0.38858	0.40248	0.34775	0.45199	0.33075
102	0.38758	0.40183	0.34663	0.45096	0.33031
103	0.38354	0.39925	0.34215	0.44679	0.32854
104	0.41467	0.41921	0.37679	0.47897	0.34223
105	0.43537	0.43249	0.39982	0.50037	0.3513
106	0.45362	0.44421	0.42014	0.51925	0.35

YR	PWSZ	CISZ	KSZ	JSZ	AKOS
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82450	0.63343	0.66662	1.09394	0.66315
94	0.80544	0.61995	0.65596	1.06546	0.64788
95	0.83805	0.64301	0.67419	1.11417	0.67399
96	0.85712	0.65651	0.68486	1.14266	0.68926
97	0.88434	0.67576	0.70007	1.18332	0.71106
98	0.90928	0.69340	0.71401	1.22056	0.73103
99	0.92522	0.70468	0.72292	1.24437	0.74379
100	0.94174	0.71636	0.73216	1.26905	0.75702
101	0.95809	0.72793	0.74130	1.29348	0.77012
102	0.97914	0.74282	0.75307	1.32491	0.78697
103	1.00090	0.75822	0.76524	1.35742	0.80440
104	1.02603	0.77599	0.77928	1.39495	0.82452
105	1.04824	0.79170	0.79170	1.42813	0.84231
106	1.07172	0.80831	0.80482	1.46319	0.86110

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59672	1.13724	1.02168	2.27170	1.37226
94	1.56042	1.12705	1.01253	2.24677	1.35605
95	1.62251	1.14447	1.02818	2.28941	1.38378
96	1.65882	1.15466	1.03733	2.31435	1.40001
97	1.71065	1.16919	1.05038	2.34994	1.42316
98	1.75812	1.18251	1.06235	2.38255	1.44437
99	1.78847	1.19102	1.06999	2.40339	1.45792
100	1.81992	1.19984	1.07792	2.42499	1.47197
101	1.85106	1.20858	1.08576	2.44637	1.48588
102	1.89113	1.21982	1.09586	2.47389	1.50378
103	1.93258	1.23144	1.10630	2.50235	1.52230
104	1.98042	1.24486	1.11836	2.53521	1.54367
105	2.02271	1.25672	1.12901	2.56425	1.56256
106	2.06740	1.26926	1.14027	2.59494	1.58252

CASE 4B -- SALMON HARVEST FROM ENHANCMENT IS DECREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ

92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37613	1.20512	1.18607	1.26210	0.95044
94	1.33827	1.17623	1.15380	1.22596	0.92419
95	1.40393	1.22634	1.20978	1.28864	0.96972
96	1.45096	1.26223	1.24987	1.33354	1.00233
97	1.52637	1.31979	1.31417	1.40553	1.05463
98	1.58707	1.36611	1.36592	1.46347	1.09672
99	1.62345	1.39388	1.39694	1.49820	1.12195
100	1.65789	1.42016	1.42630	1.53108	1.14584
101	1.68958	1.44435	1.45332	1.56133	1.16782
102	1.73148	1.47632	1.48904	1.60132	1.19687
103	1.78103	1.51414	1.53129	1.64862	1.23123
104	1.83095	1.55224	1.57385	1.69628	1.26585
105	1.87715	1.58750	1.61324	1.74038	1.29789
106	1.92786	1.62620	1.65647	1.78879	1.33306

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26547	0.23595	0.25651	0.27713	0.27144
94	0.27632	0.24431	0.26701	0.28784	0.28009
95	0.26027	0.23194	0.25148	0.27199	0.26730
96	0.26472	0.23537	0.25578	0.27638	0.27084
97	0.28560	0.25146	0.27599	0.29700	0.28748
98	0.28624	0.25194	0.27660	0.29762	0.28799
99	0.29216	0.25650	0.28233	0.30347	0.29270
100	0.30168	0.26383	0.29155	0.31287	0.30029
101	0.31746	0.27599	0.30682	0.32845	0.31287
102	0.31637	0.27515	0.30576	0.32737	0.31200
103	0.31389	0.27324	0.30336	0.32492	0.31002
104	0.34061	0.29382	0.32922	0.35130	0.33131
105	0.35979	0.30860	0.34779	0.37024	0.34660
106	0.37530	0.32054	0.36279	0.38555	0.35896

YR	PWCZ	CICZ	KCZ	
92	0.40428	0.41255	0.36522	0.4
93	0.39304	0.40534	0.35271	0.4
94	0.40505	0.41304	0.36608	0.4
95	0.38728	0.40164	0.34630	0.450 .18
96	0.39220	0.40480	0.35178	0.45574 0.33235
97	0.41532	0.41963	0.37751	0.47965 0.34251
98	0.41602	0.42008	0.37829	0.48037 0.34282
99	0.42258	0.42429	0.38559	0.48715 0.34570
100	0.43312	0.43105	0.39732	0.49804 0.35034
101	0.45059	0.44226	0.41676	0.51611 0.35802
102	0.44938	0.44149	0.41542	0.51486 0.35749
103	0.44663	0.43972	0.41236	0.51202 0.35628
104	0.47621	0.45870	0.44528	0.54260 0.36929
105	0.49745	0.47233	0.46892	0.56457 0.37862
106	0.51462	0.48334	0.48803	0.58232 0.38617

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ

92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82437	0.63334	0.66655	1.09374	0.66304
94	0.80532	0.61986	0.65590	1.06529	0.64778
95	0.83836	0.64323	0.67437	1.11464	0.67424
96	0.86203	0.65998	0.68760	1.14999	0.69319
97	0.89997	0.68682	0.70881	1.20667	0.72358
98	0.93052	0.70842	0.72589	1.25229	0.74803
99	0.94882	0.72137	0.73612	1.27963	0.76269
100	0.96616	0.73364	0.74581	1.30552	0.77657
101	0.98210	0.74491	0.75472	1.32933	0.78934
102	1.00318	0.75983	0.76651	1.36083	0.80622
103	1.02812	0.77747	0.78045	1.39807	0.82619
104	1.05324	0.79524	0.79449	1.43559	0.84630
105	1.07648	0.81168	0.80749	1.47031	0.86492
106	1.10200	0.82973	0.82175	1.50843	0.88535

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59646	1.13716	1.02161	2.27153	1.37215
94	1.56019	1.12699	1.01248	2.24662	1.35595
95	1.62310	1.14464	1.02833	2.28982	1.38405
96	1.66816	1.15727	1.03968	2.32076	1.40418
97	1.74041	1.17754	1.05788	2.37038	1.43645
98	1.79856	1.19385	1.07254	2.41032	1.46243
99	1.83341	1.20363	1.08132	2.43425	1.47800
100	1.86642	1.21288	1.08963	2.45692	1.49274
101	1.89677	1.22140	1.09728	2.47777	1.50630
102	1.93692	1.23266	1.10740	2.50533	1.52423
103	1.98439	1.24597	1.11936	2.53794	1.54544
104	2.03222	1.25939	1.13141	2.57078	1.56681
105	2.07648	1.27181	1.14256	2.60118	1.58658
106	2.12506	1.28543	1.15480	2.63455	1.60828

CASE 5 -- PINK SALMON ENHANCEMENT PROGRAM IS ELIMINATED

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37613	1.20512	1.18608	1.26211	0.95044
94	1.33829	1.17624	1.15381	1.22598	0.92419
95	1.41108	1.23179	1.21587	1.29547	0.97468
96	1.45144	1.26260	1.25028	1.33400	1.00267
97	1.51564	1.31159	1.30502	1.39528	1.04719
98	1.57372	1.35592	1.35453	1.45072	1.08746
99	1.60732	1.38156	1.38318	1.48280	1.11077
100	1.64219	1.40818	1.41291	1.51609	1.13495
101	1.67526	1.43341	1.44111	1.54765	1.15788
102	1.72102	1.46834	1.48013	1.59135	1.18962
103	1.76771	1.50398	1.51993	1.63591	1.22200
104	1.81922	1.54329	1.56385	1.68508	1.25772
105	1.86645	1.57934	1.60412	1.73018	1.29048
106	1.92116	1.62185	1.65161	1.78335	1.32911

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26[illegible]	0.28715	0.27953
93	0.26136	0.23278	0.25253	0.27306	0.26816
94	0.27140	0.24052	0.26225	0.28298	0.27617
95	0.38945	0.33144	0.37649	0.39952	0.37024
96	0.41363	0.35006	0.39988	0.42339	0.38950
97	0.42511	0.35890	0.41099	0.43472	0.39865
98	0.43010	0.36275	0.41582	0.43965	0.40263
99	0.43723	0.36824	0.42272	0.44669	0.40831
100	0.44733	0.37603	0.43250	0.45667	0.41636
101	0.45543	0.38226	0.44034	0.46466	0.42282
102	0.46705	0.39121	0.45158	0.47613	0.43207
103	0.47019	0.39363	0.45462	0.47923	0.43458
104	0.48479	0.40487	0.46875	0.49364	0.44621
105	0.49496	0.41271	0.47859	0.50369	0.45432
106	0.51511	0.42823	0.49809	0.52358	0.47038

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.392013	0.404683	0.351578	0.45555	0.332263
94	0.40383	0.412258	0.364723	0.467763	0.33746
95	0.41881	0.42187	0.381395	0.48325	0.344048
96	0.429438	0.42869	0.393223	0.494243	0.348723
97	0.441105	0.436175	0.406208	0.506303	0.353848
98	0.440888	0.43604	0.405968	0.50608	0.353755
99	0.446868	0.439873	0.412628	0.51226	0.356388
100	0.457118	0.44645	0.424028	0.522855	0.360885
101	0.47208	0.45605	0.44069	0.538335	0.367468
102	0.475858	0.458473	0.444883	0.542235	0.369128
103	0.474793	0.457785	0.443698	0.541133	0.368663
104	0.50056	0.47432	0.472375	0.567773	0.379988
105	0.519568	0.486513	0.49353	0.587433	0.38835
106	0.538525	0.498678	0.514633	0.607028	0.396683

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82437	0.63334	0.66655	1.09375	0.66304
94	0.80533	0.61987	0.65590	1.06530	0.64779
95	0.84196	0.64578	0.67638	1.12001	0.67712
96	0.86227	0.66015	0.68773	1.15035	0.69339
97	0.89457	0.68300	0.70579	1.19860	0.71925
98	0.92380	0.70367	0.72213	1.24225	0.74265
99	0.94071	0.71563	0.73158	1.26751	0.75619
100	0.95825	0.72804	0.74139	1.29371	0.77024
101	0.97489	0.73982	0.75069	1.31857	0.78357
102	0.99792	0.75611	0.76357	1.35297	0.80201
103	1.02141	0.77273	0.77670	1.38806	0.82082
104	1.04733	0.79106	0.79119	1.42677	0.84158
105	1.07110	0.80787	0.80448	1.46228	0.86061
106	1.09913	0.82770	0.82015	1.50414	0.88306

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59647	1.13717	1.02161	2.27153	1.37215
94	1.56021	1.12700	1.01248	2.24663	1.35595
95	1.62995	1.14656	1.03005	2.29452	1.38711
96	1.66862	1.15740	1.03980	2.32108	1.40438
97	1.73012	1.17466	1.05529	2.36332	1.43186
98	1.78577	1.19026	1.06931	2.40153	1.45671
99	1.81796	1.19929	1.07742	2.42364	1.47110
100	1.85137	1.20866	1.08584	2.44650	1.48602
101	1.88305	1.21755	1.09382	2.46834	1.50017
102	1.92690	1.22985	1.10487	2.49846	1.51976
103	1.97163	1.24240	1.11614	2.52917	1.53974
104	2.02098	1.25624	1.12858	2.56306	1.56178
105	2.06623	1.26893	1.13998	2.59416	1.58200
106	2.11960	1.28390	1.15343	2.63080	1.60584

CASE 6 -- SOCKEYE SALMON ENHANCEMENT PROGRAM IS ELIMINATED

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.31900	1.16152	1.13736	1.20757	0.91082
93	1.39366	1.21850	1.20102	1.27884	0.96260
94	1.36540	1.19693	1.17692	1.25186	0.94300
95	1.43587	1.25072	1.23701	1.31914	0.99187
96	1.49413	1.29518	1.28668	1.37475	1.03227
97	1.58648	1.36566	1.36542	1.46291	1.09632
98	1.66728	1.42733	1.43431	1.54004	1.15235
99	1.70029	1.45252	1.46245	1.57155	1.17524
100	1.74431	1.48611	1.49998	1.61357	1.20577
101	1.76693	1.50338	1.51926	1.63517	1.22146
102	1.82020	1.54404	1.56469	1.68602	1.25840
103	1.87327	1.58454	1.60993	1.73668	1.29520
104	1.92519	1.62417	1.65420	1.78625	1.33121
105	1.97229	1.66012	1.69436	1.83121	1.36388
106	2.02096	1.69726	1.73585	1.87767	1.39763

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27604	0.24409	0.26673	0.28755	0.27986
93	0.26623	0.23653	0.25724	0.27787	0.27204
94	0.27742	0.24515	0.26808	0.28892	0.28096
95	0.25637	0.22894	0.24770	0.26814	0.26419
96	0.26157	0.23294	0.25273	0.27327	0.26833
97	0.27260	0.24144	0.26340	0.28416	0.27712
98	0.27146	0.24056	0.26231	0.28304	0.27621
99	0.27648	0.24443	0.26716	0.28799	0.28021
100	0.28566	0.25150	0.27604	0.29705	0.28753
101	0.30076	0.26313	0.29066	0.31196	0.29956
102	0.30150	0.26370	0.29138	0.31269	0.30015
103	0.29929	0.26199	0.28923	0.31051	0.29839
104	0.32547	0.28216	0.31457	0.33636	0.31925

105	0.34490	0.29713	0.33338	0.35554	0.33474
106	0.36090	0.30945	0.34885	0.37133	0.34748

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40473	0.41284	0.36573	0.46869	0.33786
93	0.39387	0.40587	0.35364	0.45747	0.33308
94	0.40627	0.41382	0.36743	0.47028	0.33853
95	0.38296	0.39887	0.34150	0.44618	0.32828
96	0.38871	0.40256	0.34790	0.45213	0.33081
97	0.40092	0.41039	0.36149	0.46476	0.33618
98	0.39967	0.40959	0.36009	0.46346	0.33563
99	0.40522	0.41315	0.36627	0.46920	0.33807
100	0.41538	0.41967	0.37758	0.47971	0.34254
101	0.43210	0.43040	0.39619	0.49699	0.34989
102	0.43292	0.43092	0.39710	0.49784	0.35025
103	0.43047	0.42935	0.39437	0.49531	0.34917
104	0.45946	0.44795	0.42664	0.52528	0.36192
105	0.48097	0.46175	0.45058	0.54752	0.37138
106	0.49867	0.47311	0.47028	0.56583	0.37916

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.789478	0.60865	0.647035	1.04162	0.6351
93	0.82662	0.63493	0.66780	1.09711	0.664843
94	0.808778	0.622305	0.657	1.070448	0.65055
95	0.842363	0.646065	0.6766	1.120613	0.677443
96	0.86572	0.66259	0.68966	1.155505	0.696153
97	0.901458	0.687873	0.70964	1.208883	0.724768
98	0.93299	0.710175	0.72727	1.255975	0.750015
99	0.949495	0.72185	0.736493	1.280638	0.763233
100	0.967655	0.734698	0.746653	1.307763	0.777775
101	0.982845	0.745443	0.755143	1.330448	0.78994
102	1.00559	0.76153	0.767853	1.364413	0.808145
103	1.029545	0.778478	0.781245	1.400198	0.827328
104	1.05473	0.79629	0.795328	1.43781	0.8475
105	1.077943	0.812715	0.8083	1.472493	0.86609
106	1.10262	0.83017	0.822105	1.509355	0.88585

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.530023	1.118533	1.004873	2.2259	1.342473
93	1.60075	1.13837	1.022693	2.274473	1.374063
94	1.56677	1.128835	1.01413	2.251135	1.35889
95	1.630713	1.14677	1.030243	2.295053	1.387453
96	1.675193	1.15925	1.041453	2.325598	1.40732
97	1.743235	1.17833	1.058598	2.372318	1.437715
98	1.80326	1.195175	1.07372	2.413545	1.464533
99	1.834695	1.203985	1.081638	2.435133	1.478573
100	1.869275	1.213685	1.090353	2.458885	1.49402
101	1.89819	1.221798	1.097635	2.47874	1.506935
102	1.94149	1.23394	1.108545	2.50848	1.526278
103	1.987103	1.246738	1.120043	2.539808	1.546655
104	2.035053	1.260188	1.132125	2.57273	1.568073

105	2.07926	1.272583	1.143263	2.603083	1.58782
106	2.126248	1.285768	1.155103	2.635358	1.608808

CASE 7A -- PRODUCTION FROM PINK SALMON ENHANCEMENT IS INCREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37627	1.20523	1.18620	1.26224	0.95054
94	1.33840	1.17632	1.15390	1.22608	0.92427
95	1.40320	1.22578	1.20915	1.28794	0.96921
96	1.44596	1.25842	1.24561	1.32877	0.99887
97	1.50970	1.30706	1.29995	1.38961	1.04307
98	1.56627	1.35024	1.34819	1.44362	1.08230
99	1.59883	1.37508	1.37594	1.47469	1.10488
100	1.63214	1.40051	1.40434	1.50649	1.12798
101	1.66502	1.42560	1.43238	1.53788	1.15078
102	1.70718	1.45778	1.46832	1.57813	1.18002
103	1.75283	1.49262	1.50725	1.62171	1.21168
104	1.80206	1.53019	1.54922	1.66871	1.24582
105	1.84743	1.56482	1.58790	1.71201	1.27728
106	1.89633	1.60214	1.62959	1.75870	1.31120

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26626	0.23655	0.25727	0.27790	0.27206
94	0.27726	0.24503	0.26791	0.28876	0.28083
95	0.23266	0.21067	0.22475	0.24473	0.24529
96	0.23859	0.21524	0.23050	0.25059	0.25002
97	0.24639	0.22125	0.23805	0.25829	0.25623
98	0.24431	0.21965	0.23603	0.25623	0.25457
99	0.24721	0.22188	0.23884	0.25910	0.25689
100	0.25514	0.22799	0.24651	0.26692	0.26321
101	0.27487	0.24319	0.26561	0.28641	0.27893
102	0.27391	0.24244	0.26467	0.28545	0.27816
103	0.27026	0.23963	0.26114	0.28185	0.27525
104	0.29834	0.26127	0.28832	0.30958	0.29763
105	0.31700	0.27564	0.30637	0.32799	0.31350
106	0.33347	0.28832	0.32231	0.34425	0.32562

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.393368	0.405553	0.353085	0.456953	0.332858
94	0.40545	0.413295	0.366525	0.469438	0.338173
95	0.375415	0.39403	0.3331	0.438383	0.324968
96	0.380995	0.39761	0.339308	0.444153	0.327423
97	0.391643	0.40444	0.35116	0.45516	0.332098
98	0.38947	0.40305	0.34874	0.452915	0.331148
99	0.394278	0.406133	0.354098	0.457885	0.333263
100	0.403928	0.412325	0.364828	0.467855	0.337498
101	0.422108	0.423988	0.385073	0.486665	0.345495
102	0.422403	0.424175	0.38539	0.486965	0.345625

103	0.419458	0.422283	0.382115	0.48392	0.344333
104	0.44896	0.441213	0.414945	0.51442	0.357298
105	0.470315	0.454913	0.438713	0.536505	0.366693
106	0.488253	0.466425	0.45868	0.555048	0.374578

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82444	0.63339	0.66659	1.09385	0.66310
94	0.80538	0.61991	0.65593	1.06538	0.64784
95	0.83799	0.64297	0.67416	1.11409	0.67395
96	0.85951	0.65820	0.68619	1.14623	0.69118
97	0.89158	0.68088	0.70412	1.19413	0.71686
98	0.92005	0.70102	0.72004	1.23666	0.73966
99	0.93643	0.71261	0.72919	1.26112	0.75277
100	0.95319	0.72447	0.73856	1.28616	0.76619
101	0.96974	0.73617	0.74781	1.31087	0.77944
102	0.99095	0.75118	0.75967	1.34256	0.79643
103	1.01393	0.76743	0.77252	1.37687	0.81483
104	1.03870	0.78495	0.78637	1.41388	0.83466
105	1.06153	0.80110	0.79913	1.4479	0.85294
106	1.08614	0.81851	0.81289	1.4847	0.87265

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59660	1.13720	1.02165	2.27162	1.37221
94	1.56031	1.12703	1.01251	2.24670	1.35600
95	1.62240	1.14444	1.02815	2.28934	1.38373
96	1.66337	1.15593	1.03847	2.31748	1.40204
97	1.72443	1.17306	1.05386	2.35941	1.42932
98	1.77864	1.18826	1.0675	2.39663	1.45353
99	1.80982	1.19701	1.0753	2.41805	1.46746
100	1.84174	1.20596	1.0834	2.43997	1.48172
101	1.87324	1.21480	1.091	2.46160	1.49579
102	1.91363	1.22613	1.1015	2.48934	1.51383
103	1.95737	1.23840	1.11255	2.51938	1.53337
104	2.00454	1.25163	1.12444	2.55178	1.55444
105	2.04800	1.26382	1.13539	2.58163	1.57386
106	2.09486	1.27696	1.14719	2.61380	1.59479

CASE 7B -- PRODUCTION FROM PINK ENHANCEMENT IS DECREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37624	1.20520	1.18616	1.26220	0.95051
94	1.33837	1.17630	1.15388	1.22606	0.92425
95	1.40465	1.22688	1.21039	1.28932	0.97021
96	1.44688	1.25912	1.24640	1.32965	0.99951
97	1.51085	1.30794	1.30094	1.39071	1.04387

98	1.56753	1.35120	1.34926	1.44482	1.08318
99	1.60044	1.37631	1.37732	1.47623	1.10600
100	1.63405	1.40197	1.40598	1.50832	1.12931
101	1.66660	1.42681	1.43373	1.53939	1.15188
102	1.70944	1.45950	1.47025	1.58029	1.18159
103	1.75538	1.49456	1.50942	1.62414	1.21345
104	1.80523	1.53261	1.55192	1.67173	1.24802
105	1.85122	1.56771	1.59113	1.71563	1.27991
106	1.90043	1.60527	1.63309	1.76251	1.31404

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26498	0.23557	0.25603	0.27664	0.27105
94	0.27573	0.24385	0.26644	0.28725	0.27961
95	0.27722	0.24500	0.26788	0.28872	0.28080
96	0.28341	0.24976	0.27387	0.29483	0.28573
97	0.29401	0.25793	0.28412	0.30529	0.29418
98	0.29205	0.25642	0.28223	0.30336	0.29262
99	0.29793	0.26095	0.28792	0.30917	0.29731
100	0.30757	0.26837	0.29725	0.31868	0.30499
101	0.31943	0.27750	0.30872	0.33039	0.31443
102	0.32140	0.27903	0.31063	0.33234	0.31601
103	0.32020	0.27810	0.30947	0.33116	0.31506
104	0.34638	0.29827	0.33481	0.35700	0.33592
105	0.36511	0.31269	0.35293	0.37549	0.35084
106	0.37888	0.32330	0.36626	0.38909	0.36182

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.393015	0.405325	0.352693	0.456585	0.332703
94	0.405028	0.413025	0.366055	0.469	0.337988
95	0.387748	0.401943	0.346825	0.451135	0.33039
96	0.393398	0.405568	0.353113	0.456978	0.332875
97	0.40482	0.412895	0.365828	0.468785	0.337893
98	0.40268	0.411528	0.363445	0.466575	0.336958
99	0.408315	0.415138	0.36972	0.4724	0.339435
100	0.418438	0.421633	0.380978	0.48286	0.343878
101	0.434438	0.431898	0.398795	0.499415	0.350915
102	0.435548	0.43261	0.40002	0.500558	0.351405
103	0.433283	0.431153	0.397498	0.498213	0.35041
104	0.462255	0.449743	0.429743	0.528165	0.363145
105	0.48363	0.463455	0.453533	0.550273	0.372548
106	0.500823	0.47449	0.47267	0.568045	0.380105

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82442	0.63338	0.66658	1.09382	0.66308
94	0.80537	0.61990	0.65592	1.06536	0.64782
95	0.83872	0.64349	0.67457	1.11518	0.67453
96	0.85998	0.65852	0.68645	1.14602	0.69155
97	0.89216	0.68129	0.70445	1.19500	0.71732

98	0.92069	0.70147	0.72039	1.23760	0.74016
99	0.93724	0.71318	0.72965	1.26234	0.75342
100	0.95416	0.72515	0.73910	1.28760	0.76697
101	0.97054	0.73674	0.74826	1.31207	0.78008
102	0.99209	0.75198	0.76031	1.34426	0.79734
103	1.01521	0.76834	0.77323	1.37879	0.81585
104	1.04029	0.78608	0.78726	1.41626	0.83594
105	1.06344	0.80245	0.80020	1.45083	0.85447
106	1.08820	0.81997	0.81404	1.48781	0.87430

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59657	1.13719	1.02164	2.27160	1.37220
94	1.56028	1.12702	1.01250	2.24668	1.35599
95	1.62378	1.14483	1.02850	2.29029	1.38436
96	1.66425	1.15618	1.03869	2.31808	1.40243
97	1.72554	1.17337	1.05414	2.36017	1.42981
98	1.77984	1.18860	1.06782	2.39747	1.45407
99	1.81137	1.19744	1.07576	2.41912	1.46815
100	1.84358	1.20648	1.08388	2.44123	1.48254
101	1.87476	1.21523	1.09[illegible]	2.46265	1.49647
102	1.91580	1.22674	1.10208	2.49083	1.51480
103	1.9598[illegible]	1.23908	1.11317	2.52106	1.53446
104	2.00757	1.25248	1.12520	2.55386	1.55580
105	2.05164	1.26484	1.13630	2.58412	1.57548
106	2.09879	1.27806	1.14818	2.61650	1.59654

CASE 8A -- SALMON PRODUCTION FROM SOCKEYE ENHANCEMENT IS INCREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37627	1.20523	1.18620	1.26224	0.95054
94	1.33841	1.17633	1.15391	1.22609	0.92428
95	1.40390	1.22632	1.20975	1.28862	0.96970
96	1.44513	1.25778	1.24490	1.32797	0.99829
97	1.50006	1.29971	1.29174	1.38041	1.03639
98	1.55235	1.33962	1.33632	1.43033	1.07265
99	1.58423	1.36395	1.36350	1.46076	1.09476
100	1.61891	1.39041	1.39306	1.49386	1.11880
101	1.65147	1.41526	1.42083	1.52495	1.14139
102	1.69334	1.44722	1.45653	1.56492	1.17042
103	1.73726	1.48073	1.49397	1.60684	1.20088
104	1.78677	1.51852	1.53618	1.65411	1.23522
105	1.83255	1.55346	1.57521	1.69781	1.26696
106	1.87963	1.58939	1.61535	1.74275	1.29961

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155

94	0.27650	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25990	0.23166	0.25112	0.27163	0.26700
97	0.26990	0.23936	0.26079	0.28149	0.27497
98	0.26779	0.23773	0.25875	0.27941	0.27328
99	0.27254	0.24139	0.26335	0.28410	0.27707
100	0.28153	0.24831	0.27205	0.29287	0.28423
101	0.29687	0.26013	0.28690	0.30812	0.29646
102	0.29754	0.26065	0.28755	0.30879	0.29700
103	0.29518	0.25883	0.28526	0.30646	0.29512
104	0.32135	0.27899	0.31059	0.33229	0.31597
105	0.34087	0.29402	0.32948	0.35156	0.33153
106	0.35696	0.30642	0.34505	0.36745	0.34435

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0..0428	0.41255	0.36522	0.46822	0.33766
93	0.39320	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38687	0.40138	0.34585	0.45023	0.33000
97	0.39793	0.40848	0.35816	0.46167	0.33487
98	0.39560	0.40698	0.35556	0.45925	0.33384
99	0.40086	0.41035	0.36141	0.46469	0.33615
100	0.41081	0.41674	0.37249	0.47498	0.34053
101	0.42780	0.42764	0.39140	0.49254	0.34800
102	0.42854	0.42811	0.39222	0.49331	0.34832
103	0.42593	0.42644	0.38932	0.49061	0.34717
104	0.45490	0.44502	0.42156	0.52057	0.35991
105	0.47651	0.45889	0.44561	0.54291	0.36941
106	0.49432	0.47032	0.46543	0.56132	0.37725

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824433	0.633383	0.666583	1.093843	0.663093
94	0.805383	0.619903	0.65593	1.065375	0.647833
95	0.838343	0.643223	0.674353	1.114605	0.674223
96	0.859555	0.65823	0.686215	1.146298	0.691215
97	0.890585	0.68018	0.703563	1.192643	0.716063
98	0.918533	0.699948	0.719188	1.234283	0.738438
99	0.934895	0.711523	0.72833	1.25[illegible]3	0.75154
100	0.95188	0.72354	0.737833	1.2842	0.765143
101	0.968323	0.735168	0.747023	1.308753	0.77831
102	0.98963	0.75024	0.75893	1.340575	0.795368
103	1.012435	0.766375	0.77168	1.374643	0.813628
104	1.037318	0.783973	0.785595	1.411803	0.833555
105	1.060363	0.80028	0.798473	1.446233	0.852013
106	1.08484	0.817593	0.812165	1.4828	0.871613

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.596585	1.1372	1.021643	2.271613	1.372203

94	1.560305	1.127023	1.012503	2.246695	1.356003
95	1.623055	1.144623	1.028313	2.289793	1.384033
96	1.663455	1.155958	1.038495	2.317535	1.402078
97	1.722535	1.172525	1.053383	2.358103	1.428468
98	1.775733	1.187453	1.066785	2.394643	1.452235
99	1.806895	1.196188	1.074633	2.41604	1.466155
100	1.839238	1.20526	1.082785	2.43826	1.480605
101	1.870538	1.21404	1.090668	2.459748	1.49458
102	1.911105	1.225418	1.10089	2.487613	1.512703
103	1.954525	1.2376	1.111835	2.517435	1.532103
104	2.001898	1.250888	1.12377	2.549963	1.553263
105	2.045788	1.263195	1.13483	2.580098	1.572868
106	2.092395	1.276273	1.146573	2.61211	1.593685

CASE 8B -- SALMON ENHANCEMENT FROM PINK DECREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37624	1.20520	1.18616	1.26220	0.95051
94	1.33836	1.17629	1.15387	1.22605	0.92425
95	1.40386	1.22628	1.20971	1.28857	0.96967
96	1.44733	1.25946	1.24678	1.33008	0.99982
97	1.52184	1.31633	1.31030	1.40120	1.05149
98	1.58036	1.36099	1.36020	1.45706	1.09207
99	1.61373	1.38646	1.38865	1.48892	1.11522
100	1.64888	1.41329	1.41862	1.52248	1.13959
101	1.68091	1.43704	1.44516	1.55219	1.16118
102	1.72380	1.47046	1.48249	1.59399	1.19154
103	1.77111	1.50657	1.52284	1.63916	1.22436
104	1.82069	1.54441	1.56510	1.68649	1.25874
105	1.86666	1.57950	1.60430	1.73037	1.29062
106	1.91704	1.61795	1.64725	1.77847	1.32556

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25996	0.23170	0.25117	0.27168	0.26704
97	0.27044	0.23977	0.26131	0.28203	0.37540
98	0.26867	0.23841	0.25961	0.28028	0.27399
99	0.27354	0.24216	0.26432	0.28509	0.27787
100	0.28256	0.24911	0.27304	0.29399	0.28505
101	0.29785	0.26089	0.28784	0.30909	0.29724
102	0.29852	0.26140	0.28849	0.30975	0.29778
103	0.29622	0.25963	0.28626	0.30748	0.29594
104	0.32239	0.27979	0.31159	0.33332	0.31680
105	0.34188	0.29480	0.33045	0.35256	0.33233
106	0.35800	0.30722	0.34605	0.36848	0.34518

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ

92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38693	0.40142	0.34591	0.45029	0.33003
97	0.39853	0.40886	0.35883	0.46228	0.33513
98	0.39658	0.40761	0.35665	0.46026	0.33427
99	0.40197	0.41107	0.36265	0.46584	0.33664
100	0.41195	0.41747	0.37376	0.47616	0.34103
101	0.42888	0.42833	0.39260	0.49366	0.34847
102	0.42962	0.42881	0.39343	0.49443	0.34880
103	0.42707	0.42717	0.39059	0.49179	0.34768
104	0.45605	0.44576	0.42284	0.52175	0.36042
105	0.47762	0.45960	0.44685	0.54406	0.36991
106	0.49547	0.47106	0.46672	0.56252	0.37775

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824428	0.63338	0.66658	1.093835	0.663088
94	0.805378	0.619898	0.655928	1.065365	0.647828
95	0.838335	0.643218	0.67435	1.114595	0.674218
96	0.859833	0.658425	0.68637	1.146713	0.691438
97	0.893325	0.68212	0.705095	1.196735	0.718255
98	0.922055	0.70244	0.721158	1.239643	0.741258
99	0.938605	0.714148	0.730405	1.264373	0.754513
100	0.95565	0.726208	0.739943	1.289833	0.768163
101	0.97191	0.737708	0.74903	1.314115	0.781183
102	0.993463	0.75295	0.761073	1.346298	0.798435
103	1.016695	0.769388	0.77406	1.381005	0.817038
104	1.041583	0.78699	0.78798	1.418175	0.836973
105	1.064655	0.803315	0.800873	1.452643	0.855448
106	1.089548	0.820923	0.814795	1.48983	0.87538

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.596575	1.137198	1.02164	2.271608	1.3722
94	1.560295	1.12702	1.0125	2.246688	1.355998
95	1.623045	1.14462	1.02831	2.289785	1.384028
96	1.663983	1.156105	1.038628	2.3179	1.402315
97	1.727753	1.173988	1.054698	2.361685	1.430798
98	1.78244	1.189335	1.068475	2.399248	1.455233
99	1.813963	1.19817	1.076413	2.420893	1.46931
100	1.846418	1.207273	1.084595	2.44319	1.483813
101	1.877373	1.215958	1.09239	2.464443	1.497635
102	1.9184	1.227463	1.102728	2.492623	1.515963
103	1.962635	1.239875	1.11388	2.523003	1.535725
104	2.010023	1.253165	1.125818	2.55554	1.556893
105	2.053958	1.265488	1.136888	2.585708	1.576518
106	2.101358	1.278788	1.14883	2.618265	1.597688

CASE 9A -- CHUM SALMON HARVEST FROM ENHANCEMENT INCREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.22630	1.20973	1.28859	0.96968
96	1.44636	1.25872	1.24595	1.32915	0.99914
97	1.51011	1.30737	1.30030	1.39000	1.04335
98	1.56681	1.35065	1.34865	1.44413	1.08268
99	1.59958	1.37566	1.37658	1.47541	1.10540
100	1.63302	1.40118	1.40510	1.50734	1.12859
101	1.66570	1.42612	1.43296	1.53853	1.15125
102	1.70821	1.45856	1.46920	1.57911	1.18074
103	1.75400	1.49352	1.50825	1.62283	1.21249
104	1.80335	1.53117	1.55031	1.66993	1.24671
105	1.84911	1.56610	1.58934	1.71362	1.27845
106	1.89823	1.60359	1.63121	1.76051	1.31251

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27166	0.26703
97	0.268053	0.237935	0.259008	0.279678	0.273498
98	0.265485	0.235958	0.256518	0.277133	0.271448
99	0.27001	0.239443	0.2609	0.281603	0.275053
100	0.2789	0.24629	0.269503	0.29038	0.282138
101	0.294203	0.258078	0.284315	0.305485	0.294335
102	0.294883	0.258595	0.284965	0.30616	0.294873
103	0.29256	0.256813	0.282723	0.303863	0.293028
104	0.318733	0.276973	0.308045	0.329703	0.31388
105	0.338243	0.292	0.326933	0.34897	0.329428
106	0.354373	0.30442	0.342535	0.364885	0.342278

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38690	0.40140	0.34588	0.45026	0.33002
97	0.38892	0.40270	0.34813	0.45235	0.33090
98	0.38390	0.39948	0.34254	0.44716	0.32870
99	0.38793	0.40206	0.34703	0.45133	0.33047
100	0.39750	0.40820	0.35768	0.46122	0.33468
101	0.41436	0.41901	0.37644	0.47865	0.34209
102	0.41513	0.41951	0.37731	0.47945	0.34243
103	0.41260	0.41789	0.37442	0.47683	0.34131
104	0.44157	0.43648	0.40673	0.50679	0.35405
105	0.46321	0.45035	0.43081	0.52916	0.36357

106	0.48110	0.46183	0.45072	0.54765	0.37143

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.85971	0.65834	0.68630	1.14653	0.69134
97	0.89179	0.68103	0.70424	1.19444	0.71702
98	0.92032	0.70121	0.72019	1.23706	0.73987
99	0.93681	0.71288	0.72941	1.26169	0.75308
100	0.95364	0.72478	0.73881	1.28683	0.76655
101	0.97008	0.73641	0.74801	1.31139	0.77972
102	0.99147	0.75155	0.75996	1.34334	0.79685
103	1.01452	0.76785	0.77285	1.37776	0.81530
104	1.03935	0.78541	0.78673	1.41484	0.83518
105	1.06238	0.80170	0.79960	1.44924	0.85362
106	1.08709	0.81919	0.81342	1.48616	0.87341

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59658	1.13720	1.02164	2.27161	1.37220
94	1.56030	1.12702	1.01250	2.24669	1.35600
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66375	1.15604	1.03857	2.31774	1.40221
97	1.72482	1.17317	1.05396	2.35968	1.42949
98	1.77915	1.18841	1.06765	2.39699	1.45376
99	1.81054	1.19721	1.07556	2.41855	1.46778
100	1.84259	1.20620	1.08363	2.44055	1.48210
101	1.87389	1.21498	1.09152	2.46205	1.49608
102	1.91462	1.22641	1.10178	2.49002	1.51428
103	1.95850	1.23871	1.11283	2.52016	1.53387
104	2.00577	1.25197	1.12475	2.55262	1.55499
105	2.04962	1.26427	1.13579	2.58274	1.57458
106	2.09668	1.27747	1.14765	2.61505	1.59560

CASE 9B -- CHUM SALMON HARVEST FROM ENHANCEMENT DECREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.22630	1.20973	1.28859	0.96968
96	1.44636	1.25872	1.24595	1.32915	0.99914
97	1.51044	1.30762	1.30058	1.39031	1.04358
98	1.56694	1.35075	1.34876	1.44426	1.08277
99	1.59965	1.37572	1.37665	1.47548	1.10545
100	1.63312	1.40126	1.40518	1.50743	1.12866
101	1.66584	1.42623	1.43308	1.53867	1.15135
102	1.70834	1.45867	1.46932	1.57924	1.18083
103	1.75413	1.49361	1.50836	1.62295	1.21258

104	1.80363	1.53139	1.55056	1.67020	1.24691
105	1.84949	1.56639	1.58966	1.71399	1.27872
106	1.89873	1.60397	1.63164	1.76099	1.31286

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27166	0.26703
97	0.27226	0.241175	0.26308	0.28383	0.27685
98	0.271	0.240208	0.261853	0.282578	0.27584
99	0.276118	0.244145	0.26681	0.28763	0.279918
100	0.28517	0.25112	0.27557	0.29657	0.287135
101	0.300525	0.262948	0.290433	0.311728	0.299373
102	0.301188	0.263453	0.291068	0.312388	0.299898
103	0.298848	0.261655	0.288808	0.31007	0.298038
104	0.325018	0.281813	0.314128	0.335908	0.318888
105	0.34451	0.296828	0.332998	0.355158	0.334423
106	0.360615	0.309228	0.348578	0.371048	0.347253

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38690	0.40140	0.34588	0.45026	0.33002
97	0.40755	0.41465	0.36887	0.47161	0.33910
98	0.40832	0.41514	0.36972	0.47241	0.33944
99	0.41497	0.41941	0.37712	0.47928	0.34236
100	0.42527	0.42602	0.38859	0.48993	0.34689
101	0.44236	0.43698	0.40760	0.50760	0.35440
102	0.44306	0.43743	0.40838	0.50832	0.35471
103	0.44044	0.43575	0.40546	0.50561	0.35355
104	0.46941	0.45433	0.43771	0.53556	0.36629
105	0.49096	0.46816	0.46169	0.55785	0.37577
106	0.50874	0.47957	0.48149	0.57624	0.38359

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.85971	0.65834	0.68630	1.14653	0.69134
97	0.89195	0.68115	0.70433	1.19469	0.71716
98	0.92039	0.70126	0.72022	1.23716	0.73993
99	0.93685	0.71290	0.72943	1.26175	0.75311
100	0.95369	0.72482	0.73884	1.28690	0.76659
101	0.97016	0.73646	0.74805	1.31149	0.77978
102	0.99154	0.75159	0.76000	1.34344	0.79690
103	1.01458	0.76789	0.77288	1.37785	0.81535

104	1.03949	0.78551	0.78681	1.41506	0.83530
105	1.06257	0.80184	0.79971	1.44953	0.85378
106	1.08734	0.81936	0.81356	1.48654	0.87362

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.003	2.22322	1.34073
93	1.59658	1.13720	1.02164	2.27161	1.37220
94	1.56030	1.12702	1.01250	2.24669	1.35600
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66375	1.15604	1.03857	2.31774	1.40221
97	1.72514	1.17326	1.05404	2.35990	1.42963
98	1.77928	1.18844	1.06768	2.39708	1.45382
99	1.81062	1.19723	1.07557	2.41860	1.46782
100	1.84268	1.20623	1.08365	2.44062	1.48214
101	1.87403	1.21502	1.09155	2.46215	1.49644
102	1.91475	1.22644	1.10181	2.49011	1.51433
103	1.95862	1.23875	1.11287	2.52024	1.53393
104	2.00604	1.25205	1.12482	2.55281	1.55511
105	2.04999	1.26437	1.13589	2.58299	1.57474
106	2.09716	1.27761	1.14777	2.61538	1.59582

CASE 10A -- SALMON ENHANCMENT FROM COHO HARVEST INCREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.303588	1.149758	1.124225	1.192855	0.900128
93	1.37701	1.205793	1.186828	1.262945	0.951055
94	1.338073	1.176075	1.153628	1.225775	0.924048
95	1.404775	1.226983	1.210495	1.289445	0.970303
96	1.44568	1.258203	1.24537	1.3285	0.99867
97	1.509798	1.30713	1.300038	1.3897	1.043133
98	1.565343	1.349528	1.347393	1.442725	1.081655
99	1.599108	1.375298	1.376183	1.474963	1.105073
100	1.632025	1.400423	1.40425	1.506385	1.127905
101	1.664845	1.425465	1.43223	1.537718	1.15066
102	1.706485	1.457248	1.467738	1.577468	1.179543
103	1.753243	1.492935	1.507603	1.622108	1.211965
104	1.802373	1.530435	1.549485	1.669003	1.24604
105	1.847978	1.565233	1.588363	1.712538	1.277663
106	1.897258	1.602845	1.630385	1.759583	1.31184

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27576	0.24387	0.26646	0.28728	0.27964
93	0.26577	0.23617	0.25679	0.27741	0.27167
94	0.27650	0.24444	0.26718	0.28801	0.28023
95	0.25532	0.22813	0.24668	0.26710	0.26335
96	0.25996	0.23171	0.25118	0.27169	0.26705
97	0.27015	0.23955	0.26103	0.28174	0.27517
98	0.26809	0.23796	0.25904	0.27970	0.27352
99	0.27301	0.24175	0.26380	0.28456	0.27744
100	0.28194	0.24863	0.27244	0.29338	0.28456
101	0.29728	0.26044	0.28729	0.30852	0.29678

102	0.29784	0.26088	0.28783	0.30908	0.29723
103	0.29562	0.25917	0.28568	0.30688	0.29546
104	0.32177	0.27931	0.31099	0.33271	0.31630
105	0.34126	0.29432	0.32985	0.35194	0.33183
106	0.35738	0.30674	0.34545	0.36786	0.34468

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40442	0.41264	0.36538	0.46837	0.33772
93	0.39336	0.40554	0.35307	0.45694	0.33286
94	0.40524	0.41317	0.36630	0.46922	0.33808
95	0.38179	0.39812	0.34020	0.44498	0.32777
96	0.38694	0.40142	0.34592	0.45030	0.33003
97	0.39821	0.40866	0.35847	0.46195	0.33499
98	0.39593	0.40719	0.35593	0.45959	0.33398
99	0.40138	0.41069	0.36199	0.46523	0.33638
100	0.41126	0.41703	0.37300	0.47545	0.34073
101	0.42824	0.42792	0.39189	0.49300	0.34819
102	0.42887	0.42832	0.39259	0.49365	0.34847
103	0.42640	0.42674	0.38985	0.49110	0.34739
104	0.45536	0.44532	0.42208	0.52104	0.36012
105	0.47693	0.45916	0.44608	0.54334	0.36960
106	0.49478	0.47061	0.46595	0.56181	0.37745

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78919	0.60845	0.64688	1.04120	0.63487
93	0.82596	0.63446	0.66744	1.09612	0.66431
94	0.80476	0.61946	0.65558	1.06444	0.64733
95	0.84014	0.64449	0.67536	1.11729	0.67566
96	0.85834	0.65737	0.68554	1.14449	0.69024
97	0.89092	0.68041	0.70375	1.19314	0.71633
98	0.91726	0.69905	0.71848	1.23249	0.73742
99	0.93582	0.71217	0.72885	1.26020	0.75228
100	0.95156	0.72331	0.73765	1.28372	0.76489
101	0.96826	0.73512	0.74699	1.30866	0.77826
102	0.98791	0.74903	0.75797	1.33802	0.79400
103	1.01290	0.76670	0.77194	1.37534	0.81401
104	1.03719	0.78388	0.78552	1.41161	0.83345
105	1.05981	0.79988	0.79817	1.44540	0.85157
106	1.08477	0.81754	0.81212	1.48269	0.87156

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.5278	1.11791	1.004315	2.224375	1.34148
93	1.59804	1.13761	1.02201	2.27261	1.372855
94	1.55971	1.126855	1.01235	2.246285	1.355735
95	1.624765	1.145105	1.028745	2.290965	1.384795
96	1.66245	1.155675	1.03824	2.316845	1.401625
97	1.724075	1.17296	1.05377	2.35916	1.429155
98	1.77627	1.1876	1.06692	2.39501	1.452475
99	1.809615	1.19695	1.07532	2.41791	1.46737
100	1.84063	1.20565	1.083135	2.439215	1.481225
101	1.87219	1.214505	1.091085	2.460885	1.49532

102	1.91126	1.22546	1.10093	2.48772	1.512775
103	1.956985	1.23829	1.112455	2.51912	1.5332
104	2.00378	1.251415	1.124245	2.551255	1.5541
105	2.047265	1.26361	1.1352	2.581115	1.57353
106	2.094585	1.276885	1.147125	2.613615	1.594665

CASE 10B -- SALMON ENHANCEMENT FROM COHO DECREASED 15 PERCENT.

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.2263	1.20973	1.28859	0.96968
96	1.44726	1.259405	1.246718	1.330008	0.999765
97	1.511265	1.308253	1.30129	1.391103	1.044153
98	1.567885	1.351468	1.349558	1.445153	1.083418
99	1.600648	1.376473	1.377495	1.47643	1.10614
100	1.634125	1.402025	1.40604	1.508388	1.12936
101	1.666845	1.426993	1.433935	1.539625	1.152048
102	1.709373	1.459453	1.4702	1.580223	1.181545
103	1.755193	1.494425	1.509265	1.62397	1.213318
104	1.804648	1.53217	1.551425	1.671175	1.247618
105	1.850498	1.567155	1.590513	1.714943	1.27941
106	1.8997	1.60471	1.63247	1.761915	1.313533

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26624	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.2671	0.28801	0128022
95	0.25519	0.22803	0.2465	0.26697	0.26324
96	0.25998	0.23171	0.25119	0.27170	0.26706
97	0.27025	0.23963	0.26114	0.28184	0.27525
98	0.26834	0.23816	0.25929	0.27996	0.27373
99	0.27317	0.24188	0.26396	0.28472	0.27757
100	0.28214	0.24879	0.27264	0.29358	0.28472
101	0.29746	0.26059	0.28747	0.30871	0.29693
102	0.29813	0.26110	0.28812	0.30937	0.29747
103	0.29580	0.25931	0.28586	0.30707	0.29561
104	0.32197	0.27947	0.31118	0.33290	0.31646
105	0.34147	0.29449	0.33006	0.35216	0.33200
106	0.35759	0.30690	0.34565	0.36806	0.34484

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38695	0.40143	0.34594	0.45031	0.33004
97	0.39833	0.40873	0.35860	0.46207	0.33504
98	0.39621	0.40737	0.35624	0.45989	0.33411

99	0.40155	0.41080	0.36219	0.46541	0.33646
100	0.41149	0.41717	0.37324	0.47568	0.34083
101	0.42845	0.42806	0.39213	0.49322	0.34828
102	0.42919	0.42853	0.39295	0.49398	0.34861
103	0.42661	0.42688	0.39008	0.49132	0.34748
104	0.45558	0.44546	0.42232	0.52127	0.36021
105	0.47717	0.45931	0.44635	0.54360	0.36971
106	0.49501	0.47076	0.46620	0.56204	0.37755

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.86152	0.65962	0.68731	1.14923	0.69279
97	0.89387	0.68250	0.70540	1.19756	0.71869
98	0.92238	0.70267	0.72134	1.24013	0.74152
99	0.93891	0.71437	0.73058	1.26483	0.75476
100	0.95579	0.72630	0.74001	1.29003	0.76827
101	0.97228	0.73797	0.74924	1.31467	0.78148
102	0.99372	0.75314	0.76122	1.34670	0.79865
103	1.01683	0.76948	0.77414	1.38121	0.81715
104	1.04177	0.78712	0.78808	1.41845	0.83712
105	1.06488	0.80347	0.80100	1.45298	0.85563
106	1.08969	0.82102	0.81487	1.49004	0.87550

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59658	1.1372	1.02164	2.27161	1.3722
94	1.5603	1.12702	1.0125	2.24669	1.356
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66461	1.15628	1.038788	2.31833	1.402595
97	1.725935	1.173478	1.05424	2.360438	1.429985
98	1.780175	1.1887	1.067903	2.397693	1.45422
99	1.811573	1.1975	1.07581	2.419253	1.468243
100	1.84364	1.206495	1.083895	2.441283	1.48257
101	1.87499	1.21529	1.09179	2.462808	1.49657
102	1.915738	1.226718	1.102058	2.490795	1.514773
103	1.959635	1.239035	1.113123	2.520945	1.534385
104	2.00702	1.252323	1.125063	2.553478	1.55555
105	2.050945	1.264643	1.136128	2.58364	1.575173
106	2.09809	1.27787	1.148008	2.61602	1.596228

CASE 11A -- SALMON PRODUCTION FROM CHINOOK ENHANCEMENT UP 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.376278	1.20523	1.186203	1.262245	0.950548
94	1.338403	1.176328	1.153908	1.22609	0.924275
95	1.403903	1.226318	1.20975	1.288613	0.969698

96	1.446375	1.258733	1.245963	1.329163	0.999153
97	1.51024	1.307468	1.300413	1.390	1.04344
98	1.56614	1.350135	1.34807	1.443	1.082208
99	1.598885	1.375128	1.375993	1.474748	1.104918
100	1.631933	1.400353	1.40417	1.506295	1.12784
101	1.664598	1.425275	1.43202	1.53748	1.150488
102	1.707195	1.45779	1.468343	1.578145	1.180035
103	1.752878	1.492658	1.50729	1.62176	1.21171
104	1.802503	1.530533	1.549598	1.669128	1.246133
105	1.848055	1.56529	1.58843	1.71261	1.277718
106	1.897223	1.60282	1.630358	1.75955	1.311815

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27156
94	0.27650	0.24444	0.26718	0.28801	0.28023
95	0.25519	0.22803	0.24656	0.26698	0.26325
96	0.25994	0.23169	0.25115	0.27166	0.26703
97	0.27015	0.23955	0.26104	0.28174	0.27517
98	0.26814	0.23800	0.25909	0.27975	0.27356
99	0.27293	0.24170	0.26373	0.28449	0.27738
100	0.28185	0.24856	0.27236	0.29329	0.28449
101	0.29716	0.26035	0.28717	0.30841	0.29669
102	0.29784	0.26088	0.28783	0.30908	0.29723
103	0.29550	0.25908	0.28557	0.30677	0.29537
104	0.32170	0.27926	0.31093	0.33264	0.31625
105	0.34118	0.29426	0.32978	0.35187	0.33177
106	0.35730	0.30668	0.34537	0.36778	0.34462

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39320	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41317	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38691	0.40140	0.34589	0.45026	0.33002
97	0.39821	0.40866	0.35847	0.46196	0.33499
98	0.39598	0.40723	0.35599	0.45965	0.33401
99	0.40129	0.41063	0.36190	0.46514	0.33634
100	0.41116	0.41696	0.37288	0.47534	0.34068
101	0.42811	0.42784	0.39175	0.49287	0.34814
102	0.42887	0.42832	0.39259	0.49365	0.34847
103	0.42628	0.42667	0.38971	0.49098	0.34733
104	0.45529	0.44527	0.42199	0.52097	0.36008
105	0.47685	0.45911	0.44599	0.54326	0.36957
106	0.49469	0.47056	0.46585	0.56171	0.37741

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824445	0.63339	0.666588	1.093858	0.6631
94	0.80539	0.619908	0.655935	1.065388	0.647838

95	0.83835	0.643228	0.674358	1.114618	0.67423
96	0.859718	0.658345	0.686305	1.14654	0.691345
97	0.891855	0.681078	0.704273	1.194538	0.717078
98	0.919988	0.700975	0.72	1.236555	0.739603
99	0.936465	0.712633	0.729208	1.261173	0.752798
100	0.953088	0.724395	0.73[illegible]	1.286005	0.766113
101	0.96953	0.736023	0.7477	1.310558	0.779278
102	0.990968	0.751188	0.759678	1.342573	0.796438
103	1.013955	0.767448	0.772528	1.376913	0.814845
104	1.038928	0.785113	0.786495	1.414208	0.834845
105	1.061843	0.801328	0.7993	1.44[illegible]45	0.853198
106	1.086583	0.818828	0.813138	1.4[illegible]03	0.873008

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59668	1.13723	1.02167	2.27168	1.37225
94	1.56038	1.12704	1.01252	2.24675	1.35603
95	1.62314	1.14465	1.02834	2.28985	1.38407
96	1.66381	1.15605	1.03858	2.31778	1.40223
97	1.72486	1.17318	1.05397	2.35970	1.42951
98	1.77638	1.18763	1.06695	2.39509	1.45252
99	1.80780	1.19644	1.07486	2.41666	1.46656
100	1.83827	1.20499	1.08254	2.43759	1.48017
101	1.86947	1.21374	1.09040	2.45901	1.49410
102	1.91056	1.22527	1.10076	2.48724	1.51246
103	1.95402	1.23746	1.11171	2.51708	1.53188
104	2.00216	1.25096	1.12384	2.55014	1.55338
105	2.04503	1.26298	1.13464	2.57958	1.57253
106	2.09213	1.27620	1.14651	2.61193	1.59357

CASE 11B -- SALMON PRODUCTION FROM CHINOOK PRODUCTION DECREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.376225	1.205193	1.186158	1.262195	0.95051
94	1.33836	1.176295	1.153873	1.22605	0.924245
95	1.403858	1.226283	1.20971	1.28857	0.969665
96	1.446345	1.258708	1.245938	1.329135	0.99913
97	1.510433	1.307615	1.300578	1.390308	1.043575
98	1.567453	1.351138	1.34919	1.444738	1.083118
99	1.600908	1.37667	1.377718	1.47568	1.10632
100	1.634155	1.402048	1.406065	1.508415	1.12938
101	1.666953	1.427073	1.434028	1.539728	1.15212
102	1.708998	1.459165	1.46988	1.579865	1.181285
103	1.755285	1.494495	1.509343	1.624058	1.21338
104	1.804693	1.532205	1.551463	1.671218	1.24765
105	1.850528	1.567178	1.590538	1.71497	1.27943
106	1.899728	1.60473	1.63249	1.76194	1.313553

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ

92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26561	0.23606	0.25665	0.27726	0.27155
94	0.27649	0.24443	0.26717	0.28800	0.28022
95	0.25518	0.22802	0.24655	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27165	0.26702
97	0.27017	0.23957	0.26106	0.28177	0.27519
98	0.26832	0.23814	0.25927	0.27994	0.27371
99	0.27325	0.24194	0.26404	0.28481	0.27764
100	0.28223	0.24885	0.27272	0.29366	0.28479
101	0.29756	0.26067	0.28756	0.30881	0.29701
102	0.29817	0.26113	0.28815	0.30941	0.29750
103	0.29589	0.25937	0.28594	0.30715	0.29568
104	0.32206	0.27953	0.31127	0.33299	0.31653
105	0.34156	0.29455	0.33014	0.35224	0.33207
106	0.35767	0.30696	0.34573	0.36815	0.34491

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40543	0.35288	0.45676	0.33278
94	0.40523	0.41316	0.36628	0.46921	0.33808
95	0.38164	0.39803	0.34003	0.44482	0.32770
96	0.38690	0.40140	0.34588	0.45026	0.33001
97	0.39824	0.40867	0.35850	0.46198	0.33500
98	0.39619	0.40736	0.35622	0.45986	0.33410
99	0.40165	0.41086	0.36230	0.46551	0.33650
100	0.41158	0.41723	0.37335	0.47578	0.34087
101	0.42856	0.42813	0.39225	0.49333	0.34833
102	0.42923	0.42856	0.39300	0.49403	0.34863
103	0.42670	0.42694	0.39018	0.49141	0.34752
104	0.45568	0.44552	0.42243	0.52137	0.36026
105	0.47727	0.45938	0.44646	0.54369	0.36975
106	0.49510	0.47082	0.46631	0.56214	0.37759

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824405	0.633365	0.666565	1.0938	0.66307
94	0.805355	0.619885	0.655915	1.06534	0.64781
95	0.838315	0.6432	0.67434	1.114565	0.6742
96	0.859695	0.65833	0.686295	1.146505	0.691325
97	0.892035	0.681205	0.70437	1.194805	0.71722
98	0.920935	0.701645	0.72053	1.23797	0.74036
99	0.938135	0.713815	0.73014	1.26367	0.754135
100	0.954755	0.72557	0.73944	1.28849	0.767445
101	0.97131	0.73728	0.748695	1.313215	0.7807
102	0.99224	0.752085	0.76039	1.344475	0.797455
103	1.01578	0.76874	0.77355	1.37964	0.81631
104	1.040635	0.78632	0.78745	1.416765	0.836215
105	1.063705	0.80264	0.800345	1.451225	0.85469
106	1.088475	0.820165	0.814195	1.48823	0.874525

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ

92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59648	1.13717	1.02162	2.27154	1.37216
94	1.56022	1.12700	1.01248	2.24664	1.35596
95	1.62296	1.14460	1.02829	2.28973	1.38399
96	1.66369	1.15602	1.03855	2.31770	1.40218
97	1.72560	1.17339	1.05415	2.36021	1.42984
98	1.78141	1.18904	1.06821	2.39854	1.45477
99	1.81555	1.19862	1.07682	2.42199	1.47002
100	1.84679	1.20738	1.08469	2.44344	1.48397
101	1.87849	1.21627	1.09268	2.46521	1.49814
102	1.91747	1.22720	1.10250	2.49198	1.51555
103	1.96325	1.24005	1.11403	2.52342	1.53600
104	2.01054	1.25331	1.12595	2.55590	1.55713
105	2.05450	1.26564	1.13702	2.58609	1.57676
106	2.10172	1.27889	1.14892	2.61852	1.59786

SIMNLIN Procedure
Simultaneous Simulation

Solution Range T = 9 To 43

Descriptive Statistics

			Actual		Predicted	
Variable	Nobs	N	Mean	Std	Mean	Std
NXQUSA		Norw exp Q USA	4.0069	2.2509	3.9513	2.1754
NXPUSA		Norw exp P USA	21.9871	2.9363	22.2632	3.3385
NXPEEC		Norw exp P EEC	19.7802	3.0037	19.7344	3.2799
NXQJAP		Norw exp Q JAP	1.2401	1.2306	1.2139	1.2256
NXPJAP		Norw exp P JAP	21.5489	2.8177	21.5632	3.1270
NPHX		N.A. wh exp P	2.4373	0.6190	2.4815	0.7018
NPHXJ		NA P H-V sal-Jpn	2.4657	0.6666	2.5323	0.7713
NXQEEC		NA Q H-V sal-EEC	27.4308	23.0370	27.5126	22.7056
NPHXE		NA P H-V sal-EEC	2.3924	0.5769	2.4115	0.5574
NHTSUP		Tot beg H-V Supp	131.5584	136.7795	131.1849	136.6855
NHZINVE		Tot end H-V Inv	23.8234	16.9948	23.8685	17.3264
NQHXJ		NA Q H-V sal-Jpn	46.5171	63.6166	46.2489	63.5907
NHEXP		Tot NA H-V export	54.5437	68.9716	54.0954	68.8298
NQHXE		NA Q H-V sal-Jpn	8.0266	5.9285	7.8465	6.9924
JINVZE		Tot end Jpn Inv	103.4069	42.3828	101.6850	42.4151
NPLXE		NA P L-V sal-EEC	1.4303	0.3533	1.3727	0.3837
NQLXE		NA Q L-V sal-EEC	13.0180	15.9128	13.8160	15.2647
NQLXJ		NA Q L-V sal-JPN	5.6120	2.9659	5.7017	2.9031
NPLXJ		NA P L-V sal-JPN	1.4748	0.3243	1.4130	0.3325
JINVTE		Tot end Jpn Inv	156.0483	54.1726	158.4135	61.5247
NPLX		N.A. wh exp P	1.4190	0.3180	1.3658	0.3627
NLTSUP		Tot beg H-V Supp	144.2762	166.1618	145.1019	165.1933
NLZINVE		Tot end H-V Inv	29.5918	18.6374	31.0904	21.1642
HCANP		H-V NA can exp P	3.0955	0.6937	2.9819	0.2970
LCANQ		L-V NA exp can Q	8.8026	4.7669	8.6817	4.4092
LCANP		L-V NA exp can P	2.1292	0.6547	2.1778	0.6197
ULBINVE		Tot end L-V Inv Can	68.6657	43.6838	67.4633	35.6399
NLTSUPC		Tot beg H-V Supp Can	250.6330	147.6046	251.0246	148.4074
NAPHEX		Exvessel H-V	1.7297	0.7349	1.7540	0.7582
NAPLEX		Exvessel H-V	0.4931	0.2250	0.4858	0.1979

SAS

SIMNLIN Procedure
Simultaneous Simulation

Solution Range T = 9 To 43

Statistics of Fit

Variable	N	Mean Error	Mean % Error	Mean Abs Error	Mean Abs % Error
NXQUSA	35	-0.0556	5.9371	0.4010	17.77905
NXPUSA	35	0.2761	1.5334	1.7103	8.15393
NXPEEC	35	-0.0458	0.1303	1.7233	8.82741
NXQJAP	35	-0.0263	6.0744	0.3336	25.49316
NXPJAP	35	0.0144	0.5542	2.0362	9.74573
NPHX	35	0.0442	3.2964	0.4203	18.86219
NPHXJ	35	0.0665	4.6108	0.4874	21.74561
NXQEEC	35	0.0819	1.2119	0.6366	3.04369
NPHXE	35	0.0191	2.8543	0.3780	16.69246
NHTSUP	35	-0.3735	1.1544	5.0035	10.65467
NHZINVE	35	0.0451	3.1679	5.4221	24.51783
NQHXJ	35	-0.2683	7.5652	5.2357	30.81754
NHEXP	35	-0.4483	1.5198	4.6495	20.90141
NQHXE	35	-0.1800	4.3557	2.5536	36.81190
JINVZE	35	-1.7219	2.8167	18.7556	22.76753
NPLXE	35	-0.0577	-3.5583	0.2220	16.60730
NQLXE	35	0.7980	24.8097	4.4942	44.88275
NQLXJ	35	0.0896	9.0240	1.1887	27.80592
NPLXJ	35	-0.0617	-3.7588	0.1601	11.27363
JINVTE	35	2.3652	3.9132	26.3101	18.39993
NPLX	35	-0.0532	-3.8725	0.1901	14.29884
NLTSUP	35	0.8257	2.9972	5.1698	8.93675
NLZINVE	35	1.4986	5.8455	5.8427	19.40417
HCANP	35	-0.1135	0.8122	0.5989	19.77807
LCANQ	35	-0.1209	6.0660	1.6644	24.03509
LCANP	35	0.0486	4.9438	0.4344	20.90294
ULBINVE	35	-1.2024	14.6453	16.1274	33.78358
NLTSUPC	35	0.3916	1.3187	22.2858	11.84294
NAPHEX	35	0.0242	3.4049	0.2241	14.01889
NAPLEX	35	-0.007348	2.0515	0.0813	16.76242

SAS

SIMNLIN Procedure
Simultaneous Simulation

Solution Range T = 9 To 43

Statistics of Fit

Variable	RMS Error	RMS % Error
NXQUSA	0.4932	36.3555
NXPUSA	2.2256	10.9613
NXPEEC	2.0516	10.6907
NXQJAP	0.6044	34.3097
NXPJAP	2.4552	11.9235
NPHX	0.5614	26.3001
NPHXJ	0.6344	29.6726
NXQEEC	0.8618	3.9085
NPHXE	0.4840	22.1572
NHTSUP	7.2255	17.5745
NHZINVE	7.6381	29.6371
NQHXJ	7.4445	45.0224
NHEXP	6.3986	29.7228
NQHXE	3.8821	51.2270
JINVZE	23.4826	30.8980
NPLXE	0.2819	21.4445
NQLXE	8.4043	62.7209
NQLXJ	1.5310	37.0747
NPLXJ	0.1954	13.8841
JINVTE	33.2171	24.0762
NPLX	0.2253	17.6895
NLTSUP	7.4146	12.9263
NLZINVE	8.4158	23.6761
HCANP	0.7179	24.2040
LCANQ	1.9719	31.8355
LCANP	0.5449	25.8759
ULBINVE	19.3088	47.8222
NLTSUPC	26.3965	15.2242
NAPHEX	0.2997	18.1398
NAPLEX	0.1076	21.0015

(1) A

LIN1F = 1-Base Case

Use # of Case For Regular analysis

1-11 refer to Cases 1-11.

```
DATA SALMON ; SET SDATA.LIN1F;
   C=DQ1+DQ2+DQ3+DQ4;
   JLAN=JLAN/1000000;
   NXQUSA=NXQUSA/1000000;
   NXQJAP=NXQJAP/1000000;
   NXQEEC=NXQEEC/1000000;
   NXQSUP9=NXQSUP9/1000000;
   NXQSUP9=NXQSUP9/1000000;
   NQLXE=NQLXE/1000000;
   NQHXE=NQHXE/1000000;
   NQHXJ=NQHXJ/1000000;
   NQLXJ=NQLXJ/1000000;
   NHZINVE=NHZINVE/1000000;
   NLZINVE=NLZINVE/1000000;
   NHTSUP=NHTSUP/1000000;
   NLTSUP=NLTSUP/1000000;
   NHEXP=NHEXP/1000000;
   JINVZE=JINVZE/1000000;
   JINVZ=JINVZ/1000000;
   JINVZP=JINVZP/1000000;
   JINVS=JINVS/1000000;
   JINVSP=JINVSP/1000000;
   JINVT=JINVZ+JINVZP+JINVS+JINVSP;
   JINVTE=JINVTE/1000000;
   CFATL9=CFATL9/1000000;
   CHXQU9=CHXQU9/1000000;
   CFPAC9=CFPAC9/1000000;
   LCANQ=LCANQ/1000000;
   ULBINVE=ULBINVE/1000000;
   NLTSUPC=NLTSUPC/1000000;
   ULBINV=ULBINV/1000000;
   OTQHEX=OTQKEX+OTQREX+OTQSEX;
   OTQLEX=OTQCEX+OTQPEX;
   AKQHEX=AKQKEX+AKQREX+AKQSEX;
   AKQLEX=AKQCEX+AKQPEX;
   NAQHEX=AKQHEX+OTQHEX;
   NAQLEX=AKQLEX+OTQLEX;
   AKQHEX=AKQHEX/1000000;
   AKQLEX=AKQLEX/1000000;
   NAQHEX=NAQHEX/1000000;
   NAQLEX=NAQLEX/1000000;

PROC SIMNLIN DATA=SALMON NEWTON DYNAMIC OUT=HAT THEIL LIST STAT
 OUTPREDICT OUTACTUAL;
RANGE T= 9 TO 104; → 1983:1 → 2006:4
NHEXP=F1*NPHX+F2*NHTSUP+F3*C+F4*DQ2+F5*DQ3+F6*DQ4;
NHTSUP=NAQHEX+LAG(NHZINVE);
NQHXE=EXP(C1*(((NPHXE*ECUUSA)*ETAX)/ECPI)
+C2*(DQ1+DQ3+DQ4)*(((NPLXE*ECUUSA)*ETAX)/ECPI)
+C3*(((NXPEEC/NORECU)*ETAX)/ECPI)+C4*(EY/(ECPI*EPOP))+C5*DQ2
+C6*DQ3+C7*DQ4+C8*D89+C9*C)*EPOP;
NPHXJ=(EXP((LOG(NQHXJ/JPOP)-K2*LOG(LAG(JINVZE)/JPOP)-K4*LOG(FPFTF/JCPI2)
-K3*LOG(JY1/(JPOP*JCPI2))-K5*C-K6*DQ3)/K1)*JCPI2)/(JTAX*JAPUSA);
NPHXE=G1*NPHXJ+G2*C+G3*DQ2+G4*DQ3+G5*DQ4+G6*D89+G7*LAG(NPHXE);
NPHX=(NQHXE*NPHXE+NQHXJ*NPHXJ)/(NQHXE+NQHXJ);
NQHXJ=NHEXP-NQHXE;
NHZINVE=EXP(H1*LOG(NPHX)+H2*LOG(NHTSUP)+H3*LAG(LOG(NHZINVE))+H4*C+H5*DQ2+H6*DQ3
+H7*DQ4+H8*LAG(LOG(NPHX))+H9*D87);
NAPHEX=EXP(R1*NPHX+R2*((NXPUSA/NORUSA)*UTAX)
+R3*NHTSUP+R4*C+R5*DQ2+R6*DQ3+R7*DQ4+R8*D91+R9*UY2);
JINVZE=EXP(L1*LOG(NPHXJ*JTAX*JAPUSA)+L2*LOG(NQHXJ)+L3*LAG(LOG(JINVZE))
```

This scales variables

Blue 1

```
NQLXJ=EXP(N1*LOG(((NPLXJ*JAPUSA)*JTAX)/JCPI2)+N2*LAG(LOG((JINVTE)/JPOP))
+N3*LOG(FP42F/JCPI2)+N4*LOG(JY1/(JPOP*JCPI2))
+N5*C+N6*DQ1+N7*DQ2+N8*DQ3+N9*D22)*JPOP;
NQLXE=EXP(W1*LOG(((NPLXE*ECUUSA)*ETAX)/ECPI)
+W2*(DQ1+DQ3+DQ4)*LOG(((NPHXE*ECUUSA)*ETAX)/ECPI)+W3*LOG(EY/(ECPI*EPOP))
+W4*DQ2+W5*DQ3+W6*DQ4+W7*C+W8*LAG(LOG(NQLXE/EPOP))+W9*D91)*EPOP;
NLTSUP=NAQLEX+LAG(NLZINVE);
NPLXJ=Q1*NPLXE+Q2*C+Q3*DQ2+Q4*DQ3+Q5*DQ4+Q6*D89+Q7*LAG(NPLXJ);
NLZINVE=EXP(I1*LOG(NPLXJ)+I2*LOG(NLTSUP)+I3*LAG(LOG(NLZINVE))+I4*C+I5*DQ2+I6*DQ3
+I7*DQ4+I8*LAG(LOG(NPLXJ))+I9*D87);
JINVTE=EXP(O1*LOG(NPLXJ*JTAX*JAPUSA)+O2*LOG(LAG(JINVTE)+NQLXJ+JLAN)+O3*LAG(LOG(N
+O4*C+O5*DQ2+O6*DQ3+O7*DQ4+O8*D2728);
NAPLEX=V1*NPLX+V2*LCANP+V3*NLTSUP+V4*C+V5*DQ2+V6*DQ3+V7*DQ4+V8*D910;
NPLXE=(NQLXE-P2*NLTSUP-P3*C-P4*DQ2-P5*DQ3-P6*DQ4)/P1;
HCANP=X1*(NPHXE*ECUUSA)+X2*C+X3*DQ2+X4*DQ3+X5*DQ4+X6*D89
+X7*LAG(HCANP/ECPI)*ECPI;
LCANP=(LCANQ-CC2*NLTSUPC-CC3*C-CC4*DQ3-CC5*DQ4
-CC6*D86-CC7*LAG(LCANQ))/CC1;
LCANQ=(AA1*((LCANP*ECUUSA)/ECPI)+AA2*((HCANP*ECUUSA)/ECPI)+AA3*(EY/(ECPI*EPOP))
+AA4*C+AA5*DQ2+AA6*DQ3+AA7*DQ4+AA8*D86+AA9*LAG(LCANQ/EPOP))*EPOP;
NLTSUPC=NLTSUP+(1.6)*LAG(ULBINVE);
ULBINVE=BB1*LCANP+BB2*NLTSUPC+BB3*C+BB4*DQ2+BB5*DQ3+BB6*DQ4
+BB7*D86+BB8*LAG(LCANP)+BB9*LAG(ULBINVE);

ENDOGENOUS NHEXP NHTSUP NQHXE NPHXJ NPHXE NPHX NQHXJ NHZINVE JINVZE
                 NLTSUP NQLXE NPLXJ NPLXE NQLXJ NLZINVE JINVTE
                 HCANP LCANP NLTSUPC LCANQ ULBINVE
           NAPHEX NAPLEX;

EXOGENOUS NXPUSA  NXPEEC
          ECPI  EY JY1  UCPI2 UY2 JPOP JCPI2  UPOP EPOP
          NORECU  ECUUSA  JAPUSA NORUSA
          DQ1 DQ2 DQ3 DQ4 C T DSEPT90 DMAR91 JTAX UTAX D86 D89 D87 D4T
          DISEASE ETAX D91 JAPDISC
          NXQSUP9  QSCOT9 CHXQU9  CFPAC99 CFATL9 FPFTF FP42F
          AKQHEX AKQLEX NAQHEX NAQLEX AKQKEX AKQSEX AKQREX AKQCEX AKQPEX
  OTQHEX
  OTQLEX
  AKQHEX
  AKQLEX
          YEARDUM ;

PARMS
A1 2.1703078 A2 -1.6330891 A3 0.43065125 A4 -0.44089064
A5 -0.74541160 A6 -0.31479699 A7 -2.0244100 A8 -1.4647240
A9 -0.85408495 A10 0.47196112
B1 1.8406322 B2 -1.2316258 B3 0.79766897 B4 -4.4659989 B5 -0.042349681
B6 -0.61897993 B7 -0.34505981 B8  0.49632996
J1 -7.4607784 J2 4.0874656 J3 1.7783261 J4 0.00448116
J5 -0.0019660946 J6 -0.00575396 J7 -0.003197891 J8 -0.25851924 J9 0.31564177
M1 -2.7252348 M2 1.2643312 M3 2.2248377 M4 -2.2609940
M5 0.0099122491 M6 -0.35691275 M7 -0.71287453 M8 0.46522354
E1 -1.2828244 E2 0.15734950 E3 -0.0084039431 E4 2.1280588
E5 0.32531754 E6 -0.13871774 E7 0.028762792 E8 0.36656196
W1 -1.0467034 W2 1.2448608 W3 0.94053021 W4 -5.6147509
W5 2.1954520 W6 -0.71471358 W7 1.4687261 W8 0.62274874 W9 -0.51107709
N1 -0.82730252 N2 -0.63939272 N3 0.36923978 N4 1.5155688
N5 -4.0255616 N6 -0.4169835 N7 -1.5738941 N8 -0.46926983 N9 0.72414713
I1 -0.67340522 I2 0.57316548 I3 0.36389113 I4 -0.41850456
I5 -0.57053185 I6  0.015406089 I7 0.47205477 I8 0.53958869 I9 -0.18565787
O1 -0.20975730 O2 0.67579069 O3 0.38135868 O4 0.13068296
O5 -0.059642171 O6 0.51912732 O7 -0.13156785 O8 -0.18705183
P1 4.2903689 P2 0.12279124 P3 -6.2482100 P4 -0.8230557
P5 -10.925165 P6 -2.7185740
```

endo variables

exo var.

parameter block

```
H1 -0.46270487 H2 0.73062168 H3 0.33679897 H4 -1.2921083
H5 -0.94495828 H6  0.11791034 H7 0.39178974 H8 0.61108317 H9 -0.26027444
L1 -0.71298874 L2 0.20926009 L3 0.64783214 L4 0.70380465
L5 1.2800630 L6 -0.17863604 L7 -0.42841893 L8 0.31284203 L9 -0.12229471
K1 -1.5594344 K2 -0.80762371 K3 3.6054771 K4 1.4750593
K5 -8.3086840 K6 1.8814047
C1 -88.159648 C2 112.89185 C3 59.719245 C4 52.645034
C5 0.49745794 C6 1.7455694 C7 0.8468517 C8 0.53752012
C9 -7.8775829
F1 5.1711710 F2 0.42228787 F3 -13.927917 F4 -22.169020
F5 19.096809 F6 2.5516031
G1 0.52787434 G2 0.11220710 G3 0.15200501 G4 0.18909898
G5 0.36916592 G6 -0.61450273 G7 0.35885010
R1 0.21145111 R2 0.197166 R3 -0.0014624589 R4 -0.26067049
R5 -0.72153930 R6 -0.30074025 R7 -0.8504966 R8 -0.47569344
R9 0.000086045401
V1 0.33821869 V2 0.10086879 V3 -0.00032994525 V4 -0.25636447
V5 -0.002074535 V6 0.18754862 V7 0.27784296 V8 -0.10164001
X1 0.56190258 X2 1.0708838 X3 -0.10230191 X4 -0.33279205
X5 -0.33669733 X6 0.39405126 X7 0.24443156
AA1 -0.88172083 AA2 0.55536571 AA3 0.47873639 AA4 0.0029952523
AA5 -0.013587823 AA6 -0.015946397 AA7 0.012760083 AA8 0.016638944
AA9 0.19574671
BB1 -12.049532 BB2 0.19391146 BB3 -26.706668 BB4 9.6088150 BB5 35.437597
BB6 14.432225 BB7 -12.756196 BB8 11.816741 BB9 0.49524456
CC1 1.0133866 CC2 0.011614621 CC3 -0.77387759 CC4 -5.8325603
CC5 6.4645768 CC6 6.3461941 CC7 0.41091076;

DATA HATA    ; SET HAT  ;
IF _TYPE_ NE 'PREDICT' THEN DELETE ;
ULBINVEH=ULBINVE;
NLTSUPCH=NLTSUPC;
HCANPH=HCANP;
LCANQH=LCANQ;
LCANPH=LCANP;
TEMP1H=TEMP1;
TEMP2H=TEMP2;
TEMP3H=TEMP3;
NPLX1H=NPLX1;
NPLXEH=NPLXE;
JINVTEH=JINVTE;
NLZINVEH=NLZINVE;
NPLXEH=NPLXE;
NPLXJH=NPLXJ;
NQLXJH=NQLXJ;
NQLXEH=NQLXE;
NLTSUPH=NLTSUP;
NAPLEXH=NAPLEX;
NAPHEXH=NAPHEX;
NHEXPH=NHEXP;
NHTSUPH=NHTSUP;
NQHXEH=NQHXE;
NQHXJH=NQHXJ;
NPHXJH=NPHXJ;
NPLXJH=NPLXJ;
NPHXEH=NPHXE;
NPHXH=NPHX;
NHZINVEH=NHZINVE;
JINVZEH=JINVZE;
NLTSUPH=NLTSUP;

DATA HATB    ; SET HAT  ;
IF _TYPE_ NE 'ACTUAL' THEN DELETE ;
```

```
 LREX=NAPLEX*NAQLEX;
 LREXH=NAPLEXH*NAQLEX;
 HREX=NAPHEX*NAQHEX;
 HREXH=NAPHEXH*NAQHEX;
 ALREX=NAPLEX*AKQLEX;
 ALREXH=NAPLEXH*AKQLEX;
 AHREX=NAPHEX*AKQHEX;
 AHREXH=NAPHEXH*AKQHEX;

PROC MEANS DATA=TOTO; VAR NAPHEXH NAQHEX NHTSUP;

DATA TOTO ; SET TOTO ; BY YEARDUM ;
  YEARDUM1=LAG1(YEARDUM) ;
    IF YEARDUM1 = . THEN YEARDUM1=YEARDUM ;
    IF YEARDUM=YEARDUM1 THEN DO ;          *** sums up variables ;
      SLREX       +        LREX    ;
      SLREXH      +        LREXH    ;
      SHREX       +        HREX    ;
      SHREXH      +        HREXH   ;
      SNAQLEX     +        NAQLEX   ;
      SNAQHEX     +        NAQHEX   ;
      ASLREX       +        ALREX    ;
      ASLREXH      +        ALREXH    ;
      ASHREX       +        AHREX    ;
      ASHREXH      +        AHREXH   ;
      SAKQLEX     +        AKQLEX   ;
      SAKQHEX     +        AKQHEX   ;
      SAKQKEX     +        AKQKEX   ;
      SAKQREX     +        AKQREX   ;
      SAKQSEX     +        AKQSEX   ;
      SAKQCEX     +        AKQCEX   ;
      SAKQPEX     +        AKQPEX   ;

    END ;

    IF FIRST.YEARDUM THEN DO ;     *** resets sums at 1st obsv of each fisherman
      SLREX       =        LREX    ;
      SLREXH      =        LREXH    ;
      SHREX                LREX    ;
      SHREXH      =        HREXH   ;
      SNAQLEX     =        NAQLEX   ;
      SNAQHEX     =        NAQHEX   ;
      ASLREX       =        ALREX    ;
      ASLREXH      =        ALREXH    ;
      ASHREX       =        AHREX    ;
      ASHREXH      =        AHREXH   ;
      AKQLEX     =        AKQLEX   ;
      AKQHEX     =        AKQHEX   ;
      SAKQKEX      =        AKQKEX   ;
      SAKQREX     =        AKQREX   ;
      SAKQSEX     =        AKQSEX   ;
      SAKQCEX     =        AKQCEX   ;
      SAKQPEX     =        AKQPEX   ;
    END ;

PROC PRINT ; VAR NLTSUPH LCANPH  NPLXJH;
PROC PRINT ; VAR T SLREX LREX SLREXH  LREXH SHREX  HREX SHREXH  HREXH
     SNAQLEX  NAQLEX SNAQHEX NAQHEX  AKQHEX AKQLEX ;
PROC PRINT ; VAR T ASLREX ALREX ASLREXH  ALREXH ASHREX  AHREX ASHREXH  AHREXH
     SAKQLEX  AKQLEX SAKQHEX AKQHEX   ;
PROC PRINT; VAR SAKQKEX AKQKEX SAKQREX AKQREX SAKQSEX AKQSEX SAKQCEX AKQCEX
 SAKQPEX AKQPEX;
DATA TOTOYR ; SET TOTO; BY YEARDUM ;
    IF LAST.YEARDUM THEN DUM=1 ;   *** delete all obsvs except the last obsv ;
```

Sums Quarters
↓
Years

```
    NAPLEXH=SLREXH/SNAQLEX;
    NAPHEX=SHREX/SNAQHEX;
    NAPHEXH=SHREXH/SNAQHEX;
    YR=80+YEARDUM ;

PROC PRINT ; VAR YEARDUM YR SLREX SLREXH SNAQLEX;
PROC PRINT ; VAR YEARDUM YR SHREX SHREXH SNAQHEX;
PROC PRINT ; VAR YEARDUM YR ASLREX ASLREXH ASHREX ASHREXH;
PROC PRINT ; VAR YEARDUM YR SAKQKEX SAKQREX SAKQSEX SAKQCEX SAKQPEX;
PROC PRINT ; VAR YEARDUM YR NAPLEX NAPLEXH NAPHEX NAPHEXH;

PROC MEANS DATA=TOTOYR; VAR YR NAPLEX NAPLEXH NAPHEX NAPHEXH SHREX SHREXH SLREX
 ASHREX ASHREXH ASLREX ASLREXH SAKQKEX SAKQREX SAKQSEX SAKQCEX SAKQPEX;

PROC MEANS DATA=TOTOYR; VAR YR NAPHEXH SHREXH SNAQHEX NAPLEXH SLREXH SNAQLEX
 ASHREXH ASLREXH SAKQKEX SAKQREX SAKQSEX SAKQCEX SAKQPEX;

DATA SDATA.SEV2 ; SET TOTOYR ;
 KEEP YR NAPLEXH NAPHEXH SAKQKEX SAKQSEX SAKQREX SAKQCEX SAKQPEX;


* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;


DATA SEV ; MERGE SDATA.SEV2 SDATA.SAREGION SDATA.SEVAK;BY YR;
KR=KKR;
JR=SER;
IF YR<82 THEN DELETE ;
SNAPHEX=NAPHEXH ;
AKRV=AKRQ*AKRP;
AFFRQ=PWRTH+CIRTH+KKRTH+SERTH;
AFFRV=PWRTH*PWR+CIRTH*CIR+KKRTH*KR+SERTH*JR;
AFFRP=AFFRV/AFFRQ;
AKORQ=AKRQ-AFFRQ;
AKORV=AKRV-AFFRV;
AKORP=AKORV/AKORQ;


PROC SYSNLIN OLS DATA=SEV OUTEST=PARAM
     MAXIT=1775 CONVERGE=0.00001 DW OUT=PUTZ  OUTACTUAL
     OUTPREDICT OUTRESID LIST ; ID YR ;

PARAMETERS   Z0PWR  Z1PWR
             Z0CIR  Z1CIR
             Z0KR   Z1KR
             Z0JR   Z1JR
             Z0AKRP Z1AKRP
             Z0AKORP Z1AKORP;

  ENDOGENOUS PWR CIR KR JR AKRP AKORP ;
  EXOGENOUS  NAPHEX  ;

   PWR= Z0PWR+ Z1PWR*NAPHEX  ;
   CIR= Z0CIR+ Z1CIR*NAPHEX  ;
   KR = Z0KR + Z1KR *NAPHEX  ;
   JR = Z0JR + Z1JR *NAPHEX  ;
   AKRP = Z0AKRP + Z1AKRP *NAPHEX  ;
   AKORP = Z0AKORP + Z1AKORP *NAPHEX  ;

TITLE '* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;
PROC PRINT ;
```

Sucheye Annual model

```
  CALL SYMPUT('_Z0CIR',Z0CIR) ;
  CALL SYMPUT('_Z0KR',Z0KR)   ;
  CALL SYMPUT('_Z0JR',Z0JR)   ;
  CALL SYMPUT('_Z0AKRP',Z0AKRP)   ;
  CALL SYMPUT('_Z0AKORP',Z0AKORP)   ;
  CALL SYMPUT('_Z1PWR',Z1PWR) ;
  CALL SYMPUT('_Z1CIR',Z1CIR) ;
  CALL SYMPUT('_Z1KR',Z1KR)   ;
  CALL SYMPUT('_Z1JR',Z1JR)   ;
  CALL SYMPUT('_Z1AKRP',Z1AKRP)   ;
  CALL SYMPUT('_Z1AKORP',Z1AKORP)   ;



                                        * * * * SIMNLIN PROGRAM * * * * * ;
DATA SIM; SET SDATA.SEV2; KEEP YR;
DATA SIM; MERGE SEV SIM; BY YR;

 PROC MODEL OUT=SAL ;
   PWR= Z0PWR+ Z1PWR*SNAPHEX  ;
   CIR= Z0CIR+ Z1CIR*SNAPHEX  ;
   KR = Z0KR + Z1KR *SNAPHEX  ;
   JR = Z0JR + Z1JR *SNAPHEX  ;
   AKRP = Z0AKRP + Z1AKRP *SNAPHEX  ;
   AKORP = Z0AKORP + Z1AKORP *SNAPHEX  ;

  ENDOGENOUS PWR CIR KR JR AKRP AKORP;
  EXOGENOUS  SNAPHEX  ;
PARMS
        Z0PWR &_Z0PWR
        Z0CIR &_Z0CIR
        Z0KR  &_Z0KR
        Z0JR  &_Z0JR
        Z0AKRP  &_Z0AKRP
        Z0AKORP  &_Z0AKORP
        Z1PWR &_Z1PWR
        Z1CIR &_Z1CIR
        Z1KR  &_Z1KR
        Z1JR  &_Z1JR
        Z1AKRP  &_Z1AKRP
        Z1AKORP  &_Z1AKORP   ;

PROC SIMNLIN DATA=SIM MODEL=SAL NEWTON
STAT THEIL LIST OUTPREDICT OUTACTUAL OUTRESID OUT=ZIPPY ; ID YR ;
RANGE YR= 83 TO 106;


 DATA ZIPPY ; SET ZIPPY ;
  IF _TYPE_ NE 'PREDICT' THEN DELETE ;
   PWRZ=PWR  ;
   CIRZ=CIR  ;
   KRZ =KR   ;
   JRZ =JR   ;
   AKRPZ=AKRP   ;
   AKORPZ=AKORP   :
   DROP PWR CIR KR JR AKRP AKORP;
(1)
 DATA BOZO ; MERGE SEV ZIPPY SDATA.COOK1 SDATA.PRINCE1 SDATA.KODIAK1 SDATA.SOUTH1
 BY YR ;
   PWRR=PWR- PWRZ ;
   CIRR=CIR- CIRZ ;
   KRR =KR - KRZ  ;
```

Core 1 Never to change pack # to refer to the Core you running. So SDATA.PRINCE2 refers to Core 2 etc.

If you globally change cook1 → cook2 etc. you will then for all 5 species

```
   AKORPR =AKORP - AKORPZ  ;
   HAKOR = SAKQREX-HPWR-HCIR-HKKR-HSER;

   PWRREV=PWRZ*HPWR;
   CIRREV=CIRZ*HCIR;
   KRREV=KRZ*HKKR;
   JRREV=JRZ*HSER;
   AKRREV1=AKRPZ*AKRQ;
   AKORREV=HAKOR*AKORPZ;
   AKRREV=PWRREV+CIRREV+KRREV+JRREV+AKORREV;

IF YR>106 OR YR<83 THEN DELETE;
PROC MEANS DATA=BOZO; VAR PWRREV CIRREV KRREV JRREV AKRREV AKRREV1 AKRP AKRPZ;

PROC PRINT; VAR AKRQ AKORQ AKRP AKORP;
PROC PRINT; ID YR; VAR PWRZ CIRZ KRZ JRZ AKORPZ;
PROC PRINT; ID YR; VAR PWRZ CIRZ KRZ JRZ AKRPZ;
PROC PRINT; ID YR; VAR HPWR HCIR HKKR HSER HAKOR ;

DATA ZOZO; SET BOZO;
IF YR>106 OR YR<97 THEN DELETE;
PROC MEANS DATA=ZOZO; VAR PWRZ HPWR CIRZ HCIR JRZ HSER KRZ HKKR
AKORPZ HAKOR AKRPZ SAKQREX;
PROC MEANS DATA=ZOZO; VAR PWRZ PWRREV HPWR PWRREV  CIRZ HCIR
CIRREV JRZ HSER JRREV KRZ HKKR KRREV  AKORPZ HAKOR AKORREV AKRPZ SAKQREX AKRREV;
PROC MEANS DATA=ZOZO; VAR PWRREV CIRREV KRREV JRREV AKORREV AKRREV ;

* * * PINK EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;


DATA SEV ; MERGE SDATA.SEV2 SDATA.SAREGION SDATA.SEVAK;BY YR;
KP=KKP;
JP=SEP;
IF YR<82 THEN DELETE ;
SNAPLEX=NAPLEXH ;
AKPV=AKPQ*AKPP;
AFFPQ=PWPTH+CIPTH+KKPTH+SEPTH;
AFFPV=PWPTH*PWP+CIPTH*CIP+KKPTH*KP+SEPTH*JP;
AFFPP=AFFPV/AFFPQ;
AKOPQ=AKPQ-AFFPQ;
AKOPV=AKPV-AFFPV;
AKOPP=AKOPV/AKOPQ;



PROC SYSNLIN OLS DATA=SEV OUTEST=PARAM
     MAXIT=1775 CONVERGE=0.00001 DW OUT=PUTZ  OUTACTUAL
     OUTPREDICT OUTRESID LIST ; ID YR ;

PARAMETERS   Z0PWP  Z1PWP
             Z0CIP  Z1CIP
             Z0KP   Z1KP
             Z0JP   Z1JP
             Z0AKPP Z1AKPP
             Z0AKOPP Z1AKOPP;

  ENDOGENOUS PWP CIP KP JP AKPP AKOPP ;
  EXOGENOUS  NAPLEX  ;

   PWP= Z0PWP+ Z1PWP*NAPLEX  ;
   CIP= Z0CIP+ Z1CIP*NAPLEX  ;
   KP = Z0KP + Z1KP *NAPLEX  ;
   JP = Z0JP + Z1JP *NAPLEX  ;
   AKPP = Z0AKPP + Z1AKPP *NAPLEX  ;
```

```
TITLE '* * * PINK EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;
PROC PRINT ;

DATA PARAM ; SET PARAM ;
  CALL SYMPUT('_Z0PWP',Z0PWP) ;
  CALL SYMPUT('_Z0CIP',Z0CIP) ;
  CALL SYMPUT('_Z0KP',Z0KP)   ;
  CALL SYMPUT('_Z0JP',Z0JP)   ;
  CALL SYMPUT('_Z0AKPP',Z0AKPP)   ;
  CALL SYMPUT('_Z0AKOPP',Z0AKOPP)   ;
  CALL SYMPUT('_Z1PWP',Z1PWP) ;
  CALL SYMPUT('_Z1CIP',Z1CIP) ;
  CALL SYMPUT('_Z1KP',Z1KP)   ;
  CALL SYMPUT('_Z1JP',Z1JP)   ;
  CALL SYMPUT('_Z1AKPP',Z1AKPP)   ;
  CALL SYMPUT('_Z1AKOPP',Z1AKOPP)   ;



                                        * * * * SIMNLIN PROGRAM * * * * * ;
DATA SIM; SET SDATA.SEV2; KEEP YR;
DATA SIM; MERGE SEV SIM; BY YR;

 PROC MODEL OUT=SAL ;
   PWP= Z0PWP+ Z1PWP*SNAPLEX  ;
   CIP= Z0CIP+ Z1CIP*SNAPLEX  ;
   KP = Z0KP + Z1KP *SNAPLEX  ;
   JP = Z0JP + Z1JP *SNAPLEX  ;
   AKPP = Z0AKPP + Z1AKPP *SNAPLEX  ;
   AKOPP = Z0AKOPP + Z1AKOPP *SNAPLEX  ;

  ENDOGENOUS PWP CIP KP JP AKPP AKOPP;
  EXOGENOUS  SNAPLEX  ;
PARMS
        Z0PWP &_Z0PWP
        Z0CIP &_Z0CIP
        Z0KP  &_Z0KP
        Z0JP  &_Z0JP
        Z0AKPP  &_Z0AKPP
        Z0AKOPP  &_Z0AKOPP
        Z1PWP &_Z1PWP
        Z1CIP &_Z1CIP
        Z1KP  &_Z1KP
        Z1JP  &_Z1JP
        Z1AKPP  &_Z1AKPP
        Z1AKOPP  &_Z1AKOPP   ;

PROC SIMNLIN DATA=SIM MODEL=SAL NEWTON
STAT THEIL LIST OUTPREDICT OUTACTUAL OUTRESID OUT=ZIPPY ; ID YR ;
RANGE YR= 83 TO 106;



 DATA ZIPPY ; SET ZIPPY ;
  IF _TYPE_ NE 'PREDICT' THEN DELETE ;
   PWPZ=PWP  ;
   CIPZ=CIP  ;
   KPZ =KP   ;
   JPZ =JP   ;
   AKPPZ=AKPP   ;
   AKOPPZ=AKOPP   ;
   DROP PWP CIP KP JP AKPP AKOPP;
```

```
   PWPR=PWP- PWPZ ;
   CIPR=CIP- CIPZ ;
   KPR =KP - KPZ  ;
   JPR =JP - JPZ  ;
   AKPPR =AKPP - AKPPZ  ;
   AKOPPR =AKOPP - AKOPPZ  ;
   HAKOP = SAKQPEX-HPWP-HCIP-HKKP-HSEP;

   PWPREV=PWPZ*HPWP;
   CIPREV=CIPZ*HCIP;
   KPREV=KPZ*HKKP;
   JPREV=JPZ*HSEP;
   AKPREV1=AKPPZ*AKPQ;
   AKOPREV=HAKOP*AKOPPZ;
   AKPREV=PWPREV+CIPREV+KPREV+JPREV+AKOPREV;

IF YR>106 OR YR<83 THEN DELETE;
PROC MEANS DATA=BOZO; VAR PWPREV CIPREV KPREV JPREV AKPREV AKPREV1 AKPP AKPPZ;

PROC PRINT; VAR AKPQ AKOPQ AKPP AKOPP;
PROC PRINT; ID YR; VAR PWPZ CIPZ KPZ JPZ AKOPPZ;
PROC PRINT; ID YR; VAR PWPZ CIPZ KPZ JPZ AKPPZ;
PROC PRINT; ID YR; VAR HPWP HCIP HKKP HSEP HAKOP;


DATA ZOZO; SET BOZO;
IF YR>106 OR YR<97 THEN DELETE;
PROC MEANS DATA=ZOZO; VAR PWPZ HPWP CIPZ HCIP JPZ HSEP KPZ HKKP AKOPPZ HAKOP
AKPPZ SAKQPEX;
PROC MEANS DATA=ZOZO; VAR PWPZ HPWP PWPREV CIPZ HCIP CIPREV JPZ HSEP JPREV
KPZ HKKP KPREV  AKOPPZ HAKOP AKOPREV AKPPZ SAKQPEX AKPREV;
PROC MEANS DATA=ZOZO; VAR PWPREV CIPREV KPREV JPREV AKOPREV AKPREV ;

* * * CHUM EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;


DATA SEV ; MERGE SDATA.SEV2 SDATA.SAREGION SDATA.SEVAK;BY YR;
KC=KKC;
JC=SEC;
IF YR<82 THEN DELETE ;
SNAPLEX=NAPLEXH ;
AKCV=AKCQ*AKCP;
AFFCQ=PWCTH+CICTH+KKCTH+SECTH;
AFFCV=PWCTH*PWC+CICTH*CIC+KKCTH*KC+SECTH*JC;
AFFCP=AFFCV/AFFCQ;
AKOCQ=AKCQ-AFFCQ;
AKOCV=AKCV-AFFCV;
AKOCP=AKOCV/AKOCQ;



PROC SYSNLIN OLS DATA=SEV OUTEST=PARAM
     MAXIT=1775 CONVERGE=0.00001 DW OUT=PUTZ  OUTACTUAL
     OUTPREDICT OUTRESID LIST ; ID YR ;

PARAMETERS   Z0PWC  Z1PWC
             Z0CIC  Z1CIC
             Z0KC   Z1KC
             Z0JC   Z1JC
             Z0AKCP Z1AKCP
             Z0AKOCP Z1AKOCP;

  ENDOGENOUS PWC CIC KC JC AKCP AKOCP ;
```

```
   PWC= Z0PWC+ Z1PWC*NAPLEX  ;
   CIC= Z0CIC+ Z1CIC*NAPLEX  ;
   KC = Z0KC + Z1KC *NAPLEX  ;
   JC = Z0JC + Z1JC *NAPLEX  ;
   AKCP = Z0AKCP + Z1AKCP *NAPLEX  ;
   AKOCP = Z0AKOCP + Z1AKOCP *NAPLEX  ;

TITLE '* * * CHUM EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;
PROC PRINT ;

DATA PARAM ; SET PARAM ;
  CALL SYMPUT('_Z0PWC',Z0PWC) ;
  CALL SYMPUT('_Z0CIC',Z0CIC) ;
  CALL SYMPUT('_Z0KC',Z0KC)   ;
  CALL SYMPUT('_Z0JC',Z0JC)   ;
  CALL SYMPUT('_Z0AKCP',Z0AKCP)   ;
  CALL SYMPUT('_Z0AKOCP',Z0AKOCP)   ;
  CALL SYMPUT('_Z1PWC',Z1PWC) ;
  CALL SYMPUT('_Z1CIC',Z1CIC) ;
  CALL SYMPUT('_Z1KC',Z1KC)   ;
  CALL SYMPUT('_Z1JC',Z1JC)   ;
  CALL SYMPUT('_Z1AKCP',Z1AKCP)   ;
  CALL SYMPUT('_Z1AKOCP',Z1AKOCP)   ;



                                    * * * * SIMNLIN PROGRAM * * * * * ;
DATA SIM; SET SDATA.SEV2; KEEP YR;
DATA SIM; MERGE SEV SIM; BY YR;

 PROC MODEL OUT=SAL ;
   PWC= Z0PWC+ Z1PWC*SNAPLEX  ;
   CIC= Z0CIC+ Z1CIC*SNAPLEX  ;
   KC = Z0KC + Z1KC *SNAPLEX  ;
   JC = Z0JC + Z1JC *SNAPLEX  ;
   AKCP = Z0AKCP + Z1AKCP *SNAPLEX  ;
   AKOCP = Z0AKOCP + Z1AKOCP *SNAPLEX  ;

  ENDOGENOUS PWC CIC KC JC AKCP AKOCP;
  EXOGENOUS  SNAPLEX  ;
PARMS
        Z0PWC &_Z0PWC
        Z0CIC &_Z0CIC
        Z0KC  &_Z0KC
        Z0JC  &_Z0JC
        Z0AKCP  &_Z0AKCP
        Z0AKOCP  &_Z0AKOCP
        Z1PWC &_Z1PWC
        Z1CIC &_Z1CIC
        Z1KC  &_Z1KC
        Z1JC  &_Z1JC
        Z1AKCP  &_Z1AKCP
        Z1AKOCP  &_Z1AKOCP   ;

PROC SIMNLIN DATA=SIM MODEL=SAL NEWTON
STAT THEIL LIST OUTPREDICT OUTACTUAL OUTRESID OUT=ZIPPY ; ID YR ;
RANGE YR= 83 TO 106;



 DATA ZIPPY ; SET ZIPPY ;
  IF _TYPE_ NE 'PREDICT' THEN DELETE ;
   PWCZ=PWC  ;
   CICZ=CIC  ;
```

```
  . AKCPZ=AKCP    ;
    AKOCPZ=AKOCP    ;
    DROP PWC CIC KC JC AKCP AKOCP;


 DATA BOZO ; MERGE SEV ZIPPY SDATA.COOK1 SDATA.PRINCE1 SDATA.KODIAK1 SDATA.SOUTH
 BY YR ;
    PWCR=PWC- PWCZ ;
    CICR=CIC- CICZ ;
    KCR =KC - KCZ  ;
    JCR =JC - JCZ  ;
    AKCPR =AKCP - AKCPZ  ;
    AKOCPR =AKOCP - AKOCPZ  ;
    HAKOC = SAKQCEX-HPWC-HCIC-HKKC-HSEC;

    PWCREV=PWCZ*HPWC;
    CICREV=CICZ*HCIC;
    KCREV=KCZ*HKKC;
    JCREV=JCZ*HSEC;
    AKCREV1=AKCPZ*AKCQ;
    AKOCREV=HAKOC*AKOCPZ;
    AKCREV=PWCREV+CICREV+KCREV+JCREV+AKOCREV;

IF YR>106 OR YR<83 THEN DELETE;
PROC MEANS DATA=BOZO; VAR PWCREV CICREV KCREV JCREV AKCREV AKCREV1 AKCP AKCPZ;


PROC PRINT; VAR AKCQ AKOCQ AKCP AKOCP;
PROC PRINT; ID YR; VAR PWCZ CICZ KCZ JCZ AKOCPZ;
PROC PRINT; ID YR; VAR PWCZ CICZ KCZ JCZ AKCPZ;
PROC PRINT; ID YR; VAR HPWC HCIC HKKC HSEC HAKOC ;

DATA ZOZO; SET BOZO;
IF YR>106 OR YR<97 THEN DELETE;

PROC MEANS DATA=ZOZO; VAR PWCZ  HPWC CICZ HCIC JCZ HSEC KCZ HKKC AKOCPZ HAKOC
AKCPZ SAKQCEX;
PROC MEANS DATA=ZOZO; VAR PWCZ   PWCREV HPWC CICZ HCIC CICREV JCZ HSEC JCREV
KCZ HKKC KCREV AKOCPZ HAKOC AKOCREV  AKCPZ SAKQCEX AKCREV;
PROC MEANS DATA=ZOZO; VAR PWCREV CICREV KCREV JCREV AKCREV AKOCREV;


* * * COHO EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;

DATA SEV ; MERGE SDATA.SEV2 SDATA.SAREGION SDATA.SEVAK;BY YR;
KS=KKS;
JS=SES;
IF YR<82 THEN DELETE ;
SNAPHEX=NAPHEXH ;
AKSV=AKSQ*AKSP;
AFFSQ=PWSTH+CISTH+KKSTH+SESTH;
AFFSV=PWSTH*PWS+CISTH*CIS+KKSTH*KS+SESTH*JS;
AFFSP=AFFSV/AFFSQ;
AKOSQ=AKSQ-AFFSQ;
AKOSV=AKSV-AFFSV;
AKOSP=AKOSV/AKOSQ;



PROC SYSNLIN OLS DATA=SEV OUTEST=PARAM
     MAXIT=1775 CONVERGE=0.00001 DW OUT=PUTZ  OUTACTUAL
     OUTPREDICT OUTRESID LIST ; ID YR ;
```

```
            Z0CIS  Z1CIS
            Z0KS   Z1KS
            Z0JS   Z1JS
            Z0AKSP Z1AKSP
            Z0AKOSP Z1AKOSP;

  ENDOGENOUS PWS CIS KS JS AKSP AKOSP ;
  EXOGENOUS  NAPHEX  ;

   PWS= Z0PWS+ Z1PWS*NAPHEX  ;
   CIS= Z0CIS+ Z1CIS*NAPHEX  ;
   KS = Z0KS + Z1KS *NAPHEX  ;
   JS = Z0JS + Z1JS *NAPHEX  ;
   AKSP = Z0AKSP + Z1AKSP *NAPHEX  ;
   AKOSP = Z0AKOSP + Z1AKOSP *NAPHEX  ;

TITLE '* * * COHO EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;
PROC PRINT ;

DATA PARAM ; SET PARAM ;
  CALL SYMPUT('_Z0PWS',Z0PWS) ;
  CALL SYMPUT('_Z0CIS',Z0CIS) ;
  CALL SYMPUT('_Z0KS',Z0KS)   ;
  CALL SYMPUT('_Z0JS',Z0JS)   ;
  CALL SYMPUT('_Z0AKSP',Z0AKSP)   ;
  CALL SYMPUT('_Z0AKOSP',Z0AKOSP)   ;
  CALL SYMPUT('_Z1PWS',Z1PWS) ;
  CALL SYMPUT('_Z1CIS',Z1CIS) ;
  CALL SYMPUT('_Z1KS',Z1KS)   ;
  CALL SYMPUT('_Z1JS',Z1JS)   ;
  CALL SYMPUT('_Z1AKSP',Z1AKSP)   ;
  CALL SYMPUT('_Z1AKOSP',Z1AKOSP)   ;



                                  * * * * SIMNLIN PROGRAM * * * * * ;
DATA SIM; SET SDATA.SEV2; KEEP YR;
DATA SIM; MERGE SEV SIM; BY YR;

 PROC MODEL OUT=SAL ;
   PWS= Z0PWS+ Z1PWS*SNAPHEX  ;
   CIS= Z0CIS+ Z1CIS*SNAPHEX  ;
   KS = Z0KS + Z1KS *SNAPHEX  ;
   JS = Z0JS + Z1JS *SNAPHEX  ;
   AKSP = Z0AKSP + Z1AKSP *SNAPHEX  ;
   AKOSP = Z0AKOSP + Z1AKOSP *SNAPHEX  ;

  ENDOGENOUS PWS CIS KS JS AKSP AKOSP;
  EXOGENOUS  SNAPHEX  ;
PARMS
        Z0PWS &_Z0PWS
        Z0CIS &_Z0CIS
        Z0KS  &_Z0KS
        Z0JS  &_Z0JS
        Z0AKSP  &_Z0AKSP
        Z0AKOSP  &_Z0AKOSP
        Z1PWS &_Z1PWS
        Z1CIS &_Z1CIS
        Z1KS  &_Z1KS
        Z1JS  &_Z1JS
        Z1AKSP  &_Z1AKSP
        Z1AKOSP  &_Z1AKOSP   ;

PROC SIMNLIN DATA=SIM MODEL=SAL NEWTON
```

```
DATA ZIPPY ; SET ZIPPY ;
 IF _TYPE_ NE 'PREDICT' THEN DELETE ;
  PWSZ=PWS  ;
  CISZ=CIS  ;
  KSZ =KS   ;
  JSZ =JS   ;
  AKSPZ=AKSP   ;
  AKOSPZ=AKOSP   ;
  DROP PWS CIS KS JS AKSP AKOSP;


DATA BOZO ; MERGE SEV ZIPPY SDATA.COOK1 SDATA.PRINCE1 SDATA.KODIAK1 SDATA.SOUTH
BY YR ;
  PWSR=PWS- PWSZ ;
  CISR=CIS- CISZ ;
  KSR =KS - KSZ  ;
  JSR =JS - JSZ  ;
  AKSPR =AKSP - AKSPZ  ;
  AKOSPR =AKOSP - AKOSPZ  ;
  HAKOS = SAKQSEX-HPWS-HCIS-HKKS-HSES;

  PWSREV=PWSZ*HPWS;
  CISREV=CISZ*HCIS;
  KSREV=KSZ*HKKS;
  JSREV=JSZ*HSES;
  AKSREV1=AKSPZ*AKSQ;
  AKOSREV=HAKOS*AKOSPZ;
  AKSREV=PWSREV+CISREV+KSREV+JSREV+AKOSREV;

IF YR>106 OR YR<83 THEN DELETE;
PROC MEANS DATA=BOZO; VAR PWSREV CISREV KSREV JSREV AKSREV AKSREV1 AKSP AKSPZ;


PROC PRINT; VAR AKSQ AKOSQ AKSP AKOSP;
PROC PRINT; ID YR; VAR PWSZ CISZ KSZ JSZ AKOSPZ;
PROC PRINT; ID YR; VAR PWSZ CISZ KSZ JSZ AKSPZ;
PROC PRINT; ID YR; VAR HPWS HCIS HKKS HSES HAKOS ;


PROC PRINT; VAR AKSQ AKOSQ AKSP AKOSP;
PROC PRINT; ID YR; VAR PWSZ CISZ KSZ JSZ AKSPZ AKOSPZ;



DATA ZOZO; SET BOZO;
IF YR>106 OR YR<97 THEN DELETE;

PROC MEANS DATA=ZOZO; VAR PWSZ  HPWS CISZ HCIS JSZ HSES KSZ HKKS
AKOSPZ HAKOS AKSPZ SAKQSEX;
PROC MEANS DATA=ZOZO; VAR PWSZ   PWSREV HPWS CISZ HCIS CISREV JSZ HSES JSREV
KSZ HKKS KSREV  AKOSPZ HAKOS AKOSREV  AKSPZ SAKQSEX AKSREV;
PROC MEANS DATA=ZOZO; VAR PWSREV CISREV KSREV JSREV  AKOSREV AKSREV ;



* * * KING EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;
```

```
JK=SEK;
IF YR<82 THEN DELETE ;
SNAPHEX=NAPHEXH ;
AKKV=AKKQ*AKKP;
AFFKQ=PWKTH+CIKTH+KKKTH+SEKTH;
AFFKV=PWKTH*PWK+CIKTH*CIK+KKKTH*KK+SEKTH*JK;
AFFKP=AFFKV/AFFKQ;
AKOKQ=AKKQ-AFFKQ;
AKOKV=AKKV-AFFKV;
AKOKP=AKOKV/AKOKQ;



PROC SYSNLIN OLS DATA=SEV OUTEST=PARAM
     MAXIT=1775 CONVERGE=0.00001 DW OUT=PUTZ  OUTACTUAL
     OUTPREDICT OUTRESID LIST ; ID YR ;

PARAMETERS    Z0PWK  Z1PWK
              Z0CIK  Z1CIK
              Z0KK   Z1KK
              Z0JK   Z1JK
              Z0AKKP Z1AKKP
              Z0AKOKP Z1AKOKP;

  ENDOGENOUS PWK CIK KK JK AKKP AKOKP ;
  EXOGENOUS  NAPHEX  ;

   PWK= Z0PWK+ Z1PWK*NAPHEX  ;
   CIK= Z0CIK+ Z1CIK*NAPHEX  ;
   KK = Z0KK + Z1KK *NAPHEX  ;
   JK = Z0JK + Z1JK *NAPHEX  ;
   AKKP = Z0AKKP + Z1AKKP *NAPHEX  ;
   AKOKP = Z0AKOKP + Z1AKOKP *NAPHEX  ;

TITLE '* * * KING EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *' ;
PROC PRINT ;

DATA PARAM ; SET PARAM ;
  CALL SYMPUT('_Z0PWK',Z0PWK) ;
  CALL SYMPUT('_Z0CIK',Z0CIK) ;
  CALL SYMPUT('_Z0KK',Z0KK)   ;
  CALL SYMPUT('_Z0JK',Z0JK)   ;
  CALL SYMPUT('_Z0AKKP',Z0AKKP)   ;
  CALL SYMPUT('_Z0AKOKP',Z0AKOKP)   ;
  CALL SYMPUT('_Z1PWK',Z1PWK) ;
  CALL SYMPUT('_Z1CIK',Z1CIK) ;
  CALL SYMPUT('_Z1KK',Z1KK)   ;
  CALL SYMPUT('_Z1JK',Z1JK)   ;
  CALL SYMPUT('_Z1AKKP',Z1AKKP)   ;
  CALL SYMPUT('_Z1AKOKP',Z1AKOKP)   ;



                                    * * * * SIMNLIN PROGRAM * * * * * ;
DATA SIM; SET SDATA.SEV2; KEEP YR;
DATA SIM; MERGE SEV SIM; BY YR;

 PROC MODEL OUT=SAL ;
   PWK= Z0PWK+ Z1PWK*SNAPHEX  ;
   CIK= Z0CIK+ Z1CIK*SNAPHEX  ;
   KK = Z0KK + Z1KK *SNAPHEX  ;
   JK = Z0JK + Z1JK *SNAPHEX  ;
   AKKP = Z0AKKP + Z1AKKP *SNAPHEX  ;
```

```
  ENDOGENOUS PWK CIK KK JK AKKP AKOKP;
  EXOGENOUS  SNAPHEX  ;
PARMS
        Z0PWK &_Z0PWK
        Z0CIK &_Z0CIK
        Z0KK  &_Z0KK
        Z0JK  &_Z0JK
        Z0AKKP  &_Z0AKKP
        Z0AKOKP  &_Z0AKOKP
        Z1PWK &_Z1PWK
        Z1CIK &_Z1CIK
        Z1KK  &_Z1KK
        Z1JK  &_Z1JK
        Z1AKKP  &_Z1AKKP
        Z1AKOKP  &_Z1AKOKP   ;

PROC SIMNLIN DATA=SIM MODEL=SAL NEWTON
STAT THEIL LIST OUTPREDICT OUTACTUAL OUTRESID OUT=ZIPPY ; ID YR ;
RANGE YR= 83 TO 106;



 DATA ZIPPY ; SET ZIPPY ;
  IF _TYPE_ NE 'PREDICT' THEN DELETE ;
   PWKZ=PWK  ;
   CIKZ=CIK  ;
   KKZ =KK   ;
   JKZ =JK   ;
   AKKPZ=AKKP   ;
   AKOKPZ=AKOKP   ;
   DROP PWK CIK KK JK AKKP AKOKP;


 DATA BOZO ; MERGE SEV ZIPPY SDATA.COOK1 SDATA.PRINCE1 SDATA.KODIAK1 SDATA.SOUTH
 BY YR ;
   PWKR=PWK- PWKZ ;
   CIKR=CIK- CIKZ ;
   KKR =KK - KKZ  ;
   JKR =JK - JKZ  ;
   AKKPR =AKKP - AKKPZ  ;
   AKOKPR =AKOKP - AKOKPZ  ;
   HAKOK = SAKQKEX-HPWK-HCIK-HKKK-HSEK;

   PWKREV=PWKZ*HPWK;
   CIKREV=CIKZ*HCIK;
   KKREV=KKZ*HKKK;
   JKREV=JKZ*HSEK;
   AKKREV1=AKKPZ*AKKQ;
   AKOKREV=HAKOK*AKOKPZ;
   AKKREV=PWKREV+CIKREV+KKREV+JKREV+AKOKREV;

IF YR>106 OR YR<83 THEN DELETE;
PROC MEANS DATA=BOZO; VAR PWKREV CIKREV KKREV JKREV AKKREV AKKREV1 AKKP AKKPZ;



PROC PRINT; VAR AKKQ AKOKQ AKKP AKOKP;
PROC PRINT; ID YR; VAR PWKZ CIKZ KKZ JKZ AKOKPZ;
PROC PRINT; ID YR; VAR PWKZ CIKZ KKZ JKZ AKKPZ;
PROC PRINT; ID YR; VAR HPWK HCIK HKKK HSEK HAKOK ;

DATA ZOZO; SET BOZO;
IF YR>106 OR YR<97 THEN DELETE;
PROC MEANS DATA=ZOZO; VAR PWKZ  HPWK CIKZ HCIK JKZ HSEK KKZ HKKK  AKOKPZ HAKOK
```

```
KKZ HKKK KKREV  AKOKPZ HAKOK AKOKREV AKKPZ SAKQKEX AKKREV;
PROC MEANS DATA=ZOZO; VAR PWKREV CIKREV KKREV JKREV  AKOKREV AKKREV ;
```

B

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SYSNLIN Procedure

Model Summary

Model Variables	7
Endogenous	6
Exogenous	1
Parameters	12
ID Variables	1
Equations	6
Number of Statements	6

Model Variables: PWR CIR KR JR AKRP AKORP NAPHEX

Parameters: Z0PWR Z1PWR Z0CIR Z1CIR Z0KR Z1KR Z0JR Z1JR Z0AKRP Z1AKRP Z0AKORP Z1AKORP

Equations: PWR CIR KR JR AKRP AKORP

This is just one part of the output from SIM1.SAS. The first part of the output is Blue all can be ignored. The G-F stats you see for Blue I are not relevent because they span [redacted] time period. in which there are no observations. The relevent #'s start here. They are for

Sockeye
Pink
Chum
Coho
King

In that order.

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SYSNLIN Procedure

The 6 Equations to Estimate are:

```
PWR   = F( Z0PWR(1), Z1PWR(NAPHEX) )
CIR   = F( Z0CIR(1), Z1CIR(NAPHEX) )
KR    = F( Z0KR(1), Z1KR(NAPHEX) )
JR    = F( Z0JR(1), Z1JR(NAPHEX) )
AKRP  = F( Z0AKRP(1), Z1AKRP(NAPHEX) )
AKORP = F( Z0AKORP(1), Z1AKORP(NAPHEX) )
```

SYSNLIN Procedure
OLS Estimation

OLS Estimation Summary

Dataset Option	Dataset
DATA=	SEV
OUT=	PUTZ
OUTEST=	PARAM
Parameters Estimated	12

Minimization Summary

Method	GAUSS
Iterations	1

Final Convergence Criteria	
R	0
PPC	2.5E-14
RPC(Z1PWR)	14211.11
Object	0.9836553
Trace(S)	0.27399268
Objective Value	0.21919415

Observations Processed

Read	25
Solved	25
Used	10
Missing	15

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SYSNLIN Procedure
OLS Estimation

estimation of fit between Sucfaye price and NAPHEX-HAT ↳ hrv. equation Bkc

Nonlinear OLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq	Durbin Watson
PWR	2	8	0.9020	0.11275	0.33578	0.8058	0.7815	1.963
CIR	2	8	0.2409	0.03011	0.17352	0.9005	0.8881	2.008
KR	2	8	0.3453	0.04317	0.20776	0.8874	0.8733	1.662
JR	2	8	0.3129	0.03911	0.19776	0.9160	0.9055	1.473
AKRP	2	8	0.1840	0.02300	0.15166	0.9220	0.9122	1.788
AKORP	2	8	0.2069	0.02586	0.16082	0.8969	0.8840	1.827

Nonlinear OLS Parameter Estimates

Parameter	Estimate	Approx. Std Err	'T' Ratio	Approx. Prob>|T|
Z0PWR	-0.332396	0.35706	-0.93	0.3791
Z1PWR	1.435422	0.24915	5.76	0.0004
Z0CIR	-0.098836	0.18452	-0.54	0.6068
Z1CIR	1.095522	0.12875	8.51	0.0001
Z0KR	-0.270607	0.22093	-1.22	0.2555
Z1KR	1.223834	0.15416	7.94	0.0001
Z0JR	-0.368885	0.21029	-1.75	0.1175
Z1JR	1.370279	0.14674	9 34	0.0001
Z0AKRP	-0.289220	0.16127	-1.79	0.1107
Z1AKRP	1.094227	0.11253	9.72	0.0001
Z0AKORP	-0.234415	0.17101	-1.37	0.2077
Z1AKORP	0.995458	0.11933	8.34	0.0001

Number of Observations		Statistics for System	
Used	10	Objective	0.2192
Missing	15	Objective*N	2.1919

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SYSNLIN Procedure

Listing of Program:

Stmt	Line:Col	Source Text
1	323:4	PWR= Z0PWR+ Z1PWR*NAPHEX ;
		Z1PWR: 1.4354(5.76) Z0PWR: -0.3324(-0.931)
2	324:4	CIR= Z0CIR+ Z1CIR*NAPHEX ;
		Z1CIR: 1.0955(8.51) Z0CIR: -0.09884(-0.536)
3	325:4	KR = Z0KR + Z1KR *NAPHEX ;
		Z1KR: 1.2238(7.94) Z0KR: -0.27061(-1.22)
4	326:4	JR = Z0JR + Z1JR *NAPHEX ;
		Z1JR: 1.3703(9.34) Z0JR: -0.36889(-1.75)
5	327:4	AKRP = Z0AKRP + Z1AKRP *NAPHEX ;
		Z1AKRP: 1.0942(9.7) Z0AKRP: -0.28922(-1.79)
6	328:4	AKORP = Z0AKORP + Z1AKORP *NAPHEX ;
		Z1AKORP: 0.99546(8.34) Z0AKORP: -0.23442(-1.37)

*** * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * ***

OBS	_NAME_	_TYPE_	_NUSED_	Z0PWR	Z1PWR	Z0CIR	Z1CIR	Z0KR
1		OLS	10	-0.33240	1.43542	-0.098836	1.09552	-0.27061

OBS	Z1KR	Z0JR	Z1JR	Z0AKRP	Z1AKRP	Z0AKORP	Z1AKORP
1	1.22383	-0.36889	1.37028	-0.28922	1.09423	-0.23442	0.99546

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

MODEL Procedure

Model Summary

Model Variables	7
Endogenous	6
Exogenous	1
Parameters	12
Equations	6
Number of Statements	6

Model Variables: PWR SNAPHEX CIR KR JR AKRP AKORP

Parameters: Z0PWR: -0.3324 Z1PWR: 1.435 Z0CIR: -0.0988
Z1CIR: 1.096 Z0KR: -0.2706 Z1KR: 1.224 Z0JR: -0.3689
Z1JR: 1.37 Z0AKRP: -0.2892 Z1AKRP: 1.094
Z0AKORP: -0.2344 Z1AKORP: 0.9955

Equations: PWR CIR KR JR AKRP AKORP

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SIMNLIN Procedure

Model Summary

Model Variables	7
Endogenous	6
Exogenous	1
Parameters	12
RANGE Variable	YR
ID Variables	1
Equations	6
Number of Statements	6

Model Variables: PWR SNAPHEX CIR KR JR AKRP AKORP

Parameters: Z0PWR: -0.3324 Z1PWR: 1.435 Z0CIR: -0.0988
Z1CIR: 1.096 Z0KR: -0.2706 Z1KR: 1.224 Z0JR: -0.3689
Z1JR: 1.37 Z0AKRP: -0.2892 Z1AKRP: 1.094
Z0AKORP: -0.2344 Z1AKORP: 0.9955

Equations: PWR CIR KR JR AKRP AKORP

Listing of Program:

Stmt	Line:Col	Source Text
1	354:4	PWR= Z0PWR+ Z1PWR*SNAPHEX ; Z1PWR: 1.4354(.) Z0PWR: -0.3324(.)
2	355:4	CIR= Z0CIR+ Z1CIR*SNAPHEX ; Z1CIR: 1.0955(.) Z0CIR: -0.09884(.)
3	356:4	KR = Z0KR + Z1KR *SNAPHEX ; Z1KR: 1.2238(.) Z0KR: -0.27061(.)
4	357:4	JR = Z0JR + Z1JR *SNAPHEX ; Z1JR: 1.3703(.) Z0JR: -0.36889(.)
5	358:4	AKRP = Z0AKRP + Z1AKRP *SNAPHEX ; Z1AKRP: 1.0942(.) Z0AKRP: -0.28922(.)
6	359:4	AKORP = Z0AKORP + Z1AKORP *SNAPHEX ; Z1AKORP: 0.99546(.) Z0AKORP: -0.23442(.)

SIMNLIN Procedure
Simultaneous Simulation

Solution Summary

Dataset Option	Dataset
DATA=	SIM
OUT=	ZIPPY
Variables Solved	6
Solution RANGE	YR
First	83
Last	106
Solution Method	NEWTON
CONVERGE=	1E-8
Maximum CC	0
Maximum Iterations	1
Total Iterations	24
Average Iterations	1

Observations Processed	
Read	24
Solved	24
First	2
Last	25

Variables Solved For: PWR CIR KR JR AKRP AKORP

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SIMNLIN Procedure
Simultaneous Simulation

Solution Range YR = 83 To 106

Descriptive Statistics

			Actual		Predicted	
Variable	Nobs	N	Mean	Std	Mean	Std
PWR	24	10	1.5391	0.8643	1.6155	0.5117
CIR	24	10	1.2905	0.6806	1.3878	0.3905
KR	24	10	1.3149	0.7222	1.3902	0.4363
JR	24	10	1.3945	0.7968	1.4906	0.4885
AKRP	24	9	1.2500	0.5244	1.2136	0.4093
AKORP	24	9	1.1697	0.4806	1.1327	0.3724

Descriptive Statistics

Missing Values

Variable	Total	Actual	Predict
PWR	14	14	0
CIR	14	14	0
KR	14	14	0
JR	14	14	0
AKRP	15	15	0
AKORP	15	15	0

Statistics of Fit

Variable	N	Mean Error	Mean % Error	Mean Abs Error	Mean Abs % Error
PWR	10	0.0764	.	0.4222	.
CIR	10	0.0973	.	0.3155	.
KR	10	0.0752	.	0.2931	.
JR	10	0.0961	.	0.3152	.
AKRP	9	-0.0364	1.1258	0.1452	13.15330
AKORP	9	-0.0370	0.8410	0.1357	12.83644

Statistics of Fit

Variable	RMS Error	RMS % Error	R-Square
PWR	0.5675	.	0.5210
CIR	0.4455	.	0.5238
KR	0.4448	.	0.5785
JR	0.4694	.	0.6145
AKRP	0.1686	15.9107	0.8837
AKORP	0.1566	15.5815	0.8805

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SIMNLIN Procedure
Simultaneous Simulation

Solution Range YR = 83 To 106

Theil Forecast Error Statistics

				MSE Decomposition Proportions					Inequality Coef	
Variable	N	MSE	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar (UC)	U1	U
PWR	10	0.32203	0.743	0.018	0.048	0.934	0.347	0.634	0.3254	0.1654
CIR	10	0.19850	0.763	0.048	0.075	0.877	0.381	0.571	0.3088	0.1547
KR	10	0.19785	0.791	0.029	0.083	0.889	0.372	0.600	0.3000	0.1516
JR	10	0.22029	0.821	0.042	0.112	0.846	0.389	0.570	0.2959	0.1491
AKRP	9	0.02842	0.960	0.047	0.276	0.677	0.414	0.539	0.1254	0.0644
AKORP	9	0.02453	0.960	0.056	0.286	0.658	0.424	0.520	0.1248	0.0642

Theil Relative Change Forecast Error Statistics

	Relative Change			MSE Decomposition Proportions					Inequality Coef	
Variable	N	MSE	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar (UC)	U1	U
PWR	8	0.03947	0.833	0.003	0.152	0.845	0.013	0.984	0.5902	0.2866
CIR	8	0.02535	0.888	0.007	0.131	0.862	0.018	0.975	0.4779	0.2327
KR	8	0.02147	0.890	0.016	0.011	0.973	0.018	0.966	0.4570	0.2364
JR	8	0.02708	0.897	0.020	0.008	0.973	0.101	0.880	0.4390	0.2371
AKRP	8	0.02172	0.894	0.011	0.004	0.985	0.029	0.960	0.4413	0.2302
AKORP	8	0.02428	0.886	0.016	0.001	0.983	0.076	0.909	0.4576	0.2452

NOTE: Percent error statistics for 4 variables were set to missing values because an actual value was too close to zero to compute the percent error at one or more observations.

None of the GoFit statistics are valid because this is the forecasting program not the simulation program.

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

N Obs	Variable	N	Minimum	Maximum	Mean	Std Dev
24	PWRREV	24	0	30800203.92	15433091.90	12788119.38
	CIRREV	24	0	67836149.23	28266965.67	23852337.67
	KRREV	24	0	35270568.18	18131488.48	14870547.27
	JRREV	24	0	17089219.97	8761171.01	7114312.51
	AKRREV	24	189898508	366939419	288681006	46248368.44
	AKRREV1	9	201650300	397410504	285279035	70091466.99
	AKRP	9	0.6900000	2.3500000	1.2500000	0.5244044
	AKRPZ	24	0.7568826	2.1118810	1.1904528	0.2674092

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

OBS	AKRQ	AKORQ	AKRP	AKORP
1	305641044	251037984	0.69	0.66665
2	222603385	182776892	0.78	0.72614
3	224741718	173258366	0.98	0.88331
4	193808322	130504508	1.43	1.41936
5	224872711	129723039	1.55	1.48136
6	188178455	113355577	2.35	2.14242
7	260118084	199709170	1.42	1.30587
8	305571347	237512215	1.28	1.17036
9	258422585	194432637	0.77	0.73210
10	.	.	.	.
11	.	.	.	.
12	.	.	.	.
13	.	.	.	.
14	.	.	.	.
15	.	.	.	.
16	.	.	.	.
17	.	.	.	.
18	.	.	.	.
19	.	.	.	.
20	.	.	.	.
21	.	.	.	.
22	.	.	.	.
23	.	.	.	.
24	.	.	.	.

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
83	1.03990	0.94850	0.89940	0.94113	0.71726
84	1.30709	1.15243	1.12721	1.19620	0.90256
85	1.22404	1.08904	1.05640	1.11691	0.84496
86	1.75258	1.49243	1.50703	1.62147	1.21151
87	2.07083	1.73532	1.77837	1.92528	1.43221
88	2.81740	2.30511	2.41489	2.63797	1.94995
89	1.55975	1.34526	1.34263	1.43739	1.07778
90	1.60505	1.37983	1.38125	1.48063	1.10919
91	1.37441	1.20380	1.18460	1.26046	0.94924
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.22630	1.20973	1.28859	0.96968
96	1.44636	1.25872	1.24595	1.32915	0.99914
97	1.51027	1.30749	1.30044	1.39015	1.04346
98	1.56688	1.35070	1.34870	1.44419	1.08272
99	1.59961	1.37568	1.37661	1.47544	1.10542
100	1.63307	1.40122	1.40514	1.50738	1.12863
101	1.66577	1.42617	1.43302	1.53860	1.15130
102	1.70827	1.45861	1.46926	1.57917	1.18078
103	1.75406	1.49356	1.50830	1.62289	1.21253
104	1.80348	1.53128	1.55043	1.67006	1.24681
105	1.84930	1.56624	1.58949	1.71380	1.27858
106	1.89847	1.60377	1.63142	1.76074	1.31268
	PWS	CI	Kodiak	S.E.	Rest of Alaska

These are the predicted prices Base Case i Sockeye

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

YR	PWRZ	CIRZ	KRZ	JRZ	AKRPZ
83	1.03990	0.94850	0.89940	0.94113	0.75688
84	1.30709	1.15243	1.12721	1.19620	0.96057
85	1.22404	1.08904	1.05640	1.11691	0.89725
86	1.75258	1.49243	1.50703	1.62147	1.30017
87	2.07083	1.73532	1.77837	1.92528	1.54277
88	2.81740	2.30511	2.41489	2.63797	2.11188
89	1.55975	1.34526	1.34263	1.43739	1.15317
90	1.60505	1.37983	1.38125	1.48063	1.18770
91	1.37441	1.20380	1.18460	1.26046	1.01188
92	1.30271	1.14909	1.12348	1.19202	0.95723
93	1.37625	1.20521	1.18618	1.26222	1.01329
94	1.33838	1.17631	1.15389	1.22607	0.98442
95	1.40388	1.22630	1.20973	1.28859	1.03435
96	1.44636	1.25872	1.24595	1.32915	1.06673
97	1.51027	1.30749	1.30044	1.39015	1.11545
98	1.56688	1.35070	1.34870	1.44419	1.15860
99	1.59961	1.37568	1.37661	1.47544	1.18356
100	1.63307	1.40122	1.40514	1.50738	1.20906
101	1.66577	1.42617	1.43302	1.53860	1.23399
102	1.70827	1.45861	1.46926	1.57917	1.26639
103	1.75406	1.49356	1.50830	1.62289	1.30130
104	1.80348	1.53128	1.55043	1.67006	1.33897
105	1.84930	1.56624	1.58949	1.71380	1.37389
106	1.89847	1.60377	1.63142	1.76074	1.41138

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

YR	HPWR	HCIR	HKKR	HSER	HAKOR
83	0	0	0	0	305641056
84	0	0	0	0	222603381
85	0	0	0	0	224741766
86	0	0	0	0	193808287
87	0	0	0	0	224872669
88	0	0	0	0	188178481
89	0	0	0	0	260118080
90	0	0	0	0	305571332
91	0	0	0	0	258413468
92	11607212	59034873	14462148	9103137	172005492
93	11792258	49678554	17187458	9064515	172005490
94	14218659	55515178	21602617	9095915	172005493
95	14902859	40799000	26588491	9165058	172005491
96	16223684	36171804	24682932	9619039	172005491
97	16223684	29217280	23252498	9619039	172005487
98	16223684	27017642	21219613	9668023	172005487
99	16223684	26391398	20460838	9705703	172005486
100	16223684	27199453	21128736	9705703	172005487
101	16223684	27065348	21279477	9705703	172005488
102	16223684	26570347	20950956	9705703	172005486
103	16223684	26576220	21170333	9705703	172005486
104	16223684	26202138	20577370	9705703	172005486
105	16223684	25613092	21126296	9705703	172005487
106	16223684	27081065	21619562	9705703	172005487

Valid 92-2006

PWS CI Kodiak SE Rest of AK

These are predicted enhancements for each region

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

N Obs	Variable	N	Minimum	Maximum	Mean	Std Dev
10	PWRZ	10	1.5102667	1.8984716	1.6989180	0.1268500
	HPWR	10	16223684.00	16223684.00	16223684.00	0
	CIRZ	10	1.3074940	1.6037739	1.4514736	0.0968125
	HCIR	10	25613092.00	29217280.00	26893398.30	951508.23
	JRZ	10	1.3901529	1.7607400	1.5702427	0.1210932
	HSER	10	9619039.00	9705703.00	9693268.60	28643.96
	KRZ	10	1.3004377	1.6314192	1.4612808	0.1081516
	HKKR	10	20460838.00	23252498.00	21278567.90	770367.51
	AKORPZ	10	1.0434627	1.3126809	1.1742915	0.0879698
	HAKOR	10	172005486	172005488	172005487	0.6749486
	AKRPZ	10	1.1154481	1.4173779	1.2592576	0.0966981
	SAKQREV	10	244674262	250317988	246094406	1646680.32

If "H" 1st - Harvest

If "Z" last - price

If "REV" last - revenue

See next page

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

N Obs	Variable	N	Minimum	Maximum	Mean	Std Dev
10	PWRZ	10	1.5102667	1.8984716	1.6989180	0.1268500
	PWRREV	10	24502090.31	30800203.92	27562709.55	2057973.79
	HPWR	10	16223684.00	16223684.00	16223684.00	0
	CIRZ	10	1.3074940	1.6037739	1.4514736	0.0968125
	HCIR	10	25613092.00	29217260.00	26893398.30	951508.23
	CIRREV	10	36306215.19	43431906.00	38983260.35	2049788.26
	JRZ	10	1.3901529	1.7607400	1.5702427	0.1210932
	HSER	10	9619039.00	9705703.00	9693268.60	28643.96
	JRREV	10	13371935.33	17089219.97	15222820.34	1201877.08
	KRZ	10	1.3004377	1.6314192	1.4612808	0.1081516
	HKKR	10	20460838.00	23252498.00	21278567.90	770367.51
	KRREV	10	28166676.95	35270568.18	31067467.58	2181563.05
	AKORPZ	10	1.0434627	1.3126809	1.1742915	0.0879698
	HAKOR	10	172005486	172005488	172005487	0.6749486
	AKORREV	10	179481308	225788320	201984575	15131295.38
	AKRPZ	10	1.1154481	1.4113779	1.2592576	0.0966981
	SAKQREX	10	244674262	250317988	246094406	1646680.32
	AKRREV	10	285795176	352380219	314820833	22189261.25

PWRZ - Pws are annual price
year 1997-2006
real 1991 $.-

* * * RED EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

N Obs	Variable	N	Minimum	Maximum	Mean	Std Dev
10	PWRREV PWS	10	24502020.31	30800203.92	27562709.55	2057973.79
	CIRREV CI	10	36306215.19	43431906.00	38983260.35	2049788.26
	KRREV Kodiak	10	28166676.95	35270568.18	31067467.58	2181563.05
	JRREV SE	10	13371935.33	17089219.97	15222820.34	1201877.08
	AKORREV Rest	10	179481308	225788320	201984575	15131295.38
	AKRREV	10	285795176	352380219	314820833	22199261.25

Just the Revenues

'* * * PINK EXVESSEL PRICE MODEL -- STATE ENHANCEMENT EVALUATION * * *

SYSNLIN Procedure

Model Summary

Model Variables	7
Endogenous	6
Exogenous	1
Parameters	12
ID Variables	1
Equations	6
Number of Statements	6

Model Variables: PWP CIP KP JP AKPP AKOPP NAPLEX

Parameters: Z0PWP Z1PWP Z0CIP Z1CIP Z0KP Z1KP Z0JP Z1JP Z0AKPP Z1AKPP Z0AKOPP Z1AKOPP

Equations: PWP CIP KP JP AKPP AKOPP

Pink starts here etc.

C

This is the program I give to John. I do not know how he uses it!

CASE 1 -- BASE SCENARIO

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.22630	1.20973	1.28859	0.96968
96	1.44636	1.25872	1.24595	1.32915	0.99914
97	1.51027	1.30749	1.30044	1.39015	1.04346
98	1.56688	1.35070	1.34870	1.44419	1.08272
99	1.59961	1.37568	1.37661	1.47544	1.10542
100	1.63307	1.40122	1.40514	1.50738	1.12863
101	1.66577	1.42617	1.43302	1.53860	1.15130
102	1.70827	1.45861	1.46926	1.57917	1.18078
103	1.75406	1.49356	1.50830	1.62289	1.21253
104	1.80348	1.53128	1.55043	1.67006	1.24681
105	1.84930	1.56624	1.58949	1.71380	1.27858
106	1.89847	1.60377	1.63142	1.76074	1.31268

Sockeye

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27166	0.26703
97	0.27015	0.23955	0.26104	0.28175	0.27517
98	0.26824	0.23808	0.25918	0.27985	0.27364
99	0.27306	0.24179	0.26385	0.28461	0.27748
100	0.28203	0.24870	0.27253	0.29347	0.28463
101	0.29736	0.26051	0.28737	0.30860	0.29685
102	0.29803	0.26103	0.28801	0.30927	0.29738
103	0.29570	0.25923	0.28576	0.30696	0.29553
104	0.32187	0.27939	0.31108	0.33280	0.31638
105	0.34137	0.29441	0.32996	0.35206	0.33192
106	0.35749	0.30682	0.34555	0.36796	0.34476

Pink

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38690	0.40140	0.34588	0.45026	0.33002
97	0.39822	0.40866	0.35848	0.46196	0.33499
98	0.39609	0.40730	0.35611	0.45976	0.33406
99	0.40143	0.41072	0.36206	0.46528	0.33641
100	0.41137	0.41710	0.37311	0.47555	0.34077
101	0.42833	0.42798	0.39200	0.49310	0.34823
102	0.42908	0.42846	0.39282	0.49387	0.34856
103	0.42650	0.42680	0.38995	0.49120	0.34743
104	0.45547	0.44539	0.42219	0.52115	0.36016
105	0.47706	0.45924	0.44622	0.54348	0.36966
106	0.49490	0.47069	0.46608	0.56192	0.37750

Chum

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346

93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.85971	0.65834	0.68630	1.14653	0.69134
97	0.89187	0.68109	0.70428	1.19456	0.71709
98	0.92036	0.70124	0.72021	1.23711	0.73990
99	0.93683	0.71289	0.72941	1.26172	0.75309
100	0.95366	0.72480	0.73883	1.28686	0.76657
101	0.97012	0.73644	0.74803	1.31144	0.77975
102	0.99151	0.75157	0.75998	1.34338	0.79687
103	1.01455	0.76787	0.77286	1.37780	0.81532
104	1.03942	0.78546	0.78677	1.41494	0.83524
105	1.06247	0.80177	0.79965	1.44938	0.85370
106	1.08721	0.81927	0.81349	1.48634	0.87351

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59658	1.13720	1.02164	2.27161	1.37220
94	1.56030	1.12702	1.01250	2.24669	1.35600
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66375	1.15604	1.03857	2.31774	1.40221
97	1.72498	1.17321	1.05400	2.35978	1.42956
98	1.77921	1.18843	1.06766	2.39703	1.45379
99	1.81058	1.19722	1.07556	2.41857	1.46780
100	1.84263	1.20621	1.08364	2.44059	1.48212
101	1.87396	1.21500	1.09153	2.46210	1.49611
102	1.91468	1.22642	1.10179	2.49007	1.51430
103	1.95855	1.23873	1.11285	2.52020	1.53390
104	2.00590	1.25201	1.12478	2.55271	1.55505
105	2.04980	1.26432	1.13584	2.58285	1.57466
106	2.09691	1.27754	1.14771	2.61521	1.59570

CASE 2 -- WISH LIST

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.28421	1.13497	1.10770	1.17435	0.88669
93	1.35656	1.19018	1.16939	1.24342	0.93687
94	1.32995	1.16988	1.14670	1.21802	0.91841
95	1.39646	1.22064	1.20341	1.28152	0.96454
96	1.44365	1.25665	1.24364	1.32656	0.99726
97	1.50278	1.30178	1.29406	1.38301	1.03827
98	1.55916	1.34481	1.34213	1.43683	1.07737
99	1.57114	1.35395	1.35234	1.44826	1.08568
100	1.59915	1.37533	1.37622	1.47500	1.10510
101	1.62876	1.39793	1.40146	1.50327	1.12564
102	1.66036	1.42205	1.42841	1.53343	1.14755
103	1.61556	1.38786	1.39021	1.49067	1.11649
104	1.66011	1.42185	1.42819	1.53319	1.14738
105	1.70320	1.45474	1.46493	1.57433	1.17726
106	1.75018	1.49060	1.50499	1.61918	1.20984

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27536	0.24356	0.26608	0.28689	0.27932
93	0.26778	0.23773	0.25875	0.27941	0.27328
94	0.27027	0.23964	0.26115	0.28186	0.27526
95	0.24813	0.22259	0.23973	0.26001	0.25762

96	0.24904	0.22329	0.24061	0.26090	0.25834
97	0.25880	0.23081	0.25005	0.27053	0.26612
98	0.25494	0.22784	0.24632	0.26673	0.26305
99	0.25975	0.23154	0.25097	0.27147	0.26688
100	0.26824	0.23808	0.25919	0.27986	0.27365
101	0.28530	0.25122	0.27570	0.29670	0.28724
102	0.28486	0.25088	0.27527	0.29626	0.28689
103	0.27906	0.24641	0.26966	0.29054	0.28227
104	0.30488	0.26630	0.29465	0.31603	0.30285
105	0.32515	0.28192	0.31426	0.33604	0.31900
106	0.34134	0.29438	0.32992	0.35202	0.33189

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40398	0.41236	0.36489	0.46792	0.33753
93	0.39559	0.40698	0.35556	0.45925	0.33384
94	0.39834	0.40874	0.35862	0.46209	0.33505
95	0.37384	0.39302	0.33135	0.43675	0.32427
96	0.37484	0.39366	0.33246	0.43779	0.32471
97	0.38564	0.40059	0.34448	0.44896	0.32946
98	0.38137	0.39785	0.33973	0.44454	0.32759
99	0.38670	0.40127	0.34565	0.45005	0.32993
100	0.39610	0.40730	0.35612	0.45977	0.33406
101	0.41499	0.41942	0.37714	0.47930	0.34237
102	0.41449	0.41910	0.37659	0.47879	0.34215
103	0.40808	0.41498	0.36945	0.47215	0.33933
104	0.43667	0.43333	0.40127	0.50171	0.35190
105	0.45910	0.44772	0.42624	0.52491	0.36176
106	0.47702	0.45922	0.44618	0.54344	0.36964

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.77812	0.60062	0.64069	1.02465	0.62600
93	0.81452	0.62637	0.66104	1.07903	0.65515
94	0.80113	0.61690	0.65356	1.05903	0.64443
95	0.83460	0.64058	0.67227	1.10903	0.67123
96	0.85835	0.65737	0.68554	1.14449	0.69025
97	0.88810	0.67842	0.70218	1.18894	0.71407
98	0.91647	0.69849	0.71804	1.23131	0.73679
99	0.92250	0.70275	0.72140	1.24031	0.74162
100	0.93660	0.71273	0.72929	1.26137	0.75290
101	0.95149	0.72326	0.73761	1.28362	0.76483
102	0.96740	0.73451	0.74650	1.30737	0.77757
103	0.94485	0.71857	0.73390	1.27370	0.75952
104	0.96727	0.73442	0.74643	1.30718	0.77746
105	0.98896	0.74976	0.75856	1.33957	0.79483
106	1.01259	0.76649	0.77177	1.37488	0.81376

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.50840	1.11246	0.99942	2.21105	1.33281
93	1.57771	1.13191	1.01689	2.25865	1.36378
94	1.55222	1.12476	1.01047	2.24114	1.35239
95	1.61595	1.14263	1.02652	2.28491	1.38085
96	1.66115	1.15531	1.03791	2.31595	1.40105
97	1.71781	1.17120	1.05219	2.35486	1.42636
98	1.77183	1.18635	1.06580	2.39196	1.45049
99	1.78330	1.18957	1.06869	2.39984	1.45561
100	1.81014	1.19710	1.07545	2.41827	1.46760
101	1.83850	1.20505	1.08260	2.43775	1.48027

102	1.86878	1.21355	1.09023	2.45854	1.49380
103	1.82586	1.20151	1.07941	2.42907	1.47463
104	1.86854	1.21348	1.09017	2.45837	1.49369
105	1.90983	1.22506	1.10057	2.48673	1.51213
106	1.95484	1.23769	1.11191	2.51764	1.53224

CASE 3 -- SALMON ENHANCEMENT PROGRAM IS ELIMINATED

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37529	1.20448	1.18535	1.26130	0.94985
94	1.33757	1.17569	1.15320	1.22529	0.92370
95	1.41029	1.23119	1.21520	1.29472	0.97413
96	1.48124	1.28534	1.27569	1.36244	1.02333
97	1.62979	1.39871	1.40234	1.50425	1.12635
98	1.77768	1.47343	1.48581	1.59770	1.19424
99	1.77755	1.51148	1.52832	1.64530	1.22882
100	1.82675	1.54903	1.57027	1.69227	1.26294
101	1.85131	1.56778	1.59121	1.71572	1.27998
102	1.90895	1.61177	1.64035	1.77074	1.31995
103	1.96692	1.65601	1.68978	1.82608	1.36015
104	2.02623	1.70128	1.74035	1.88270	1.40128
105	2.07731	1.74026	1.78389	1.93146	1.43670
106	2.13953	1.78775	1.83694	1.99086	1.47985

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26133	0.23276	0.25250	0.27303	0.26814
94	0.27137	0.24049	0.26222	0.28295	0.27614
95	0.38941	0.33141	0.37645	0.39948	0.37021
96	0.41403	0.35037	0.40027	0.42379	0.38982
97	0.48671	0.40635	0.47060	0.49554	0.44774
98	0.51052	0.42469	0.49364	0.51905	0.46672
99	0.52624	0.43680	0.50886	0.53456	0.47924
100	0.53877	0.44645	0.52099	0.54694	0.48923
101	0.54737	0.45307	0.52930	0.55542	0.49608
102	0.55905	0.46207	0.54061	0.56696	0.50539
103	0.56213	0.46444	0.54359	0.56999	0.50784
104	0.57665	0.47562	0.55764	0.58433	0.51941
105	0.58662	0.48330	0.56728	0.59417	0.52736
106	0.60666	0.49874	0.58668	0.61396	0.54333

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.38845	0.40239	0.34760	0.45186	0.33069
94	0.39956	0.40952	0.35997	0.46335	0.33558
95	0.53024	0.49336	0.50542	0.59847	0.39304
96	0.55749	0.51085	0.53574	0.62664	0.40502
97	0.63795	0.56247	0.62529	0.70984	0.44040
98	0.66431	0.57938	0.65463	0.73709	0.45199
99	0.68172	0.59054	0.67400	0.75509	0.45964
100	0.69559	0.59945	0.68944	0.76943	0.46574
101	0.70511	0.60555	0.70003	0.77927	0.46993
102	0.71804	0.61385	0.71442	0.79264	0.47561
103	0.72145	0.61603	0.71822	0.79616	0.47711
104	0.73752	0.62635	0.73611	0.81279	0.48418
105	0.74856	0.63343	0.74839	0.82420	0.48903

106	0.77075	0.64767	0.77309	0.84714	0.49879

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82395	0.63304	0.66631	1.09311	0.66270
94	0.80497	0.61961	0.65570	1.06476	0.64750
95	0.84156	0.64550	0.67616	1.11942	0.67680
96	0.87726	0.67075	0.69611	1.17274	0.70539
97	0.95201	0.72363	0.73790	1.28439	0.76525
98	1.00127	0.75848	0.76544	1.35797	0.80469
99	1.02636	0.77623	0.77947	1.39545	0.82479
100	1.05112	0.79374	0.79331	1.43243	0.84461
101	1.06348	0.80248	0.80022	1.45089	0.85451
102	1.09249	0.82300	0.81644	1.49422	0.87773
103	1.12166	0.84364	0.83274	1.53779	0.90109
104	1.15150	0.86475	0.84943	1.58236	0.92499
105	1.17720	0.88293	0.86380	1.62075	0.94557
106	1.20851	0.90508	0.88130	1.66752	0.97064

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59566	1.13694	1.02141	2.27097	1.37179
94	1.55952	1.12680	1.01231	2.24616	1.35565
95	1.62919	1.14635	1.02986	2.29401	1.38677
96	1.69716	1.16541	1.04699	2.34068	1.41713
97	1.83949	1.20533	1.08285	2.43843	1.48071
98	1.93328	1.23164	1.10648	2.50284	1.52261
99	1.98105	1.24504	1.11852	2.53564	1.54395
100	2.02819	1.25826	1.13040	2.56802	1.56501
101	2.05173	1.26486	1.13633	2.58418	1.57552
102	2.10695	1.28035	1.15024	2.62210	1.60019
103	2.16249	1.29593	1.16423	2.66025	1.62500
104	2.21931	1.31187	1.17855	2.69927	1.65038
105	2.26825	1.32559	1.19088	2.73288	1.67224
106	2.32786	1.34232	1.20590	2.77382	1.69887

CASE 4A -- SALMON PRODUCTION FROM ENHANCEMENT PROGRAM IS INCREASED BY 15%

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37639	1.20532	1.18630	1.26236	0.95062
94	1.33850	1.17640	1.15399	1.22619	0.92435
95	1.40331	1.22587	1.20925	1.28805	0.96929
96	1.44121	1.25479	1.24156	1.32423	0.99557
97	1.49531	1.29608	1.28769	1.37588	1.03309
98	1.54486	1.33390	1.32993	1.42318	1.06746
99	1.57654	1.35807	1.35694	1.45342	1.08942
100	1.60937	1.38313	1.38493	1.48476	1.11219
101	1.64187	1.40793	1.41264	1.51578	1.13473
102	1.68369	1.43985	1.44830	1.55571	1.16373
103	1.72695	1.47287	1.48518	1.59700	1.19373
104	1.77688	1.51098	1.52775	1.64467	1.22836
105	1.82103	1.54467	1.56539	1.68681	1.25897
106	1.86767	1.58027	1.60516	1.73134	1.29132

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26626	0.23655	0.25727	0.27790	0.27207
94	0.27726	0.24503	0.26792	0.28876	0.28083
95	0.23266	0.21068	0.22476	0.24473	0.24529
96	0.23852	0.21519	0.23043	0.25052	0.24596
97	0.23766	0.21453	0.22960	0.24967	0.24928
98	0.23265	0.21067	0.22475	0.24472	0.24528
99	0.23427	0.21191	0.22631	0.24632	0.24657
100	0.24182	0.21773	0.23362	0.25377	0.25259
101	0.26145	0.23285	0.25261	0.27315	0.26823
102	0.26054	0.23215	0.25174	0.27226	0.26751
103	0.25690	0.22934	0.24821	0.26866	0.26461
104	0.28501	0.25100	0.27542	0.29642	0.28701
105	0.30371	0.26540	0.29351	0.31487	0.30191
106	0.32020	0.27810	0.30947	0.33116	0.31505

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39391	0.40589	0.35368	0.45750	0.33310
94	0.40609	0.41371	0.36723	0.47010	0.33845
95	0.35671	0.38203	0.31228	0.41904	0.31674
96	0.36320	0.38619	0.31951	0.42575	0.31960
97	0.36225	0.38558	0.31844	0.42477	0.31918
98	0.35670	0.38202	0.31227	0.41903	0.31674
99	0.35849	0.38317	0.31426	0.42088	0.31752
100	0.36685	0.38853	0.32357	0.42953	0.32120
101	0.38858	0.40248	0.34775	0.45199	0.33075
102	0.38758	0.40183	0.34663	0.45096	0.33031
103	0.38354	0.39925	0.34215	0.44679	0.32854
104	0.41467	0.41921	0.37679	0.47897	0.34223
105	0.43537	0.43249	0.39982	0.50037	0.35133
106	0.45362	0.44421	0.42014	0.51925	0.35935

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82450	0.63343	0.66662	1.09394	0.66315
94	0.80544	0.61995	0.65596	1.06546	0.64788
95	0.83805	0.64301	0.67419	1.11417	0.67399
96	0.85712	0.65651	0.68486	1.14266	0.68926
97	0.88434	0.67576	0.70007	1.18332	0.71106
98	0.90928	0.69340	0.71401	1.22056	0.73103
99	0.92522	0.70468	0.72292	1.24437	0.74379
100	0.94174	0.71636	0.73216	1.26905	0.75702
101	0.95809	0.72793	0.74130	1.29348	0.77012
102	0.97914	0.74282	0.75307	1.32491	0.78697
103	1.00090	0.75822	0.76524	1.35742	0.80440
104	1.02603	0.77599	0.77928	1.39495	0.82452
105	1.04824	0.79170	0.79170	1.42813	0.84231
106	1.07172	0.80831	0.80482	1.46319	0.86110

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59672	1.13724	1.02168	2.27170	1.37226
94	1.56042	1.12705	1.01253	2.24677	1.35605
95	1.62251	1.14447	1.02818	2.28941	1.38378

96	1.65882	1.15466	1.03733	2.31435	1.40001
97	1.71065	1.16919	1.05038	2.34994	1.42316
98	1.75812	1.18251	1.06235	2.38255	1.44437
99	1.78847	1.19102	1.06999	2.40339	1.45792
100	1.81992	1.19984	1.07792	2.42499	1.47197
101	1.85106	1.20858	1.08576	2.44637	1.48588
102	1.89113	1.21982	1.09586	2.47389	1.50378
103	1.93258	1.23144	1.10630	2.50235	1.52230
104	1.98042	1.24486	1.11836	2.53521	1.54367
105	2.02271	1.25672	1.12901	2.56425	1.56256
106	2.06740	1.26926	1.14027	2.59494	1.58252

CASE 4B -- SALMON HARVEST FROM ENHANCMENT IS DECREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37613	1.20512	1.18607	1.26210	0.95044
94	1.33827	1.17623	1.15380	1.22596	0.92419
95	1.40393	1.22634	1.20978	1.28864	0.96972
96	1.45096	1.26223	1.24987	1.33354	1.00233
97	1.52637	1.31979	1.31417	1.40553	1.05463
98	1.58707	1.36611	1.36592	1.46347	1.09672
99	1.62345	1.39388	1.39694	1.49820	1.12195
100	1.65789	1.42016	1.42630	1.53108	1.14584
101	1.68958	1.44435	1.45332	1.56133	1.16782
102	1.73148	1.47632	1.48904	1.60132	1.19687
103	1.78103	1.51414	1.53129	1.64862	1.23123
104	1.83095	1.55224	1.57385	1.69628	1.26585
105	1.87715	1.58750	1.61324	1.74038	1.29789
106	1.92786	1.62620	1.65647	1.78879	1.33306

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26547	0.23595	0.25651	0.27713	0.27144
94	0.27632	0.24431	0.26701	0.28784	0.28009
95	0.26027	0.23194	0.25148	0.27199	0.26730
96	0.26472	0.23537	0.25578	0.27638	0.27084
97	0.28560	0.25146	0.27599	0.29700	0.28748
98	0.28624	0.25194	0.27660	0.29762	0.28799
99	0.29216	0.25650	0.28233	0.30347	0.29270
100	0.30168	0.26383	0.29155	0.31287	0.30029
101	0.31746	0.27599	0.30682	0.32845	0.31287
102	0.31637	0.27515	0.30576	0.32737	0.31200
103	0.31389	0.27324	0.30336	0.32492	0.31002
104	0.3`061	0.29382	0.32922	0.35130	0.33131
105	0.3 979	0.30860	0.34779	0.37024	0.34660
106	0.3`530	0.32054	0.36279	0.38555	0.35896

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39304	0.40534	0.35271	0.45660	0.33271
94	0.40505	0.41304	0.36608	0.46902	0.33799
95	0.38728	0.40164	0.34630	0.45065	0.33018
96	0.39220	0.40480	0.35178	0.45574	0.33235
97	0.41532	0.41963	0.37751	0.47965	0.34251

98	0.41602	0.42008	0.37829	0.48037	0.34282
99	0.42258	0.42429	0.38559	0.48715	0.34570
100	0.43312	0.43105	0.39732	0.49804	0.35034
101	0.45059	0.44226	0.41676	0.51611	0.35802
102	0.44938	0.44149	0.41542	0.51486	0.35749
103	0.44663	0.43972	0.41236	0.51202	0.35628
104	0.47621	0.45870	0.44528	0.54260	0.36929
105	0.49745	0.47233	0.46892	0.56457	0.37862
106	0.51462	0.48334	0.48803	0.58232	0.38617

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82437	0.63334	0.66655	1.09374	0.66304
94	0.80532	0.61986	0.65590	1.06529	0.64778
95	0.83836	0.64323	0.67437	1.11464	0.67424
96	0.86203	0.65998	0.68760	1.14999	0.69319
97	0.89997	0.68682	0.70881	1.20667	0.72358
98	0.93052	0.70842	0.72589	1.25229	0.74803
99	0.94882	0.72137	0.73612	1.27963	0.76269
100	0.96616	0.73364	0.74581	1.30552	0.77657
101	0.98210	0.74491	0.75472	1.32933	0.78934
102	1.00318	0.75983	0.76651	1.36083	0.80622
103	1.02812	0.77747	0.78045	1.39807	0.82619
104	1.05324	0.79524	0.79449	1.43559	0.84630
105	1.07648	0.81168	0.80749	1.47031	0.86492
106	1.10200	0.82973	0.82175	1.50843	0.88535

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59646	1.13716	1.02161	2.27153	1.37215
94	1.56019	1.12699	1.01248	2.24662	1.35595
95	1.62310	1.14464	1.02833	2.28982	1.38405
96	1.66816	1.15727	1.03968	2.32076	1.40418
97	1.74041	1.17754	1.05788	2.37038	1.43645
98	1.79856	1.19385	1.07254	2.41032	1.46243
99	1.83341	1.20363	1.08132	2.43425	1.47800
100	1.86642	1.21288	1.08963	2.45692	1.49274
101	1.89677	1.22140	1.09728	2.47777	1.50630
102	1.93692	1.23266	1.10740	2.50533	1.52423
103	1.98439	1.24597	1.11936	2.53794	1.54544
104	2.03222	1.25939	1.13141	2.57078	1.56681
105	2.07648	1.27181	1.14256	2.60118	1.58658
106	2.12506	1.28543	1.15480	2.63455	1.60828

CASE 5 -- PINK SALMON ENHANCEMENT PROGRAM IS ELIMINATED

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37613	1.20512	1.18608	1.26211	0.95044
94	1.33829	1.17624	1.15381	1.22598	0.92419
95	1.41108	1.23179	1.21587	1.29547	0.97468
96	1.45144	1.26260	1.25028	1.33400	1.00267
97	1.51564	1.31159	1.30502	1.39528	1.04719
98	1.57372	1.35592	1.35453	1.45072	1.08746
99	1.60732	1.38156	1.38318	1.48280	1.11077
100	1.64219	1.40818	1.41291	1.51609	1.13495
101	1.67526	1.43341	1.44111	1.54765	1.15788

102	1.72102	1.46834	1.48013	1.59135	1.18962
103	1.76771	1.50398	1.51993	1.63591	1.22200
104	1.81922	1.54329	1.56385	1.68508	1.25772
105	1.86645	1.57934	1.60412	1.73018	1.29048
106	1.92216	1.62185	1.65161	1.78335	1.32911

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26136	0.23278	0.25253	0.27306	0.26816
94	0.27140	0.24052	0.26225	0.28298	0.27617
95	0.38945	0.33144	0.37649	0.39952	0.37024
96	0.41363	0.35006	0.39988	0.42339	0.38950
97	0.42511	0.35890	0.41099	0.43472	0.39365
98	0.43010	0.36275	0.41582	0.43965	0.40263
99	0.43723	0.36824	0.42272	0.44669	0.40831
100	0.44733	0.37602	0.43250	0.45667	0.41636
101	0.45543	0.38226	0.44034	0.46466	0.42282
102	0.46705	0.39121	0.45158	0.47613	0.43207
103	0.47019	0.39363	0.45462	0.47923	0.43458
104	0.48479	0.40487	0.46875	0.49364	0.44621
105	0.49496	0.41271	0.47859	0.50369	0.45432
106	0.51511	0.42823	0.49809	0.52358	0.47038

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.392013	0.404683	0.351578	0.45555	0.332263
94	0.40383	0.412258	0.364723	0.467763	0.33746
95	0.41881	0.42187	0.381395	0.48325	0.344048
96	0.429438	0.42869	0.393223	0.494243	0.348723
97	0.441105	0.436175	0.406208	0.506303	0.353848
98	0.440888	0.43604	0.405968	0.50608	0.353755
99	0.446868	0.439873	0.412628	0.51226	0.356388
100	0.457118	0.44645	0.424028	0.522855	0.360885
101	0.47208	0.45605	0.44069	0.538335	0.367468
102	0.475858	0.458473	0.444883	0.542235	0.369128
103	0.474793	0.457785	0.443698	0.541133	0.368663
104	0.50056	0.47432	0.472375	0.567773	0.379988
105	0.519568	0.486513	0.49353	0.587433	0.38835
106	0.538525	0.498678	0.514633	0.607028	0.396683

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82437	0.63334	0.66655	1.09375	0.66304
94	0.80533	0.61987	0.65590	1.06530	0.64779
95	0.84196	0.64578	0.67638	1.12001	0.67712
96	0.86227	0.66015	0.68773	1.15035	0.69339
97	0.89457	0.68300	0.70579	1.19860	0.71925
98	0.92380	0.70367	0.72213	1.24225	0.74265
99	0.94071	0.71563	0.73158	1.26751	0.75619
100	0.95825	0.72804	0.74139	1.29371	0.77024
101	0.97489	0.73982	0.75069	1.31857	0.78357
102	0.99792	0.75611	0.76357	1.35297	0.80201
103	1.02141	0.77273	0.77670	1.38806	0.82082
104	1.04733	0.79106	0.79119	1.42677	0.84158
105	1.07110	0.80787	0.80448	1.46228	0.86061
106	1.09913	0.82770	0.82015	1.50414	0.88306

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59647	1.13717	1.02161	2.27153	1.37215
94	1.56021	1.12700	1.01248	2.24663	1.35595
95	1.62995	1.14656	1.03005	2.29452	1.38711
96	1.66862	1.15740	1.03980	2.32108	1.40438
97	1.73012	1.17466	1.05529	2.36332	1.43186
98	1.78577	1.19026	1.06931	2.40153	1.45671
99	1.81796	1.19929	1.07742	2.42364	1.47110
100	1.85137	1.20866	1.08584	2.44658	1.48602
101	1.88305	1.21755	1.09382	2.46834	1.50017
102	1.92690	1.22985	1.10487	2.49846	1.51976
103	1.97163	1.24240	1.11614	2.52917	1.53974
104	2.02098	1.25624	1.12858	2.56306	1.56178
105	2.06623	1.26893	1.13998	2.59414	1.58200
106	2.11960	1.28390	1.15343	2.63080	1.60584

CASE 6 -- SOCKEYE SALMON ENHANCEMENT PROGRAM IS ELIMINATED

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.31900	1.16152	1.13736	1.20757	0.91082
93	1.39366	1.21850	1.20102	1.27884	0.96260
94	1.36540	1.19693	1.17692	1.25186	0.94300
95	1.43587	1.25072	1.23701	1.31914	0.99187
96	1.49413	1.29518	1.28668	1.37475	1.03227
97	1.58648	1.36566	1.36542	1.46291	1.09632
98	1.66728	1.42733	1.43431	1.54004	1.15235
99	1.70029	1.45252	1.46245	1.57155	1.17524
100	1.74431	1.48611	1.49998	1.61357	1.20577
101	1.76693	1.50338	1.51926	1.63517	1.22146
102	1.82020	1.54404	1.56469	1.68602	1.25840
103	1.87327	1.58454	1.60993	1.73668	1.29520
104	1.92519	1.62417	1.65420	1.78625	1.33121
105	1.97229	1.66012	1.69436	1.83121	1.36388
106	2.02096	1.69726	1.73585	1.87767	1.39763

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27604	0.24409	0.26673	0.28755	0.27986
93	0.26623	0.23653	0.25724	0.27787	0.27204
94	0.27742	0.24515	0.26808	0.28892	0.28096
95	0.25637	0.22894	0.24770	0.26814	0.26419
96	0.26157	0.23294	0.25273	0.27327	0.26833
97	0.27260	0.24144	0.26340	0.28416	0.27712
98	0.27146	0.24056	0.26231	0.28304	0.27621
99	0.27648	0.24443	0.26716	0.28799	0.28021
100	0.28566	0.25150	0.27604	0.29705	0.28753
101	0.30076	0.26313	0.29066	0.31196	0.29956
102	0.30150	0.26370	0.29138	0.31269	0.30015
103	0.29929	0.26199	0.28923	0.31051	0.29839
104	0.32547	0.28216	0.31457	0.33636	0.31925
105	0.34490	0.29713	0.33338	0.35554	0.33474
106	0.36090	0.30945	0.34885	0.37133	0.34748

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40473	0.41284	0.36573	0.46869	0.33786

93	0.39387	0.40587	0.35364	0.45747	0.33308
94	0.40627	0.41382	0.36743	0.47028	0.33853
95	0.38296	0.39887	0.34150	0.44618	0.32828
96	0.38871	0.40256	0.34790	0.45213	0.33081
97	0.40092	0.41039	0.36149	0.46476	0.33618
98	0.39967	0.40959	0.36009	0.46346	0.33563
99	0.40522	0.41315	0.36627	0.46920	0.33807
100	0.41538	0.41967	0.37758	0.47971	0.34254
101	0.43210	0.43040	0.39619	0.49699	0.34989
102	0.43292	0.43092	0.39710	0.49784	0.35025
103	0.43047	0.42935	0.39437	0.49531	0.34917
104	0.45946	0.44795	0.42664	0.52528	0.36192
105	0.48097	0.46175	0.45058	0.54752	0.37138
106	0.49867	0.47311	0.47028	0.56583	0.37916

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.789478	0.60865	0.647035	1.04162	0.6351
93	0.82662	0.63493	0.667805	1.09711	0.664843
94	0.808778	0.622305	0.65783	1.070448	0.65055
95	0.842363	0.646065	0.6766	1.120613	0.677443
96	0.86572	0.66259	0.68966	1.155505	0.696153
97	0.901458	0.687873	0.70964	1.208883	0.724768
98	0.93299	0.710175	0.72727	1.255975	0.750015
99	0.949495	0.72185	0.736493	1.280638	0.763233
100	0.967655	0.734698	0.746653	1.307763	0.777775
101	0.982845	0.745443	0.755143	1.330448	0.78994
102	1.00559	0.76153	0.767853	1.364413	0.808145
103	1.029545	0.778478	0.781245	1.400198	0.827328
104	1.05473	0.79629	0.795328	1.43781	0.8475
105	1.077943	0.812715	0.8083	1.472493	0.86609
106	1.10262	0.83017	0.822105	1.509355	0.88585

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.530023	1.118533	1.004873	2.2259	1.3424[illegible]3
93	1.60075	1.13837	1.022693	2.274473	1.374063
94	1.56677	1.128835	1.01413	2.251135	1.35889
95	1.630713	1.14677	1.030243	2.295053	1.387453
96	1.675193	1.15925	1.041453	2.325598	1.40732
97	1.743235	1.17833	1.058598	2.372318	1.437715
98	1.80326	1.195175	1.07372	2.413545	1.464533
99	1.834695	1.203985	1.081638	2.435133	1.478573
100	1.869275	1.213685	1.090353	2.458885	1.49402
101	1.89819	1.221798	1.097635	2.47874	1.506935
102	1.94149	1.23394	1.108545	2.50848	1.526278
103	1.987103	1.246738	1.120043	2.539808	1.546655
104	2.035053	1.260188	1.132125	2.57273	1.568073
105	2.07926	1.272583	1.143263	2.603083	1.58782
106	2.126248	1.285768	1.155103	2.635358	1.608808

CASE 7A -- PRODUCTION FROM PINK SALMON ENHANCEMENT IS INCREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37627	1.20523	1.18620	1.26224	0.95054
94	1.33840	1.17632	1.15390	1.22608	0.92427
95	1.40320	1.22578	1.20915	1.28794	0.96921
96	1.44596	1.25842	1.24561	1.32877	0.99887

97	1.50970	1.30706	1.29995	1.38961	1.04307
98	1.56627	1.35024	1.34819	1.44362	1.08230
99	1.59883	1.37508	1.37594	1.47469	1.10488
100	1.63214	1.40051	1.40434	1.50649	1.12798
101	1.66502	1.42560	1.43238	1.53788	1.15078
102	1.70718	1.45778	1.46832	1.57813	1.18002
103	1.75283	1.49262	1.50725	1.62171	1.21168
104	1.80206	1.53019	1.54922	1.66871	1.24582
105	1.84743	1.56482	1.58790	1.71201	1.27728
106	1.89633	1.60214	1.62959	1.75870	1.31120

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26626	0.23655	0.25727	0.27790	0.27206
94	0.27726	0.24503	0.26791	0.28876	0.28083
95	0.23266	0.21067	0.22475	0.24473	0.24529
96	0.23859	0.21524	0.23050	0.25059	0.25002
97	0.24639	0.22125	0.23805	0.25829	0.25623
98	0.24431	0.21965	0.23603	0.25623	0.25457
99	0.24721	0.22188	0.23884	0.25910	0.25689
100	0.25514	0.22799	0.24651	0.26692	0.26321
101	0.27487	0.24319	0.26561	0.28641	0.27893
102	0.27391	0.24244	0.26467	0.28545	0.27816
103	0.27026	0.23963	0.26114	0.28185	0.27525
104	0.29834	0.26127	0.28832	0.30958	0.29763
105	0.31700	0.27564	0.30637	0.32799	0.31250
106	0.33347	0.28832	0.32231	0.34425	0.32562

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.393368	0.405553	0.353085	0.456953	0.332858
94	0.40545	0.413295	0.366525	0.469438	0.338173
95	0.375415	0.39403	0.3331	0.438383	0.324968
96	0.380995	0.39761	0.339308	0.444153	0.327423
97	0.391643	0.40444	0.35116	0.45516	0.332098
98	0.38947	0.40305	0.34874	0.452915	0.331148
99	0.394278	0.406133	0.354098	0.457885	0.333263
100	0.403928	0.412325	0.364828	0.467855	0.337498
101	0.422108	0.423988	0.385073	0.486665	0.345495
102	0.422403	0.424175	0.38539	0.486965	0.345625
103	0.419458	0.422283	0.382115	0.48392	0.344333
104	0.44896	0.441213	0.414945	0.51442	0.357298
105	0.470315	0.454913	0.438713	0.536505	0.366693
106	0.488253	0.466425	0.45868	0.555048	0.374578

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82444	0.63339	0.66659	1.09385	0.66310
94	0.80538	0.61991	0.65593	1.06538	0.64784
95	0.83799	0.64297	0.67416	1.11409	0.67395
96	0.85951	0.65820	0.68619	1.14623	0.69118
97	0.89158	0.68088	0.70412	1.19413	0.71686
98	0.92005	0.70102	0.72004	1.23666	0.73966
99	0.93642	0.71261	0.72919	1.26112	0.75277
100	0.95319	0.72447	0.73856	1.28616	0.76619
101	0.96974	0.73617	0.74781	1.31087	0.77944
102	0.99095	0.75118	0.75967	1.34256	0.79643

103	1.01393	0.76743	0.77252	1.37687	0.81483
104	1.03870	0.78495	0.78637	1.41388	0.83466
105	1.06153	0.80110	0.79913	1.44797	0.85294
106	1.08614	0.81851	0.81289	1.48473	0.87265

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22?22	1.34073
93	1.59660	1.13720	1.02165	2.27162	1.37221
94	1.56031	1.12703	1.01251	2.24670	1.35600
95	1.62240	1.14444	1.02815	2.28934	1.38373
96	1.66337	1.15593	1.03847	2.31748	1.40204
97	1.72443	1.17306	1.05386	2.35941	1.42932
98	1.77864	1.18826	1.06752	2.39663	1.45353
99	1.80982	1.19701	1.07537	2.41805	1.46746
100	1.84174	1.20596	1.08342	2.43997	1.48172
101	1.87324	1.21480	1.09135	2.46160	1.49579
102	1.91363	1.22613	1.10153	2.48934	1.51383
103	1.95737	1.23840	1.11255	2.51938	1.53337
104	2.00454	1.25163	1.12444	2.55178	1.55444
105	2.04800	1.26382	1.13539	2.58163	1.57386
106	2.09486	1.27696	1.14719	2.61380	1.59479

CASE 7B -- PRODUCTION FROM PINK ENHANCEMENT IS DECREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37624	1.20520	1.18616	1.26220	0.95051
94	1.33837	1.17630	1.15388	1.22606	0.92425
95	1.40465	1.22688	1.21039	1.28932	0.97021
96	1.44688	1.25912	1.24640	1.32965	0.99951
97	1.51085	1.30794	1.30094	1.39071	1.04387
98	1.56753	1.35120	1.34926	1.44482	1.08318
99	1.60044	1.37631	1.37732	1.47623	1.10600
100	1.63405	1.40197	1.40598	1.50832	1.12931
101	1.66660	1.42681	1.43373	1.53939	1.15188
102	1.70944	1.45950	1.47025	1.58029	1.18159
103	1.75538	1.49456	1.50942	1.62414	1.21345
104	1.80523	1.53261	1.55192	1.67173	1.24802
105	1.85122	1.56771	1.59113	1.71563	1.27991
106	1.90043	1.60527	1.63309	1.76261	1.31404

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26498	0.23557	0.25603	0.27664	0.27105
94	0.27573	0.24385	0.266[illegible]	0.28725	0.27961
95	0.27722	0.24500	0.267[illegible]	0.28872	0.28080
96	0.28341	0.24976	0.27387	0.29483	0.28573
97	0.29401	0.25793	0.28412	0.30529	0.29418
98	0.29205	0.25642	0.28223	0.30336	0.29262
99	0.29793	0.26095	0.28792	0.30917	0.29731
100	0.30757	0.26837	0.29725	0.31868	0.30499
101	0.31943	0.27750	0.30872	0.33039	0.31443
102	0.32140	0.27903	0.31063	0.33234	0.31601
103	0.32020	0.27810	0.30947	0.33116	0.31506

104	0.34638	0.29827	0.33481	0.35700	0.33592
105	0.36511	0.31269	0.35293	0.37549	0.35084
106	0.37888	0.32330	0.36626	0.38909	0.36182

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.393015	0.405325	0.352693	0.456585	0.332703
94	0.405028	0.413025	0.366055	0.469	0.337988
95	0.387748	0.401943	0.346825	0.451135	0.33039
96	0.393398	0.405568	0.353113	0.456978	0.332875
97	0.40482	0.412895	0.365828	0.468785	0.337893
98	0.40268	0.411528	0.363445	0.466575	0.336958
99	0.408315	0.415138	0.36972	0.4724	0.339435
100	0.418438	0.421633	0.380978	0.48286	0.343878
101	0.434438	0.431898	0.398795	0.499415	0.350915
102	0.435548	0.43261	0.40002	0.500558	0.351405
103	0.433283	0.431153	0.397498	0.498213	0.35041
104	0.462255	0.449743	0.429743	0.528165	0.363145
105	0.48363	0.463455	0.453533	0.550273	0.372548
106	0.500823	0.47449	0.47267	0.568045	0.380105

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82442	0.63338	0.66658	1.09382	0.66308
94	0.80537	0.61990	0.65592	1.06536	0.64782
95	0.83872	0.64349	0.67457	1.11518	0.67453
96	0.85998	0.65852	0.68645	1.14692	0.69155
97	0.89216	0.68129	0.70445	1.19500	0.71732
98	0.92069	0.70147	0.72039	1.23760	0.74016
99	0.93724	0.71318	0.72965	1.26234	0.75342
100	0.95416	0.72515	0.73910	1.28760	0.76697
101	0.97054	0.73674	0.74826	1.31207	0.78008
102	0.99209	0.75198	0.76031	1.34426	0.79734
103	1.01521	0.76834	0.77323	1.37879	0.81585
104	1.04029	0.78608	0.78726	1.41626	0.83594
105	1.06344	0.80245	0.80020	1.45083	0.85447
106	1.08820	0.81997	0.81404	1.48781	0.87430

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59657	1.13719	1.02164	2.27160	1.37220
94	1.56028	1.12702	1.01250	2.24668	1.35599
95	1.62378	1.14483	1.02850	2.29029	1.38436
96	1.66425	1.15618	1.03869	2.31808	1.40243
97	1.72554	1.17337	1.05414	2.36017	1.42981
98	1.77984	1.18860	1.06782	2.39747	1.45407
99	1.81137	1.19744	1.07576	2.41912	1.46815
100	1.84358	1.20648	1.08388	2.44123	1.48254
101	1.87476	1.21523	1.09174	2.46265	1.49647
102	1.91580	1.22674	1.10208	2.49083	1.51480
103	1.95981	1.23908	1.11317	2.52106	1.53446
104	2.00757	1.25248	1.12520	2.55386	1.55580
105	2.05164	1.26484	1.13630	2.58412	1.57548
106	2.09879	1.27806	1.14818	2.61650	1.59654

CASE 8A -- SALMON PRODUCTION FROM SOCKEYE ENHANCEMENT IS INCREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37627	1.20523	1.18620	1.26224	0.95054
94	1.33841	1.17633	1.15391	1.22609	0.92428
95	1.40390	1.22632	1.20975	1.28862	0.96970
96	1.44513	1.25778	1.24490	1.32797	0.99829
97	1.50006	1.29971	1.29174	1.38041	1.03639
98	1.55235	1.33962	1.33632	1.43033	1.07265
99	1.58423	1.36395	1.36350	1.46076	1.09476
100	1.61891	1.39041	1.39306	1.49386	1.11880
101	1.65147	1.41526	1.42083	1.52495	1.14139
102	1.69334	1.44722	1.45653	1.56492	1.17042
103	1.73726	1.48073	1.49397	1.60684	1.20088
104	1.78677	1.51852	1.53618	1.65411	1.23522
105	1.83255	1.55346	1.57521	1.69781	1.26696
106	1.87963	1.58939	1.61535	1.74275	1.29961

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27650	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25990	0.23166	0.25112	0.27163	0.26700
97	0.26990	0.23936	0.26079	0.28149	0.27497
98	0.26779	0.23773	0.25875	0.27941	0.27328
99	0.27254	0.24139	0.26335	0.28410	0.27707
100	0.28153	0.24831	0.27205	0.29297	0.28423
101	0.29687	0.26013	0.28690	0.30812	0.29646
102	0.29754	0.26065	0.28755	0.30879	0.29700
103	0.29518	0.25883	0.28526	0.30646	0.29512
104	0.32135	0.27899	0.31059	0.33229	0.31597
105	0.34087	0.29402	0.32948	0.35156	0.33153
106	0.35696	0.30642	0.34505	0.36745	0.34435

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39320	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38687	0.40138	0.34585	0.45023	0.33000
97	0.39793	0.40848	0.35816	0.46167	0.33487
98	0.39560	0.40698	0.35556	0.45925	0.33384
99	0.40086	0.41035	0.36141	0.46469	0.33615
100	0.41081	0.41674	0.37249	0.47498	0.34053
101	0.42780	0.42764	0.39140	0.49254	0.34800
102	0.42854	0.42811	0.39222	0.49331	0.34832
103	0.42593	0.42644	0.38932	0.49061	0.34717
104	0.45490	0.44502	0.42156	0.52057	0.35991
105	0.47651	0.45889	0.44561	0.54291	0.36941
106	0.49432	0.47032	0.46543	0.56132	0.37725

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824433	0.633383	0.666583	1.093843	0.663093

94	0.805383	0.619903	0.65593	1.065375	0.647833
95	0.838343	0.643223	0.674353	1.114605	0.674223
96	0.859555	0.65823	0.686215	1.146298	0.691215
97	0.890585	0.68018	0.703563	1.192643	0.716063
98	0.918533	0.699948	0.719188	1.234383	0.738438
99	0.934895	0.711523	0.72833	1.25883	0.75154
100	0.95188	0.72354	0.737833	1.2842	0.765143
101	0.968323	0.735168	0.747023	1.308753	0.77831
102	0.98963	0.75024	0.75893	1.340575	0.795368
103	1.012435	0.766375	0.77168	1.374643	0.813628
104	1.037318	0.783973	0.785595	1.411803	0.833555
105	1.060363	0.80028	0.798473	1.446233	0.852013
106	1.08484	0.817593	0.812165	1.4828	0.871613

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.596585	1.1372	1.021643	2.271613	1.372203
94	1.560305	1.127023	1.012503	2.246695	1.356003
95	1.623055	1.144623	1.028313	2.289793	1.384033
96	1.663455	1.155958	1.038495	2.317535	1.402078
97	1.722535	1.172525	1.053383	2.358103	1.428468
98	1.775733	1.187453	1.066785	2.394643	1.452235
99	1.806895	1.196188	1.074633	2.41604	1.466155
100	1.839238	1.20526	1.082785	2.43826	1.480605
101	1.870538	1.21404	1.090668	2.459748	1.49458
102	1.911105	1.225418	1.10089	2.487613	1.512703
103	1.954525	1.2376	1.111835	2.517435	1.532103
104	2.001898	1.250888	1.12377	2.549963	1.553263
105	2.045788	1.263195	1.13483	2.580098	1.572868
106	2.092395	1.276273	1.146573	2.61211	1.593685

CASE 8B -- SALMON ENHANCEMENT FROM PINK DECREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37624	1.20520	1.18616	1.26220	0.95051
94	1.33836	1.17629	1.15387	1.22605	0.92425
95	1.40386	1.22628	1.20971	1.28857	0.96967
96	1.44733	1.25946	1.24678	1.33008	0.99982
97	1.52184	1.31633	1.31030	1.40120	1.05149
98	1.58036	1.36099	1.36020	1.45706	1.09207
99	1.61373	1.38646	1.38865	1.48892	1.11522
100	1.64888	1.41329	1.41862	1.52248	1.13959
101	1.68001	1.43704	1.44516	1.55219	1.16118
102	1.72380	1.47046	1.48249	1.59399	1.19154
103	1.77111	1.50657	1.52284	1.63916	1.22436
104	1.82069	1.54441	1.56510	1.68649	1.25874
105	1.86666	1.57950	1.60430	1.73037	1.29062
106	1.91704	1.61795	1.64725	1.77847	1.32556

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25996	0.23170	0.25117	0.27168	0.26704
97	0.27044	0.23977	0.26131	0.28203	0.27540

98	0.26867	0.23841	0.25961	0.28028	0.27399
99	0.27354	0.24216	0.26432	0.28509	0.27787
100	0.28256	0.24911	0.27304	0.29399	0.28505
101	0.29785	0.26089	0.28784	0.30909	0.29724
102	0.29852	0.26140	0.28849	0.30975	0.29778
103	0.29622	0.25963	0.28626	0.30748	0.29594
104	0.32239	0.27979	0.31159	0.33332	0.31680
105	0.34188	0.29480	0.33045	0.35256	0.33233
106	0.35800	0.30722	0.34605	0.36848	0.34518

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38693	0.40142	0.34591	0.45029	0.33003
97	0.39853	0.40886	0.35883	0.46228	0.33513
98	0.39658	0.40761	0.35665	0.46026	0.33427
99	0.40197	0.41107	0.36265	0.46584	0.33664
100	0.41195	0.41747	0.37376	0.47616	0.34103
101	0.42888	0.42833	0.39260	0.49366	0.34847
102	0.42962	0.42881	0.39343	0.49443	0.34880
103	0.42707	0.42717	0.39059	0.49179	0.34768
104	0.45605	0.44576	0.42284	0.52175	0.36042
105	0.47762	0.45960	0.44685	0.54406	0.36991
106	0.49547	0.47106	0.46672	0.56252	0.37775

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824428	0.63338	0.66658	1.093835	0.653088
94	0.805378	0.619898	0.655928	1.065365	0.647828
95	0.838335	0.643218	0.67435	1.114595	0.674218
96	0.859833	0.658425	0.68637	1.146713	0.691438
97	0.893325	0.68212	0.705095	1.196735	0.718255
98	0.922055	0.70244	0.721158	1.239643	0.741258
99	0.938605	0.714148	0.730405	1.261373	0.754513
100	0.95565	0.726208	0.739943	1.289833	0.768163
101	0.97191	0.737708	0.74903	1.314115	0.781183
102	0.993463	0.75295	0.761073	1.346298	0.798435
103	1.016695	0.769388	0.77406	1.381005	0.817038
104	1.041583	0.78699	0.78798	1.418175	0.836973
105	1.064655	0.803315	0.800873	1.452643	0.855448
106	1.089548	0.820923	0.814795	1.48983	0.87538

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.596575	1.137198	1.02164	2.271608	1.3722
94	1.560295	1.12702	1.0125	2.246688	1.355998
95	1.623045	1.14462	1.02831	2.289785	1.384028
96	1.663983	1.156105	1.038628	2.3179	1.402315
97	1.727753	1.173988	1.054698	2.361685	1.430798
98	1.78244	1.189335	1.068475	2.399248	1.455233
99	1.813963	1.19817	1.076413	2.420893	1.46931
100	1.846418	1.207273	1.084595	2.44319	1.483813
101	1.877373	1.215958	1.09239	2.464443	1.497635
102	1.9184	1.227463	1.102728	2.492623	1.515963
103	1.962635	1.239875	1.11388	2.523003	1.535725

104	2.010023	1.253165	1.125818	2.55554	1.556895
105	2.053958	1.265488	1.136888	2.585703	1.576518
106	2.101358	1.278788	1.14883	2.618265	1.597688

CASE 9A -- CHUM SALMON HARVEST FROM ENHANCEMENT INCREASED BY 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.22630	1.20973	1.28859	0.96968
96	1.44636	1.25872	1.24595	1.32915	0.99914
97	1.51011	1.30737	1.30030	1.39000	1.04335
98	1.56681	1.35065	1.34865	1.44413	1.08268
99	1.59958	1.37566	1.37658	1.47541	1.10540
100	1.63302	1.40118	1.40510	1.50734	1.12859
101	1.66570	1.42612	1.43296	1.53853	1.15125
102	1.70821	1.45856	1.46920	1.57911	1.18074
103	1.75400	1.49352	1.50825	1.62283	1.21249
104	1.80335	1.53117	1.55031	1.66993	1.24671
105	1.84911	1.56610	1.58934	1.71362	1.27845
106	1.89823	1.60359	1.63121	1.76051	1.31251

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27166	0.26703
97	0.268053	0.237935	0.259008	0.279678	0.273498
98	0.265485	0.235958	0.256518	0.277133	0.271448
99	0.27001	0.239443	0.2609	0.281603	0.275053
100	0.2789	0.24629	0.269503	0.29038	0.282138
101	0.294203	0.258078	0.284315	0.305485	0.294335
102	0.294883	0.258595	0.284965	0.30616	0.294873
103	0.29256	0.256813	0.282723	0.303863	0.293028
104	0.318733	0.276973	0.308045	0.329703	0.31388
105	0.338243	0.292	0.326933	0.34897	0.329428
106	0.354373	0.30442	0.342535	0.364885	0.342278

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38690	0.40140	0.34588	0.45026	0.33002
97	0.38892	0.40270	0.34813	0.45235	0.33090
98	0.38390	0.39948	0.34254	0.44716	0.32870
99	0.38793	0.40206	0.34703	0.45133	0.33047
100	0.39750	0.40820	0.35768	0.46122	0.33468
101	0.41436	0.41901	0.37644	0.47865	0.34209
102	0.41513	0.41951	0.37731	0.47945	0.34243
103	0.41260	0.41789	0.37448	0.47683	0.34131
104	0.44157	0.43648	0.40673	0.50679	0.35405
105	0.46321	0.45035	0.43081	0.52916	0.36357

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.85971	0.65834	0.68630	1.14653	0.69134
97	0.89179	0.68103	0.70424	1.19444	0.71702
98	0.92032	0.70121	0.72019	1.23706	0.73987
99	0.93681	0.71288	0.72941	1.26169	0.75308
100	0.95364	0.72478	0.73881	1.28683	0.76655
101	0.97008	0.73641	0.74801	1.31139	0.77972
102	0.99147	0.75155	0.75996	1.34334	0.79685
103	1.01452	0.76785	0.77285	1.37776	0.81530
104	1.03935	0.78541	0.78673	1.41484	0.83518
105	1.06238	0.80170	0.79960	1.44924	0.85362
106	1.08709	0.81919	0.81342	1.48616	0.87341

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59658	1.13720	1.02164	2.27161	1.37220
94	1.56030	1.12702	1.01250	2.24669	1.35600
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66375	1.15604	1.03857	2.31774	1.40221
97	1.72482	1.17317	1.05396	2.35968	1.42949
98	1.77915	1.18841	1.06765	2.39699	1.45376
99	1.81054	1.19721	1.07556	2.41855	1.46778
100	1.84259	1.20620	1.08363	2.44055	1.48210
101	1.87389	1.21498	1.09152	2.46205	1.49608
102	1.91462	1.22641	1.10178	2.49002	1.51428
103	1.95850	1.23871	1.11283	2.52016	1.53387
104	2.00577	1.25197	1.12475	2.55262	1.55499
105	2.04962	1.26427	1.13579	2.58274	1.57458
106	2.09668	1.27747	1.14765	2.61505	1.59560

CASE 9B -- CHUM SALMON HARVEST FROM ENHANCEMENT DECREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.22630	1.20973	1.28859	0.96968
96	1.44636	1.25872	1.24595	1.32915	0.99914
97	1.51044	1.30762	1.30058	1.39031	1.04358
98	1.56694	1.35075	1.34876	1.44426	1.08277
99	1.59965	1.37572	1.37665	1.47548	1.10545
100	1.63312	1.40126	1.40518	1.50743	1.12866
101	1.66584	1.42623	1.43308	1.53867	1.15135
102	1.70834	1.45867	1.46932	1.57924	1.18083
103	1.75413	1.49361	1.50836	1.62295	1.21258
104	1.80363	1.53139	1.55056	1.67020	1.24691
105	1.84949	1.56639	1.58966	1.71399	1.27872
106	1.89873	1.60397	1.63164	1.76099	1.31286

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ

93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27166	0.26703
97	0.27226	0.241175	0.26308	0.28383	0.27685
98	0.271	0.240208	0.261853	0.282578	0.27584
99	0.276118	0.244145	0.26681	0.28763	0.279918
100	0.28517	0.25112	0.27557	0.29657	0.287135
101	0.300525	0.262948	0.290433	0.311728	0.299373
102	0.301188	0.263453	0.291068	0.312388	0.299898
103	0.298848	0.261655	0.288808	0.31007	0.298038
104	0.325018	0.281813	0.314128	0.335908	0.318888
105	0.34451	0.296828	0.332998	0.355158	0.334423
106	0.360615	0.309228	0.348578	0.371048	0.347253

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33756
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38690	0.40140	0.34588	0.45026	0.33002
97	0.40755	0.41465	0.36887	0.47161	0.33910
98	0.40832	0.41514	0.36972	0.47241	0.33944
99	0.41497	0.41941	0.37712	0.47928	0.34236
100	0.42527	0.42602	0.38859	0.48993	0.34689
101	0.44236	0.43698	0.40760	0.50760	0.35440
102	0.44306	0.43743	0.40838	0.50832	0.35471
103	0.44044	0.43575	0.40546	0.50561	0.35355
104	0.46941	0.45433	0.43771	0.53556	0.36629
105	0.49096	0.46816	0.46169	0.55785	0.37577
106	0.50874	0.47957	0.48149	0.57624	0.38359

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.85971	0.65834	0.68630	1.14653	0.69134
97	0.89195	0.68115	0.70433	1.19469	0.71716
98	0.92039	0.70126	0.72022	1.23716	0.73993
99	0.93685	0.71290	0.72943	1.26175	0.75311
100	0.95369	0.72482	0.73884	1.28690	0.76659
101	0.97016	0.73646	0.74805	1.31149	0.77978
102	0.99154	0.75159	0.76000	1.34344	0.79690
103	1.01458	0.76789	0.77288	1.37785	0.81535
104	1.03949	0.78551	0.78681	1.41506	0.83530
105	1.06257	0.80184	0.79971	1.44953	0.85378
106	1.08734	0.81936	0.81356	1.48654	0.87362

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59658	1.13720	1.02164	2.27161	1.37220
94	1.56030	1.12702	1.01250	2.24669	1.35600
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66375	1.15604	1.03857	2.31774	1.40221
97	1.72514	1.17326	1.05404	2.35990	1.42963

98	1.77928	1.18844	1.06768	2.39708	1.45382
99	1.81062	1.19723	1.07557	2.41860	1.46782
100	1.84268	1.20623	1.08365	2.44062	1.48214
101	1.87403	1.21502	1.09155	2.46215	1.49614
102	1.91475	1.22644	1.10181	2.49011	1.51433
103	1.95862	1.23875	1.11287	2.52024	1.53393
104	2.00604	1.25205	1.12482	2.55281	1.55511
105	2.04999	1.26437	1.13589	2.58299	1.57474
106	2.09716	1.27761	1.14777	2.61538	1.59582

CASE 10A -- SALMON ENHANCMENT FROM COHO HARVEST INCREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.303588	1.149758	1.124225	1.192855	0.900128
93	1.37701	1.205793	1.186828	1.262945	0.951055
94	1.338073	1.176075	1.153628	1.225775	0.924048
95	1.404775	1.226983	1.210495	1.289445	0.970303
96	1.44568	1.258203	1.24537	1.3285	0.99867
97	1.509798	1.30713	1.300038	1.3897	1.043133
98	1.565343	1.349528	1.347393	1.442725	1.081655
99	1.599108	1.375298	1.376183	1.474963	1.105073
100	1.632025	1.400423	1.40425	1.506385	1.127905
101	1.664845	1.425465	1.43223	1.537718	1.15066
102	1.706485	1.457248	1.467738	1.577468	1.179543
103	1.753243	1.492935	1.507603	1.622108	1.211965
104	1.802373	1.530435	1.549485	1.669003	1.24604
105	1.847978	1.565233	1.588363	1.712538	1.277663
106	1.897258	1.602845	1.630385	1.759583	1.31184

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27576	0.24387	0.26646	0.28728	0.27964
93	0.26577	0.23617	0.25679	0.27741	0.27167
94	0.27650	0.24444	0.26718	0.28801	0.28023
95	0.25532	0.22813	0.24668	0.26710	0.26335
96	0.25996	0.23171	0.25118	0.27169	0.26705
97	0.27015	0.23955	0.26103	0.28174	0.27517
98	0.26809	0.23796	0.25904	0.27970	0.27352
99	0.27301	0.24175	0.26380	0.28456	0.27744
100	0.28194	0.24863	0.27244	0.29338	0.28456
101	0.29728	0.26044	0.28729	0.30852	0.29678
102	0.29784	0.26088	0.28783	0.30908	0.29723
103	0.29562	0.25917	0.28568	0.30688	0.29546
104	0.32177	0.27931	0.31099	0.33271	0.31630
105	0.34126	0.29432	0.32985	0.35194	0.33183
106	0.35738	0.30674	0.34545	0.36786	0.34468

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40442	0.41264	0.36538	0.46837	0.33772
93	0.39336	0.40554	0.35307	0.45694	0.33286
94	0.40524	0.41317	0.36630	0.46922	0.33808
95	0.38179	0.39812	0.34020	0.44498	0.32777
96	0.38694	0.40142	0.34592	0.45030	0.33003
97	0.39821	0.40866	0.35847	0.46195	0.33499
98	0.39593	0.40719	0.35593	0.45959	0.33398
99	0.40138	0.41069	0.36199	0.46523	0.33638
100	0.41126	0.41703	0.37300	0.47545	0.34073
101	0.42824	0.42792	0.39189	0.49300	0.34819

102	0.42887	0.42832	0.39259	0.49365	0.34847
103	0.42640	0.42674	0.38985	0.49110	0.34739
104	0.45536	0.44532	0.42208	0.52104	0.36012
105	0.47693	0.45916	0.44608	0.54334	0.36960
106	0.49478	0.47061	0.46595	0.56181	0.37745

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78919	0.60845	0.64688	1.04120	0.63487
93	0.82596	0.63446	0.66744	1.09612	0.66431
94	0.80476	0.61946	0.65558	1.06444	0.64733
95	0.84014	0.64449	0.67536	1.11729	0.67566
96	0.85834	0.65737	0.68554	1.14449	0.69024
97	0.89092	0.68041	0.70375	1.19314	0.71633
98	0.91726	0.69905	0.71848	1.232	0.73742
99	0.93582	0.71217	0.72885	1.26020	0.75228
100	0.95156	0.72331	0.73765	1.28372	0.76489
101	0.96826	0.73512	0.74699	1.30866	0.77826
102	0.98791	0.74903	0.75797	1.33802	0.79400
103	1.01290	0.76670	0.77194	1.37534	0.81401
104	1.03719	0.78388	0.78552	1.41161	0.83345
105	1.05981	0.79988	0.79817	1.44540	0.85157
106	1.08477	0.81754	0.81212	1.48269	0.87156

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.5278	1.11791	1.004315	2.224375	1.34148
93	1.59804	1.13761	1.02201	2.27261	1.372855
94	1.55971	1.126855	1.01235	2.246285	1.355735
95	1.624765	1.145105	1.028745	2.290965	1.384795
96	1.66245	1.155675	1.03824	2.316845	1.401625
97	1.724075	1.17296	1.05377	2.35916	1.429155
98	1.77627	1.1876	1.06692	2.39501	1.452475
99	1.809615	1.19695	1.07532	2.41791	1.46737
100	1.84063	1.20565	1.083135	2.439215	1.481225
101	1.87219	1.214505	1.091085	2.460885	1.49532
102	1.91126	1.22546	1.10093	2.48772	1.512775
103	1.956985	1.23829	1.112455	2.51912	1.5332
104	2.00378	1.251415	1.124245	2.551255	1.5541
105	2.047265	1.26361	1.1352	2.581115	1.57353
106	2.094585	1.276885	1.147125	2.613615	1.594665

CASE 10B -- SALMON ENHANCEMENT FROM COHO DECREASED 15 PERCENT.

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.37625	1.20521	1.18618	1.26222	0.95053
94	1.33838	1.17631	1.15389	1.22607	0.92426
95	1.40388	1.2263	1.20973	1.28859	0.96968
96	1.44726	1.259405	1.246718	1.330008	0.999765
97	1.511265	1.308253	1.30129	1.391103	1.044153
98	1.567885	1.351468	1.349558	1.445153	1.083418
99	1.600648	1.376473	1.377495	1.47643	1.10614
100	1.634125	1.402025	1.40604	1.508388	1.12936
101	1.666845	1.426993	1.433935	1.539625	1.152048
102	1.709373	1.459453	1.4702	1.580223	1.181545
103	1.755193	1.494425	1.509265	1.62397	1.213318
104	1.804648	1.53217	1.551425	1.671175	1.247618

105	1.850498	1.567155	1.590513	1.714943	1.27941
106	1.8997	1.60471	1.63247	1.761915	1.313533

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27155
94	0.27649	0.24444	0.26718	0.28801	0.28022
95	0.25519	0.22803	0.24656	0.26697	0.26324
96	0.25998	0.23171	0.25119	0.27170	0.26706
97	0.27025	0.23963	0.26114	0.28184	0.27525
98	0.26834	0.23816	0.25929	0.27996	0.27373
99	0.27317	0.24188	0.26396	0.28472	0.27757
100	0.28214	0.24879	0.27264	0.29358	0.28472
101	0.29746	0.26059	0.28747	0.30871	0.29693
102	0.29813	0.26110	0.28812	0.30937	0.29747
103	0.29580	0.25931	0.28586	0.30707	0.29561
104	0.32197	0.27947	0.31118	0.33290	0.31646
105	0.34147	0.29449	0.33006	0.35216	0.33200
106	0.35759	0.30690	0.34565	0.36806	0.34484

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41316	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771
96	0.38695	0.40143	0.34594	0.45031	0.33004
97	0.39833	0.40873	0.35860	0.46207	0.33504
98	0.39621	0.40737	0.35624	0.45989	0.33411
99	0.40155	0.41080	0.36219	0.46541	0.33646
100	0.41149	0.41717	0.37324	0.47568	0.34083
101	0.42845	0.42806	0.39213	0.49322	0.34828
102	0.42919	0.42853	0.39295	0.49398	0.34861
103	0.42661	0.42688	0.39008	0.49132	0.34748
104	0.45558	0.44546	0.42232	0.52127	0.36021
105	0.47717	0.45931	0.44635	0.54360	0.36971
106	0.49501	0.47076	0.46620	0.56204	0.37755

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.60720	0.64589	1.03856	0.63346
93	0.82443	0.63338	0.66658	1.09384	0.66309
94	0.80538	0.61990	0.65593	1.06537	0.64783
95	0.83834	0.64322	0.67435	1.11460	0.67422
96	0.86152	0.65962	0.68731	1.14923	0.69279
97	0.89387	0.68250	0.70540	1.19756	0.71869
98	0.92238	0.70267	0.72134	1.24013	0.74152
99	0.93891	0.71437	0.73058	1.26483	0.75476
100	0.95579	0.72630	0.74001	1.29003	0.76827
101	0.97228	0.73797	0.74924	1.31467	0.78148
102	0.99372	0.75314	0.76122	1.34670	0.79865
103	1.01683	0.76948	0.77414	1.38121	0.81715
104	1.04177	0.78712	0.78808	1.41845	0.83712
105	1.06488	0.80347	0.80100	1.45298	0.85563
106	1.08969	0.82102	0.81487	1.49004	0.87550

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073

93	1.59658	1.1372	1.02164	2.27161	1.3722
94	1.5603	1.12702	1.0125	2.24669	1.356
95	1.62305	1.14462	1.02831	2.28979	1.38403
96	1.66461	1.15628	1.038788	2.31833	1.402595
97	1.725935	1.173478	1.05424	2.360438	1.429985
98	1.780175	1.1887	1.067903	2.397693	1.45422
99	1.811573	1.1975	1.07581	2.419253	1.468243
100	1.84364	1.206495	1.083895	2.441283	1.48257
101	1.87499	1.21529	1.09179	2.462808	1.49657
102	1.915738	1.226718	1.102058	2.490795	1.514773
103	1.959635	1.239035	1.113123	2.520945	1.536385
104	2.00702	1.252323	1.125063	2.553478	1.55555
105	2.050945	1.264643	1.136128	2.58364	1.575173
106	2.09809	1.27787	1.148008	2.61602	1.596228

CASE 11A -- SALMON PRODUCTION FROM CHINOOK ENHANCEMENT UP 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.376278	1.20523	1.186203	1.262245	0.950548
94	1.338403	1.176328	1.153908	1.22609	0.924275
95	1.403903	1.226318	1.20975	1.288613	0.969698
96	1.446375	1.258733	1.245963	1.329163	0.999153
97	1.51024	1.307468	1.300413	1.390123	1.04344
98	1.56614	1.350135	1.34807	1.443485	1.082208
99	1.598885	1.375128	1.375993	1.474748	1.104918
100	1.631933	1.400353	1.40417	1.506295	1.12784
101	1.664598	1.425275	1.43302	1.53748	1.150488
102	1.707195	1.45779	1.468343	1.578145	1.180035
103	1.752878	1.492658	1.50729	1.62176	1.21171
104	1.802503	1.530533	1.549598	1.669128	1.246133
105	1.848055	1.56529	1.58843	1.71261	1.277718
106	1.897223	1.60282	1.630358	1.75955	1.311815

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26562	0.23606	0.25665	0.27727	0.27156
94	0.27650	0.24444	0.26718	0.28801	0.28023
95	0.25519	0.22803	0.24656	0.26698	0.26325
96	0.25994	0.23169	0.25115	0.27166	0.26703
97	0.27015	0.23955	0.26104	0.28174	0.27517
98	0.26814	0.23800	0.25909	0.27975	0.27356
99	0.27293	0.24170	0.26373	0.28449	0.27738
100	0.28185	0.24856	0.27236	0.29329	0.28449
101	0.29716	0.26035	0.28717	0.30841	0.29669
102	0.29784	0.26088	0.28783	0.30908	0.29723
103	0.29550	0.25908	0.28557	0.30677	0.29537
104	0.32170	0.27926	0.31093	0.33264	0.31625
105	0.34118	0.29426	0.32978	0.35187	0.33177
106	0.35730	0.30668	0.34537	0.36778	0.34462

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39320	0.40544	0.35289	0.45677	0.33278
94	0.40524	0.41317	0.36629	0.46922	0.33808
95	0.38165	0.39803	0.34004	0.44483	0.32771

96	0.38691	0.40140	0.34589	0.45026	0.33002
97	0.39821	0.40866	0.35847	0.46196	0.33499
98	0.39598	0.40723	0.35599	0.45965	0.33401
99	0.40129	0.41063	0.36190	0.46514	0.33634
100	0.41116	0.41696	0.37288	0.47534	0.34068
101	0.42811	0.42784	0.39175	0.49287	0.34814
102	0.42887	0.42832	0.39259	0.49365	0.34847
103	0.42628	0.42667	0.38971	0.49098	0.34733
104	0.45529	0.44527	0.42199	0.52097	0.36008
105	0.47685	0.45911	0.44599	0.54326	0.36957
106	0.49469	0.47056	0.46585	0.56171	0.37741

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824445	0.63339	0.666588	1.093858	0.6631
94	0.80539	0.619908	0.655935	1.065388	0.647838
95	0.83835	0.643228	0.674358	1.114618	0.67423
96	0.859718	0.658345	0.686305	1.14654	0.691345
97	0.891855	0.681078	0.704273	1.194538	0.717078
98	0.919988	0.700975	0.72	1.236555	0.739603
99	0.936465	0.712633	0.729208	1.261173	0.752798
100	0.953088	0.724395	0.73851	1.286005	0.766113
101	0.96953	0.736023	0.7477	1.310558	0.779278
102	0.990968	0.751188	0.759678	1.342573	0.796438
103	1.013955	0.767448	0.772528	1.376913	0.814845
104	1.038928	0.785113	0.786495	1.414208	0.834845
105	1.061843	0.801328	0.7993	1.448445	0.853198
106	1.086583	0.818828	0.813138	1.485403	0.873008

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59668	1.13723	1.02167	2.27168	1.37225
94	1.56038	1.12704	1.01252	2.24675	1.35603
95	1.62314	1.14465	1.02834	2.28985	1.38407
96	1.66381	1.15605	1.03858	2.31778	1.40223
97	186	1.17318	1.05397	2.35970	1.42951
98	38	1.18763	1.06695	2.39509	1.45252
99	30	1.19644	1.07486	2.41666	1.46656
100	27	1.20499	1.08254	2.43759	1.48017
101	947	1.21374	1.09040	2.45901	1.49410
102	91056	1.22527	1.10076	2.48724	1.51246
103	1.95402	1.23746	1.11171	2.51708	1.53188
104	2.00216	1.25096	1.12384	2.55014	1.55338
105	2.04503	1.26298	1.13464	2.57958	1.57253
106	2.09213	1.27620	1.14651	2.61193	1.59357

CASE 11B -- SALMON PRODUCTION FROM CHINOOK PRODUCTION DECREASED 15 PERCENT

YR	PWRZ	CIRZ	KRZ	JRZ	AKORPZ
92	1.30271	1.14909	1.12348	1.19202	0.89952
93	1.376225	1.205193	1.186158	1.262195	0.95051
94	1.33836	1.176295	1.153873	1.22605	0.924245
95	1.403858	1.226283	1.20971	1.28857	0.969665
96	1.446345	1.258708	1.245938	1.329135	0.99913
97	1.510433	1.307615	1.300578	1.390308	1.043575
98	1.567453	1.351138	1.34919	1.444738	1.083118

99	1.600908	1.37667	1.377718	1.47668	1.10632
100	1.634155	1.402048	1.406065	1.508415	1.12938
101	1.666953	1.427073	1.434028	1.539728	1.15212
102	1.708998	1.459165	1.46988	1.579865	1.181285
103	1.755285	1.494495	1.509343	1.624058	1.21338
104	1.804693	1.532205	1.551463	1.671218	1.24765
105	1.850528	1.567178	1.590538	1.71497	1.27943
106	1.899728	1.60473	1.63249	1.76194	1.313553

YR	PWPZ	CIPZ	KPZ	JPZ	AKOPPZ
92	0.27563	0.24377	0.26634	0.28715	0.27953
93	0.26561	0.23606	0.25665	0.27726	0.27155
94	0.27649	0.24443	0.26717	0.28800	0.28022
95	0.25518	0.22802	0.24655	0.26697	0.26324
96	0.25993	0.23168	0.25115	0.27165	0.26702
97	0.27017	0.23957	0.26106	0.28177	0.27519
98	0.26832	0.23814	0.25927	0.27994	0.27371
99	0.27325	0.24194	0.26404	0.28481	0.27764
100	0.28223	0.24885	0.27272	0.29366	0.28479
101	0.29756	0.26067	0.28756	0.30881	0.29701
102	0.29817	0.26113	0.28815	0.30941	0.29750
103	0.29589	0.25937	0.28594	0.30715	0.29568
104	0.32206	0.27953	0.31127	0.33299	0.31653
105	0.34156	0.29455	0.33014	0.35224	0.33207
106	0.35767	0.30696	0.34573	0.36815	0.34491

YR	PWCZ	CICZ	KCZ	JCZ	AKOCPZ
92	0.40428	0.41255	0.36522	0.46822	0.33766
93	0.39319	0.40543	0.35288	0.45676	0.33278
94	0.40523	0.41316	0.36628	0.46921	0.33808
95	0.38164	0.39803	0.34003	0.44482	0.32770
96	0.38690	0.40140	0.34588	0.45026	0.33001
97	0.39824	0.40867	0.35850	0.46198	0.33500
98	0.39619	0.40736	0.35622	0.45986	0.33410
99	0.40165	0.41086	0.36230	0.46551	0.33650
100	0.41158	0.41723	0.37335	0.47578	0.34087
101	0.42856	0.42813	0.39225	0.49333	0.34833
102	0.42923	0.42856	0.39300	0.49403	0.34863
103	0.42670	0.42694	0.39018	0.49141	0.34752
104	0.45568	0.44552	0.42243	0.52137	0.36026
105	0.47727	0.45938	0.44646	0.54369	0.36975
106	0.49510	0.47082	0.46631	0.56214	0.37759

YR	PWSZ	CISZ	KSZ	JSZ	AKOSPZ
92	0.78743	0.6072	0.64589	1.03856	0.63346
93	0.824405	0.633365	0.666565	1.0938	0.66307
94	0.805355	0.619885	0.655915	1.06534	0.64781
95	0.838315	0.6432	0.67434	1.114565	0.6742
96	0.859695	0.65833	0.686295	1.146505	0.691325
97	0.892035	0.681205	0.70437	1.194805	0.71722
98	0.920935	0.701645	0.72053	1.23797	0.74036
99	0.938135	0.713815	0.73014	1.26367	0.754135
100	0.954755	0.72557	0.73944	1.28849	0.767445
101	0.97131	0.73728	0.748695	1.313215	0.7807
102	0.99224	0.752085	0.76039	1.344475	0.797455
103	1.01578	0.76874	0.77355	1.37964	0.81631

104	1.040635	0.78632	0.78745	1.416765	0.836215
105	1.063705	0.80264	0.800345	1.451225	0.85469
106	1.088475	0.820165	0.814195	1.48823	0.874525

YR	PWKZ	CIKZ	KKZ	JKZ	AKOKPZ
92	1.52612	1.11744	1.00389	2.22322	1.34073
93	1.59648	1.13717	1.02162	2.27154	1.37216
94	1.56022	1.12700	1.01248	2.24664	1.35596
95	1.62296	1.14460	1.02829	2.28973	1.38399
96	1.66369	1.15602	1.03855	2.31770	1.40218
97	1.72560	1.17339	1.05415	2.36021	1.42984
98	1.78141	1.18904	1.06821	2.39854	1.45477
99	1.81555	1.19862	1.07682	2.42199	1.47002
100	1.84679	1.20738	1.08469	2.44344	1.48397
101	1.87849	1.21627	1.09268	2.46521	1.49814
102	1.91747	1.22720	1.10250	2.49198	1.51555
103	1.96325	1.24005	1.11403	2.52342	1.53600
104	2.01054	1.25331	1.12595	2.55590	1.55713
105	2.05450	1.26564	1.13702	2.58609	1.57676
106	2.10172	1.27889	1.14892	2.61852	1.59786

UNIVERSITY OF ALASKA FAIRBANKS
School of Management
Fairbanks, Alaska 99775-1070

DATE: **April 29, 1992**

TO: **Ginny Fay**

FROM **Mark L. Herrmann**
Department of Economics

Re. **Statewide Salmon Grant**

I am faxing you the short report on the salmon demand project. I will look forward to your comments. I am also sending you the longer version of the report. I have put it in Fed Express this morning. There may be a few errors in the longer report but it is just a draft. I am sending you the original (which is why it is not copied two-sided). I have a backup on disk.

The conference call for Monday 1:00 is fine. I'll try to contact you before then. When I am not in my office I am usually working at home at 455-9073.

Give me a call if you have any questions.

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

DIVISION OF FISHERIES REHABILITATION, ENHANCEMENT & DEVELOPMENT (FRED)

WALTER J. HICKEL, GOVERNOR

P.O. BOX 25526
JUNEAU, ALASKA 99802-5526
PHONE: (907) 465-4160
FAX: (907) 465-4168

December 11, 1992

Ms. Molly McCammon
Legislative Hatchery Research
Group Coordinator
P.O. Box V
Room 510
State Capitol
Juneau, AK 99801-1182

Dear Ms. McCammon:

This provides further comments on, "A Benefit-Cost Analysis of the Alaska Salmon Hatchery Program," in reference to Ms. Ginny Fay's deadline for final input from the Fisheries Rehabilitation, Enhancement and Development (FRED) Division. These comments are divided into two areas: (1) General concerns with the completion of the study and policy implications, and (2) further technical comments provided to me by the division's economist, Mr. Jeff Hartman (enclosed).

I first want to state my high level of concern at the abbreviated review process that has been applied to the University of Alaska-Fairbanks (UAF) work products. This is one of the most complicated fisheries studies that the State of Alaska has ever commissioned, and has potentially large policy impacts. I realize your time constraints, however, our review of the draft study, and associated draft technical reports is simply not complete. We have been working hundreds of hours on reviewing an intermittent supply of related work products from UAF over the last three weeks, and are still identifying significant problems with the overall simulation models and documentation. Releasing the full study results before a complete review and correction of the work products have occurred could easily lead to a later retraction of some portion of the results, and seriously deteriorate the confidence of the fishery industry in this endeavor.

To illustrate the very real probability of this occurrence, I call to your attention a recent problem which Mr. Jeff Hartman identified in the simulation model that resulted in the cost-benefit analysis' (CBA) incorrect assumption that the enormous cost-recovery harvest of private sector enhancement groups occurs in and are subjected to the same harvesting costs of the common-property fishery. In the current simulation model, costs of harvesting the cost-recovery fish are first accounted for appropriately in the operators' budgets, and again inappropriately in the fishing cost model for the common- property fishery.

I do not know how much of a difference this structural error will make in the final results (because we do not have the models form), but that is not the problem. I cannot imagine explaining this assumption to the private nonprofit (PNP) operators, fishermen, or anyone in the fishing industry. Would you just say that instead of resimulating the results that some other conservative assumption was balancing the overstated costs somewhere else? This problem should be corrected by resimulating the results of the overall CBA cases, and not by the caveats of the study.

A second reason for citing this example is that it illustrates that the documentation for the simulation model (dated 18 November 1992) is not complete and not in a form that the RSA requires. The RSA explicitly requires a standard scientific report with a description of the methods and results. Nowhere in the documentation for the overall CBA, by Dr. John Boyce, do we see any algorithm of how the basic cost-benefit identities were estimated. Unlike the demand study, there is no listing of variables and no equations. Had these basic components been included, it would have been obvious when we first reviewed this manuscript that the producer surplus estimates for the common-property fishery inappropriately aggregated the cost-recovery and common-property harvests.

I do not support submission of the author's Recommendations Section in the simulation report. The recommendations in the report do not reflect a sound understanding of how the statewide fishery enhancement program is financed and how it currently operates. Terms such as privatization are used without any description of what the authors are explicitly suggesting. The comments on alternative investment strategies are offered without any supporting evidence. It is almost as though once the more time-consuming technical analysis was completed, the critical step of developing an explanatory report for the final, combined CBA was secondary to the process.

Aside from our best effort to comment on the report of the overall simulations by today, we still have additional questions on the technical manuscripts that are to be completed by 10 January 1993. We would like to be able to forward our editorial comments to the contractors.

Related to the above problem is the need for completing other parts of the RSAs. I have had our contract staff review the language on the requirement for a users manual for each of the simulation models in the system. My staff believes that the RSA is clear on the point that each analyst was to provide full SAS software with clear documentation that could be used by the State of Alaska for policy analysis. I see no transmittals to the authors that indicate they must fulfill these requirements. Particularly for the very complex demand models, this is essential. Without user-friendly simulation model software and equally clear documentation, we have no way of knowing whether the models could ever be updated or used again by other economists, as the authors may not be willing to update the models or simulations in the future.

The various fishing interest groups were promised the opportunity to review the entire legislative hatchery research study, including the results of the economic studies. I understand that the public review process has now been eliminated. I would encourage you to keep this commitment, if at all possible.

The FRED Division previously provided numerous written comments to Ms. Fay that were not summarized in her 25 November 1992 letter to Mark Herrmann and John Boyce. The 8 December 1992 phone conference with UAF staff helped answer a few of these questions. Many others remain unanswered and, as far as I and my staff are aware, these questions have not been transmitted to the authors.

This study can be narrowly viewed as a CBA of the enhancement program, and misconceptions of the results and conclusions could have far reaching impacts on Alaska's fisheries policy. For example, they may (1) impact government perception and support of all of Alaska's fisheries programs, (2) influence fishing and investment decisions of thousands of entry permitholders and their lenders, (3) impact salmon bycatch issues at a national level, and (4) impact Pacific Salmon Commissioner policies.

I clearly want to be on the record as encouraging you to not release any portion of the studies until our existing questions have been answered, problems in the models corrected, manuscripts rewritten, and final deliverables of the RSA clearly identified. The rewritten reports and materials then should be given a final error check before they are released.

If these steps require additional funds to complete, then we need to identify those funding requirements as quickly as possible. Alaska's fishery resources deserve nothing less.

Sincerely,

Jeffery P. Koenings, Ph.D.
Director

Enclosure

cc: Ginny Fay
Jeff Hartman
Mary McDowell

TECHNICAL COMMENTS

The following comments on the UAF study entitled, "A Benefit-Cost Analysis of the Alaska Salmon Hatchery Program," were constructed following a three-hour phone conference between the UAF contractors, Ginny Fay, Kurt Schelle, Ben Muse, and Jeff Hartman. Ms. Fay stated that she needed to receive any further comments on the UAF economic studies by Thursday, 10 December 1992 in order to provide final comments to the contractors by 14 December 1992. The majority of these comments are new, but a few questions from a previous memo are repeated since they were never addressed.

1. It appears that the simulation model assumes that fishers in the common-property fishery are also incurring the cost of harvesting fish destined for harvest in the facility cost-recovery zones. I did not realize this until our last conference call and after verifying the outputs that Jeremy Collie supplied to John Boyce. This is a difficult model logic error to just explain away and probably warrants some additional simulations. It also implies that John Boyce included the fish ticket observations of the PNP operators in his cost models. In a cost-recovery harvest such as occurs in Prince William Sound, hundreds of thousands of salmon (instead of thousands of salmon) could be recorded in an observation. I have no idea what this did to John's fishing cost model, but it is clear that the overall simulation model results were negatively biased by this action. The fix for the overall simulation model problem is rather simple. Total revenue numbers used in the overall simulation model need to be stratified into the proportion that is not cost recovered (and subject to common-property harvesting costs) and the proportion (of total revenue) that is cost-recovered by species and region. The cost-recovery harvests are provided in the operators' surveys, and the operators' harvesting costs are already accounted for in the operators' cost data.

2. The equations and variables used for the overall CBA need to be listed in the manuscript prepared by the team. While these descriptions of how the present value of the benefits and costs are undoubtedly the simplest step in the analysis, it is an important one. I cannot determine if the data was used in the way intended without this sort of information. I might have detected the odd treatment of portion of the revenues attributed to the cost-recovery harvest sooner if this step had been taken.

3. The CBA manuscript includes results and conclusions but very little about the general methods used or where the data came from. The RSA calls for a report written in standard scientific format. To me this means methods, results, conclusions, and discussion of errors and biases. This report has a way to go before it will become a very finished document.

4. The sources for the production-related variables came from several sources which I have listed. These sources should be properly cited in the overall CBA documentation written by the UAF team. They include:

   A. The original RFP explained that some simulations would be made with the assumption of a 10-, 15-, and 20-year mean background harvests of wild fish. The contractors requested the use of one background level of catches to achieve

their deadline. The report should note that the project manager released them from this prior obligation and set background catches for non-intensively modeled sites at the 10-year mean.

B. Production numbers for juvenile releases at intensively modeled sites and adult returns at non-intensively modeled sites came from a survey administered by the Legislative Research Agency to the PNP operators.

C. A similar survey was developed by the CBA project manager for ADF&G and FRED Division staff. Field and regional office staffs completed the surveys.

D. Jeremy Collie applied the intensively modeled site releases to population/ exploitation models to determine catches. The operators' estimates of adult harvest from the intensively modeled sites were not simulated in any of the cases.

E. Mark Herrmann made determinations following interviews with other farmed salmon producers and agency people familiar with the wild and ranched production of other countries.

I do not believe the current document makes it clear on where each of the sets of production assumptions originated from. These will be important issues for the readers of this study, and the origin of the assumptions should be accurate and occur in one location in the report.

5. The manuscript does not describe that the basic intent of the CBA study is to look at the most global salmon production questions only; that is, it considers the entire salmon fishery and does not attempt to evaluate every project individually or multiple production levels. Some projects, undoubtedly, have higher or lower net benefits than others.

6. It is not clear from our 8 December 1992 telephone conference of whether Mark Herrmann will really provide the information necessary for us to operate the SAS program. The response letter from Mark Herrmann to Ginny Fay of 6 December 1992 apologizes for making an "extremely user unfriendly software package." I suggest that he provide the cleaned up software with as many explanatory statements in the code as possible, along with a users guide. Also, to truly operate the models, I believe that a demonstration of the steps required to edit all input files and run each of the modules of the model will be required.

Mark Herrmann also conveyed in our telephone conference that he would be making further changes in the model, including making the software operation less cumbersome. Since the RSA calls for a users manual and documentation that was intended for subsequent ADF&G CBA, I would like to have a copy of the improved software and documentation.

7. The project manager released the contractors from some of the requirements in the original RSA. These should be noted in an appendix of this report.

- Jeremy Collie was to carry out initial simulations in SAS.

- Collie did not have to write a final report, only a summary.
- John Boyce did not have to carry out the simulations for the policy analysis in SAS, but did have to make the final model in SAS.
- The UAF team was told that they could truncate the change in annual net present value at 15 years instead of estimating the model using the production data provided from 16 years to 30 years, as called for in the RFP.

8. Table 8. In the 8 December 1992 telephone conference, it was pointed out by Kurt Schelle that the simulations in Table 8 show that the king salmon program has positive net benefits if you increase or decrease production in comparison to the current program. No clear explanation was offered except to say that the differences were small and not significant. This may be the case, but readers of this manuscript will want to have answers to these types of questions. Some clear answer should be offered in the text.

9. In the 8 December 1992 telephone conference, John Boyce presented a reason for keeping his recommendation of "privatizing" the program in his report. First, I would argue that policy recommendations of this type should be made after John spends more time learning about the financing of the PNP program. The 8 December 1992 telephone conference demonstrated that he was not aware of the extent of the enhancement program financing that currently comes from the fleets, as well as how fishermen decisions are translated into the decisions of the regional associations. Secondly, I am not sure that the subsidy-removing actions he refers to would achieve the option 5 result that the authors seem to feel most comfortable with. The pink salmon programs in the state are largely supported by cost recovery and, to a lesser extent, by loans. A complete elimination of the PNP loan program, as John implies, would first reduce production of the species which are difficult to cost recover in the existing fisheries. Much of the pink salmon production would initially be left in tact, in contrast to the UAF study results which imply that pink salmon production has the lowest net benefits.

10. John Boyce states in the CBA documentation (page 5, single-spaced version), "...We assumed that the strength of the substitution effect between pink and chum salmon to be one quarter of the strength imposed in the model...." It was clarified in the 8 December 1992 telephone conference that the adjustments in the "strength" of the model were actually adjustments to the change in total revenue, so that price-response effects would be reduced to 25%. The description in John's text does not make this clear.

11. It is difficult to determine where the revenue loss is being distributed between each species in the simulations. I tried to generate my own price elasticity from the revenue tables in the simulations and could not do it because there are no tables of annual ex-vessel prices generated for the cases. It would be helpful to see a table of the point prices estimated for each year of the simulations by species so that we can determine which species are bearing the revenue loss when another species is enhanced. John Boyce included such a table for the salmon demand studies for the State of Alaska in 1990, and it was very helpful for understanding how the revenue changes are distributed.

12. There is no rationale given for using the real interest rates specified in the text. I agree that 4% and 7% are reasonable alternatives, but there should be some explanation of why these were used instead of, say, 3% and 6%.

13. Page 7 (footnote). The text and footnote read that the ending revenues at year 15 are too high, so the authors estimated a mean from year 10 to 15. Why is the mean used here? I do not recall any discussion along these lines. Even if revenues were higher at the end of the 15-year period, that is what happens with some enhancement programs in the brood stock development process. The footnote reads that the rankings from highest to lowest NPV may not be affected with this assumption; I believe that the total NPV may be. If revenues are expressed as a mean, shouldn't costs be as well? This is a departure from what I thought the contractors had initially proposed to use for projecting year 16 to 30 NPV in our September meeting, and from what seems to make sense based on my understanding of the operators' production plans.

14. There are a number of syntax errors in the manuscript that makes the document difficult to understand and detracts from the overall study. These should be corrected.

15. Page 16. The text reads, "To get a measure of the cost of a 15% decrease, we took 15% of the reported costs of a 100% decrease." This is different than the instructions given to the contractors by the project manager, Ginny Fay, in the September meeting at UAF. The decrease was to be equivalent to the increment used for the 15% increase case.

16. I generally believe there needs to be further clarification of what was included in the operators' serves, at least by including a copy of the survey instruments in the appendix.

Alaska State Legislature

SENATE

Official Business

P.O. Box V
State Capitol
Juneau, Alaska 99811

December 14, 1992

Drs. Mark Herrmann and John Boyce
Department of Economics
University of Alaska Fairbanks 101 Bunnell Building
Fairbanks, Alaska 99775-1070

Dear Drs. Boyce and Herrmann:

Here are some general comments to address in the rewriting of the benefit- cost analysis report.

First, you will notice that I have used editor's license and not been at all shy about my mark up. I hope you are not offended but quite frankly, the draft warranted it. As with any editing of these proportions, it will probably need some reworking when changes are made. I have already fo' nd myself editing my editing. I have tried not to radically change style but cushioned the results in the context of the limitations of the analysis. I have also added explanatory material that was wanting in the first draft. I sincerely hope that you will incorporate all my proposed changes because in the interest of time, I have only proposed changes that are really needed.

I've added a new subsection entitled "Research Scope." I think it is very important that the audience clearly understand the limited scope of the analysis. Some material from the old "Caveat and Assumptions" section are moved to the scope section. Another entirely new section is added called "Assumptions." It is insert 2. The "Caveats and Assumptions" section has been renamed "Caveats and Technical Limitations of the Models." My logic for this reorganization is that there are three levels of limitations of the study. First, is the scope limitation that was imposed by the Committee, at least in terms of commercial fisheries. The second limitation is based on one's inability to precisely predict the future and the value of exogenous variables. The third limitation is the technical limitations of modeling. I think the current organization makes it a little easier for the lay reader to understand.

In what is now the "caveats" section, there is a disproportionate amount of discussion on the fishing cost model. The assumption section adds a little more background on the demand and population models but my guess is that there is still too little on these models and maybe too much on fishing costs. Please keep this point in mind when doing the rewrite and adjust as necessary.

I have highlighted in the text all the numbers that I am not able to correct because I do not have sufficient information. I am leaving these corrections up to you.

This editing should be considered a second draft because of uncertainty regarding some of the outstanding numbers. Once all the numbers become final, we can do a final draft. I am still hoping that can occur by the end of this week.

Sincerely,

Ginny Fay

insert #1

In addition, the analysis makes no attempt to discern whether fishermen benefitting from the enhancement program are residents or nonresidents. To the extent that benefits accrue to nonresidents, the benefits will "flow" out-of-state --- this is especially true without a state income tax.

As is standard methodology of benefit-cost analyses, this analysis only considers direct benefits and costs. Indirect primary and secondary benefits and costs such as fish processing employment and service sector support are not considered.

At the direction of the legislature,

The analysis we conducted concentrates only on the commercial fisheries. We separated out the hatchery returns and costs that went to other uses (i.e., sport and subsistence) from the analysis. This means that the benefits of production of kings, silvers, and reds that goes to sport fish purposes (especially in Southeast) and the species, especially chum, that goes to subsistence purposes are ignored by our analysis. We have also ignored the hatchery costs associated with these uses.

Alaska's
salmon
enhanced
not included in
did not include enhancement

[illegible] the Alaska enhancement program [illegible] individual hatcheries or facilities. [illegible] results apply to the private state and private programs and not individual facilities.

There may be some problems with the way we did that. We assumed that if 75% of the fish were earmarked for commercial catch (including the commercial share of the cost recovery catch), then 75% of the hatchery costs could be attributed to the commercial catch. This may be untrue in the sense that the costs of production of sport and subsistence fish may in part be reduced by the costs incurred producing commercial catch.

John - this is not true. We asked for total commercial production, total costs, and the % of total costs attributable to commercial harvests. Therefore, costs should be properly allocated between uses. This was purposefully done because, for example, sport fish species are generally more costly to produce. JG

Insert #2

The reliability of the results of this analysis depend on the extent to which 1) future international salmon markets reflect current markets, 2) assumptions regarding the future values of exogenous variables are accurate (an exogenous variable is a variable we have no control over such as Norwegian farmed-salmon production and exchange rates), and 3) the model structure is accurate.

The assumption regarding international salmon markets means that the research results reflect the relative value of changes in enhanced salmon production if international salmon markets remain unchanged. However, Alaska fishermen, processors, and enhanced salmon producers are actively attempting to recapture Alaska's salmon markets. Therefore, the extent to which these efforts are successful, the research results will underestimate potential net benefits to Alaska. Conversely, if Alaska's share of world salmon markets continues to erode, as it has during the last decade, the research results will overestimate potential net benefits to Alaska.

All modeling efforts used to project future values require assumptions regarding exogenous variables. The complicated nature of this study required numerous modeling assumptions regarding events in the future. This section summarizes some of the most significant assumptions of the population, demand and fishing cost models. For a more detailed discussion of modeling assumptions, see the individual reports.

Salmon Population and Exploitation Model. It was assumed that the Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries would continue to utilize current 1) wild stock escapement targets and 2) fisheries management practices. In addition, it was assumed that all stocks available for harvest by common property fisheries and cost recovery fisheries were harvested. The model used ADF&G biologists' estimates of enhanced production survival rates.

International Salmon Demand Model. This modeling effort required a considerable number of assumptions. Some of the most significant assumptions are provided below.

Future values of these variables were estimated using ordinary-least-squares on the basis of observed 1983 to 1991 growth rates---

- population of the EEC, 0.32% annual growth rate;
- population of the Japan, 0.43% annual growth rate;
- population of the United States, 0.92% annual growth rate;
- the "real" food consumption expenditure in Japan, 0.29%

- the "real" private consumption expenditure in Japan, 2.9%

Future values of these variables, as well as consumer price indexes and tariffs, are held constant at 1991 levels as is usual practice in benefit - cost analysis---

- European Currency Unit(ECU)/U.S. exchange rate, 0.7968
- Norwegian kroner/U.S. dollar exchange rate, 6.3549
- Japanese yen/U.S. dollar exchange rate, 129.50
- Norwegian kroner/Japanese yen exchange rate (NORUSA/JAPUSA)
- Norwegian kroner/ECU exchange rate, 7.9755

Future values for these variable are based on expert opinion---

- the "real" United States personal disposable income, 2.5% annually

A 3% annual growth rate for U.S. real personal income growth was specified. The total supply of farmed Atlantic salmon was held at its 1991 level, coinciding with the opinion of many experts that growth has reached its maximum sustainable level. However, there are some current indications that the industry may expand in the future, especially with a recent court decision regarding U.S. tariffs on Norwegian imports of farmed salmon. Farmed salmon production in Canada and Chile were allowed to grow at 3% annually despite there much higher rates of growth in recent years. No Russian production was included in the analysis. Therefore, background levels of farmed-salmon production are quite conservative. To the extent to which world farmed-salmon production exceeds these estimates, Alaska net benefits will be overestimated and visa versa.

All wild salmon harvests for Canada, Washington, Oregon, and California were estimated based on 10-year historical averages. All Alaska non-hatchery wild salmon harvests were estimated on the same basis, with the exception of Prince William Sound pink salmon, Cook Inlet sockeye salmon, Kodiak sockeye and pink salmon, and Southeast Alaska king salmon. Wild and enhanced harvests for these salmon species were predicted by Dr. Jeremy Collie in the population modeling portion of this analysis. It has been argued that the ten-year average for Alaska wild salmon stocks is both too high and too low. Similar to assumptions regarding farmed salmon production, the extent to which wild harvests are overestimated, resulting net benefits will be underestimated and visa versa.

Fishing Cost Model. The primary assumptions of the fishing cost model are that future harvests are distributed similarly to 1990 harvests, that fishing and management patterns remain similar, that the number of permit-holders remains near 1990 levels, that fishing costs of particular gear types are similar between regions, and that no dramatic changes in ex-vessel prices occur that would significantly alter participation rates.

As a result of the uncertainty regarding actual values of exogenous variables, sensitivity analysis was conducted to simulated high-, mid- and low-salmon-price scenarios. Study results are presented using each of these price scenarios to show the extent of variations in benefits possible as a result of actual price outcomes.

A BENEFIT-COST ANALYSIS OF THE ALASKA SALMON HATCHERY PROGRAM

John Boyce*, Mark Herrmann*, Diane Blachak**, and Joshua Greenberg***

*Department of Economics
University of Alaska Fairbanks
Fairbanks, Alaska 99775

**Department of Business Administration
University of Alaska Fairbanks
Fairbanks, Alaska 99775

***School of Agriculture, Land and Resource Management
University of Alaska Fairbanks
Fairbanks, Alaska 99775

A Report to the Legislature of The State of Alaska

November, 1992

DRAFT: NOT FOR QUOTATION WITHOUT WRITTEN PERMISSION FROM THE AUTHORS

none of the #'s are final

A BENEFIT-COST ANALYSIS OF THE ALASKA SALMON ~~HATCHERY~~ PROGRAM

Enhancement

Introduction

initiated

The ~~hatchery~~ program in Alaska was created in the early 1970's. At that time, Pacific salmon dominated the world salmon markets. Since then, there has been a rapid rise in the supply of salmon world-wide. In Alaska, this has been in large part due to production from the hatchery program. However, the increase in production has been worldwide, and it appears that supplies of salmon on the world market are more likely to continue to increase than to decrease. Given this backdrop, the Legislature of the State of Alaska asked for a cost-benefit analysis of the ~~state-funded hatchery~~ enhancement program. This report summarizes the findings of that study.

as well as increases in wild stocks.

as a result of ongoing increases in farmed-salmon production.

the results of this analysis is intended to assist policy makers in their deliberations regarding the level of continued state support of the program

Scope of the Research

This analysis uses a state accounting stance which means that

~~Since the hatchery program is funded by the State of Alaska, we considered~~ only the ~~interests of the state in our analysis.~~ ~~This means~~, for example, that benefits to consumers ~~either~~ in the U.S. or in other world markets were ~~ignored~~ ~~completely.~~ This ~~is~~ not ~~to~~ imply that these benefits do not exist but is recognition of the ~~fact that they are not benefits that are~~ captured by the State of Alaska. ~~The~~ benefits ~~to the state~~ were measured by two variables. First, we were interested in ~~what~~ the net benefits to ~~the fishermen were~~ from the ~~hatchery~~ program. That is, we wanted to ~~estimate~~ the return to fishermen above their costs ~~that occurs~~ under ~~different hatchery production~~ output levels. Second, we wanted to estimate the cost of producing benefits to ~~the fishermen~~, which is the cost of running the ~~hatchery program~~. These costs include enhancement facility costs, as well as Alaska Department of Fish and Game administrative, support and management costs.

only benefits accruing in Alaska were included.

other parts of the

not considered.

due to

recognizes that these benefits are not captured

insert #1

Research Methods

primarily

salmon enhancement

These net benefits to fishermen were estimated

assumptions regarding enhanced salmon

these

enhancement

* first the term Alaska and state of Alaska are used broadly to reflect the public of Alaska and not just the state government.

At the beginning of this I would add a new section heading:

Research Methods

discussion in the demand model is where revenue

determine their current actual costs and their expecte

were surveyed to find out what they expected their costs to be if
tion for a particular species were increased or decreased. While
difficulty in interpreting these numbers in certain instances,
the costs of the hatchery program are relatively straightforward.

efit to fishermen are not as easily determined. We considered
producer's surplus to be the appropriate measure of benefits to the
Producer's surplus measures the return above opportunity costs to the
fisherman. If the fisherman does not expect to earn revenues higher than his or
her next best alternative (their "opportunity cost"), then they choose not to fish.
Any returns they get above the minimum required to attract them into the fishery
are what we measure as the surplus. The surplus benefits may differ across
fishermen because some fishermen may be willing to fish even when revenues are
low, and others may not.

Fold

The *net benefits to the state* of the hatchery program are the net benefits to the
fishermen as measured by producer's surplus minus the hatchery costs. This
measure indicates the net benefits to fishermen above the costs of providing these
benefits.

The calculation of the producer's surplus to the fishery is by no means a
straight forward procedure. The request for proposals required that we consider a
number of alternative management plans for the hatchery program. These
management alternatives are described below in Table One. Each management
plan was to be considered over a 15– and a 30–year planning horizon. To imagine
that we can precisely predict events 15 or 30 years in advance based on a decade

of data from an industry in transition is, of course, precarious at best.[1] However, given the world-wide trends in demand and supply as suggested by the events over the past several decades, we do have a rough idea of the direction in which the fishery is heading. Our estimates are likely to be very inaccurate within particular years, but should, on average, capture the trend. Since we are asked to conduct a cost-benefit analysis of the hatchery program over a long lifetime, the trend will be much more important than specific yearly predictions.

The model used to generate our projections for these 15- and 30-year planning horizons use results from three other parts of this study. For each management alternative, projections about the biological stocks were generated. These biological projections were then put into an international salmon demand model to make projections about the prices for each species in each area (Herrmann and Greenberg, 1992). The quantity and price projections were then used to estimate the costs to fishermen of participating in the fishery (Boyce, 1992). Each of these models are described in the citations.

Research objectives

The request for proposals outlined seventeen alternatives to consider. These are given in Table One.

Our complete reported findings are contained in Appendix One, Two, Three and Four. We report fifteen year projections for catch, revenues, producer's surplus, hatchery costs, and net benefits. For each management alternative, we report projections for Western Alaska and AYK combined (the part of the state

[1] While data for annual prices and quantities exist for several decades, inventory and export data restrict us to the years 1980 and beyond.

enhancement

with no hatchery program), and for Cook Inlet, Kodiak, Prince William Sound, Southeast, and for the state total. Thus, in each Appendix there are six tables on three pages for each alternative. At the bottom of each table we report the ~~fifteen~~ 15-year sum, the ~~thirty~~ 30-year sum, and the present value of the ~~thirty~~ 30-year sum discounted at 4% real rate of interest.[2] The difference between the Appendices is that Appendix One reports the estimate of returns using our midpoint price estimates from the demand model, Appendix Two reports the estimates of returns under optimistic price projections, and Appendix Three reports the estimates of returns under pessimistic price projections. The data reported in the Appendices is aggregated to the regional level. In the actual simulations, *fleet* specific estimates of returns and costs were calculated. However, this data is too voluminous to be included in the report. Appendix Four contains summary data for present value calculations at 0, 4 and 7% discount rates.

[2]We examined the cases of four and seven percent real rates of interest (i.e., we removed the inflation part of the interest rate since all dollars are expressed in real 1992 dollars). The seven percent discount rate figures are not contained in Appendix One, but do appear Appendix Four.

Table One: The Alternatives Considered in the Policy Analysis

Case 1.	Maintain current hatchery production
Case 2	Planned hatchery production levels
Case 3	Eliminate entire hatchery program
Case 4a	Increase entire hatchery production level by 15%
Case 4b	Decrease entire hatchery production level by 15%
Case 5	Eliminate entire pink salmon hatchery production
Case 6	Eliminate entire red salmon hatchery production
Case 7a	Increase pink salmon hatchery production level by 15%
Case 7b	Decrease pink salmon hatchery production level by 15%
Case 8a	Increase red salmon hatchery production level by 15%
Case 8b	Decrease red salmon hatchery production level by 15%
Case 9a	Increase chum salmon hatchery production level by 15%
Case 9b	Decrease chum salmon hatchery production level by 15%
Case 10a	Increase silver salmon hatchery production level by 15%
Case 10b	Decrease silver salmon hatchery production level by 15%
Case 11a	Increase king salmon hatchery production level by 15%
Case 11b	Decrease king salmon hatchery production level by 15%

The revenue data in each table represents the projected *gross* returns to the region or to the state from the salmon fishery. We estimated the costs to the fishermen as the minimum level of returns required before the fishermen would participate. Thus part of the revenues was the cost of luring the resources away from their next best alternative. Since they would have earned returns equal to the value of their next best alternative, these costs are real economic costs.[3] The *producer's surplus* is the difference between the estimated revenues and fishing costs. The producer's surplus measures the net benefits to the fishing sector. Again, the cost of providing these net benefits to the fishermen is the cost of the enhancement hatchery

[3]It is inappropriate to simply view the cost part of the revenues as benefits because they represent expenditures to the other sectors of the state. While it is true that they represent expenditures to other sectors, they also represent what was foregone by the fishermen if they had been engaged in their next best alternative.

program. To get the net benefits to the entire hatchery program, we subtracted the hatchery costs from the producer's surplus.

Caveats and Assumptions

Before we explore the actual findings, let us explain why we believe our estimates must be treated with some caution. First, these predictions are based on models using data from only a small number of years. The demand data uses quarterly data from 1982 to 1991. The cost data was generated entirely from data for 1990. To extrapolate 15 or 30 years based on such a short time series is very dangerous. Certainly projections made in the 1960's could not have foreseen the changes that occurred one or two decades later.

The analysis we conducted concentrates only on the commercial fisheries. We separated out the hatchery returns and costs that went to other uses (i.e., sport and subsistence) from the analysis. This means that the benefits of production of kings, silvers, and reds that goes to sport fish purposes (especially in Southeast) and the species, especially chum, that goes to subsistence purposes are ignored by our analysis. We have also ignored the hatchery costs associated with these uses. There may be some problems with the way we did that. We assumed that if 75% of the fish were returned for commercial catch (including the commercial share of the cost recovery catch), then 75% of the hatchery costs could be attributed to the commercial catch. This may be untrue in the sense that the costs of production of sport and subsistence fish may in part be reduced by the costs incurred producing commercial catch.

All of our analysis is based on point estimates. Even though we predict high, mid, and low prices, we are still comparing revenue cases against the base cases

for average vs. average prices, high vs. high prices, and low vs. low prices. In addition, our predictions of total revenues and producer's surplus are missing confidence levels which could make some of our findings insignificant.

In addition, the production levels under each of the elimination alternatives are vastly different from the production levels we observed in the historical time period used to estimate our demand and fishing cost models. All of our estimation of salmon demand and fishing cost parameters occurred with hatchery and production figures that were considerably higher than the levels considered in Cases 3, 5 and 6. (Table one) It is less true for Case 6 because enhanced production of red salmon is small relative to the total quantity of wild stocks of red salmon. However, it This is particularly true for Cases 3 and 5, which involve drastic reductions in the pink salmon catches. Because of this, we are forced to extrapolate well beyond the data in our analysis. The result of the extreme extrapolation may be to predict prices which are above their historical levels.[4]

Also, in the international salmon demand model it was necessary to aggregate Pacific salmon into high-valued (sockeye, king, and coho) and low-valued salmon (chum and pink) in the demand side of the model. This was due to the need to simplify the number of specified species in order to estimate the model. However, because of this, there are no *empirical estimates* of cross-price effects between species within an aggregate grouping. As a result, ad hoc assignments of substitution effects between species within each aggregate grouping were made. For example, we assumed that the strength of the substitution effect between

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[4] This occurs with some extent to our predictions of pink salmon prices. If the pink salmon program is eliminated, we estimate pink prices to average about $0.46 per pound ex vessel. Over the period 1980 to 1991, nominal prices averaged only $0.31 per pound, although in approximately one-third of the years the real 1992 dollars prices rose to this level. The two most recent cases, 1987 and 1988, are years for which pink salmon volumes were at their lowest over the period.

pink and chum salmon to be one-quarter of the strength imposed in the model, and vice versa. The assumed cross-price effects were kept fairly low in order to err on the side of conservatism.[5] Similar assumptions were made for other species. We do have empirical cross-price effects for species within the low-valued grouping on species within the high-valued grouping, and vice versa. These are reported and discussed in the demand model report (Herrmann and Greenberg, 1992).

As a result of species aggregation in the demand model, it was not possible to use the ad hoc cross-price effects between species within a particular grouping when there were simultaneous changes to salmon species within the aggregate groupings because the movements of own-price effect and cross-price effect could not be sorted out. Because of this, an accurate estimation of cases 2-4, where there were simultaneous changes in hatchery production, was not possible. Because the model-imposed cross-price effect within the groupings are overstated, the revenues assigned to cases 2, 3, and 4a will be understated. For this reason, only the cases of 1 and 5-11, when the ad hoc cross-price effects within the aggregate salmon groupings can be imposed, offer realistic revenue forecasts. The losses found in cases 2-4 must be seen as absolutely worst case scenarios and probably should not be taken seriously. Because we have less confidence in the results of cases 2-4, these results are segregated from the main body of the report and presented in the final section.

The fishing cost data was calculated as follows. In the fishing cost model, we estimated a model predicting the number of fishermen participating in a particular opening based on the total run strength as measured by the total revenues earned

[5] We practiced the restricting the full cross-price effects. The result was that a decrease in pink salmon caused chum salmon revenues to increase dramatically. This made the effect of reducing the pink salmon program even less costly since there was a large compensation due to an increase in chum revenues. It appears that the relationship between chum and pink salmon revenues is an issue which deserves more research.

For example, if coho and king salmon production were simultaneously increased or decreased, a portion of the resulting change in coho price would be from the change in coho production (own-price effect) while a portion would be from the change in King production (cross price effect)

In these cases, could not be imposed and an ad hoc price effect more accurate

for all species

enhanced

production

Also a result

there are at least limitations to the fishing cost model. In particular, it is a novel, previously unused approach to the extremely difficult task of modeling commercial fishing costs. The model developed is based on [illegible] participation. Costs such as loan payments and vessel [illegible] do not vary with participation, these costs are not calculated in the estimated costs. Instead, variable costs, including alternative fishing or employment opportunity income. [illegible]

the decrease in the costs of harvesting changes in enhanced salmon production, the producer surplus estimated underestimate true long-term [illegible]

in the opening. We found a very consistent relationship that as total revenues rise, the number of fishermen also increased. The relationship also indicated that to add another fisherman, the revenues would have to rise by a larger amount than was required to attract the previous fisherman. This suggested that fishermen have different costs of fishing and that those with the lowest costs entered first. The cost equation was then derived from the participation equation by solving for the average revenue given the number of fishermen predicted to participate. The behavioral assumption was that the last fisherman to enter expected to earn just enough in revenues to cover his costs of fishing. Thus, the average revenues for each opening gave us a measure of the fishing cost of the last fisherman participating in the opening. Since we observed a large number of openings with different numbers of fishermen, we obtained an estimate of fishing costs as a function of the number of participants.

In the extrapolation of the fishing cost model to future years, we took the 1990 run for the fishery as our guide for how the run would be dispersed over time and across the statistical areas within the fishery. If the future year showed an increase over the 1990 data for a particular species of, say, 10%, then we inflated the catch of that species by 10% for each opening over the season. Having done this for each species, we then multiplied the estimated catch by the price per pound for each species. We then used the data on percentage by species of the catch and of total revenues per opening to make a prediction of the number of fishermen participating in each opening throughout the season using the parameters of our participation model estimated on 1990 data. To obtain our estimate of fishing costs for the opening, we utilized the relationship between average revenues and the number of fishermen and the behavioral assumption that the last fisherman to enter earned revenues equal to their fishing costs. The fishing costs for the entire

opening were obtained by summing the fishing costs for each fisherman up to the estimated number of participants. The fishing costs for the season were simply the sum of these fishing costs over all of the openings. Producer's surplus was estimated as the difference between the fishing cost estimates and the revenue estimates.

One problem with our extrapolation is that we did not have estimates of which statistical areas would be affected by the changes in the hatchery stocks production. Thus, we used the average cost over all statistical areas weighted by the distribution of 1990 catch over those areas. Thus, if the distribution of catch changes or if the 1990 catch was aberrant in the distribution of returns, we would introduce error.

A more serious problem which is consistent across all of the analyses of alternatives is the problem of extrapolating cost data from one fishery to another. In particular, the estimates of fishing costs was conducted for only a select number of fisheries. For all other fisheries, we used the *average* estimate of fishing costs for similar gear type fleets elsewhere in the state. In particular, this problem is acute for Western Alaska. The main problem here occurs in the drift net fleet. The Bristol Bay drift net fleet is about 2,000 vessels strong. None of the other drift net fleets are anywhere near th[illegible]. Thus, our estimates of producer's surplus in Western Alaska may be off by an order of magnitude. While it is true that the relative error should be constant across the alternatives, the magnitude of that error may be considerable. We doubt, however, that it accounts for the results of our analysis with regard to the elimination of all, or portions, of the hatchery program.

A technical caveat on the interpretation of producer's surplus should also be mentioned. Producer's surplus in essence measures the "skill rents" to fishermen. That is, given the common property ownership in the fishery, the reason economic rents even exist at all is because of differences in the fishermen. These differences are measured as the minimum amount of revenues per fishermen that are required before a particular fisherman decides that it is profitable to participate in an opening. If these rents are transferable, then the present value of the producer's surplus should equal the value of the permits in a particular fishery. However, if the skills are not transferable, then the correlation between the producer's surplus and the value of the permits will be dampened. (The correlation should be positive under any conditions.) If the economic skill rents are not transferable, then the present value estimates of producer's surplus should be in excess of the value of the permits.

i'm not sure this should stay in given differences are attributable to more than just skill rents. if we want to keep it, plus, modify to more correct.

Finally, our estimates of catch, revenues, and producer's surplus for the second 15 years of the planning horizon are based on the average of years 10 to 15 (2001-2006). The cost estimates from the hatcheries were provided by the hatcheries for those years.[6]

Results not benefits to Alaska

Returns to the state if hatchery production continues at current levels

Under current hatchery production levels (Case 1) we estimated the net benefits to the state to be on the order of $10[illegible] (in millions) in 1992. The net benefits were projected to rise steadily in real (1992) dollars over the thirty year planning

of Alaska's salmon fisheries

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[6] We were requested to use the 15th year to predict the final 15 years in the RSA. However, we found that our demand model predictions for the fifteenth year were quite a bit higher than previous years, so we used the 5 year average instead. The relative effects that all revenues are slightly lower than would have occurred if we had used the 15th year. However, none of the relative rankings of the alternatives is affected by this change.

10-15-

We believe this is a better estimate of potential net benefits and has no effect on the relative ranking of the alternatives.

therefore,

because of the model's behavior projecting beyond a ten-year horizon given the relatively short time-series data available for estimating the model.

horizon. By 2006 we projected the net benefits to the state to be $154.37 m. per year. The thirty year average was estimated to be $140.8 m. Over thirty years, we estimated that the salmon fishery with the hatchery program at its current levels would bring in $4.001 b. (b. = 10^9) in net benefits ($2.329 b. in present value at 4% discount rate) to the Alaskan Economy on revenues of $[illegible] b. The difference over the thirty-year planning horizon between the gross revenues and the net benefits was made up of hatchery costs ($[illegible] m.) and fishery costs ($[illegible]). This data is based on the midpoint price estimates from the demand model (Appendix One). The optimistic price estimates (Appendix Two) yielded an undiscounted return of $4.731 b. and the pessimistic price estimates yielded an undiscounted return of $3.548 b. over the 30 years. In present value of 1992 dollars discounted at four percent, the estimates for current production levels are $2.329 b. for the midpoint, $2.746 b. for the optimistic, and $2.071 b. for the pessimistic price predictions. Thus, our estimates vary by about 1.2 b. undiscounted dollars to about 700 million discounted dollars over the thirty-year planning horizon. This magnitude of prediction error is present in all our analysis reflecting the uncertainty whether low, high, or mid-level salmon prices actually materialize in the future.

The distribution of the undiscounted $4.001 b. net benefits over the next thirty years under current hatchery production levels was as follows. The largest share is in Western Alaska (dominated by Bristol Bay), with about $[illegible] m. in net benefits per year over the next thirty years, for a total of $1.700 b. (present value of $[illegible] at 4% discount rate). The next largest share went to Southeast, with $[illegible] per year for a total of $1.201 b. over the thirty year lifetime (present value, discounted at 4%, of $[illegible] m.). Kodiak had net benefits of $[illegible] m. per year for a thirty-year total of $[illegible] m (PV of $288.69 m.). Cook Inlet had net benefits projected to be $[illegible] per year for a thirty year total of $441.79 m. (PV of $271.08 m.). Prince William Sound had net benefits projected to be $[illegible] per year for a

1	993.40	239.93	288.53	55.63	662.31	2239.81
5	1016.91	236.92	312.48	35.82	810.81	2412.98
6	1036.43	226.06	253.76	23.77	712.29	2252.32
7A	990.19	240.66	280.99	50.16	635.02	2197.02
7B	996.61	240.49	293.38	61.88	685.12	2277.48
8A	987.77	242.27	291.21	56.74	648.94	2226.93
8B	999.17	237.72	283.91	52.00	669.82	2242.61
9A	992.53	236.54	287.30	51.19	672.29	2239.85
9B	994.43	244.13	289.88	59.67	649.27	2237.39
10A	991.88	238.87	288.09	54.31	662.93	2236.08
10B	994.02	240.50	288.89	55.35	662.55	2241.31
11A	992.97	238.69	288.32	54.04	664.88	2238.91
11B	993.94	240.79	288.73	55.83	658.53	2237.83

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Thirty Year Present Values by Region, by Case (4% discount rate)
Optimistic Price Prediction Levels

CASE	WESTERN	COOKINL	KODIAK	PWS	SOUTHEAS	TOTAL
1.00	1173.08	289.06	341.07	91.96	761.01	2656.19
5.00	1200.71	285.83	366.71	63.88	919.00	2836.13
6.00	1209.47	270.44	296.80	48.08	776.28	2601.06

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Thirty Year Present Values by Region, by Case (4% discount rate)
Pessimistic Price Prediction Levels

CASE	WESTERN	COOKINL	KODIAK	PWS	SOUTHEAS	TOTAL
1.00	886.98	210.46	255.20	31.32	597.36	1981.32
6.00	923.13	192.27	213.74	-21.64	566.08	1873.58

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more to the issue of the distribution and the reasons for the distribution below.

Table Three contains summary statistics for the 30-year sums (undiscounted) for the current hatchery output levels (Case 1) as well as each of the three cases where a portion of the some (Case 5, elimination of pinks, and Case 6, elimination of reds) or the entire program is eliminated (Case 7). Looking at the statewide total net benefits under each program, it is clear that elimination of all of some portion of the program results in the largest net benefits to the state. In particular, the thirty-year sum of undiscounted net benefits under the current hatchery output levels is estimated to be $4,000 M.

(Case 1) Base Case: Current Hatchery Production

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4167.79	993.40	0.00	993.40
Cook Inlet	1702.43	971.00	311.34	71.41	239.93
Kodiak	2425.80	859.36	317.38	28.85	288.53
Prince Wm	5215.02	1428.06	311.80	256.17	55.63
Southeast	6153.45	2065.68	909.34	247.03	662.31
Grand Total	23332.47	9491.89	2843.27	603.46	2239.81

(Case 5) Eliminate Entire Pink Salmon Program

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4263.68	1016.91	0.00	1016.91
Cook Inlet	1362.23	934.06	295.95	59.03	236.92
Kodiak	2135.11	901.06	334.69	22.21	312.48
Prince Wm	2199.21	995.61	198.25	162.43	35.82
Southeast	5920.16	2309.83	1031.25	220.43	810.81
Grand Total	19452.47	9404.23	2877.04	464.10	2412.95

(Case 6) Eliminate Entire Red Salmon Program

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4354.59	1036.43	0.00	1036.43
Cook Inlet	1604.31	931.62	297.47	71.41	226.06
Kodiak	2266.73	768.07	277.49	23.73	253.76
Prince Wm	4988.08	1236.60	276.32	252.54	23.77
Southeast	6122.87	2067.53	910.82	198.53	712.29
Grand Total	22817.76	9358.41	2798.53	546.21	2252.32

(Case 7a) Pink Salmon Production Increases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT

commercial

Elimination of the pink salmon program also reduces total estimated catch, although not by as much as elimination of the entire hatchery program. The reduction in the catch due to the pink salmon hatchery program would be a drop to 197,527 b. pounds over thirty years from the 233,332 b. under current output levels, or a reduction by 16.6% in catch. Revenues (undiscounted) would drop to $15,920 b. from revenues of $16,925 b. under the current output levels, or a drop of only 1.0% over the thirty years. If the red salmon hatchery production is eliminated, total catch drops by a much smaller amount, down to 22,747 b. pounds over thirty years from the 23,332 under current output levels. This drop of 2.2% causes a reduction in revenues to $15,834 b. dollars over thirty years from $16,085 under current output levels. The percentage reduction in revenues is 1.5%. The reduction in revenues appears to occur because of cross-price effects on the lower-valued species.

commercial and cost recovery harvest

decline

the 30-

of

gross? need better explanation

1,404

9,491

enhanced

30-

revenues to decline

9,358

4,477 b

this is not clear some decline in revenues accounted for by sales because of lower price. are you saying revenues decline by the 2.2% because price response of low valued species?

The net return to the fishermen measured by producer's surplus is a much better measure of the value of the enhancement hatchery program to fishermen. We find that relative to the current production level of Case 1, producer's surplus actually increases by $[illegible] under Case 5, the elimination of the pink salmon hatchery program. The increase is relatively small, $[illegible] m. over thirty years, or $2.0[illegible] m.

30

per year. Producer's surplus is estimated to decrease if either the red salmon program is eliminated or if the entire hatchery program is eliminated. While the producer's surplus for the entire state increases if the pink salmon program is eliminated, not every region has gains under the elimination of the pink program. In particular, producer's surplus decreases in Prince William Sound and Cook Inlet under each of the elimination alternatives relative to current levels. Western Alaska gains producer's surplus in each elimination scenario relative to the current levels, and Southeast gains big if pinks are eliminated, slightly if reds are eliminated, and loses if all species are eliminated. Kodiak gains if pinks are eliminated, but loses if reds or all species are eliminated.

It is only in the elimination of pink salmon that the net change in producer's surplus summed over all of the regions is positive. That is, in the elimination of pink salmon alternative, we estimate that the gains in producer's surplus to regions gaining are more than sufficient to compensate the losses in Prince William Sound and Cook Inlet. This is not true of either the elimination of the entire salmon hatchery program or the elimination of the red salmon hatchery program alternatives. In each of those cases, the increase in producer's surplus benefits to the gaining regions is less than the loss in producer's surplus to the losing regions. [redacted] Under the elimination of reds alternative, we find that fishermen's producer's surplus decreases to [redacted] from the [redacted] under the current hatchery output levels, or a decrease of [redacted] over thirty years, or [redacted] per year.

It should be noted that these changes in producer surpluses are relatively small in magnitude and statistically within the margin of modeling error. However, they do help explain the results of the analysis.

From a state-wide perspective, the changes in producer's surplus is only one part of the equation. The other part is the hatchery (enhancement production and management) costs. Under the current production levels, to produce $4.860 b. in producer's surplus over the next 30 years, there are expenditures of ~~the state spends $839M~~, for a net benefit of ~~$4.000B~~. In fact, we find that when changes in the hatchery (enhancement) costs are taken into account in addition to the changes in the producer's surplus, the pink and sockeye ~~each elimination~~ alternative dominates the current output level alternative. Furthermore, the net effect by region shows that each region also gains with the exception of Cook Inlet, in the cases where either pink or red salmon are eliminated, and for Kodiak in the case where red salmon is eliminated. The biggest surprise in this result is our finding that when hatchery costs are included, Prince William Sound also gains in net by eliminating each of the programs. This latter result is probably due to the relatively high cost for producing, harvesting, and managing enhanced pink salmon as compared to their value. This is discussed in more detail in the next section.

In summary,

Under the elimination of the pink salmon program, there are two sources of gain. First, producer's surplus actually increases by $[redacted] m. Secondly, the costs of the hatchery program declines by $[redacted] m. over the thirty year planning horizon. This says that by saving itself $[redacted] m. in hatchery costs, the state could actually increase fishermen's producer's surplus by $[redacted] m. over the next thirty years. Of course, not all regions gain by the increase in producer's surplus, but the losses to the regions that do lose is $[redacted] less than the gains to regions that gain, i.e., the net change in benefits is positive.

Under elimination of the red salmon program, the fishermen suffer net losses in producer's surplus of $84.62 m. However, this is more than offset by the $106.7 m. in savings from closing the red salmon hatchery program. The net effect of eliminating the red salmon program is an increase in net benefits to the state of $21.36 m., or about $0.71 m. per year.

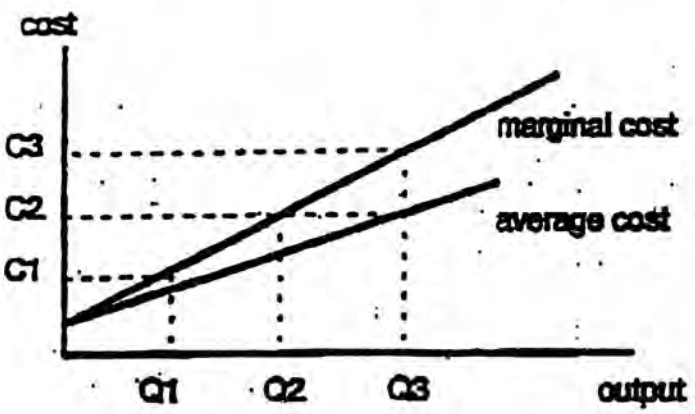
The cost per fish of the hatchery program

Our analysis of the potential effects of elimination of the hatchery program, or of some of its parts, reveals some interesting information about the cost per pound of fish of the hatchery program. Eliminating the pink salmon program shows that the estimated catch over thirty years will drop by 3.880 b. pounds. The reduction in hatchery costs due to eliminating the pink salmon hatchery program causes hatchery costs to decline by $400.11 m. Thus the cost per pound of the pink hatchery program is roughly 10.3 cents per pound. This is less than 2 cents per pound below the price being offered in 1991 when pink salmon were left to rot. Given that fishermen could not afford to fish at 12.1 cents per pound, it suggests that pink salmon prices have to be over 22.4 (= 10.3 + 12.1) cents a pound before producing hatchery fish is profitable.

I have not edited this section because I have insufficient information - I do not know how the PWS costs changed if the additional Valdez costs

A similar comparison can be made for the red salmon program. The reduction in catch due to eliminating the red salmon program is 514.71 m. pounds over thirty years. The estimated savings in costs due to the elimination of the red salmon program are $106.00 m. undiscounted dollars over ~~thirty~~ 30 years. Thus the estimated cost of producing a hatchery raised red salmon is 20.6 cents per pound on average.

Figure One: Marginal and average hatchery costs



bold

Two points should be made about the foregoing analysis. First, the cost of producing a pound of red salmon by the hatchery program appears to be almost twice as much as the cost of producing a pink salmon. This explains why it is that the elimination of the sockeye salmon hatchery production may possibly be a good idea. A second point has to do with the way in which we have measured the change in hatchery costs. The survey filled out by hatchery producers asked the question of what would be the change in their operating costs if either the red or pink salmon programs were eliminated.

There is good reason to believe that the answers given by the hatcheries will tend to understate the cost of an additional hatchery produced fish. Consider Figure One. In Figure One, there are three different levels of output depicted. The marginal cost line measures the cost of an additional unit of output. For example, the cost of the output Q1 is C1. If output were to be increased to Q2, then the cost of the cost of the Q2th unit would be C2. The average cost if Q2 is produced would be the mean of C1 and C2. Since the average cost includes units of output that have lower marginal costs, the average cost is less than the marginal cost.

To further examine the hatchery cost per pound of various species, we collected data from each of the cases 7a, 7b through 11a, 11b, which considers increases or decreases for the particular species by 15% over current commercial catch. The data in Table Four shows a couple of things. First, the relationship between the cost per pound of an increase and a decrease in hatchery output of each species is consistent with what we would believe to be true of costs for red, chum and coho salmon. However, it does not appear to be true for king and pink salmon. For pink salmon, we have that the marginal cost (on average) of an increase by 15% is 5.6 cents per pound. However, the average cost of pink salmon already produced is 10.8 cents per pound. This is inconsistent with what we have shown to be expected in Figure One. The costs are estimated from the hatchery responses to the question of the change in costs to a 15% increase or a 100% decrease. To get a measure of the cost of a 15% decrease, we took 15% of the reported costs of a 100% decrease. The king salmon data appears to suffer from the same problem. It is our feeling that the cost associated with the increase in 15% is the more reliable figure since it is directly estimated by the hatcheries themselves. However, the figure given for the decrease is obtained by imposing

the restriction that the total commercial share of costs of all species produced add up to the total commercial costs. This restriction is not imposed by the increase in production data.[9] Again, a problem only appears to occur with the pink and king salmon hatchery costs.

Table Four: The hatchery cost per fish for a 15% change in returns by species

(millions of pounds and millions of 1992 dollars)

	CATCH	HATCHCOST	ACATCH	ACOST	$/LB
Current Level	23338.47	863.45	****	****	****
Increase Pink	2330[illegible]	[illegible]	[illegible]	[illegible]	0.056[illegible]
Decrease Pink	2277.05	[illegible]	[illegible]	[illegible]	[illegible]
Increase Red	23404.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]6
Decrease Red	23260.40	843.55	72.07	15.90	0.221
Increase Chum	23615.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Decrease Chum	23049.0[illegible]	[illegible]	289.43	24.13	0.085
Increase Coho	23357.6[illegible]	869.71	25.27	10.26	0.407
Decrease Coho	23305.74	852.[illegible]	26.73	7.27	0.272
Increase King	23346.81	863.71	14.34	4.26	0.297
Decrease King	23318.08	837.86	14.39	21.59	1.500

need new numbers

Since the difference in hatchery costs has the greatest effect on our cost-benefit calculations in the pink salmon case, we consider what would happen if we have overstated our estimate of cost savings from eliminating pink salmon production.

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[9] The cost data provided by the hatcheries was not entirely reliable. We found that if we added up the total cost savings for the commercial portion of the hatchery output, we generally got a number that was somewhat less than the total cost of the current commercial portion of hatchery costs. We adjusted the figures so that the sum of the 100% reductions would add up to the current hatchery costs attributable to commercial catch (i.e., including the commercial share of the cost recovery catch). For example, the total cost reduction from eliminating all commercial hatchery programs in Prince William Sound accounted for only about 50% of the total current level of commercial hatchery costs there. Thus we increased their estimate by a factor of two to get all costs to be accounted for. This adjustment may account for our difference in estimate of cost for increases versus decreases.

We estimated our cost savings to be about 10 cents per pound. Suppose that instead they had been only 5 cents per pound, which is being charitable to the hypothesis that we are wrong. Then under Case 5, hatchery costs would have decreased by $200 m. over ~~thirty~~ 30 years instead of by $400 m. as we have estimated. Elimination of the pink salmon ~~hatchery~~ enhancement production would still result in an increase over current hatchery levels of $260 m. dollars over ~~thirty~~ 30 years, undiscounted. Thus, even at 5 cents a pound hatchery production costs for pink salmon, the elimination of pink salmon alternative ~~is considerably more attractive than any other alternative save the elimination of the entire program~~ still results in an increase in net benefits.

Case 1 23335 1401.7 2843.3 603.45

Pink salmon production increases by 15%

Western AK	7835.77	4154.82	990.19	0.00	990.19
Cook Inlet	1753.46	972.85	312.24	71.58	240.66
Kodiak	2470.38	849.70	313.05	32.06	280.99
Prince Wm	5656.48	1444.63	317.17	267.01	50.16
Southeast	6188.45	2026.62	889.38	254.36	635.02
Grand Total	23904.53	9448.63	2822.03	625.01	2197.02

(Case 7b) Pink Salmon Production Decreases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western Ak	7835.77	4180.72	996.61	0.00	996.61
Cook Inlet	1651.40	968.08	310.04	69.55	240.49
Kodiak	2385.11	865.61	321.23	27.85	293.38
Prince Wm	4784.22	1403.25	303.99	242.11	61.88
Southeast AK	6118.46	2103.16	928.16	243.04	685.12
Grand Total	22774.95	9520.82	2860.03	582.55	2277.48

(Case 8a) Red Salmon Production Increases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4143.60	987.77	0.00	987.77
Cook Inlet	1718.31	977.08	313.68	71.41	242.27
Kodiak	2447.88	872.09	322.54	31.33	291.21
Prince Wm	5244.94	1450.22	315.66	258.93	56.74
Southeast	6157.58	2065.19	909.05	260.11	648.94
Grand Total	23404.47	9508.17	2848.71	621.78	2226.93

(Case 8b) Red Salmon Production Decreases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4192.13	999.17	0.00	999.17
Cook Inlet	1687.44	965.91	309.13	71.41	237.72
Kodiak	2402.77	845.60	311.99	28.08	283.91
Prince Wm	5185.11	1405.45	307.62	255.62	52.00
Southeast	6149.32	2066.13	909.57	239.75	669.82
Grand Total	23260.40	9476.22	2837.49	594.87	2242.61

(Case 9a) Chum Salmon Production Increases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.81	4163.64	992.53	0.00	992.53
Cook Inlet	1702.43	969.69	310.95	74.41	236.54
Kodiak	2460.86	859.74	317.38	30.08	287.30
Prince Wm	5273.15	1431.51	312.59	261.40	51.19
Southeast	6353.95	2099.98	924.04	251.75	672.29
Grand Total	23615.89	9524.57	2857.48	617.63	2239.85

(Case 9b) Chum Salmon Production Decreases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.73	4171.96	994.43	0.00	994.43
Cook Inlet	1702.43	972.31	311.71	67.58	244.13
Kodiak	2401.04	858.60	317.25	27.37	289.88
Prince Wm	5156.89	1423.79	310.69	251.02	59.67
Southeast	5952.96	2028.44	893.55	244.28	649.27
Grand Total	23049.04	9455.10	2827.64	590.25	2237.39

(Case 10a) Coho Salmon Production Increases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7834.25	4162.83	991.88	0.00	991.88
Cook Inlet	1703.06	970.95	311.30	72.43	238.87
Kodiak	2426.13	859.20	317.29	29.19	288.09
Prince Wm	5222.87	1431.70	312.44	258.13	54.31
Southeast	6171.38	2077.50	914.36	251.43	662.93
Grand Total	23357.68	9502.18	2847.26	611.18	2236.08

(Case 10b) Coho Salmon Production Decreases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4170.04	994.02	0.00	994.02
Cook Inlet	1701.79	971.18	311.31	70.80	240.50
Kodiak	2425.47	859.63	317.52	28.64	288.89
Prince Wm	5207.18	1424.58	311.18	255.83	55.35
Southeast	6136.53	2054.08	904.11	241.56	662.55
Grand Total	23305.74	9479.51	2838.13	596.82	2241.31

(Case 11a) King Salmon Production Increases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7836.81	4165.84	992.97	0.00	992.97
Cook Inlet	1702.55	970.72	311.33	72.64	238.69
Kodiak	2425.80	858.96	317.17	28.85	288.32
Prince Wm	5216.71	1429.03	311.92	257.87	54.04
Southeast	6165.94	2081.42	916.17	251.29	664.88
Grand Total	23346.81	9505.98	2849.55	610.64	2238.91

(Case 11b) King Salmon Production Decreases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	[illegible]	4168.87	993.94	0.00	993.94
Cook Inlet	[illegible]	971.20	[illegible]	70.40	240.79
Kodiak	[illegible]	859.78	[illegible]	27.85	288.73
Prince Wm	5213.27	1427.04	311.78	255.95	55.83
Southeast	6140.99	2049.88	902.56	244.03	658.53
Grand Total	23318.08	9477.87	2837.15	599.32	2237.83

We now turn to the consideration of changes in individual species. We find in net that a 15% increase or a 15% decrease of a particular species has a very small effect (less than 1%) on net benefits for all cases except pink salmon. Even for pink salmon a 15% increase or decrease in hatchery output has only about a 2%

effect on net benefits. Although we have not calculated variance parameters for our estimates, it is likely that none of these is a statistically significant change from the current hatchery output levels. The summary data for the entire state is given in Table Six. We have not included regional data since the total effect is so small. However, this data can be found in Appendix One.

Table Six: Comparison of current hatchery production levels with 15% increases and decreases by species for hatchery produced stocks

(millions of pounds and millions of 1992 dollars)

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Case 1 current level	25332.47	16075.00	4860.79	859.45	4001.34
Case 7					
Increase Pink	23904.53	15997.97	4823.10	891.71	3931.39
Decrease Pink	22774.95	16126.83	4890.49	799.44	4091.06
Case 8					
Increase Red	25404.47	16105.51	4871.04	884.36	3986.68
Decrease Red	25260.40	16043.79	4848.71	863.55	4006.16
Case 9					
Increase Chum	25615.89	16136.18	4887.74	885.79	4001.95
Decrease Chum	25049.04	16006.04	4831.22	835.32	3995.90
Case 10					
Increase Coho	25357.68	16094.85	4868.94	869.71	3999.22
Decrease Coho	25309.74	16052.27	4851.11	852.18	3999.00
Case 11					
Increase King	25346.81	16102.67	4873.08	863.71	4009.37
Decrease King	25318.08	16047.68	4848.88	837.86	4011.01

insert new #'s

A more interesting comparison is contained in Table Seven. There we calculate the change in producer surplus resulting from either an increase or decrease in the quantity of salmon produced by the hatcheries. Our numbers suggest that each pound of pink salmon produced between [illegible] (Table Four)

bold

of the cost per pound to produce a pound of hatchery raised pink salmon was 5.6[redacted] and [redacted] cents per pound. Thus it appears that the cost per pound of producing pink salmon by hatchery production is greater than the producer's surplus it generates to fishermen.

This result seems to be true of red salmon also. Our estimate of the cost per pound to raise red salmon in hatcheries ranged from [redacted] to [redacted] cents per pound. However, our estimate of the average producer's surplus gained by this production is only [redacted] cents per pound. Before too much credence is placed on these numbers, however, it must be mentioned that our estimate of producer's surplus for red salmon is mainly from Bristol Bay (recorded as Western Alaska in our tables). Recall that our estimates for producer's surplus for Bristol Bay were made using average data from similar fisheries elsewhere in the state. We have no way of knowing how accurate these predictions are given that they are extrapolating well beyond the data available from fisheries elsewhere in Alaska.

Chum salmon also appears to have hatchery production costs that are roughly equal to the producer's surplus generated by an extra pound produced. We estimate that it costs between [redacted] and [redacted] cents to produce another pound of hatchery raised chum salmon, but fishermen receive producer's surplus of only about [redacted] cents per pound.

Coho is similar. Coho are estimated to cost between [redacted] and [redacted] cents per pound to produce, but generate producer's surplus on the order of between [redacted] and [redacted] cents per pound.

King salmon may be the best bet. If the marginal cost of king salmon based on an increase of [redacted] is accurate, then the cost of a king salmon is estimated to be about [redacted] cents per pound. Our estimate of the return in producer's surplus per

pound of king salmon is between [redacted] per pound. However, if the marginal cost of king salmon based on a decrease is correct, then king salmon costs about [redacted] per pound to produce. If this is true, then even king salmon fails to produce net benefits.

Table SIX Estimates of producer's surplus created by an additional pound of salmon by species

(millions of pounds and millions of 1992 dollars)

	CATCH	SURPLUS	ΔCATCH	ΔSURPLUS	SURPLUS $/LB
Case 1 current level	23332.47	4860.79	****	****	****
Case 7					
Increase Pink	23904.53	4823.10	572.06	37.69	0.066
Decrease Pink	22774.95	4890.49	-557.52	-29.70	0.053
Case 8					
Increase Red	23404.47	4871.04	72.00	10.25	0.142
Decrease Red	23260.40	4849.71	-72.07	-11.08	0.154
Case 9					
Increase Chum	23615.89	4887.74	283.42	26.95	0.095
Decrease Chum	23049.04	4831.22	-283.43	-29.57	0.104
Case 10					
Increase Coho	23357.68	4868.94	25.21	8.15	0.323
Decrease Coho	23305.74	4851.17	-26.73	-9.62	0.360
Case 11					
Increase King	23345.81	4873.08	14.36	12.29	0.857
Decrease King	23318.08	4848.88	-14.39	-11.91	0.828

needs #'s

Conclusions and Recommendations

Our results do not paint a very encouraging picture for the hatchery program. Based on our point estimates for the alternatives we believe our models were able to generate accurate results, the best alternative from a strictly economic perspective of direct benefits to commercial is to actually close the pink salmon hatcheries, or at least considerably scale them back. However, we would because of the magnitude not recommend that the state force all hatcheries to shut down. We would

of the difference in net benefits relative to the size of the pink program and uncertainty regarding [illegible] that would [illegible] Alaska salmon prices, the best [illegible] for Alaska may be the curtailment of state subsidies (primarily through [illegible] loan program) for continued expansion of enhanced pink salmon production. In addition, study results indicate that shifting enhanced production may not be cost effective because [illegible]

recommend that if a region wants to continue with a hatchery program, that it should be funded by the local user groups rather than by the state.

If the fishermen themselves fund the hatchery program, they will only choose projects which are cost-effective within their own region. There may still be regional effects in that production in one region causes prices to decline elsewhere, but whatever hatchery production remains will be cost effective. Table Eight compares the thirty year returns (undiscounted) for each alternative by region. Because we believe that our estimates of net benefits for Cases 2, 3, 4a, and 4b must be viewed with a great deal of caution, we separate them out in Table Eight.

Table Eight: Net Benefits by Region, By Alternative

(millions of 1992 dollars)

CASE	WESTERN	COOK INLET	KODIAK	PWS	SOUTHEAST	TOTAL
1	1700.36	441.79	499.07	158.36	1201.76	4001.34
5	1763.25	413.84	531.77	206.90	1565.88	4461.65
6	1779.38	413.77	422.60	201.97	1205.00	4022.72
7a	1696.53	443.16	485.68	152.87	1155.14	3931.39
7b	1706.17	439.39	506.20	182.35	1256.94	4091.06
8a	1689.64	441.46	506.79	157.25	1191.55	3986.68
8b	1711.29	437.49	488.84	166.35	1202.19	4006.16
9a	1698.72	441.04	494.97	155.98	1211.24	4001.95
9b	1702.31	442.96	498.74	158.16	1193.73	3995.90
10a	1698.45	440.36	498.31	157.17	1204.94	3999.22
10b	1701.52	444.58	499.33	157.63	1196.93	3999.00
11a	1699.56	443.07	498.68	157.80	1210.27	4009.37
11b	1701.62	448.25	506.80	158.31	1196.23	4011.01
2	1626.56	481.57	471.51	228.96	1151.24	3957.84
3	1918.86	467.50	538.37	229.91	1471.58	4621.20
4a	1671.50	436.81	479.91	134.11	1122.38	3844.72
4b	1728.08	445.81	499.93	217.09	1226.90	4113.80

The net benefit figures in each row of Table Eight are the returns for each region given that all regions are following the same hatchery production alternative. That is, for the region to get the estimated net benefits listed for a particular alternative, every region has to be following the same alternative.

We have bolded the number in each column that corresponds to the best alternative for the region under the assumption that the region is financing its own hatchery program. In the subset of alternatives for which we express confidence in our net benefits estimates (Cases 1, and 5-11), alternative 5, shutting down the entire pink salmon hatchery production, is the best alternative for Kodiak, Prince William Sound, and Southeast. That is, if these regions could get the rest of the state to agree to follow alternative 5, they would get the highest returns under a self-financed hatchery program.

The question is would the other two regions also want to follow alternative 5? While Western Alaska would benefit if the pink salmon program be shut down, their first preference would be that the red salmon hatchery production be shut down (Alternative 6). This is because red salmon dominates Western Alaska catch, so if everyone else shuts down red salmon hatchery production, Western Alaska red salmon prices rise at no additional cost to them. However, since Western Alaska only has one hatchery, and it produces only chum, it cannot independently influence the behavior of the other regions.

Cook Inlet is the odd one of the regions. Under a self-financing program, our estimates indicate that Cook Inlet would prefer everyone else shut down their king salmon programs. But since no other region will prefer this option, this alternative is not a feasible solution. If every other region is scaling back pink salmon hatchery production, Cook Inlet is made worse off relative to the current

production levels. The question is could Cook Inlet by itself influence the actions of the other regions? The answer is probably, though not definitely, "no." The reason is this: Prince William Sound is producing currently 124 m. pounds of pink salmon. Cook Inlet is currently producing under 7 m. pounds, of which less than half comes from enhanced hatchery production. Thus, even if Cook Inlet felt that it could produce pink salmon at a net benefit to its fishermen, it is doubtful that it would have enough of an impact on prices to warrant the other regions changing their minds about scaling back their own pink salmon programs.

Notice that when Alternatives 2, 3, 4a and 4b are included, Kodiak, Southeast, Prince William Sound and Western Alaska all prefer shutting down either all of the pink salmon or shutting down the entire program. This suggests that if the hatcheries are to be completely self-financed, they will on their own choose to scale back their operations.[19] Thus, we view turning over the financing of the hatcheries entirely to the regions as the best alternative for enhancement program the state. Alaska The actions we predict the regions to take assumes that our point estimates are correct. If they are not correct, complete self-financing is still a better idea than continued state funding support because it makes the regions themselves decide what levels of enhanced hatchery production give them the highest returns.

It is likely that enhanced

If our recommendations are followed, hatchery production of fish for sport and subsistence purposes will most likely not continue without some continued state funding. support

We have made no effort to analyze the net benefits from enhanced hatchery production on other user groups. The way that we have calculated enhancement hatchery costs suggests that the same per pound costs obtained in our study are a reasonable approximation in

[19] There may be a problem with the information gained by the hatcheries under a self-financing operation. Since the hatcheries generally take fish that are higher quality (because of less handling) and are cheap to harvest (because they are close right at the hatchery), the price and cost information may be biased. However, as long as the fishermen themselves have a say in the quantity produced by the hatcheries, this bias should not be a problem.

However, Alaska fisheries do compete with farmed-salmon production subsidized in other countries. If the state of Alaska chooses to continue to subsidize enhanced production more attention should be made to ensuring a more optimal output. Expansion of pink or red salmon production do not appear to meet that criterion.

enhanced enhancement

the range of small changes in hatchery production to the hatchery costs for fish no matter what their use. To estimate more fully the benefits and costs to other user groups, the state would have to determine the net benefits to those groups.

avoiding abrupt reductions in enhanced

There also may be some strategic reasons for maintaining some hatchery production. For example, it appears that hatchery exports of pink salmon may be starting in the former Soviet Union. Chile also appears to have room for expansion of its farmed salmon program. If these countries are able to produce fish less expensively than Alaska, then there will be impossible no way to stop them from entering in the long run. However, by maintaining Alaska enhanced some hatchery production, prices may remain depressed enough to prevent or postpone some of expansions in those areas. As long as the price is not driven down to the level that it would reach if those areas do enter the market, the hatchery dollars spent on prevention of entry may be well spent. However, this is not a strategy which can remain viable over the long run.

There are a number of other things that the state might do with monies saved from the hatchery program. One obvious area is to engage in demand-enhancing activities, such as increased attention to quality and seeking out new product forms. Again, we emphasize that if such activities are truely profitable, then the fishing industry itself should be willing to finance them rather than the state.

Another area that appears to be fruitful for future exploration is the allocation among gear groups. In the cost study we observed that the different gear groups have vastly different levels of producer's surplus. The gear group that does the best is the set net fleets. This is mainly because these fleets have such low capital costs. The bottom line is it is more efficient to let the fish come to the fisherman than to have the fisherman go to the fish.

I do not believe the analysis was sufficient to make this type of conclusion esp. since they are at set fishery was only one of the Bristol Bay fisheries

Finally, let us re-emphasize that our estimates of net benefit are based on parameters estimated from relatively short time periods and were extrapolated well beyond the time horizon for which accurate estimates may be obtained. There are also a number of exogenous factors, such as what is happening in the rest of the salmon suppliers' markets, that have changed far too rapidly over the last decade to allow precise estimates of where the industry will be in one, two or three decades. In spite of this, given our predictions of trends in the rest of the markets, we believe that the hatchery program, at the very least and especially the pink salmon program, should be scaled back. Our estimates suggest that to do so could result in an increase of net benefits to the state on the order of almost a half billion dollars over thirty years relative to current and planned production levels.

not be as profitable and might produce great benefits if it were

30

Need this in # when discounted

Results of Case 2, 3, 4a and 4b

This section compares current enhanced production levels (Case 1) with operators planned production (case 2), elimination of the entire program (Case 3), and 15% increase, decrease in entire enhancement program production levels (Case 4a and 4b).

Comparing planned hatchery production with current hatchery production

The second alternative considered was the "planned hatchery production levels," Case 2. This comparison is made in Table Two. The catch levels projected by the hatcheries were obtained in a survey conducted by the Department of Fish and Game, FRED division. We estimated that if the state follows the planned hatchery production alternative the thirty year undiscounted sum is [redacted] ($2.303 b\ if discounted at 4%), for an average net benefit of [redacted] per year. The estimated returns under the current hatchery production levels were [redacted] per year, or about a million dollars a year higher. Our estimation results of Case 2 should be viewed as a lower bound prediction of net benefits for Case 2. The reason is that the simultaneous large increases in a number of species under the planned output levels forces into play a number of complex cross price effects, which our demand model is not well adapted to consider.

The distribution of net benefits under the planned hatchery production levels also changes from the current levels. Under the planned levels, Prince William Sound will gain almost seventy million dollars over thirty years, up to net benefits of [redacted] from net benefits of [redacted] under current levels.[7] Cook Inlet also gains, increasing to [redacted] from [redacted] under current levels.

[7] The figures we are citing are the undiscounted sums. The appropriate measure for cost-benefit analysis is the discounted figures. We found that the discounting did not affect the relative standings of the various alternatives since costs and benefits are dispersed fairly evenly over the planning horizon. Since the undiscounted numbers are the least confusing to look at, we use them in the analysis.

However, these projected gains are more than offset by the projected losses elsewhere. Western Alaska loses the most, down to $[redacted] m. from $1700.36 m. over thirty years. Southeast is projected to have net benefits under the planned case of $[redacted] m., down from $[redacted] m. under the current levels. Kodiak also loses under the planned alternative relative to the current levels since net benefits drop to $[redacted] m. from $[redacted]. The regions that gain, Prince William Sound and Cook Inlet, gain by an amount less than the remaining regions lose by average of $[redacted] per year. Thus our projection suggests that the current hatchery levels are to be preferred over the planned hatchery production levels.

It is instructive to look at what is changing under the planned hatchery levels relative to the current hatchery production levels. The thirty year sum (undiscounted) totals for each alternative are given below in Table Two.

The catch differences between the current (Case 1) and the planned (Case 2) production are that Cook Inlet, Prince William Sound, and Southeast all have larger catches under the planned than under the current case. Prince William Sound accounted for the largest share of the increase, adding [redacted] million pounds over the thirty year period. Cook Inlet and Southeast increase catch by about [redacted] and [redacted] million pounds, respectively. The catch in Kodiak and Western Alaska are almost unchanged. In net, there is an increase of [redacted] million pounds of fish caught over the thirty years, or about [redacted] million pounds per year more in catch.

Table H Regional summaries for current (Case 1) and planned (Case 2) hatchery production

(millions of pounds and millions of 1992 dollars)

Case 1: Current Level

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.77	7078.92	1700.36	0.00	1700.36
Cook Inlet	1702.43	1572.88	508.05	66.26	441.79
Kodiak	2425.80	1466.39	548.09	49.02	499.07
Prince Wm.	5215.02	2422.53	536.05	377.69	158.36
Southeast	6153.45	3534.28	1568.25	366.48	1201.76
State Total	23332.47	16075.00	4860.79	859.45	4001.34

wrong #5

(Case 2) Planned Hatchery Production Levels

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.79	4061.99	955.09	0.00	955.09
Cook Inlet	1840.07	1034.46	332.27	41.79	290.48
Kodiak	2424.90	833.69	303.21	28.85	274.36
Prince Wm	5702.03	1533.45	352.20	262.05	90.16
Southeast	6268.58	2048.66	893.61	118.82	774.79
Grand Total	24071.37	9512.25	2836.38	451.50	2384.88

Consider how the changes in the catch affected the changes in revenues. In net, revenues increased to $16[redacted] under the planned production levels from $[redacted] under current production levels. This increase of $35.16 m. over thirty years is relatively small, about $[redacted] per year. The increase in revenues was not uniform across the regions, however. Revenues in Cook Inlet and Prince William Sound increase under the planned hatchery production relative to the current, but all other areas would have a decrease in revenues. Cook Inlet revenues increase by $[redacted], or about $[redacted] m. per year. Prince William Sound revenues increased by $[redacted], or an average of [redacted] m. per year. Western Alaska, Kodiak, and Southeast all had reductions in revenues. Western Alaska revenues decreased by $[redacted], or an average loss in revenues of $6.26

m., per year. Kodiak revenues decreased by $45.79 m., or by $1.58 m. per year. Southeast lost an additional $27.41 m., or about $0.91 m. per year.

The revenue changes are discussed in more detail in the demand analysis report. However, the main effect on revenues of the increase in production in Prince William Sound, Cook Inlet, and Southeast is to depress revenues in three areas (Western Alaska, Kodiak, and Southeast), and increase revenues in two areas (Cook Inlet and Prince William Sound). In net, the increases in revenues were greater than the losses. The curious finding here is that increases in Southeast, when coupled with the increases in Prince William Sound and Cook Inlet, actually lead to decreases in revenues in Southeast. It is doubtful that taken by itself, an increase in Southeast production would have depressed revenues in Southeast. However, when coupled with the increases in Prince William Sound and Cook Inlet, the net effect was a decrease in Southeast revenues.

The producer's surplus measures the net benefits (revenues minus costs) to the fishermen in each region. If the hatchery program continued at planned levels rather than at current production levels, we estimated that while gross revenues increased by $35.16 m. over the thirty year period, net revenues to the fishermen measured by producer's surplus actually *decreased* $11.39 m. As with the revenues, the distribution of gains and losses was not the same across regions. Cook Inlet and Prince William Sound each experienced gains in producer's surplus. Each of the other regions experienced losses in producer's surplus. The net gains and losses are as follows: Prince William Sound was the biggest gainer, with an increase in producer's surplus of $80.49 m., or $2.68 m. per year. Cook Inlet showed gains of $41.92 m., or $1.40 m. per year. The total gain of these two areas was $122.41 m. total over thirty years, or $4.08 m. per year. The biggest loser was Western Alaska. The losses there would be $75.80 m. over thirty years,

or $2.53 m. per year. Southeast lost the next most, having a reduction in producer's surplus of $30.45 m. over thirty years; or $1.02 m. per year. Kodiak would lose producer's surplus of $27.56 m. over thirty years, or $0.92 m. per year. The totals for the three areas losing producer's surplus are losses of $133.81 m. over thirty years, or $4.46 m. per year. Compare this with the total gain per year in Cook Inlet and Prince William Sound, and there is a net loss of $0.38 m. per year relative to the current case.

While the producer's surplus net gains and losses are almost a wash, with the losers losing about $0.38 m. a year more than the winners are gaining, the true measure of the difference is in the hatchery costs. Given net losses to fishermen on the order of $11.69 m. over thirty years, we estimate that hatchery costs will *rise* by $32.10 m. dollars over the thirty year planning horizon. That is, in addition to the net losses in producer's surplus by fishermen of $11.69 m., there is also an increase in hatchery costs of $32.10 m. The total cost of the planned hatchery output relative to the current hatchery output levels is thus the sum of the reduction in producer's surplus plus the increase in hatchery costs. This sums to a net loss of $43.79 m. over the thirty year planning horizon, or a net cost of $1.46 m. per year. In present value terms at a discount rate of 4%, the difference is -$26.62 m. That is, our estimates say that if we follow the planned levels rather than the current levels, it will be as though we lost $26.62 m. today.

The direction of the changes is consistent under alternative assumptions about the prices. If prices follow the optimistic projections instead of the midpoints, the current production levels provide an estimated net return to the state over thirty years of $50.93 m. undiscounted dollars and $30.17 m. discounted dollars. Under the pessimistic price scenario, the difference is $41.26 m. undiscounted or $25.47 m. discounted dollars at a 4% rate of discount.

The next set of alternatives we consider are the alternatives in which either all hatchery production is increased by 15% (Case 4a), or all hatchery production is decreased by 15% (Case 4b). Before we turn to the analysis of the actual alternatives, we want to remind the reader of the main caveat having to do with these alternatives. That is, because all hatchery production for all species are simultaneously increasing or decreasing by 15%, there are a number of complicated interaction effects that are taking place. Our demand models are very weak in this respect. Because we restricted the international level of the demand model to low and high valued species, we do not have estimates of substitution elasticity's that were calculated within each group. To estimate prices by species we used correlation's between the species price and the aggregate price for the group. While these correlation's give us an idea about how the relative prices of the species move in relation to one another, they do not give us a measure of the substitution elasticity between species. Therefore, when all species are simultaneously increasing or decreasing, we end up with a measure of correlation's

between price movements. The problem is that a salmon is not a salmon. Pink and chum salmon, for example are very different from one another, and there is no a priori reason to believe that the correlation between prices conveys much information about the actual willingness of consumers to substitute between the two as relative prices change. Not only is a salmon not a salmon to consumers, but our analysis on the cost of producing an additional salmon shows that the relative hatchery costs are much different. We will consider below the effect on fishermen's net revenues of increases in each species.

Table Five: Comparison of current hatchery production levels with 15% increases and decreases in all hatchery produced stocks

(millions of pounds and millions of 1992 dollars)

Case 1: Current Level

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7838.77	7078.92	1700.36	0.00	1700.36
Cook Inlet	1702.43	1572.88	508.05	66.26	441.79
Kodiak	2425.80	1466.39	548.89	49.02	498.07
Prince Wm.	5215.02	2422.53	535.05	377.69	158.36
Southeast	6153.45	3534.28	1568.25	366.48	1201.76
State Total	23332.47	16075.00	4860.79	859.45	4001.34

Case 4(a): Increase all species by 15%

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7833.85	6957.94	1671.50	0.00	1671.50
Cook Inlet	1770.18	1574.82	509.85	73.03	436.81
Kodiak	2517.54	1480.58	541.22	61.31	479.91
Prince Wm.	5754.06	2456.17	543.22	409.11	134.11
Southeast	6423.49	3506.01	1347.67	425.29	1122.38
State Total	24301.03	15945.46	4813.45	968.74	3844.72

Case 4(b): Decrease all species by 15%

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.69	7178.62	1724.08	0.00	1724.08
Cook Inlet	1635.65	1563.02	502.13	56.32	445.81
Kodiak	2336.98	1444.22	541.59	41.66	499.93
Prince Wm.	5117.45	2420.15	538.13	321.04	217.09
Southeast	5883.45	3462.62	1538.41	311.51	1226.90
State Total	22809.22	15068.62	4844.34	730.53	4113.80

new table

Having given all of these caveats, let us consider the effect of either an increase or a decrease in the entire hatchery program. Data from Case 4a and 4b is compared with the current hatchery production levels in Table Five.

B.

The results of Table Five can be summarized as follows. Either an increase or a decrease in all hatchery production by 15% will cause both revenues and producer's surplus to decrease. The decrease in revenues and producer's surplus is

Table B

(Case 1) Base Case: Current Hatchery Production

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4167.79	993.40	0.00	993.40
Cook Inlet	1702.43	971.00	311.34	71.41	239.93
Kodiak	2425.80	859.36	317.38	28.85	288.53
Prince Wm	5215.02	1428.06	311.80	256.17	55.63
Southeast	6153.45	2065.68	909.34	247.03	662.31
Grand Total	23332.47	9491.89	2843.27	603.46	2239.81

(Case 4a) All Hatchery Production Increases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.85	4102.64	978.03	0.00	978.03
Cook Inlet	1770.10	972.06	312.23	76.82	235.41
Kodiak	2517.54	850.27	313.51	36.11	277.39
Prince Wm	5754.06	1446.75	315.58	278.67	36.91
Southeast	6423.49	2047.35	896.97	280.81	616.15
Grand Total	24301.03	9419.07	2816.32	672.42	2143.90

(Case 4b) All Hatchery Production Decreases 15%

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.69	4220.93	1005.97	0.00	1005.97
Cook Inlet	1635.65	965.21	308.19	64.20	243.99
Kodiak	2336.98	847.79	313.84	25.39	288.45
Prince Wm	5117.45	1427.09	313.03	235.86	77.17
Southeast	5883.45	2027.96	893.89	224.54	669.35
Grand Total	22808.22	9488.97	2834.92	549.99	2284.93

greater if the hatchery production increases (Case 4a) than if it decreases (Case 4b). If hatchery production increases by 15% for all species, then the estimated increase in hatchery costs is almost $110 m. over thirty years. The increase in hatchery costs plus the decrease in producer's surplus means that relative to current hatchery output levels, an increase by 15% across the board would cause the state to lose $156.62 m. (undiscounted) over thirty years, or about $5 per year. If all hatchery production decreases by 15%, then producer's surplus is estimated to decrease by $16.45 m. (undiscounted) over thirty years. However, hatchery costs are estimated to decrease by $128.92, for a net increase of $112.46 m. (undiscounted) over thirty years. Interestingly, about the only major distributional effect in producer's surplus has to do with Western Alaska, which stands to lose slightly less than a million dollars a year with an increase of 15% of all hatchery stocks and stands to gain less than a million a year with a decrease of 15%.

Again, we want to emphasize that neither of these alternatives are very appealing. The idea of an across the board increase or decrease ignores the fact that the effect of a change in the quantity of one species may be considerably different than for another species both for consumers and hence for ex-vessel prices, and for production since hatchery costs are not identical across species.

Comparison of current production with eliminating the entire enhancement program

Under Case 5, elimination of the entire pink salmon portion of the hatchery program, we estimate tentatively that the state received returns of $4.461 b. dollars over the thirty year planning horizon. This is $460 m. more than under the current hatchery output levels, or an increase in welfare of the state of $ m. per year. Elimination of the red

Under elimination of the entire hatchery program, we find that undiscounted producer's surplus to fishermen over thirty years decreases to $ b. from $4.868 b. under the current hatchery output alternative, for a decrease of $217.41 m., or a decrease of about $7.25 m. per year. This is only $21 m. more than under current production levels over thirty years, or about $0.70 m. per year.

Case 1, Current production with

Table B Comparison of eliminating the entire hatchery program (Case 3), the entire pink salmon hatchery production (Case 5), and the entire red salmon hatchery production (Case 6)

(millions of pounds and millions of 1992 dollars) discount 4%

(Case 1) Base Case: Current Hatchery Production

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.77	4167.79	993.40	0.00	993.40
Cook Inlet	1702.43	971.00	311.34	71.41	239.93
Kodiak	2425.80	859.36	317.38	28.85	288.53
Prince Wm	5215.02	1428.06	311.80	256.17	55.63
Southeast	6153.45	2065.68	909.34	247.03	662.31
Grand Total	23332.47	9491.89	2843.27	603.46	2239.81

AREA	CATCH	REVENUES	SURPLUS	HATCHCST	NETBENFT
Western AK	7835.24	4654.05	1109.59	0.00	1109.59
Cook Inlet	1289.05	925.04	290.69	1.78	288.91
Kodiak	1908.76	844.08	316.86	1.38	309.48
Prince Wm	1548.73	756.25	150.48	5.81	144.67
Southeast	4330.53	1923.53	872.27	8.58	863.69
Grand Total	16907.32	9101.87	2733.88	17.55	2716.33

The differences in total net benefits to the state cannot be explained by catch and revenue data alone. What we find is that elimination of any portion of the program causes catch to decrease. This results in a reduction in revenues relative to the current production levels. Thus, the gain in net benefits is not due to a gain in revenues but to a decrease in costs of running the enhancement program. Under the eliminate all alternative (Case 3), catch decreases by 28%, down to 16.802 b. pounds over 30 years from 23.332 b. pounds under the current output level. However, revenues only decrease by 4.6%, down to $15.335 b. from $16.075 b. over thirty years.

Thus if the financing for the hatchery program were to entirely be financed within the region, the best alternative to Prince William Sound would be to eliminate the hatchery program given that the same is occurring throughout the rest of the state.

Under the elimination of the entire hatchery program, the producer's surplus decreases by $217.41 m. over thirty years, but this is more than offset by a decrease in hatchery costs of $837.27 m. Thus the net gain to the state of $619.86 m. over thirty years is due to savings in the cost of the hatchery program. In essence, this tells us that the cost to provide fishermen with $217.41 m. in additional producer's surplus is an additional $837.27 m. in hatchery costs. This means that if the state wishes to increase the producer's surplus of fishermen by $217.41 m., by giving a direct subsidy to the fishermen of the $217.41 m. in lost producer's surplus instead of running the hatchery program, the state would savings of $619.86 m. over the next thirty years.

International Marketing Model of Alaska Salmon: Progress Report

This research is being conducted by Dr. Mark Herrmann and Dr. Joshua Greenberg, economists at the University of Alaska Fairbanks for the Senate Special Committee on Domestic and International Commercial Fisheries. It is one component of the economic benefit-cost analysis being conducted for the Legislative Review of the Alaska Salmon Enhancement Project. The purpose of the salmon demand and marketing research is to describe the relationship between salmon prices and quantities, and the various market conditions that influence these variables. The following information summarizes some of the preliminary findings.

* The current economic model is being constructed with the specific objective of developing long-term forecasts for benefit-cost analysis rather than for annual price forecasting.

* Alaska salmon ex-vessel prices by region, species, and gear type of the harvest fishery will be forecasted to conduct the benefit-cost analysis of the salmon enhancement program.

* One of the findings was that farmed Atlantic salmon substituted with sockeye, chinook, and coho salmon with a 98.1 percent probability.

* Ex-vessel price flexibilities measure the percentage change in the ex-vessel price given a one percent change in landings, holding other factors constant. For an increase in landings, a price flexibility of greater than one (in absolute terms) suggests that the percentage decrease in price will more than offset the percentage increase in landings. In such cases, increased landing would result in decreased total revenues to the fishery.

* Preliminary estimations of the average salmon ex-vessel price flexibilities range between -0.60 and -0.85. this means that a one percent increase in landings results in a 0.60 to 0.85 percent decrease in ex-vessel price. Thus, the increase in landings in the fishery are partially offset by the price reductions. These price flexibilities are higher than those found in previous studies.

* These preliminary results raise the possibility that very high landings in the Alaska salmon fisheries may decrease revenues to the industry.

* Preliminary results indicate that the increased supply of world salmon may have shifted the demand curve for salmon inward (see page 9 of the executive summary). This suggests that Alaska salmon prices will face continued downward pressure during years of high production unless market expansions can shift the demand curve outward again.

* The downward price adjustments are the mechanism through which increased Alaska production is absorbed into the existing world market.

* These early results indicate that Alaska ex-vessel salmon prices may be more responsive to landings than previously believed. These leaves open the possibility theat, in higher yielding years, Alaska salmon hatcheries may be producing near the economic optimum number of salmon. However, given their potential ramifications, these finds should be viewed as strictly preliminary. To evaluate their full implication, they must be integrated with the fishing cost and population project components of the project.

Proposal to Conduct a Benefit-Cost Analysis of the Fishery Enhancement Program:
Emphasis on the Price Responsiveness of Alaska Salmon to Enhancement Production

Introduction

In May 1991, the Senate Special Committee on International and Domestic Fisheries initiated an extensive review of the Alaska salmon hatchery and enhancement program. As a result of considerable interest in the project, participation in the Hatchery Research Project includes representatives from both the Senate and the House of Representatives. The purpose of the study is to 1) review the history and legislative intent of the enhancement program, 2) analyze the current status of the program, and 3) consider future options for the program--ranging from fine tuning to possible redirection.

As part of the Hatchery Research Project, an **Economics and Marketing** study group was developed to provide information to the legislature on the economic impacts of salmon hatchery production. The group is to help determine

- if the current levels of Alaska salmon harvests are over-or under-supplied from a world-market perspective and
- if increased hatchery production of salmon will lower prices, fishing and processing revenues, and the total net value of Alaska's salmon fisheries.

To address these public policy questions requires a benefit-cost analysis. This type of analysis measures the level and cost of enhanced salmon production, the cost of managing, harvesting, and processing enhanced salmon stocks, and the impact or "price responsiveness" of world salmon markets to various levels of Alaska enhanced salmon production. The costs are then subtracted from the benefits to estimate the net benefits of the salmon enhancement program and the incremental net benefits of different levels of enhanced salmon production to commercial fisheries. To analyze only the impact of different levels of salmon production on world salmon markets and prices paid to fishermen is insufficient for thorough policy analysis because it does not measure the net benefits (benefits minus costs) of the commercial salmon fisheries to fishermen or all Alaskans.

An example of some of the policy questions a benefit-cost analysis would help to address are as follows:

- Is increased Alaska salmon hatchery production the cause of this year's lower salmon prices? What is the significance of other factors, such as increased farmed-salmon production, exchange rates, economic recessions, and prices of food substitutes?

- What is the most profitable salmon species mix and level of production for the statewide enhancement program? Should the emphasis shift from pink salmon to king and coho salmon, for example, or even to other non-salmon species?

- If Alaska curtailed hatchery salmon production, would Alaska salmon (both wild and hatchery) prices increase or would the resulting market share be filled by farmed salmon from other countries? Ultimately, what would be the net effect or benefits to Alaskans from these changes?

- How are the estimated benefits and/or costs of the existing hatchery production distributed to fishermen and processors in each region of the state? If changes in production occurred, how would these benefits and/or costs be distributed?

- What would be the economic benefits of changes in policy or additional legislative oversight regarding the production capacity and releases of hatchery salmon?

Rather than initiating a new benefit-cost analysis, the Senate Special Fisheries Committee requested the Hatchery Research Group to first identify the specific issues that need additional economic research. In response, the economics group developed a study plan with the initial tasks of reviewing economic and marketing studies completed to date and assessing the need for additional research.

After reviewing current research, the group determined that insufficient economic information currently exists to accurately address salmon enhancement public policy questions. The research that has been completed is either out-of-date, or additional research needs to be done to improve the reliability of existing economic models. As a result of the significant investment by private parties and the state of Alaska in both enhancement projects and commercial fishing, a rigorous analysis using accepted bioeconomic techniques is warranted to fill these information gaps.

Based on our review, the economics group is proposing a set of contracts for additional research. The group worked closely with staff from the Alaska Department of Fish and Game (ADF&G), FRED Division to develop this proposal because FRED Division staff have considerable experience in these areas of research and have contracted for previous studies. In addition, we have solicited comments from the Divisions of Commercial Fisheries and Sport Fish to ensure that their concerns are addressed. As the committee requested, this proposal builds on previous research to close information gaps. It should be noted that the cost estimates are preliminary and more specific contract language will be developed if the legislature pursues the research.

Proposed Research

The five principal research components are:

1) a hatchery production and cost model,

2) a fish population model linked to fishing effort and harvests,

3) a demand model for Alaska salmon in world markets,

4) a fishing cost model, and

5) a computer software system to combine the four models.

The five components are described below including researchers and estimated costs. Based on prior research conducted for the FRED Division and expertise, the economics group contacted potential University of Alaska researchers to determine interest in the projects. The researchers identified have submitted proposals for research at the specified funding levels.

As a result of the short time period available to complete the research, it will be funded through RSAs. Therefore, interested parties will not formally bid on the projects, but instead will provide information on proposed research methodology, pertinent research experience and qualifications, and the ability to complete the contract in the time available.

Hatchery Cost and Production Model

Principal Investigators: Economics Group, Legislative Research Agency, and the ADF&G, FRED Division staff

Anticipated Cost: $0

This research component would consist of a survey of hatchery and enhancement project operators to determine the cost of producing salmon. In economics jargon, survey information will be used to develop an enhancement project "production function" to estimate the incremental cost of changes in the number of salmon produced by these projects. The survey will be developed by the economics group and FRED division staff and administered by the Legislative Research Agency and FRED division. This portion of the research will also solicit information from the ADF&G, Division of Commercial Fisheries regarding the costs of fisheries management of enhancement project stocks.

Biological Population Model

Principal Investigators: Dr. Jeremy Collie, Juneau Center for Fisheries and Ocean Sciences, University of Alaska Fairbanks

Anticipated Cost: $10,000

The purpose of the biological population model is to estimate the number of adult fish produced by enhancement projects and available for harvesting. Salmon produced by hatcheries and other projects are exposed to similar biological and environmental conditions and fisheries as wild stocks--as compared to farmed salmon. As a result, this research would estimate the interdependence of wild and enhanced stocks. These estimates will taken into consideration varying management assumptions regarding stock separation and cost recovery.

Salmon Demand Model

Principal Investigator: Dr. Mark Herrmann, Department of Economics, and Dr. Joshua Greenberg, School of Land Resources Management, University of Alaska Fairbanks

Anticipated Cost: $18,000

This contract will extend and improve research on the salmon enhancement program completed to date by Dr. Boyce for the FRED division. To more fully understand world salmon markets, improvements to existing demand models are needed. Relatively little research has been conducted to date on the demand for Alaska salmon, and models that do exist are insufficient to reliably answer the Legislature's policy questions. The additional work has not been contracted by the FRED because of insufficient funding. There are two major improvements needed. The first is in the ability to forecast salmon prices and the amount of price responsiveness to changes in enhanced salmon production and harvest levels. The second improvement is incorporating the impact of changes in world salmon-farming production levels on Alaska salmon markets and prices.

Fishing Cost Model

Principal Investigator: Dr. John Boyce, Department of Economics, University of Alaska Fairbanks

Anticipated Cost: $20,000

This portion of this study will estimate the cost to fishermen of harvesting salmon to determine the incremental cost of harvesting different levels of enhancement project produced fish. This information can address questions such as--if hatchery production results in a 10 percent increase in harvest levels and a 2 percent decrease in the price of pink salmon, are the additional revenues minus the additional cost of harvesting the fish sufficient to increase fishermen's net revenues. Little extensive or reliable research has been completed on this topic which accounts for the relatively higher cost of this study component.

Combining of Models

Principal Investigator: Drs. John Boyce and Mark Herrmann, Department of Economics, and Dr. Diane Bischak, School of Management, University of Alaska Fairbanks

Anticipated Cost: $10,000

When completed, the four models will be combined into a single, complete software system for the analysis of specific policy questions. This contract will test specific future enhancement program options--such as maintaining, decreasing, or increasing current enhanced salmon production levels, changing the current species mix, and maintaining or changing the location of enhancement projects--on the net economic benefits to fishermen and Alaskans. To the extent possible the analysis will differentiate the distribution of enhancement program net benefits among regions of the state. The results of this analysis will be a written report for the committee that will facilitate the development of public policy decisions.

Conclusion

In addition to providing information on Alaska's salmon enhancement programs, the models developed by the study could be used for evaluating other salmon management policy questions.

The total estimated cost of the research is $58,000 which is approximately $17,000 less than the UAA, Institute of Economic and Social Research proposal provided in May 1991. The reasons for the estimated lower costs are that the hatchery cost model work would be done with current legislative and ADF&G staff.

The research proposed does not include studies to develop new markets or products for Alaska salmon for a number of reasons. The time available is insufficient, the cost of reliable marketing studies is usually quite high, and the Alaska Department of Commerce and Economic Development (DCED), Division of Economic Development and the Alaska Seafood Marketing Institute (ASMI) are both initiating salmon marketing studies in response to this summer's lower salmon prices. Therefore, the legislative economics and marketing group plans to provide information to the legislature on the success of past state efforts to market Alaska salmon and coordinate with the DCED efforts to avoid research duplication and encourage the best possible information. A copy of the DCED proposal is attached.

The proposed research also does not include studies to estimate the net benefits of the salmon enhancement program to sport or subsistence users. Including these additional uses would significantly expand the scope and cost of the studies.

October 28, 1991

Fishing Cost Model Progress Report

Dr. John R. Boyce
Department of Economics
University of Alaska Fairbanks
Fairbanks, Alaska 99775

May 4, 1992

Introduction

The fishing cost model estimates the economic profits accrued to the harvesting sector as a function of the harvest size and value. To analyze the costs and benefits of the Alaska salmon enhancement program, it is necessary to predict how changes in the size and value of the harvest affect participation choices by fishermen. This document summarizes the modeling approach as well as progress to date.

Observations and hypotheses

Even though the salmon fisheries are limited entry fisheries, the number of fishermen actually participating at any point in time is generally less than the number who could be participating. Why are we not observing all of the fishermen participating when the fishery is open? The answer appears to be that the fishermen vary with respect to fishing costs.

The central hypothesis underlying the fishing cost model is that higher profits invite greater participation in the fisheries. Information on profits (profits = revenues - costs) is not collected by the state. The state does, however, collect data on revenues as well as participation by fishermen. In its simplest form, the fishing cost model uses expected gross revenues to explain participation rates. If fishermen were the same, this procedure would determine a threshold gross revenues above which participation would occur, and below which participation would not occur. Then we should observe fluctuations between "no one fishing" and "everyone fishing" as average gross revenues fluctuate below and above the cost threshold. This, however, is not what is observed. What we observe is a pattern showing as gross revenues increase, the participation rates increase. This suggests that fishermen do not have identical costs. Some fishermen have higher costs than others.

To estimate the profits to the industry, we must have some measurable variable that differentiates between the fishermen with higher and lower costs. Several hypotheses have emerged. The first is that the costs fishermen have are related to characteristics

about the configuration of the equipment the fisherman uses. For example, larger vessels might be more costly to operate, therefore requiring a better return before they are willing to participate. A second hypothesis is that some fishermen may be more efficient than others. Even though there may be no observable differences in their gear configuration, the more efficient fisherman may be able to fish profitably during days when other less skilled captains cannot. A third hypothesis relates to the effect of congestion in a fishery. It is hypothesized that as the number of fishermen in an area increases, the return to each fisherman per day of effort declines because of fishermen are getting in each other's way.

The fishing cost model may be summarized as being comprised of the following hypotheses:

H_0: Higher gross revenues attract greater participation.

H_1: Fishing costs are related to gear configuration.

H_2: Fishing costs are related to inherent differences in the fishermen.

H_3: Fishing costs increase with the number of fishermen participating.

The methodology

Data were purchased from the Commercial Fisheries Entry Commission (CFEC) for a number of the major salmon fisheries served by the enhancement program in Alaska. In particular, we have obtained data for the following fisheries for the years 1990 and 1986:[1]

Table One: FISHERIES ANALYZED

Cook Inlet	drift net, set net, and purse seine
Kodiak	set net and purse seine
Prince William Sound	drift net and purse seine
Southeast	hand troll and power troll

[1]We chose the year 1990 because it was the most recent year for which data has been completely compiled. We requested each of the years from 1984 through 1990, but this would have accounted for over 50% of the funding for this portion of the project. 1986 was chosen in consultation with CFEC staff because it is a fairly representative year.

The data *CFEC* collects for these fisheries includes *fish ticket file* data, which describes the harvesting patterns of each member of the fleet, the *permit file* data, which describes the range of permits held by each member of the fleet, and the *vessel file* data, which describes the configuration of the vessel(s) used by each member of the fleet.

The fishing cost model requires the data to be organized by fisherman and by opening. The idea is to predict whether or not the fisherman will participate in the opening. For each fisherman, we observe the days they did and did not participate, and the revenues they and others earned in each fishery that was active. We also know what vessel or equipment the fisherman was using and we know how each fisherman compares with others in the fleet in matters such as average catch, number of days active, number of areas visited, and number of processors sold to.

For each day there is fishing, we observe whether or not the fisherman participated. The model predicts whether or not the fisherman will participate on the basis of (1) expected gross revenues, (2) the configuration of the vessel, (3) systematic differences in the skills and behavior of the fishermen, and (4) the number of other fishermen in the fishery. These four sets of factors correspond to the four hypotheses stated above.

What we have found

Most of the research time to date has been spent organizing the CFEC data files to test the four hypotheses listed above. These hypotheses test the relative importance of each factor on participation in a particular fishery and opening. As a result of the very large data sets used for this modeling effort and extensive computer programming requirements, this work is still in progress but will not delay the final combined report. This report primarily presents findings from the Cook Inlet purse seine fishery.

The Cook Inlet purse seine fishery operated in 1990 over a season of 85 days. There were 73 fishermen who participated. The Cook Inlet purse seine fishery regularly had openings of 5-6 days in length. The Cook Inlet purse seine fishermen on average participated slightly over 16 days, and earned approximately $1200/day, for total gross revenues of about $19,500 per fisherman. None of the fishermen were active the entire season.

The fishermen participating in the Cook Inlet purse seine fishery vary considerably from one another in terms of their gross revenues. Table Two shows the mean, standard deviation, maximum and minimum value for a set of selected summary statistics for the Cook Inlet purse seine fleet. A good rule of thumb for reading standard deviations is that approximately 35 percent of the sample will have values outside of the range of the mean plus and minus the standard deviation. Thus 35 percent of the fishermen earned revenues less than $100/day or greater than $2200/day. Therefore, it appears that the fishermen do not behave in the same way or possess the same skills. This suggests that fishermen do have different levels of profits. This lends support to the assumption of hypothesis H_2, that fishermen have different inherent skills and behavior.

The fishermen in the Cook Inlet purse seine fishery are also quite different in the configuration of the vessel that they use. Table Three shows summary statistics for the vessel characteristics. The vessels differ in hold capacity, length, gross tonnage, and engine type and horsepower. This evidence suggests that fishermen probably have different operating costs. This data was used to these costs depend systematically upon the configuration of their vessel that depend, among other things, upon the configuration of their vessel. This lends support to the assumption of hypothesis H_1 that fishermen have different costs associated with the configuration of their vessel.

Table Two

VESSEL DESCRIPTIVE STATISTICS (COOK INLET PURSE SEINE FISHERY, 1990)

Variable	Mean	Std Dev
VALUE OF VESSEL	$54,992.65	$60,728.57
YEAR VESSEL BUILT	1975.88	12.51
VESSEL LENGTH	32.53	8.04
GROSS TONS	12.17	12.99
HORSE POWER	254.19	123.74
HOLD CAPACITY	1660.75	6308.93
FUEL CAPACITY	359.41	300.33

Table Three

FISHERMEN DESCRIPTIVE STATISTICS (COOK INLET PURSE SEINE FISHERY, 1990)

Variable	Mean	Std Dev	Minimum	Maximum
NUMBER OF DAYS ACTIVE	16.46	8.10	1.00	33.00
CATCH (LBS) PER DAY FISHED	1359.08	1008.89	242.16	6202.75
GROSS REVENURS PER DAY FISHED	1191.92	1023.06	187.09	7598.02
LENGTH OF ACTIVE SEASON	37.32	16.24	1.00	76.00
NUMBER OF AREAS VISITED	3.72	1.85	1.00	9.00

The hypothesis H_0 postulates a relationship between participation and gross revenues that exists *holding all else constant.* Thus we control for each of the other hypothesized effects on participation when testing for this effect. We have found strong support for this hypothesis. The probability that a fisherman will participate in a fishery increases as the gross revenues they may expect to earn increases. This means that fishermen do have different thresholds above which they earn profits and below which they do not.

The hypotheses H_1 and H_2 attempt to discern *which* fishermen have higher costs. These hypotheses are tested by using variables from Tables Two and Three, respectively, to predict participation rates. With the Cook Inlet purse seine fishery we have found weak support for these hypotheses. That is, some but not all of the variables on these lists help predict whether or not a fisherman will participate in a particular opening.

The evidence is mixed in regards to the hypothesis that observable differences in the behavior and skill of the captain contribute to differences in profitability. For the Cook Inlet purse seine fleet, we found some evidence that fishermen who make more trips are less likely to continue participating in a particular opening if the fishing is bad, but fishermen who participate more days of the year are more inclined to stick around. We measured the summary statistics for each fisherman for the year 1986 to predict their behavior in 1990. This was done to disassociate the influence their decision in a particular day with the statistic describing their behavior over the whole season.

The congestion hypothesis H_3 is only weakly supported also. We found that the number of fishermen who were in the fishery the previous day had a positive effect upon whether or not a fisherman would remain in the fishery today. This suggests that when the fishing is good, fishermen participate regardless of how many other fishermen there are.

Table Four

PRELIMINARY RESULTS FROM COOK INLET PURSE SEINE FISHERY

H_0: Higher gross revenues attract greater participation.	STRONG SUPPORT
H_1: Fishing costs are related to gear configuration.	SUPPORT
H_2: Fishing costs are related to inherent differences in the captains.	SUPPORT
H_3: Fishing cost increase with the number of fishermen participating.	WEAK SUPPORT

We have relatively good prediction statistics. For entry into the fishery, we are able to predict correctly whether or not the fisherman will enter over 90 percent of the time. Once a fisherman is in the fishery, our ability to predict whether or not they will stay is over 60 percent accurate. However, while we are very accurate at predicting whether or not someone will not enter the fishery, most of our success in predicting that people will stay out of the fishery. For those who do actually enter, our prediction rate is less than 50 percent. Similarly, while we are very accurate on predicting whether or not a fisherman will stay in the fishery, we are less accurate in predicting accurately for those who leave the fishery.

We suspect that some of our inaccuracy is due to not yet having adequately constructed a variable that controls for whether or not the fisherman is already active in another statistical area. Likewise, we suspect that many of the people who exit one area are doing so to participate elsewhere. We are in the process of constructing variables to measure these effects.

What remains to be done

We have yet to examine a number of the fisheries, including both the troll fisheries in Southeast, the drift net and purse seine fishery in Prince William Sound, the set and drift net fisheries in Cook Inlet, and the Kodiak purse seine and set net fisheries.

We have not yet made a calculation of the net profits that accrue to a particular area given the size of the harvest and the average price received by fishermen.

An International Marketing Model for Alaska Salmon
Progress Report: Executive Summary

May 1, 1992

Mark Herrmann
Assistant Professor
Department of Economics
University of Alaska Fairbanks
Fairbanks, Alaska 99775
(907) 474-7116

Joshua A. Greenberg
Assistant Professor
Department of Resource Management
University of Alaska Fairbanks
Fairbanks, Alaska 99775
(907) 474-7189

The purpose of this report is to give a progress report on the economic demand component of the Legislative Review of Alaska's Fisheries Enhancement Program and may not be quoted elsewhere without the permission of the authors. This report was made possible by a grant received from the Alaska State Legislature and is the result of research sponsored by Alaska Sea Grant with funds from the National Oceanic and Atmospheric Administration, Office of Sea Grant, Department of Commerce, under grant no. NA90AA-D-SG066, project #R/14-13, and from the University of Alaska with funds appropriated by the state.

Abstract

This report is an executive summary of work performed to date on the salmon demand model portion of the Legislative Review of Alaska's Fisheries Enhancement Program contracted by the Senate Special Committee on Domestic and International Commercial Fisheries. As this reports on work in progress, reported theoretical models and preliminary findings are likely to differ slightly from the final analysis. For example, the final analysis will use a 1991 data set that is not complete at the time of this report.

The theoretical work on this portion of the project develops a 94-equation equilibrium supply and demand model for Pacific and Atlantic salmon. This system of equations includes various market components that affect Alaska salmon exvessel prices. The objective of this modelling effort is to project future Alaska salmon exvessel prices under various market scenarios that can ultimately be used in a cost/benefit analysis.

The modelled systems can be broken into two connected parts. The main body of the model is a 49-equation bloc in which salmon is traded among North America, Japan, the European Economic Community[1] (EEC), Chile, Australia, and New Zealand. Both fresh/frozen and canned salmon forms are modelled. The salmon species were divided into fresh/frozen farmed Atlantic, farmed Pacific, high-valued wild Pacific, low-valued wild Pacific, and canned low-valued wild Pacific salmon. The flows will be modelled recursively into two North American Pacific salmon exvessel prices (for high- and low-valued salmon). Quarterly data from 1982 to 1991 is used for this part of the model.

The second part of the model is a 45-equation bloc in which Alaska exvessel prices by species, region, and gear type are correlated with the North American exvessel prices from the main body of the modelling. Specifically, chinook, sockeye, and coho prices are correlated against North American high-valued Pacific salmon exvessel prices, and chum and pink prices are correlated against North American low-valued Pacific salmon exvessel prices. The purpose of this second set of equations is to analyze the salmon demand modelling results by region, species, and gear type for the fisheries in the state with the largest enhanced production component.

Early results indicate that Alaska exvessel salmon prices may be more responsive to landings than previously believed. This leaves open the possibility that, in higher yielding years, Alaska hatcheries may be producing near the economic optimum number of salmon. But, even if the demand portion of the project were completed, this conclusion could not be stated with certainty until it is integrated and simulated with the cost and biological project components. The bulk of the effort on the demand portion of the project has so far been spent building the theoretical model and collecting data. The model results reported are very preliminary; and given their potential ramifications, this study must continue to be done carefully, with specific attention to paid achieving model accuracy.

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[1] The region designated as the European Economic Community (EEC) will, for this study, include all of the EEC member countries (Belgium, Luxembourg, Denmark, West Germany, France, Ireland, Italy, Netherlands, United Kingdom, Greece, Portugal, and Spain) as well as Sweden and Switzerland.

Introduction

The purpose of this project is to describe the relationship between salmon prices and quantities, and the various market conditions that can influence these variables. The relationships between market factors and salmon prices have a hypothesized structure. By using econometric techniques, we can test the validity of this hypothetical structure. Econometrics is a blending of economic theory and regression analysis. Through model simulation, the developed system of equations can provide a framework for predicting, under various market conditions, future salmon quantities and prices.

The current econometric model is being constructed with the specific objective of developing long-term forecasts. Alaska salmon exvessel prices by region, species, and gear type will be forecasted to facilitate the incorporation of these projections into a cost/benefit analysis of Alaska's salmon hatchery system. Additional benefits of this modelling effort include obtaining estimated mean-level and point elasticities (an economic term measuring relationships among variables), as well as obtaining results from the sensitivity analysis.

Project Goals

Following are the specific objectives of the international market modelling section of the salmon enhancement study. These objectives are modified from those found in the original proposal as necessitated by knowledge gained in initial modelling efforts. The following objectives are more specific than those found in the original proposal.

The specific objectives of this project are as follows:

1) Update the existing international econometric salmon model of fresh/frozen salmon as published in a work by Mittelhammer, Herrmann, and Lin for the National Marine Fisheries Service entitled *An Economic Analysis of World Salmon Markets: Effects of Salmon Farming*, using 1989 and 1990 data (and possibly 1991). Quarterly data will again be used (Also see Herrmann 1990).

2) Examine the possibilities of changing the functional form of the relevant equations in the above models to linear (or log-linear) instead of double-log to allow for changing elasticities along the demand curve.

3) Expand the model to include canned pink and chum salmon (canned chum salmon is merely added to keep the definition of low-valued salmon intact. Canned chum salmon is relatively insignificant in terms of overall quantity).

4) Model at the exvessel and export levels. Factors affecting the wholesale level will be included in the reduced form exvessel price equations.

5) Disaggregate the salmon species at the exvessel level into Alaska chinook, sockeye, coho, chum, and pink salmon by area and gear type. Current targeted fisheries are Prince William Sound drift gill net and purse seine, Cook Inlet drift gill net, purse seine and set net, Kodiak purse seine and set net, and Southeast hand and power troll. (For the

final report these targeted areas may be altered). In an attempt to locate regional price changes, these areas are being modelled by relating the aggregate North American price of salmon to the regional prices of salmon in Alaska through correlation analysis.

6) Report all relevant own-price, cross-price, and income elasticities. Cross-price elasticities will be between relevant Pacific and farmed salmon species.[2]

7) Perform sensitivity analyses over the historical time period to validate the models and to answer questions as to the effects of cases 1-11 found in the original RFP (see appendix A) over the historical time period. Sensitivity analysis will also be done on various market factors such as changing exchange rates, tariff rates, income levels, etc. This sensitivity analysis may be performed independently of the entire demand, cost, and biological model, or may be done exclusively as a part of the final integrations of the three models.

8) Prepare the model to be used in the "Combining of Models for Policy Analysis" part of the enhancement project. This will include price predictions and sensitivity analysis on future prices for cases 1-11.

9) To write a final report with a targeted finish date of October 1992.

A progress report of the work completed to date can be found in Appendix B.

The Theoretical Model

Econometric models are constructed with an end goal in mind. The purpose of this model is to project salmon price over a long time horizon. This necessitates a different type of model than would be constructed if the goal was to forecast one year in advance. A model with a goal of forecasting one year in advance might include ADF&G forecasted biomass; current United States, Canadian, and Japanese inventory levels; and other variables. Unfortunately, these variables are not available for inclusion in a model with a 15-year forecasting horizon.

A model that is geared toward multi-year predictions cannot use variables such as ADF&G forecasts of salmon runs and actual inventory figures. Instead, model-generated salmon landings must replace ADF&G forecasts, and predicted inventory levels must replace actual inventory levels. Additionally, future values of other market factors, such as exchange rates, must also be projected into the future in order to predict salmon prices.

This long-run emphasis necessitates an aggregate modelling approach that emphasizes accurately estimating trends in long-term price movements rather than accurately estimating the price in any single year. In other words, the model will have achieved its objective if at any point in time it is able to predict mean price levels for the next ten-

2 An elasticity measures the percentage change in a dependent variable for a one-percent change in an independent variable, holding all other variables constant. For example, if the price of farmed salmon increases by 1 percent and the quantity demanded decreases by 1.2 percent, then the own-price elasticity of farmed salmon is -1.2.

year time period better than a naive expectation. This will be true even if the variance of the model estimates are high indicating that any single year's predictions are not entirely accurate.

Because world salmon markets are highly integrated, an international approach to modelling was necessary. The flowchart gives a visual representation of the salmon model that is being constructed. The arrows show the direction of trade flows that are being modelled.

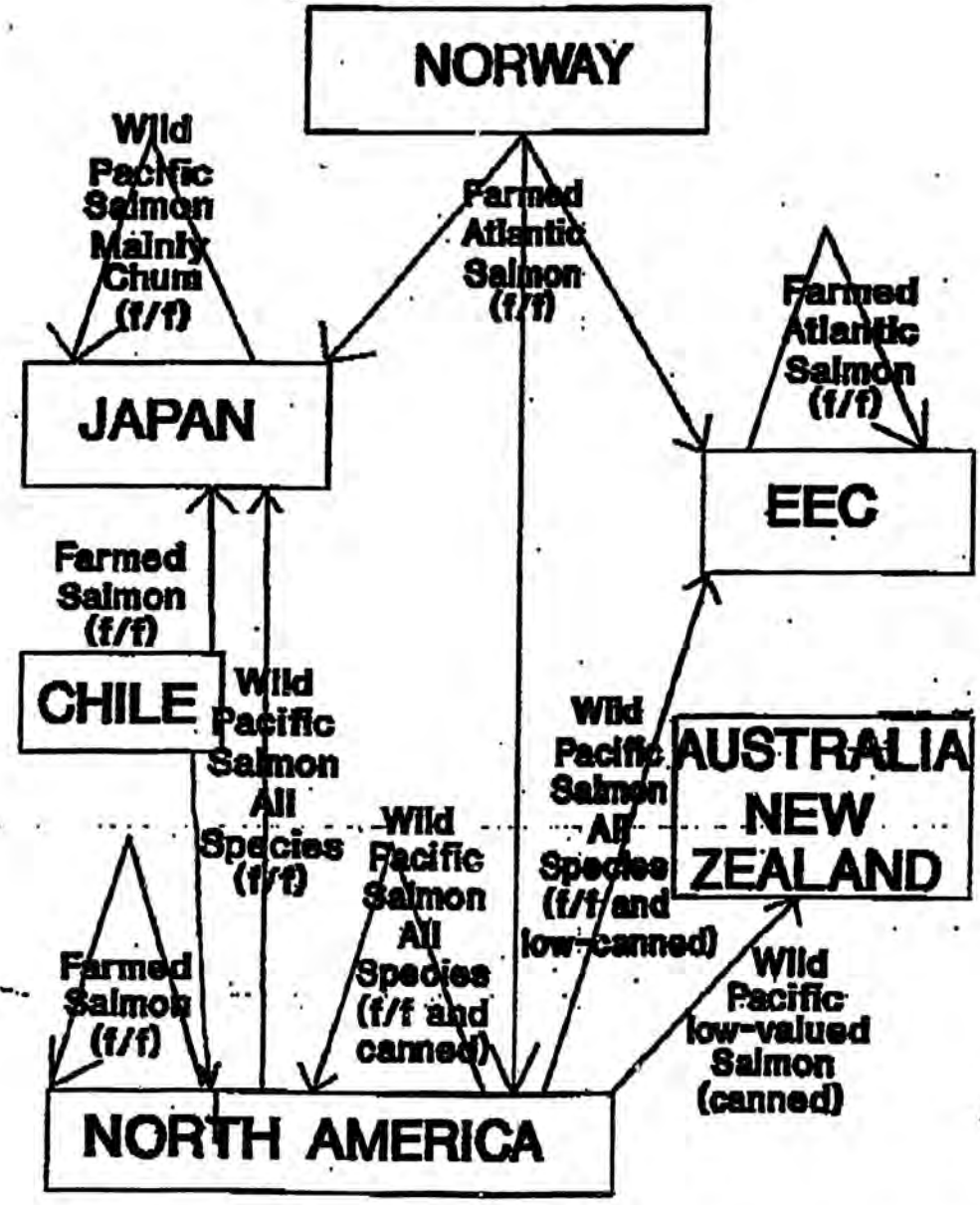

Figure 1. International salmon flowchart. (Note: f/f indicates fresh/frozen).

Listed below are the dependent variables that are being modelled in bloc 1. The final model may be somewhat different. All quantities are fresh/frozen unless otherwise noted as canned.

1. Norwegian allocation of farm-raised Atlantic salmon

   - Quantity allocated to the EEC
   - Quantity allocated to Japan
   - Quantity allocated to the United States

2. EEC demand for salmon

   - Quantity demanded of Scottish, Irish, and Norwegian farmed Atlantic salmon
   - Quantity demanded of North American high-valued wild Pacific salmon
   - Quantity demanded of North American low-valued wild Pacific salmon
   - Quantity demanded of canned North American low-valued wild Pacific salmon

3. Japanese demand for salmon

   - Quantity demanded of Norwegian farmed Atlantic, Chilean farmed Atlantic and coho salmon
   - Quantity demanded of North American high-valued wild Pacific salmon
   - Quantity demanded of North American low-valued wild Pacific salmon

4. North American demand for Atlantic salmon

   - Quantity demanded of Norwegian, Chilean, British Columbian, and U.S. farmed Atlantic salmon

5. Australia and New Zealand Demand

   - Quantity demanded of canned North American low-valued salmon.

6. North American allocation of high-valued wild salmon

   - Quantity allocated to Japan

   - Quantity allocated to the EEC

7. North American allocation of low-valued wild salmon

   - Quantity allocated to Japan
   - Quantity allocated to the EEC

8. North American allocation of canned low-valued wild salmon

   - Quantity allocated to the EEC
   - Quantity allocated to Australia and New Zealand

9. North American inventory holdings

- Quantity of high-valued wild salmon inventory

- Quantity of low-valued wild salmon inventory
- Quantity of canned low-valued wild salmon inventory

10. North American exvessel prices

- Price of high-valued wild salmon
- Price of low-valued wild salmon

11. Exvessel Regional Mappings

- The exvessel prices of species and regions in Alaska as listed under project objective 5.

The model includes flows of farmed salmon from Norway, Scotland, Chile, British Columbia, Ireland, and the United States. The farmed salmon from Norway, Ireland, and Scotland is exclusively Atlantic salmon. Farmed salmon from the United States, British Columbia, and Chile are a mixture of Pacific and Atlantic salmon. North American salmon exports include all species of Pacific salmon. Japanese landings of salmon also include all species of Pacific salmon, although most Japanese landings are chum salmon.

To keep the model manageable and because of data limitations, some countries and salmon species were aggregated, and some markets were omitted. Aggregated markets include the United States and Canada into 'North America' and European countries into the EEC. Omitted countries include the former Soviet Union which historically has kept its salmon in the Eastern Bloc countries. Despite this, it is felt that the resulting model is sufficiently inclusive to generate insights into the operations of world salmon markets.

In bloc 2 the current Alaska salmon exvessel prices that will be predicted include all species for Prince William Sound drift gill net and purse seine, Cook Inlet drift gill net, purse seine and set net, Kodiak purse seine and set net, and Southeast hand and power troll.

(For the complete model and data variable definition, see Appendix C.)

Estimation Results

For bloc 1, the two equations that have been partially estimated are equations 47 and 48, the North American high-valued exvessel price equations. These equations are reduced form equations based on derived demand theory. For the North American high-valued Pacific salmon exvessel equation, 93.7 percent of the variation in the exvessel prices was explained by the explanatory variables (see figures 2 and 3 which show the historical fit between the actual and predicted exvessel prices for high- and low-valued salmon). One of the findings was that farmed Atlantic salmon substituted with sockeye, chinook, and coho salmon with a 98.1 percent probability.

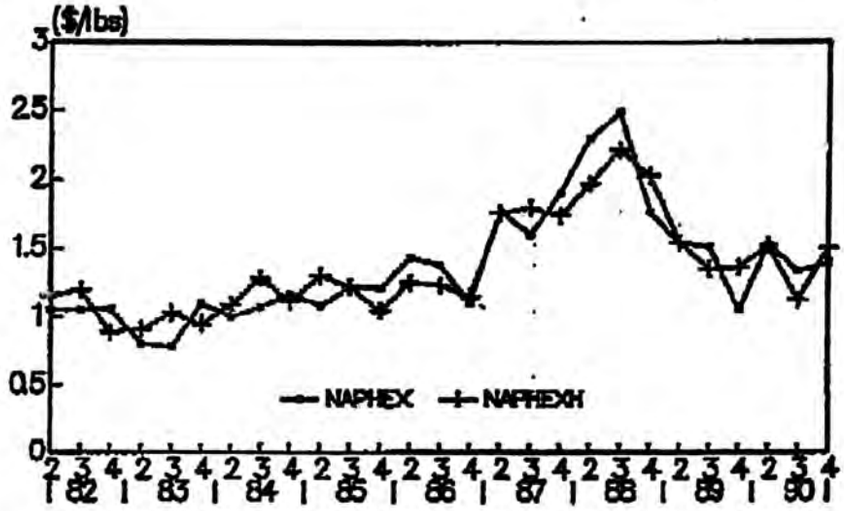

Figure 2. Predicted (NAPHEXH) vs. actual (NAPHEX) North American high-valued salmon exvessel price (1982 to 1990).

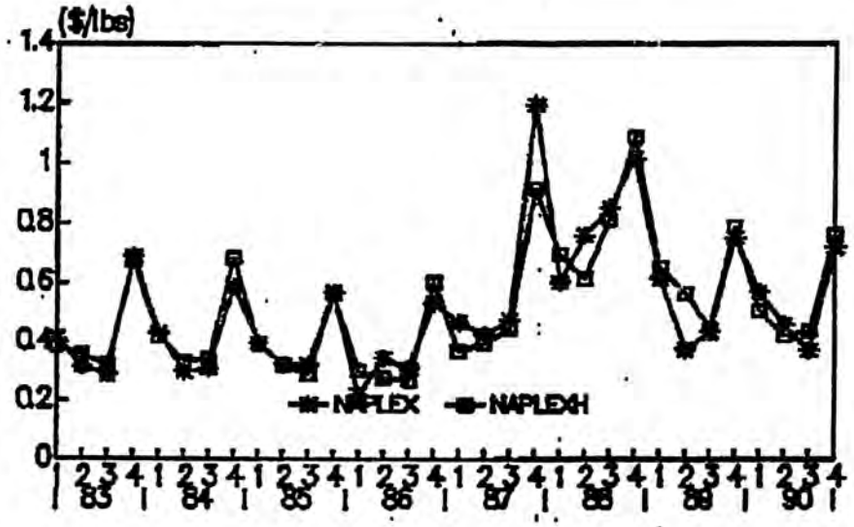

Figure 3. Predicted (NAPLEXH) vs. actual (NAPLEX) North American low-valued salmon Exvessel price (1983 to 1990).

In the low-valued exvessel price equation, the explanatory variables explained 86.5 percent of the variation in the low-valued exvessel price. When data becomes available, Chilean coho and canned tuna will be included as potential substitutes for Alaska salmon products.

Exvessel price flexibilities measure the percentage change in the exvessel price given a one percent change in landings, holding all other variables constant. For an increase in landings, a price-flexibility of greater than one (in absolute terms) suggests that the percentage decrease in price will more than offset the percentage increase in landings. In such cases, increased landings would result in decreased revenues to the fishery. Price flexibilities for this model are calculated at their mean-levels for 1962 to 1990. Price flexibilities are only an approximation of exvessel price adjustments to changes in landings. For example, wholesale prices are held constant in calculating price flexibilities.

Given these data, preliminary estimations of mean-level price flexibilities for salmon at the exvessel level range between -0.60 and -0.85. This means that a one-percent increase in landings results in a 0.60 to 0.85 percent decrease in exvessel price. Thus, the increase in landings in the fishery are partially offset by the price reductions. These price flexibilities are much higher, in absolute values, than those previously found in other studies. This raises the possibility that very high landings in the Alaska salmon fisheries may decrease revenues to the industry (price flexibilities under those circumstances will exceed those calculated at the mean. As landings increase the price flexibility also increases.) This conclusion will hold if, given a high productivity in the fishery, the estimated price flexibility coefficients exceed one. However, the full impact of changes in landings to fishery revenues cannot be ascertained until the full model is simulated.

In bloc 2, all 46 equations have been preliminarily estimated. The correlations between the Alaska exvessel prices by species, gear type, and area, and the appropriate North American exvessel prices were estimated. The correlations were quite high, with the strongest correlations for sockeye and pink salmon. For example, the correlation between Prince William Sound purse seined sockeye salmon and the North American high-valued Pacific salmon exvessel prices was 0.961. Squaring this term gives us a coefficient of determination of 92.4 percent. This means that 92.4 percent of the variation in the Prince William Sound purse seined sockeye salmon is explained by the variation in the North American (Canadian and U.S.) high-valued Pacific salmon exvessel prices. A graphical representation of the fit between the predicted and actual exvessel prices Prince William Sound purse seined sockeye salmon is shown in figure 4. These preliminary results indicate that regional results of the modelling effort should be reliable.

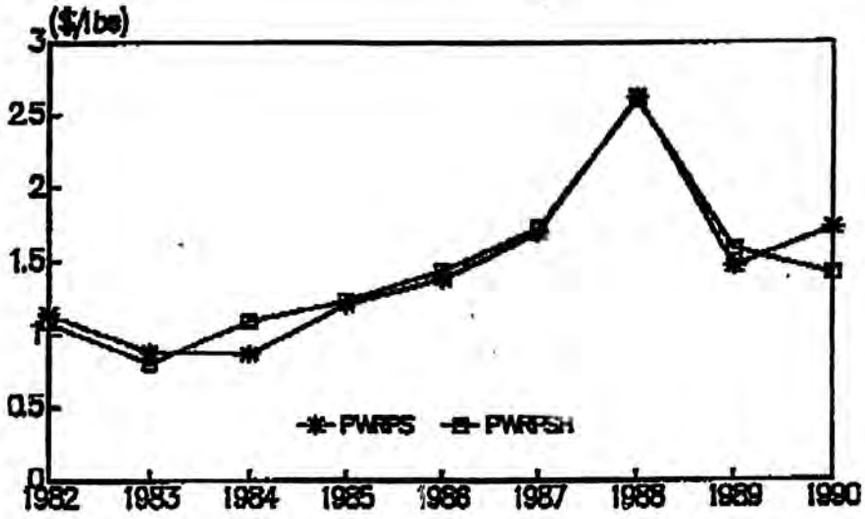

Figure 4. Predicted (PWRPSH) vs. actual (PWRPS) prince William Sound sockeye purse seined salmon exvessel price (1982 to 1990).

The only unsatisfactory correlations have been for chinook salmon. The low correlations are probably the consequence of a few outliers in the exvessel price data set. In part, this may be a result of chinook not being the target species in several of the regional fisheries. Low chinook landings in these regions allow for the reported exvessel price to be easily distorted by the activities of a single year or few fishery participants. The investigators are awaiting CFEC harvest data, disaggregated by region, to address this problem.

Conclusion

When the entire model is estimated and simulated, the regional Alaska exvessel prices will be forecasted into the future by correlating the regional exvessel prices with the predicted North American exvessel prices. This task will not be completed for several months.

Preliminary results, in comparison to previous studies, indicate that the increased supply of world salmon may have shifted the demand curve for Alaska salmon inward. As one can see from figure 5, this means that to continue selling quantity X, prices would decline to P_1 unless market expansions could shift the demand curve outward again.

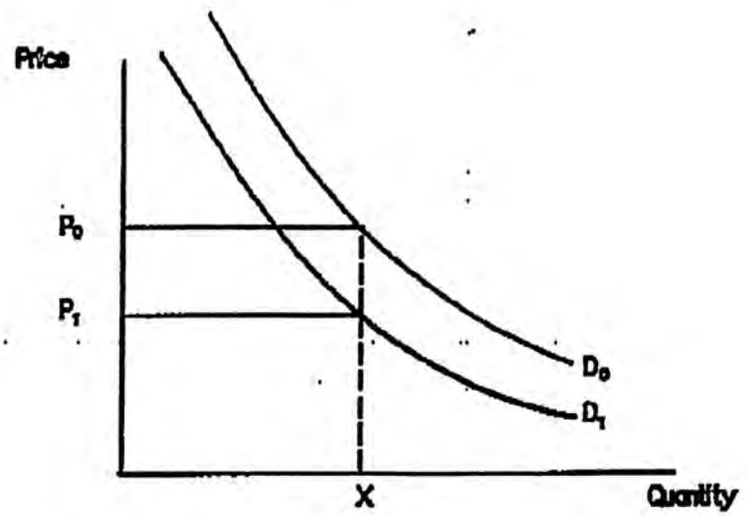

Figure 6. Price effect of an inward shift of a demand curve keeping quantity constant.

This suggests that there is significant downward pressure on Alaska salmon prices in years of high Alaska production. The downward price adjustments are the mechanism through which increased Alaska production is absorbed into the existing world market. However, full simulation results along with more information as to future farmed salmon supply levels and other market conditions, are needed before any conclusions can be drawn as to the course that the hatchery program should take.

Appendix A

Cases to be Simulated

Case 1: Base Case - the salmon enhancement program continues at currently permitted capacity levels.

Case 2 - The salmon enhancement program continues at state and PNP projected production levels.

Case 3 - The salmon enhancement program is eliminated in FY 93.

Case 4 - Salmon production from enhancement projects is increased/decreased by increments of 15 percent.

Case 5 - The pink salmon program is eliminated and all else remains at the currently permitted capacity level.

Case 6 - The sockeye salmon program is eliminated and all else remains at the currently permitted capacity levels.

Case 7 - Salmon production from pink salmon enhancement projects is increased/decreased by an increment of 15 percent and all else remains at the currently permitted capacity level.

Case 8 - Salmon production from sockeye salmon enhancement projects is increased/decreased by an increment of 15 percent and all else remains at the currently permitted capacity level.

Case 9 - Salmon production from chum salmon enhancement projects is increased/decreased by an increment of 15 percent and all else remains at the currently permitted capacity level.

Case 10 Salmon production from coho salmon enhancement projects is increased/decreased by an increment of 15 percent and all else remains at the currently permitted capacity level.

Case 11 Salmon production from king salmon enhancement projects is increased/decreased by an increment of 15 percent and all else remains at the currently permitted capacity level.

Appendix B

Project Progress Report.

Below the progress is reported against the timeline reported in the original milestone chart (summarized below).

Areas	Description	Targeted Completion Date	Percent Completed
1)	Data Collection and Update of Model	3/92	75
2)	Functional Form Work	3/92	70
3)	Disaggregation work	7/92	80
4)	Canned Salmon Work	6/92	10
5)	Disaggregation of Countries	6/92	90
6)	Elasticity Estimates	7/92	10
7)	Level estimation (market)	7/92	20
8)	Sensitivity Case Analysis	10/92	5
9)	Regional Correlation	8/92	80
10)	Predictions	10/92	0
11)	Sensitivity of 11 cases	10/92	0
12)	SAS program	10/92	10
13)	Final Report	10/92	5
14)	Preliminary Report	4/92	Finished

Overall, the marketing portion project is on schedule. Areas 1 and 2 were to have been the only areas to be fully completed by April. Area 1 is mostly complete, but is still in progress because all the 1991 data is not available. (For example, CFEC salmon exvessel prices will not be fully compiled until August). Area #2 has also been mostly completed but the model is being expanded and fine tuned as additional data becomes available. Progress has been made in all areas except areas 10, and 11 which cannot be performed until the modelling phase is complete.

Appendix C

The Full Model

Bloc One

Norwegian Atlantic

1) $NQAE^s = f_1(NPAE, NPAJ, NPAIJ, QTOTA, EXO_1)$
2) $NQAJ^s = f_2(NPAE, NPAJ, NPAIJ, QTOTA, EXO_2)$
3) $NQAEP^d = F_3(EPAERT, EPHERT, EPLERT, EXO_3)$
4) $NQAJP^d = F_4(JPAJRT, JPHJRT, JPLJRT, EXO_4)$
5) $NQAIJP^d = F_5(UPAIJRT, UPHIJRT, UPLIJRT, EXO_5)$
6) $QTOTA = NQAE^s + NQAJ^s + NQAIJ^s$
7) EPAERT = (((NPAE/NORECU)*ETARIFF))/ECPI
8) EPAJRT = (((NPAJ/NORJAP)*ETARIFF))/ECPI
9) EPAIJRT = (((NPAIJ/NORUSA)*ETARIFF))/ECPI
10) $NQAE^d = NQAE^s + QSCIR^s$
11) $NQAJ^d = NQAJ^s$
12) $NQAIJ^d = NQAIJ^s$

North American High-Valued Salmon

13) $UQHXE^s = F_6(UPHXE, UPHXJ, QTOTH, EXO_6)$
14) $UQHXJ^s = F_7(UPHXE, UPHXJ, QTOTH, EXO_7)$
15) $UHINV = F_8(NPH, QTOTH, EXO_8)$
16) $UQHXE^d = F_9(EPHERT, EPLERT, EPAERT, EXO_9)$
17) $UQHXJ^d = F_{10}(JPHJRT, JPLJRT, JPAJRT, EXO_{10})$
18) $UPH = (UPHXE*UQHXE^s + UPHXJ*UQHXJ^s)/(UQHXE^s + UQHXJ^s)$
19) EPHERT = (UPHERT / USAECU)/(ETARIFF * ECPI)
20) JPHJRT = (UPHJRT * JAPUSA)/(JTARIFF * JCPI)
21) QTOTH = ULANH + $UHINV_{t-1}$
22) $UQHXE^s = UQHXE^d$
23) $UQHXJ^s = UQHXJ^d$

North American Low-Valued Salmon

24) $QTOTLZ = f_{11}(UPL, UPLC, QTOTL, EXO_{11})$
25) QTOTLC = QTOTL-QTOTLC + $ULINVC_{t-1}$
26) $UQLXE^s = f_{12}(UPLXE, UPLXJ, QTOTLZ, EXO_{12})$
27) $UQLXJ^s = f_{13}(UPLXE, UPLXJ, QTOTLZ, EXO_{13})$
28) $ULINV = F_{14}(UPL, QTOTLZ, EXO_{14})$
29) $UQLXEC^s = f_{15}(UPLXEC, UPLXAC, QTOTLZC, EXO_{15})$
30) $UQLXAC^s = f_{16}(UPLXEC, UPLXAC, QTOTLZC, EXO_{16})$
31) $ULINVC = F_{17}(UPLC, QTOTLC, EXO_{17})$
32) $UQLXE^d = F_{18}(EPHERT, EPLERT, EPAERT, EXO_{18})$
33) $UQLXJ^d = F_{19}(JPHJRT, JPLJRT, JPAJRT, EXO_{19})$
34) $UQLXEC^d = F_{20}(EPLECRT, EXO_{20})$
35) $UQLXAC^d = F_{21}(APLACRT, EXO_{21})$
36) $UPL = (UPLXE*UQLXE^s + UPLXJ*UQLXJ^s)/(UQLXE^s + UQLXJ^s)$
37) $UPLC = (UPLXEC*UQLXEC^s+UPLXAC*UQLXAC^s)/(UQLXEC^s+UQLXA)$
38) EPLERT = (UPLERT / USAECU)/(ETARIFF * JCPI)

39) JPLJRT = (UPLJRT * JAPUSA)/(JTARIFF * ECPI)
40) EPLECRT = (UPLECRT /USAECU)/(ETARIFF * JCPI)
41) APLACRT = (UPLACRT * AUSUSA)/(ACPI)
42) QTOTL = ULANL + $ULINVL_{t-1}$
43) $UQLXE^s = UQLXE^d$
44) $UQLXJ^s = UQLXJ^d$
45) $UQLXEC^s = UQLXEC^d$
46) $UQLXAC^s = UQLXAC^d$

North American Exvessel Price Equations

47) NAPHEX = f_{22}(UPH, UPL, TSUPH, UPAU, EXO22)
48) NAPLEX = f_{23}(UPL, UPH, TSUPH, UPAU, EXO23)
49) UPAU = (NPAU * USAECU)

Endogenous Variables: (bloc 1)
$NQAE^s$, $NQAJ^s$, $NQAU^s$, $NQAEP^d$, $NQAJP^d$, $NQAUP^d$, NPAE, NPAJ, NPAU, EPAERT, JPAJRT, UPAUERT $UQHXE^s$, $UQHXJ^s$, UHINV, $UQHXE^d$, $UQHXJ^d$, UPH, UPHXE, UPHXJ, EPHERT, JPHJRT, QTOTH QTOTL, QTOTLZ, QTOTCL, $UQLXE^s$, $UQLXJ^s$, ULINV, $UQLXEC^s$, $UQLXAC^s$, ULINVC, $UQHXE^d$, $UQHXJ^d$, $UQHXEC^d$, $UQHXAC^d$, UPLXE, UPLXJ, UPLXEC, UPLXAC, UPL, UPLC, EPLERT, JPLJRT, EPLECRT, APLACRT, NAPHEX, NAPLEX, UPAU

Bloc Two

Alaska Exvessel Price Correlations

50) PWKDG = (NAPHEX, C)
51) PWRDG = (NAPHEX, C)
52) PWSDG = (NAPHEX, C)
53) PWCDG = (NAPLEX, C)
54) PWPDG = (NAPLEX, C)
55) PWKPS = (NAPHEX, C)
56) PWRPS = (NAPHEX, C)
57) PWSPS = (NAPHEX, C)
58) PWCPS = (NAPLEX, C)
59) PWPPS = (NAPLEX, C)
60) CIKDG = (NAPHEX, C)
61) CIRDG = (NAPHEX, C)
62) CISDG = (NAPHEX, C)
63) CICDG = (NAPLEX, C)
64) CIPDG = (NAPLEX, C)
65) CIKPS = (NAPHEX, C)
66) CIRPS = (NAPHEX, C)
67) CISPS = (NAPHEX, C)
68) CICPS = (NAPLEX, C)
69) CIPPS = (NAPLEX, C)
70) CIKSN = (NAPHEX, C)
71) CIRSN = (NAPHEX, C)
72) CISSN = (NAPHEX, C)
73) CICSN = (NAPLEX, C)
74) CIPSN = (NAPLEX, C)
75) AOKPS = (NAPHEX, C)

76) KORPS = (NAPHEX, C)
77) KOSPS = (NAPHEX, C)
78) KOCPS = (NAPLEX, C)
79) KOPPS = (NAPLEX, C)
80) KOESN = (NAPHEX, C)
81) KORSN = (NAPHEX, C)
82) KOSSN = (NAPHEX, C)
83) KOCSN = (NAPLEX, C)
84) KOPSN = (NAPLEX, C)
85) JUKHT = (NAPHEX, C)
86) JURHT = (NAPHEX, C)
87) JUSHT = (NAPHEX, C)
88) JUCHT = (NAPLEX, C)
89) JUPHT = (NAPLEX, C)
90) JUKPT = (NAPHEX, C)
91) JURPT = (NAPHEX, C)
92) JUSPT = (NAPHEX, C)
93) JUCPT = (NAPLEX, C)
94) JUPPT = (NAPLEX, C)

Variable Names

(Note, a more thorough definition of the variable names can be found in the full report.)

Endogenous Variables: (bloc 1)

$NQAE^{d}$ = the quantity of Norwegian farmed Atlantic salmon exported to the EEC.
$NQAJ^{d}$ = the quantity of Norwegian farmed Atlantic salmon exported to Japan.
$NQAU^{d}$ = the quantity of Norwegian farmed Atlantic salmon exported to the U.S.
$NQAEP^{d}$ = the per capita quantity of imported Norwegian, Scot. and Irish farmed Atlantic salmon in the EEC.
$NQAJP^{d}$ = the per capita quantity of imported Norwegian Atlantic salmon in Japan.
$NQAUP^{d}$ = the per capita quantity of imported Norwegian Atlantic salmon in the United States.
NPAE = the Norwegian price of Norwegian farmed Atlantic salmon exported to the EEC.
NPAJ = the Norwegian price of Norwegian farmed Atlantic salmon exported to Japan.
NPAU = the Norwegian price of Norwegian farmed Atlantic salmon exported to the United States
EPAERT = the "real" after tariff price of Norwegian farmed Atlantic salmon in the EEC.
JPAJRT = the "real" after tariff price of Norwegian farmed Atlantic salmon in Japan.
UPAURT = the "real" after tariff price of Norwegian farmed Atlantic salmon in the United States.
$UQHXE^{d}$ = the quantity of North American exports of high-valued salmon to the EEC.
$UQHXJ^{d}$ = the quantity of North American exports of high-valued salmon to Japan.
UHINV = the ending inventory of North American high-valued salmon.
$UQHDE^{d}$ = the quantity of EEC imports of North American high-valued salmon.
$UQHDJ^{d}$ = the quantity of Japanese imports of North American high-valued salmon.
UPH = the North American weighted average export price of high-valued salmon.
UPHXE = the North American export price of high-valued salmon.
UPHXJ = the North American export price of high-valued salmon.
EPHERT = the "real" after tariff price of North American high-valued Pacific salmon in the EEC.
JPHERT = the "real" after tariff price of North American high-valued Pacific salmon in Japan.
QTOTH = the North American total available supply of high-valued salmon.
QTOTL = the North American total available supply of low-valued salmon.
QTOTLZ = the North American total available supply of fresh/frozen low-valued salmon.
QTOTLC = the North American total available supply of canned low-valued salmon.
$UQLXE^{d}$ = the quantity of North American exports of low-valued salmon to the EEC.

UQLXJ[a] = the quantity of North American exports of low-valued salmon to Japan.
ULINV = the ending inventory of North American low-valued salmon.
UQLXEC[a] = the quantity of North American exports of low-valued canned salmon to the EEC.
UQLXAC[a] = the quantity of North American exports of low-valued canned salmon to Australia and N.Z.
ULINVC = the ending inventory of North American low-valued canned salmon.
UQLXE[d] = the quantity of EEC imports of North American low-valued salmon.
UQLXJ[d] = the quantity of Japanese imports of North American low-valued salmon.
UPL = the North American weighted average export price of low-valued salmon.
UQLXEC[d] = the quantity of EEC imports of North American low-valued canned salmon.
UQLXAC[d] = the quantity of Japanese imports of North American low-valued canned salmon.
UPLC = the North American weighted average export price of low-valued salmon.
UPLXE = the North American export price of low-valued salmon exported to the EEC.
UPLXJ = the North American export price of low-valued salmon exported to Japan.
UPLXEC = the North American export price of low-valued canned salmon exported to the EEC.
UPLXAC = the North American export price of low-valued canned salmon exported to Australia and N.Z.
EPLERT = the "real" after tariff price of North American low-valued Pacific salmon in the EEC.
JPLJRT = the "real" after tariff price of North American low-valued Pacific salmon in Japan.
EPLECRT = the "real" after tariff price of North American low-valued can Pacific salmon in the EEC.
APLACRT = the "real" after tariff price of North American low-valued can Pacific salmon in Australia and N.Z.
NAPHEX = the North American exvessel price of high-valued salmon.
NAPLEX = the North American exvessel price of low-valued salmon.
UPAU = the price of Norwegian farmed Atlantic salmon in North America.

Exogenous Variables: (bloc 1)

EXO_1 = indicated exogenous factors to be included in equation 1.
NORECU = the Norwegian kroner/ECU exchange rate.
NORJAP = the Norwegian kroner/yen exchange rate.
NORUSA = the Norwegian kroner/U.S. dollar exchange rate.
USAECU = the U.S. dollar/ECU exchange rate.
JAPUSA = the yen/U.S. dollar exchange rate.
AUSUSA = the Australian dollar/U.S. dollar exchange rate.
ECPI = the EEC consumer price index for food.
UCPI = the U.S. consumer price index for food.
JCPI = the Japanese consumer price index for food.
ACPI = the general Australian consumer price index for food.
JTARRIF = The Japanese tariff rate on fresh/frozen salmon.
ETARRIF = The EEC tariff rate on fresh/frozen salmon.
QSCIR = the quantity of Scottish and Irish farmed Atlantic salmon.

Endogenous Variables: (bloc 2)

PWKPS PWSPS PWRPS PWCPS PWPPS is the exvessel price in the Prince William Sound purse seine fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

PWKDG PWSDG PWRDG PWCDG PWPDG is the exvessel price in the Prince William Sound drift gill fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

CIKPS CISPS CIRPS CICPS CIPPS is the exvessel price in the Cook Inlet purse seine fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

CIKPS CISPS CIRPS CICPS CIPPS is the exvessel price in the Cook Inlet drift gill fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

CISSN CISSN CIRSN CICSN CIPSN is the exvessel price in the Cook Inlet set net fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

KOKPS KOSPS KORPS KOCPS KOPPS is the exvessel price in the Kodiak purse seine fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

KOKSN KOSSN KORSN KOCSN KOPSN is the exvessel price in the Kodiak set net fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

JUKHT JUSHT JURHT JUCHT JUPHT is the exvessel price in the Kodiak hand troll fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

JUKPT JUSPT JURPT JUCPT JUPPT is the exvessel price in the Kodiak power troll fishery for chinook, coho, sockeye, chum, and pink salmon, respectively.

NAPHEX = the North American exvessel price of high-valued salmon, measured in U.S. dollars per pound.

NAPLEX = the North American exvessel price of low-valued.

Exogenous Variables: (bloc 2)

C: A constant.

Economic Review of the Salmon Enhancement Program: Emphasis on the Price Responsiveness of Alaska Salmon to Enhancement Production

Introduction

In May 1991, the Senate Special Committee on International and Domestic Fisheries initiated an extensive review of the Alaska salmon hatchery and enhancement program. As a result of considerable interest in the project, participation in the Hatchery Research Project includes representatives from both the Senate and the House of Representatives. The purpose of the study is to 1) review the history and legislative intent of the enhancement program, 2) analyze the current status of the program, and 3) consider future options for the program--ranging from fine tuning to possible redirection.

As part of the Hatchery Research Project, an **Economics and Marketing** study group was developed to provide information to the legislature on the economic impacts of salmon hatchery production. The group is to help determine

- if the current levels of Alaska salmon harvests are over-or under-supplied from a world-market perspective and
- if increased hatchery production of salmon will lower prices, fishing and processing revenues, and the total net value of Alaska's salmon fisheries.

To address these public policy questions requires a benefit-cost analysis. This type of analysis measures the level and cost of enhanced salmon production, the cost of managing, harvesting, and processing enhanced salmon stocks, and the impact or "price responsiveness" of world salmon markets to various levels of Alaska enhanced salmon production. The costs are then subtracted from the benefits to estimate the net benefits of the salmon enhancement program and the incremental net benefits of different levels of enhanced salmon production to commercial fisheries. To analyze only the impact of different levels of salmon production on world salmon markets and prices paid to fishermen is insufficient for thorough policy analysis because it does not measure the net benefits (benefits minus costs) of the commercial salmon fisheries to fishermen or all Alaskans.

An example of some of the policy questions a benefit-cost analysis would help to address are as follows:

- Is increased Alaska salmon hatchery production the cause of this year's lower salmon prices? What is the significance of other factors, such as increased farmed-salmon production, exchange rates, economic recessions, and prices of food substitutes?

- What is the most profitable salmon species mix and level of production for the statewide enhancement program? Should the emphasis shift from pink salmon to king and coho salmon, for example, or even to other non-salmon species?

- If Alaska curtailed hatchery salmon production, would Alaska salmon (both wild and hatchery) prices increase or would the resulting market share be filled by farmed salmon from other countries? Ultimately, what would be the net effect or benefits to Alaskans from these changes?

- How are the estimated benefits and/or costs of the existing hatchery production distributed to fishermen and processors in each region of the state? If changes in production occurred, how would these benefits and/or costs be distributed?

- What would be the economic benefits of changes in policy or additional legislative oversight regarding the production capacity and releases of hatchery salmon?

Need for Additional Research

Rather than initiating a new benefit-cost analysis, the Senate Special Fisheries Committee requested the Hatchery Research Group to first identify the specific issues that need additional economic research. In response, the economics group developed a study plan with the initial tasks of reviewing economic and marketing studies completed to date and assessing the need for additional research.

After reviewing current research, the group determined that insufficient economic information currently exists to accurately address salmon enhancement public policy questions. The research that has been completed is either out-of-date, or additional research needs to be done to improve the reliability of existing economic models. As a result of the significant investment by private parties and the state of Alaska in both enhancement projects and commercial fishing, a rigorous analysis using accepted bioeconomic techniques is warranted to fill these information gaps.

Based on our review, the economics group proposed a set of contracts for additional research. The group worked closely with staff from the Alaska Department of Fish and Game (ADF&G), FRED Division to develop the research plan because FRED Division staff have considerable experience in these areas of research and have contracted for previous studies. In addition, we solicited comments from the Divisions of Commercial Fisheries and Sport Fish to ensure that their concerns are addressed. As the committee requested, the studies build on previous research to close information gaps. Funding for the research contracts was approved at the November 1 Legislative Council meeting.

Research Components

The five principal research components are:

1) a hatchery production and cost model,

2) a fish population model linked to fishing effort and harvests,

3) a demand model for Alaska salmon in world markets,

4) a fishing cost model, and

5) a computer software system to combine the four models.

The five components are described below including estimated costs and a brief summary of the information gaps the research is intended to address. Based on prior research conducted for the FRED Division and expertise, the economics group contacted potential University of Alaska researchers to determine interest in the projects.

As a result of the short time period available to complete the research, it will be funded through RSAs. Therefore, interested parties did not formally bid on the projects, but instead provided information on proposed research methodology, pertinent research experience and qualifications, and the ability to complete the contract in the time available.

Hatchery Cost and Production Model

Principal Investigators: Economics Group, Legislative Research Agency, and the ADF&G, FRED Division staff

Anticipated Cost: $0

This research component consists of a survey of hatchery and enhancement project operators to determine the cost of producing salmon. In economics jargon, survey information will be used to develop an enhancement project "production function" to estimate the incremental cost of changes in the number of salmon produced by these projects. The survey will be developed by the economics group and FRED division staff and administered by the Legislative Research Agency and FRED division. This portion of the research will also solicit information from the ADF&G, Division of Commercial Fisheries regarding the costs of fisheries management of enhancement project stocks. This portion of the research needs to be conducted because no data exist on the incremental costs of enhancement project fish production. When the Governor's fisheries mini-cabinet reviewed the Alaska salmon enhancement program in 1984, a similar survey was conducted. Those results, however, are out-dated and additional salmon enhancement projects have been developed since that time.

Biological Population Model

Principal Investigators: Dr. Jeremy Collie, Juneau Center for Fisheries and Ocean Sciences, University of Alaska Fairbanks

Anticipated Cost: $10,000

The purpose of the biological population model is to estimate the number of adult fish produced by enhancement projects and available for harvesting. Salmon produced by hatcheries and other projects are exposed to similar biological and environmental conditions and fisheries as wild stocks--as compared to farmed salmon. As a result, this research would estimate the interdependence of wild and enhanced stocks. These estimates will taken into consideration varying management assumptions regarding stock separation and cost recovery. This research component is necessary because ADF&G has not comprehensively analyzed the interaction of wild and enhanced stocks and the impact of different levels of enhanced stock production on commercial fisheries harvests.

Salmon Demand Model

Principal Investigator: Dr. Mark Herrmann, Department of Economics, and Dr. Joshua Greenberg, School of Land Resources Management, University of Alaska Fairbanks

Anticipated Cost: $18,000

This contract will extend and improve research on the salmon enhancement program completed to date by Dr. Boyce for the FRED division. To more fully understand world salmon markets, improvements to existing demand models are needed. Relatively little research has been conducted to date on the demand for Alaska salmon, and models that do exist are insufficient to reliably answer the Legislature's policy questions. The additional work has not been contracted by the FRED because of insufficient funding.

In 1990, Dr. John Boyce's research compared single-equation and system of equations demand models for Alaska salmon. The study compared two, single-equation models developed by Ben Muse of the Alaska Commercial Fisheries Entry Commission (CFEC) in 1984 and Nick Ronan, University of Alaska Anchorage, Institute for Social and Economic Research (ISER) in 1989, and an alternative model proposed by Hongru Zhang, University of Alaska Fairbanks graduate student, using a Two-Stage-Least-Squares (2SLS) approach. Boyce found that the 2SLS approach appears to have superior predictive capability within the sample.

Boyce (1990) estimates ex-vessel and wholesale prices for five species of Pacific salmon, which is required for evaluating enhancement project tradeoffs between different salmon species and markets that are relevant to the state of Alaska. However, Boyce's study did not (1) develop a satisfactory profit function at the wholesale level for all salmon species, (2) conduct a full testing of wild, enhanced, and farmed salmon substitutes, including the extent to which farmed-salmon production is a substitute for Alaska salmon harvests, (3) link ex-vessel

markets or wholesale markets to retail consumer markets, and (4) produce demand models for pink and sockeye salmon with low estimation errors.

In addition to this recently completed research by Dr. Boyce, recent econometric analyses completed by Lin and Herrmann (1988) and Mittelhammer, Herrmann, and Lin (1989) provide considerable information on the import and export markets for salmon, and the relationship of farmed-salmon markets to capture-fishery markets.

The models of Mittelhammer, Herrmann, and Lin develop demand functions using import and export data closer to the final markets. They include more substitutes, and incorporate a supply and demand model for farmed salmon. However, the models are not sufficiently stratified by species at the ex-vessel level for evaluating tradeoffs in Alaska's statewide enhancement program.

Neither of the two modeling efforts (Boyce or Mittelhammer, Herrmann, and Lin) were designed to compute regional distribution of gross earnings within the major Alaska salmon fisheries, or the amount of price response imposed on a given region by another region's salmon production. The ability to discern regional impacts is a high priority in evaluating the benefits and costs of the salmon enhancement program.

In summary, two major salmon demand model improvements are needed. The first is in the ability to project future salmon prices and the impact of changes in enhanced salmon production and harvest levels on Alaska salmon prices. The second improvement is incorporating into salmon demand models the impact of changes in world salmon-farming production levels on Alaska salmon markets and prices.

Fishing Cost Model

Principal Investigator: Dr. John Boyce, Department of Economics, University of Alaska Fairbanks

Anticipated Cost: $20,000

This portion of this study will estimate the cost to fishermen of harvesting salmon to determine the incremental cost of harvesting different levels of enhancement project produced fish. This information can address questions such as--if hatchery production results in a 10 percent increase in harvest levels and a 2 percent decrease in the price of pink salmon, are the additional revenues minus the additional cost of harvesting the fish sufficient to increase fishermen's net revenues.

The objective of this study is to formulate and test empirical models that will project short- and long-run fishing costs for specific Alaska salmon fisheries. To conduct a benefit-cost analysis, fishing costs must be determined in the short and long run. In the short run, an enhancement project or a management action may encourage salmon fishermen to direct more fishing effort--which is a function of gear, boat size, horse power, and crew size, for example--into a specific statistical area and away from another statistical area (or alternative fishing opportunity). With the existing management constraints on salmon fishing in

place, such as limited entry and fisheries openings and closures, the short-run increases in marginal costs may be smaller or larger than the potential short-run revenues from a given project. However, in the long run, fishermen can be expected to increase fishing effort in statistical areas where the marginal revenues are greater than marginal costs of fishing. Fishing effort would be increased even if new vessels are not allowed to enter the fishery. As a result of insufficient research, economists currently can only provide informed guesses of the magnitude of these short- and long-run fishing costs in Alaska's salmon fisheries. Because little extensive or reliable research has been completed on this topic which accounts for the relatively higher cost of this study component.

Combining of Models

Principal Investigator: Drs. John Boyce and Mark Herrmann, Department of Economics, and Dr. Diane Bischak, School of Management, University of Alaska Fairbanks

Anticipated Cost: $10,000

When completed, the four models will be combined into a single, complete software system for the analysis of specific policy questions. This contract will test specific future enhancement program options--such as maintaining, decreasing, or increasing current enhanced salmon production levels, changing the current species mix, and maintaining or changing the location of enhancement projects--on the net economic benefits to fishermen and Alaskans. To the extent possible the analysis will differentiate the distribution of enhancement program net benefits among regions of the state. The results of this analysis will be a written report for the committee that will facilitate the development of public policy decisions.

Conclusion

In addition to providing information on Alaska's salmon enhancement programs, the models developed by the study could be used for evaluating other salmon management policy questions.

The total estimated cost of the research is $58,000 which is approximately $17,000 less than the UAA, Institute of Economic and Social Research proposal provided in May 1991. The reasons for the estimated lower costs are that the hatchery cost model work would be done with current legislative and ADF&G staff.

The research does not include studies to develop new markets or products for Alaska salmon for a number of reasons. The time available is insufficient, the cost of reliable marketing studies is usually quite high, and the Alaska Department of Commerce and Economic Development (DCED), Division of Economic Development and the Alaska Seafood Marketing Institute (ASMI) are both initiating salmon marketing studies in response to this summer's lower salmon prices. Therefore, the legislative economics and marketing group plans to provide

information to the legislature on the success of past state efforts to market Alaska salmon and coordinate with the DCED efforts to avoid research duplication and encourage the best possible information.

The research also does not include studies to estimate the net benefits of the salmon enhancement program tc sport or subsistence users. Including these additional uses would significantly expand the scope and cost of the studies.

November 30, 1991

Ginny Fay

ALASKA STATE LEGISLATURE SENATE
SENATOR RICHARD I. ELIASON

PRESIDENT OF THE SENATE
LABOR & COMMERCE COMMITTEE
RESOURCES COMMITTEE
RULES COMMITTEE
CHAIRMAN, SPECIAL COMMITTEE ON DOMESTIC & INTERNATIONAL COMMERCIAL FISHERIES

P.O. BOX 143
SITKA, ALASKA 99835

P.O. BOX V
JUNEAU, ALASKA 99811
(907) 465-4916

FAX (907) 465-4928

July 16, 1992

Dave Houseworth, Manager
Tamgas Creek Hatchery
Metlakatla Indian Community
P.O. Box 410
Metlakatla, AK 99926

Dear Mr. Houseworth:

We would like to thank you for the time and effort you have invested in responding to the survey of **intensively** modeled enhancement projects sent to you as part of the Legislative Enhancement Program Review Project. The contractor for the salmon population modeling research is using the survey data to complete that aspect of the study.

Enclosed is the last survey portion of the project; we would again like your assistance by completing two additional forms (enclosed). The first form is the **Salmon Enhancement Project production survey** for the non-intensively modeled projects. This pink survey form is shorter and simpler than the survey form for more intensively modeled enhanced fisheries which you have already completed.

There are three primary reasons for modeling some of the enhancement projects less intensively--1) enhanced production is a relatively small portion of a particular fishery's commercial harvest, 2) Alaska Department of Fish and Game (ADF&G) data are insufficient for more extensive modeling efforts, and 3) the scope of the review project does not allow intensive population modeling of all enhanced fisheries.

As with the more intensively modeled production survey, a separate survey form is included for each "project." The first page of each production survey has been partially completed based on ADF&G, FRED Division staff identification of salmon enhancement projects. If you have any

corrections to the project name or other identifying data, or if there are additional projects not included in the surveys provided, please make the appropriate corrections or additions. Blank forms are attached.

The second (blue) form is a cost-of-production survey for each facility identified under FACILITY NAME in the SALMON ENHANCEMENT PRODUCTION SURVEY. This form is called the **FACILITY OPERATING, CONSTRUCTION, AND MANAGEMENT COST SURVEY** and is designed to be similar to budget forecasting that your facility probably does for any upcoming fiscal year. Only one of these production cost survey forms is to be completed for each facility. You also should not adjust any future costs for inflation.

It is important to note that in completing the one production cost survey form for your facility that "years" in this form refers to state fiscal years (July 1 - June 30) while the production surveys refer to calendar years. However, **if your fiscal year does not begin on July 1, please indicate the starting date on your survey form.**

There are some special hypothetical production cost cases in the survey that will require you to project costs for production levels that may not be likely or feasible for your facility's operations. For example, question four asks you to estimate how your production costs would change if a portion of your production was excluded. These hypothetical cases are necessary to create a mathematical model of operating and construction costs for the statewide enhancement program, which allows the computation of costs of production levels not included in the survey. These cases will only be analyzed in aggregate and will not be used to determine benefits and costs of individual hatchery outputs.

Operating and construction costs for some increased production scenarios are also requested in the survey form. These production increases are combined together by species (not projects) while production survey forms have been completed on a project basis. Some facilities will have more than one project and release location for a given species; this may cause some confusion in determining how to apportion these costs between projects. In these cases, the total incremental production costs (for the 15 percent increase scenario) should be estimated for the most likely and efficient combination of production from each project that would result in

the increased production. **For all of the hypothetical cases in questions 4 and 5, the total annual costs for a facility should be entered on the survey form rather than the estimated change in annual costs.** For example:

> Two sockeye projects (Project 1 and Project 2) are carried out at Facility Z. Together they produce 20,000 sockeye harvests in 1996 and are projected to produce 30,000 harvests in 1999 to 2021.
>
> Increased production of Project 1 for sockeye salmon (producing harvests of 10,000 fish in 1996 from smolt releases in previous years) would be difficult to increase by 15 percent without some radical changes in operation or new construction.
>
> On the other hand, Project 2 also produces 10,000 harvested fish in 1996 but fry releases could easily be increased to 15 percent of the total sockeye production of 20,000 harvested fish (20,000 x 1.15 = 23,000 fish from Project 2). Thus, costs for the increase production should be estimated for Project 2, the most likely source of increased production in this example.

For the 15 percent incremental increased production scenario, it may not be possible to increase production for a particular species in your facility. If there is simply no way to do this without adding a new project, leave the associated 15 percent production case blank for that species but note why you could not carry it out on the form.

Finally, the cost projections for the 15 percent production level increase should be based upon obtaining the increased harvests in one single salmon life cycle or as nearly as possible to that time interval.

The completed survey forms need to be sent to Steve McGee at the ADF&G, FRED Division Headquarters Office by June 15, 1992. There will undoubtedly be questions about how to fill out the survey. Please address these to Jeff Hartman or Steve McGee, ADF&G, 465-4160.

Again, thank you for your time and cooperation.

Sincerely,

Senator Dick Eliason
Senate President

Jeff Koenings, Director
Division of FRED

ALASKA STATE LEGISLATURE SENAT

SENATOR RICHARD I. ELIASON

PRESIDENT OF THE SENATE
LABOR & COMMERCE COMMITTEE
RESOURCES COMMITTEE
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SITKA, ALASKA 99835

P.O. BOX V
JUNEAU, ALASKA 99811
(907) 465-4916

FAX (907) 465-4928

July 16, 1992

Frank Thrower, Manager
Little Port Walter Research Station
c/o NOAA, NMFS
Auke Bay Laboratory
11305 Glacier Highway
Juneau, AK 99801

Dear Mr. Thrower:

We would like to thank you for the time and effort you have invested in responding to the survey of **intensively** modeled enhancement projects sent to you as part of the Legislative Enhancement Program Review Project. The contractor for the salmon population modeling research is using the survey data to complete that aspect of the study.

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percent increase scenario) should be estimated for the most likely and efficient combination of production from each project that would result in the increased production. **For all of the hypothetical cases in questions 4 and 5, the total annual costs for a facility should be entered on the survey form rather than the estimated change in annual costs.** For example:

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Again, thank you for your time and cooperation.

Sincerely,

Senator Dick Eliason
Senate President

Jeff Koenings, Director
Division of FRED

FACSIMILE TRANSMITTAL SHEET

FROM: J. Boyce

SCHOOL OF MANAGEMENT
UNIVERSITY OF ALASKA, FAIRBANKS
101 BUNNELL BLDG.
FAIRBANKS, ALASKA 99775

TELEPHONE: (907) 474-7461
FAX: (907) 474-5219

John A. Lehman, Acting Dean

TRANSMITTED TO: Ginny Fay
Legislative Research Assistant

DATE: 11/10/92 TIME: 1:30 PAGES: 8

MESSAGES:

THANK YOU!!

6-2465

A BENEFIT-COST ANALYSIS OF THE ALASKA SALMON HATCHERY PROGRAM

EXECUTIVE SUMMARY

John Boyce*, Mark Herrmann*, Diane Bischak**, and Joshua Greenberg***

*Department of Economics
University of Alaska Fairbanks
Fairbanks, Alaska 99775

**Department of Business Administration
University of Alaska Fairbanks
Fairbanks, Alaska 99775

***School of Agriculture, Land and Resource Management
University of Alaska Fairbanks
Fairbanks, Alaska 99775

A Report to the Legislature of the State of Alaska

November, 1992

A Benefit-Cost Analysis of the Alaska Salmon Hatchery Program

Executive Summary

Introduction

The hatchery program in Alaska was created in the early 1970's. At that time, Pacific salmon dominated the world salmon markets. Since then, there has been a rapid rise in the supply of salmon. In Alaska, this has been in large part due to production from the hatchery program. However, the increase in production has been worldwide, and it appears that supplies of salmon on the world market are more likely to continue to increase than to decrease. Given this backdrop, the Legislature of the State of Alaska asked for a cost-benefit analysis of the state-funded hatchery program. This report summarizes the findings of that study.

Since the hatchery program is funded entirely within Alaska, we considered only the interests of the state in our analysis. This means, for example, that benefits to consumers either in the U.S. or in other world markets were ignored completely because they are not benefits that are captured by the state. The benefits to the state were measured by two variables. The net benefits to the fishermen from the hatchery program is the *producer's surplus*, which is the return to fishermen above their fishing costs. The cost of producing the surplus benefits to the fishermen is the cost of running the hatchery program. The net benefits to the state is the net benefits to the fishermen minus the costs of operating the hatchery program.

The study consisted of four parts. First, a biological model (Collie, 1992) was used to estimate the returns of catchable fish under a variety of scenarios. Second, given the return of fish, an international demand model was estimated to predict the prices fishermen would receive at the ex vessel level (Herrmann and Greenberg, 1992). Third, a fishing cost model was estimated to predict the producer's surplus in each fishery given the ex vessel prices and returns of fish from the biological model. Finally, a survey of the hatcheries revealed the costs of producing various levels of hatchery fish.

Research objectives

The request for proposals outlined seventeen alternatives to consider. These management alternatives are described in the first column of Table One. Each management plan was to be considered over a 15- and a 30-year planning horizon. Given the trends in demand and supply as suggested by the events over the past several decades, we have a rough idea of the direction in which the fishery is heading. Our estimates are likely to be very inaccurate within particular years, but should, on average, capture the trend. Since we were asked to conduct a cost-benefit analysis of the hatchery program over a long lifetime, the trend will be much more important than specific yearly predictions.

Comparison of Alternatives

Our calculations suggest that two alternatives dominate all other alternatives in producing net economic benefits to the state. These alternatives are Alternative 3, elimination of the entire hatchery

program, and Alternative 5, elimination of the entire pink salmon program. In addition, we find that the next best alternative is a reduction of the entire program by 15%. However, the order of magnitude difference between a reduction of 15% and eliminating all of the pink salmon program is over $350 m. over thirty years (undiscounted) and the difference between a 15% reduction and eliminating the entire program is over $500 m. over thirty years. These numbers suggest that large decreases in either the entire hatchery program, or at least in pink salmon, are warranted.

The differences in total net benefits to the state cannot be explained by catch and revenue data alone. Elimination of any portion of the program causes catch to decrease. Depending upon the species, a reduction in catch may actually increase revenues. However, the gain in net benefits is generally not due to a gain in revenues but to a decrease in costs of running the hatchery program.

Under the current production levels, to produce $4.260 b. in producer's surplus over the next thirty years, the state spends $859 m. in hatchery costs, for a net benefit of $4.001 b. When changes in the hatchery costs are taken into account in addition to the changes in the producer's surplus, each elimination alternative provides a larger net benefit than the current or planned output levels. Furthermore, the net effect by region shows that each region also gains where either pink or red salmon are eliminated (with the exception of Cook Inlet, which loses if either reds or pinks decrease, and Kodiak, which loses if red salmon is eliminated). The biggest surprise in this result is our finding that when hatchery costs are included, Prince William Sound also gains in net by eliminating each of the programs. Thus if the hatchery program were to be financed entirely *within* the region, the best alternative to Prince William Sound would be to eliminate the hatchery program given that the hatchery programs are eliminated throughout the state.

The net benefit figures in each row of Table One are the returns for each region given that all regions are following the same hatchery production alternative. That is, for the region to get the estimated net benefits listed for a particular alternative, every region has to be following the same alternative.

Hatchery Costs and Net Benefits by Species

We also calculated the cost of producing a pound of salmon from the hatchery program and compared that with the net benefits we estimate fishermen to get on average from a pound of salmon. Our estimates are averaged over the entire state, so there may be substantial regional differences. However, our estimates suggest that for most species, the cost of producing a pound of salmon is greater than the net benefit that pound of salmon provides to fishermen. Table Two presents our estimate of the cost and benefit of a pound of salmon estimated from the 15% increase and decrease alternatives (thus there are two estimates in each case).

In Table Two, we calculate the change in producer's surplus resulting from either an increase or decrease in the quantity of salmon produced by the hatcheries. Our numbers suggest that on average, each pound of pink salmon provides between 5.3 and 6.6 cents of producer's surplus to fishermen. Our estimate of the cost per pound to produce a pound of hatchery raised pink salmon is between 5.6 and 10.8 cents per pound. Thus it appears that the cost per pound of producing pink salmon by hatchery production is greater than the producer's surplus it generates to fishermen.

This result seems to be true of red salmon also. Our estimate of the cost per pound to raise red salmon in hatcheries ranged from 22.1 to 34.6 cents per pound. However, our estimate of the average producer's surplus gained by this production is only 14.2 to 15.4 cents per pound. Before too much emphasis is placed in these numbers, however, it must be mentioned that our estimate of producer's surplus for red salmon is mainly from Bristol Bay (recorded as Western Alaska in our tables). Our estimates for producer's surplus for Bristol Bay were made using average data from similar fisheries

elsewhere in the state. We have no way of knowing how accurate these predictions are given that they are extrapolating well beyond the data available from fisheries elsewhere in Alaska.

Chum salmon also appears to have hatchery production costs that are roughly equal to the producer's surplus generated by an extra pound produced. We estimate that it costs between 8.5 and 9.3 cents to produce another pound of hatchery raised chum salmon, but fishermen receive producer's surplus of only about 9.5 to 10.4 cents per pound.

Coho is similar. Coho are estimated to cost between 27.2 and 40.7 cents per pound to produce, but generate producer's surplus on the order of between 32.3 and 36.0 cents per pound.

King salmon may be the best bet. If the marginal cost of king salmon based on an increase of 15% is accurate, then the cost of a king salmon is estimated to be about 29.7 cents per pound. Our estimate of the return in producer's surplus per pound of king salmon is between 82.8 and 85.7 cents per pound. However, if the marginal cost of king salmon based on a decrease is correct, then king salmon costs about $1.50 per pound to produce. If this is true, then even king salmon fails to produce net benefits.

Recommendations

Our results do not paint a very encouraging picture for the hatchery program. Based on our point estimates, the best alternative is to close the pink salmon hatcheries, or at least scale them back considerably. However, we would not recommend that the state force all hatcheries to shut down. Instead, we recommend that *if a region wants to continue with a hatchery program, that it should be funded by the local user groups rather than by the state.*

If the fishermen themselves fund the hatchery program, they will only choose projects which are cost-effective within their own region. There may still be regional effects in that production in one region causes prices to decline elsewhere, but whatever hatchery production remains will be cost effective. Table One compares the thirty year returns (undiscounted) for each alternative by region. Because we believe that our estimates of net benefits for Alternatives 2, 3, 4a, and 4b must be viewed with a great deal of caution, we separate them out in Table One.

We have bolded the number in each column that corresponds to the best alternative for the region under the assumption that the region is financing its own hatchery program. In the subset of alternatives excluding Alternatives 2, 3, 4a, and 4b, Alternative 5--shutting down the entire pink salmon hatchery production--is the best alternative for Kodiak, Prince William Sound, and Southeast. That is, if these regions could get the rest of the state to agree to follow alternative 5, they would get the highest returns under a self-financed hatchery program.

The question is would the other two regions also want to follow alternative 5? While Western Alaska would benefit if the pink salmon program be shut down, their first preference would be that the red salmon hatchery production be shut down (Alternative 6). However, since Western Alaska only has one hatchery, and it produces only chum, it cannot independently influence the behavior of the other regions. Cook Inlet is the odd one of the regions. Under a self-financing program, our estimates indicate that Cook Inlet would prefer everyone else shut down their king salmon programs. But since no other region will prefer this option, this alternative is not feasible. If every other region scales back pink salmon hatchery production, Cook Inlet is made worse off relative to the current production levels. Could Cook Inlet by itself influence the actions of the other regions? The answer is probably, though not definitely, "no." Prince William Sound is currently producing currently 124 m. pounds of pink salmon. Cook Inlet is currently producing under 7 m. pounds, of which less than half comes from hatchery production. Thus, even if Cook Inlet felt that it could produce pink salmon at a net benefit to its

fishermen, it is doubtful that it would have enough of an impact on prices to warrant the other regions changing their minds about scaling back their own pink salmon programs.

When Alternatives 2, 3, 4a and 4b are included, Kodiak, Southeast, Prince William Sound and Western Alaska all prefer shutting down either all pink salmon or the entire program. This suggests that if the hatcheries are self-financed, they will choose to scale back their operations on their own. Thus, *we view turning over the financing of the hatcheries entirely to the regions as the best alternative for the state*. The actions we predict the regions to take assumes that our point estimates are correct. If they are not correct, self-financing is still a better idea than continued state funding because it makes the regions themselves decide what levels of hatchery production give them the highest returns.

Conclusions

If our recommendations are followed, hatchery production of fish for sport and subsistence purposes will most likely not continue without some state funding. We have made no effort to analyze the net benefits from hatchery production on other user groups. The way that we have calculated hatchery costs suggests that the per pound costs obtained in our study are a reasonable approximation to the hatchery costs for fish (in the range of small changes in hatchery production) no matter what their use. To estimate more fully the benefits and costs to other user groups, the state would have to determine the net benefits to those groups.

There also may be strategic reasons for maintaining some hatchery production. For example, it appears that hatchery exports of pink salmon may be starting in the former Soviet Union. Chile also appears to have room for expansion of its farmed salmon program. If these countries are able to produce fish less expensively than Alaska, then there will be no way to stop them from entering in the long run. However, by maintaining some hatchery production, prices may remain depressed enough to prevent expansion in those areas. As long as the price is not driven down to the level that it would reach if those areas do enter the market, the hatchery dollars spent on prevention of entry may be well spent. However, this is not a strategy which can remain viable over the long run.

There are a number of other things that the state might do with money saved from the hatchery program. One obvious area is to engage in demand-enhancing activities, such as increased attention to quality and seeking out new product forms. Again, we emphasize that if such activities are truly profitable, then the fishing industry itself should be willing to finance them rather than the state.

Another area that appears to be fruitful for future exploration is the allocation among gear groups. In the cost study we observed that the different gear groups have vastly different levels of producer's surplus. The gear group that does the best is the set net fleets. This is mainly because these fleets have such low capital costs. The bottom line is it is more efficient to let the fish come to the fisherman than to have the fisherman go to the fish.

Finally, let us emphasize that our estimates of net benefit are based on parameters estimated from relatively short time periods and were extrapolated well beyond the time horizon for which accurate estimates may be obtained. There are also a number of exogenous factors, such as what is happening in the rest of the salmon suppliers' markets, that have changed far too rapidly over the last decade to allow precise estimates of where the industry will be in one, two or three decades. In spite of this, given our predictions of trends in the rest of the markets, we believe that the hatchery program, and especially the pink salmon program, should be scaled back. Our estimates suggest that to do so could result in an increase of net benefits to the state on the order of almost a half billion dollars over thirty years relative to current and planned production levels.

Table One: Net Benefits by Region, By Alternative

(Net benefits over thirty years in millions of 1992 dollars)

ALTERNATIVE	WESTERN ALASKA	COOK INLET	KODIAK	PRINCE WM SD	SOUTH EAST	STATE TOTAL
(1) *Maintain current hatchery production*	1700.36	441.79	499.07	158.36	1201.76	4001.34
(5) *Eliminate pink salmon production*	1743.25	413.84	531.77	206.90	1565.88	4461.65
(6) *Eliminate red salmon production*	1779.38	413.77	422.60	201.97	1205.00	4022.72
(7a) *Increase pink salmon production by 15%*	1694.53	443.16	485.68	152.87	1155.14	3931.39
(7b) *Decrease pink salmon production by 15%*	1706.17	439.39	506.20	182.35	1256.94	4091.06
(8a) *Increase red salmon production by 15%*	1689.64	441.46	506.79	157.25	1191.55	3986.68
(8b) *Decrease red salmon production by 15%*	1711.29	437.49	488.84	166.35	1202.19	4006.16
(9a) *Increase chum salmon production by 15%*	1698.72	441.04	494.97	155.98	1211.24	4001.95
(9b) *Decrease chum salmon production by 15%*	1702.31	442.96	498.74	158.16	1193.73	3995.90
(10a) *Increase coho salmon production by 15%*	1698.45	440.36	498.31	157.17	1204.94	3999.22
(10b) *Decrease coho salmon production by 15%*	1701.52	444.58	499.33	157.63	1195.93	3999.00
(11a) *Increase king salmon production by 15%*	1699.54	443.07	498.68	157.80	1210.27	4009.37
(11b) *Decrease king salmon production by 15%*	1701.42	448.25	506.80	158.31	1196.23	4011.01
(2) *Planned hatchery salmon production levels*	1624.56	481.57	471.51	228.96	1151.24	3957.84
(3) *Eliminate entire salmon hatchery program*	1918.84	467.50	533.37	229.91	1471.58	4621.20
(4a) *Increase entire hatchery production by 15%*	1671.50	436.81	479.91	134.11	1122.38	3844.72
(4b) *Decrease entire hatchery production by 15%*	1724.08	445.81	499.93	217.09	1226.90	4113.80

Table Two: Hatchery Cost and Producer's Surplus per Pound by species

Alternative	Hatchery Cost ($/lb)	Net Benefits ($/lb)
(7a) *Increase pink salmon production by 15%*	0.056	0.066
(7b) *Decrease pink salmon production by 15%*	0.108	0.053
(8a) *Increase red salmon production by 15%*	0.346	0.142
(8b) *Decrease red salmon production by 15%*	0.221	0.154
(9a) *Increase chum salmon production by 15%*	0.093	0.095
(9b) *Decrease chum salmon production by 15%*	0.085	0.104
(10a) *Increase coho salmon production by 15%*	0.407	0.323
(10b) *Decrease coho salmon production by 15%*	0.272	0.360
(11a) *Increase king salmon production by 15%*	0.297	0.857
(11b) *Decrease king salmon production by 15%*	1.500	0.828

To: Ginny Fay
Legislative Research Assistant

465-4928 Fax
465-3741 Phone

From Jonas Boyce

474-5219 Fax
488-4580 Phone.

FACSIMILE TRANSMITTAL SHEET

FROM: JOHN BOYCE

SCHOOL OF MANAGEMENT
UNIVERSITY OF ALASKA, FAIRBANKS
101 BUNNELL BLDG.
FAIRBANKS, ALASKA 99775

TELEPHONE: (907) 474-7461
FAX: (907) 474-5219

John A. Lehman, Acting Dean

TRANSMITTED TO: GINNY FAY

DATE: 11/4/92 TIME: 11:00 am PAGES: 25 to follow

MESSAGES: THIS IS THE TECHNICAL Report.

I trust the Appendices came through ok?

Will send the Exec Summary ASAP.

THANK YOU!!

Are benefits to State calculated to include spin-offs (employment, raw fish tax, etc.) of herring fishing industry big here?

A BENEFIT-COST ANALYSIS OF THE ALASKA SALMON HATCHERY PROGRAM

John Boyce*, Mark Herrmann*, Diane Bischak**, and Joshua Greenberg***

*Department of Economics
University of Alaska Fairbanks
Fairbanks, Alaska 99775

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***School of Agriculture, Land and Resource Management
University of Alaska Fairbanks
Fairbanks, Alaska 99775

A Report to the Legislature of The State of Alaska

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A Benefit-Cost Analysis of the Alaska Salmon Hatchery Program

Introduction

The hatchery program in Alaska was created in the early 1970's. At that time, Pacific salmon dominated the world salmon markets. Since then, there has been a rapid rise in the supply of salmon world-wide. In Alaska, this has been in large part due to production from the hatchery program. However, the increase in production has been worldwide, and it appears that supplies of salmon on the world market are more likely to continue to increase than to decrease. Given this backdrop, the Legislature of the State of Alaska asked for a cost-benefit analysis of the state-funded hatchery program. This report summarizes the findings of that study.

Since the hatchery program is funded by the State of Alaska, we considered only the interests of the state in our analysis. This means, for example, that benefits to consumers either in the U.S. or in other world markets were ignored completely. This is not to imply that these benefits do not exist but is recognition of the fact that they are not benefits that are captured by the State of Alaska. The benefits to the state were measured by two variables. First, we were interested in what the net benefits to the fishermen were from the hatchery program. That is, we wanted to estimate the return to fishermen above their costs that occurs under different hatchery production output levels. Second, we wanted to estimate the cost of producing benefits to the fishermen, which is the cost of running the hatchery program.

The hatcheries were surveyed to find out what they expected their costs to be if hatchery production for a particular species were increased or decreased. While there is some difficulty in interpreting these numbers in certain instances, measurement of the costs of the hatchery program are relatively straightforward.

The benefits to fishermen are not as easily determined. We considered fishermen's *producer's surplus* to be the appropriate measure of benefits to the fishermen. Producer's surplus measures the return above opportunity costs to the fishermen. If the fisherman does not expect to earn revenues higher than his or her next best alternative (their "opportunity cost"), then they choose not to fish. Any returns they get above the minimum required to attract them into the fishery are what we measure as the surplus. The surplus benefits may differ across fishermen because some fishermen may be willing to fish even when revenues are low, and others may not.

The *net benefits* to the state of the hatchery program are the net benefits to the fishermen as measured by producer's surplus minus the hatchery costs. This measure indicates the net benefits to fishermen above the costs of providing these benefits.

The calculation of the producer's surplus to the fishery is by no means a straight forward procedure. The request for proposals required that we consider a number of alternative management plans for the hatchery program. These management alternatives are described below in Table One. Each management plan was to be considered over a 15– and a 30–year planning horizon. To imagine that we can precisely predict events 15 or 30 years in advance based on a decade of data from an industry in transition is, of course, precarious at best.[1] However, given the world-wide trends in demand and supply as suggested by the events over the past several decades, we do have a rough idea of the direction in which the fishery is heading. Our estimates are likely to be very inaccurate within particular years, but should, on average, capture the trend. Since we are asked to conduct a cost-benefit analysis of the hatchery program over a long lifetime, the trend will be much more important than specific yearly predictions.

The model used to generate our projections for these 15– and 30–year planning horizons use results from three other parts of this study. For each management alternative, projections about the biological stocks were generated (Collie, 1992). These biological projections were then put into an international salmon demand model to make projections about the prices for each species in each area (Herrmann and Greenberg, 1992). The quantity and price projections were then used to estimate the costs to fishermen of participating in the fishery (Boyce, 1992). Each of these models are described in the citations.

Research objectives

The request for proposals outlined seventeen alternatives to consider. These are given in Table One.

Our complete reported findings are contained in Appendix One, Two, Three and Four. We report fifteen year projections for catch, revenues, producer's surplus, hatchery costs, and net benefits. For each management alternative, we report projections for Western Alaska and AYK combined (the part of the state with no hatchery program), and for Cook Inlet, Kodiak, Prince William Sound, Southeast, and for the state total. Thus, in each Appendix there are six tables on three pages for each alternative. At the bottom of each table we report the fifteen year sum, the thirty year sum, and the present value of the thirty year sum discounted at 4% real rate of interest.[2] The difference between the Appendices is that Appendix One reports the estimate of returns using our

[1]While data for annual prices and quantities exist for several decades, inventory and export data restrict us to the years 1980 and beyond.

[2]We examined the cases of four and seven percent real rates of interest (i.e., we removed the inflation part of the interest rate since all dollars are expressed in real 1992 dollars). The seven percent discount rate figures are not contained in Appendix One, but do appear Appendix Four.

midpoint price estimates from the demand model. Appendix Two reports the estimates of returns under optimistic price projections, and Appendix Three reports the estimates of returns under pessimistic price projections. The data reported in the Appendices is aggregated to the regional level. In the actual simulations, *fleet* specific estimates of returns and costs were calculated. However, this data is too voluminous to be included in the report. Appendix Four contains summary data for present value calculations at 0, 4 and 7% discount rates.

Table One: The Alternatives Considered in the Policy Analysis

Case 1	Maintain current hatchery production
Case 2	Planned hatchery production levels
Case 3	Eliminate entire hatchery program
Case 4a	Increase entire hatchery production level by 15%
Case 4b	Decrease entire hatchery production level by 15%
Case 5	Eliminate entire pink salmon hatchery production
Case 6	Eliminate entire red salmon hatchery production
Case 7a	Increase pink salmon hatchery production level by 15%
Case 7b	Decrease pink salmon hatchery production level by 15%
Case 8a	Increase red salmon hatchery production level by 15%
Case 8b	Decrease red salmon hatchery production level by 15%
Case 9a	Increase chum salmon hatchery production level by 15%
Case 9b	Decrease chum salmon hatchery production level by 15%
Case 10a	Increase silver salmon hatchery production level by 15%
Case 10b	Decrease silver salmon hatchery production level by 15%
Case 11a	Increase king salmon hatchery production level by 15%
Case 11b	Decrease king salmon hatchery production level by 15%

The revenue data in each table represents the projected *gross* returns to the region or to the state from the salmon fishery. We estimated the costs to the fishermen as the minimum level of returns required before the fishermen would participate. Thus part of the revenues was the cost of luring the resources away from their next best alternative. Since they would have earned returns equal to the value of their next best alternative, these costs are real economic costs.[3] The *producer's surplus* is the difference between the estimated revenues and costs. The producer's surplus measures the net benefits to the

[3]It is inappropriate to simply view the cost part of the revenues as benefits because they represent expenditures to the other sectors of the state. While it is true that they represent expenditures to other sectors, they also represent what was foregone by the fishermen if they had been engaged in their next best alternative.

fishing sector. Again, the cost of providing these net benefits to the fishermen is the cost of the hatchery program. To get the net benefits to the entire hatchery program, we subtracted the hatchery costs from the producer's surplus.

Caveats and Assumptions

Before we explore the actual findings, let us explain why we believe our estimates must be treated with some caution. First, these predictions are based on models using data from only a small number of years. The demand data uses quarterly data from 1982 to 1991. The cost data was generated entirely from data for 1990. To extrapolate 15 or 30 years based on such a short time series is very dangerous. Certainly projections made in the 1960's could not have foreseen the changes that occurred one or two decades later.

The analysis we conducted concentrates only on the commercial fisheries. We separated out the hatchery return and costs that went to other uses (i.e., sport and subsistence) from the analysis. This means that the benefits of production of kings, silvers, and reds that goes to sport fish purposes (especially in Southeast) and the species, especially chum, that goes to subsistence purposes are ignored by our analysis. We have also ignored the hatchery costs associated with these uses. There may be some problems with the way we did that. We assumed that if 75% of the fish were returned for commercial catch (including the commercial share of the cost recovery catch), then 75% of the hatchery costs could be attributed to the commercial catch. This may be untrue in the sense that the costs of production of sport and subsistence fish may in part be reduced by the costs incurred producing commercial catch.

All of our analysis is based on point estimates. Even though we predict high and low prices, we are still comparing revenue cases against the base cases for average vs. average prices, high vs. high prices, and low vs. low prices. In addition, our predictions of total revenues and producer's surplus are missing confidence levels which could make some of our findings insignificant.

In addition, the production levels under each of the elimination alternatives are vastly different from the production levels we observed in the historical time period used to estimate our demand and fishing cost models. All of our estimation of demand and fishing cost parameters occurred with hatchery and production figures that were considerably higher than the levels considered in Cases 3, 5 and 6. It is less true for Case 6 because hatchery production of red salmon is small relative to the total quantity of wild stocks of red salmon. This is particularly true for Cases 3 and 5, which involve drastic reductions in the pink salmon catches. Because of this, we are forced to extrapolate well beyond the data in our analysis. The result of the extreme extrapolation may be to predict prices which are above their historical levels.[4]

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[4]This occurs with some extent to our predictions of pink salmon prices. If the pink salmon program is eliminated, we estimate pink prices to average about $0.46 per pound ex vessel. Over the period 1980 to 1991, nominal prices averaged only $0.31 per pound, although in approximately one-third of the years

Also, it was necessary to aggregate Pacific salmon into high-valued (sockeye, king, and coho) and low-valued salmon (chum and pink) in the demand side of the model. This was due to the need to simplify the number of specified species in order to estimate the model. However, because of this, there are no *empirical estimates* of cross-price effects between species within an aggregate grouping. As a result, ad hoc assignments to substitution effects between species within each aggregate grouping were made. For example, we assumed that the strength of the substitution effect between pink and chum salmon to be one-quarter of the strength imposed in the model, and vice versa. The assumed cross-price effects were kept fairly low in order to err on the side of conservatism.[5] Similar assumptions were made for other species. We do have empirical cross-price effects for species within the low-valued grouping on species within the high-valued grouping, and vice versa. These are reported and discussed in the demand model report (Herrmann and Greenberg, 1992).

It was not possible to use the ad hoc cross-price effects between species within a particular grouping when there was simultaneous changes to salmon species within the aggregate groupings because the movements of own-price effect and cross-price effect could not be sorted out. Because of this, an accurate estimation of cases 2-4, where there were simultaneous changes in hatchery production, was not possible. Because the model-imposed cross-price effect within the groupings are oversated, the revenues assigned to cases 2, 3, and 4a will be understated. For this reason, only the cases of 1 and 5-11, when the ad hoc cross-price effects within the aggregate salmon groupings can be imposed, offer realistic revenue forecasts. The losses found in cases 2-4 must be seen as absolutely worst case scenario and probably should not be taken seriously.

The fishing cost data was calculated as follows. In the fishing cost model, we estimated a model predicting the number of fishermen participating in a particular opening based on the total run strength as measured by the total revenues earned in the opening. We found a very consistent relationship that as total revenues rise, the number of fishermen also increased. The relationship also indicated that to add another fisherman, the revenues would have to rise by a larger amount than was required to attract the previous fisherman. This suggested that fishermen have different costs of fishing and that those with the lowest costs entered first. The cost equation was then derived from the participation equation by solving for the average revenue given the number of fishermen predicted to participate. The behavioral assumption was that the last fisherman to enter expected to earn just enough in revenues to cover his costs of fishing. Thus the average revenues for each opening gave us a measure of the fishing cost of the last fisherman participating in the opening. Since we observed a large number

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the real 1992 dollars prices rose to this level. The two most recent cases, 1987 and 1988, are years for which pink salmon volumes were at their lowest over the period.

[5]We examined the results using the full cross-price effects. The result was that a decrease in pink salmon caused chum salmon revenues to increase dramatically. This made the effect of reducing the pink salmon program even less costly since there was a large compensation due to an increase in chum revenues. It appears that the relationship between chum and pink salmon revenues is an issue which deserves more research.

of openings with different numbers of fishermen, we obtained an estimate of fishing costs as a function of the number of participants.

In the extrapolation of the fishing cost model to future years, we took the 1990 run for the fishery as our guide for how the run would be dispersed over time and across the statistical areas within the fishery. If the future year showed an increase over the 1990 data for a particular species of, say, 10%, then we inflated the catch of that species by 10% for each opening over the season. Having done this for each species, we then multiplied the estimated catch by the price per pound for each species. We then used the data on percentage by species of the catch and of total revenues per opening to make a prediction of the number of fishermen participating in each opening throughout the season using the parameters of our participation model estimated on 1990 data. To obtain our estimate of fishing costs for the opening, we utilized the relationship between average revenues and the number of fishermen and the behavioral assumption that the last fisherman to enter earned revenues equal to their fishing costs. The fishing costs for the entire opening were obtained by summing the fishing costs for each fisherman up to the estimated number of participants. The fishing costs for the season were simply the sum of these fishing costs over all of the openings. Producer's surplus was estimated as the difference between the fishing cost estimates and the revenue estimates.

One problem with our extrapolation is that we did not have estimates of which statistical areas would be affected by the changes in the hatchery stocks production. Thus we used the average cost over all statistical areas weighted by the distribution of 1990 catch over those areas. Thus if the distribution of catch changes or if the 1990 catch was aberrant in the distribution of returns, we would introduce error.

A more serious problem which is consistent across all of the analyses of alternatives is the problem of extrapolating cost data from one fishery to another. In particular, the estimates of fishing costs was conducted for only a select number of fisheries. For all other fisheries, we used the *average* estimate of fishing costs for similar gear type fleets elsewhere in the state. In particular, this problem is acute for Western Alaska. The main problem here occurs in the drift net fleet. The Bristol Bay drift net fleet is about 2,000 vessels strong. None of the other drift net fleets are anywhere near this size. Thus our estimates of producer's surplus in Western Alaska may be off by an order of magnitude. While it is true that the relative error should be constant across the alternatives, the magnitude of that error may be considerable. We doubt, however, that it accounts for the results of our analysis with regard to the elimination of all, or portions, of the hatchery program.

A technical caveat on the interpretation of producer's surplus should also be mentioned. Producer's surplus in essence measures the "skill rents" to fishermen. That is, given the common property ownership in the fishery, the reason economic rents even exist at all is because of differences in the fishermen. These differences are measured as the minimum amount of revenues per fishermen that are required before a particular fisherman decides that it is profitable to participate in an opening. If these rents are transferable, then the present value of the producer's surplus should equal the value of the permits in a particular fishery. However, if the skills are not transferable, then the

correlation between the producer's surplus and the value of the permits will be dampened. (The correlation should be positive under any conditions.) If the economic skill rents are not transferable, then the present value estimates of producer's surplus should be in excess of the value of the permits.

Finally, our estimates of catch, revenues, and producer's surplus for the second 15 years of the planning horizon are based on the average of years 10 to 15 (2001-2006). The cost estimates from the hatcheries were provided by the hatcheries for those years.[6]

Returns to the state if hatchery production continues at current levels

Under current hatchery production levels (Case 1) we estimated the net benefit to the state to be on the order of $109.71 m. (m. = 10^6) in 1992. The net benefits were projected to rise steadily in real (1992) dollars over the thirty year planning horizon. By 2006 we projected the net benefits to the state to be $154.37 m. per year. The thirty year average was estimated to be $140 m. Over thirty years, we estimated that the salmon fishery with the hatchery program at its current levels would bring in $4.001 b. (b. = 10^9) in net benefits ($2.329 b. in present value at 4% discount rate) to the Alaskan Economy on revenues of $16.075 b. The difference over the thirty year planning horizon between the gross revenues and the net benefits was made up of hatchery costs ($859 m.) and fishery costs ($11.215 b.). This data is based on the midpoint price estimates from the demand model (Appendix One). The optimistic price estimates (Appendix Two) yielded an undiscounted return of $4.731 b. and the pessimistic price estimates yielded an undiscounted return of $3.548 b. over the 30 years. In present value of 1992 dollars discounted at four percent, the estimates for current production levels are $2.330 b. for the midpoint, $2.746 b. for the optimistic, and $2.071 b. for the pessimistic price predictions. Thus our estimates vary by about 1.2 b. undiscounted dollars to about 700 million discounted dollars over the thirty year planning horizon. This magnitude of prediction error is present in all our analysis.

The distribution of the undiscounted $4.001 b. net benefits over the next thirty years under current hatchery production levels was as follows. The largest share is in Western Alaska (dominated by Bristol Bay), with about $56.67 m. in net benefits per year over the next thirty years, for a total of $1.700 b. (present value of $933.40 m. at 4% discount rate). The next largest share went to Southeast, with $40.03 m. per year for a total of $1.201 b. over the thirty year lifetime (present value of $689.34 m.). Kodiak had net benefits of $ 16.64 m. per year for a thirty year total of $499.07 m (PV of $288.69 m.) Cook Inlet had net benefits projected to be $14.73 m. per year for a thirty year total of $441.79 m. (PV of $271.08 m). Prince William Sound had net benefits projected to be $5.279 m. per year for a thirty year total of $158.36 m., or a present value of $87.41 m.

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[6]We were requested to use the 15th year to predict the final 15 years in the RSA. However, we found that our demand model predictions for the fifteenth year were quite a bit higher than previous years, so we used the 5 year average instead. The relative effect is that all revenues are slightly lower than would have occurred if we had used the 15th year. However, none of the relative rankings of the alternatives is affected by this change.

We shall speak more to the issue of the distribution and the reasons for the distribution below.

Comparing planned hatchery production with current hatchery production

The second alternative considered was the "planned hatchery production levels," Case 2. This comparison is made in Table Two. The catch levels projected by the hatcheries were obtained in a survey conducted by the Department of Fish and Game, FRED division. We estimated that if the state follows the planned hatchery production alternative the thirty year undiscounted sum is $3.958 b. ($2.303 b. if discounted at 4%), for an average net benefit of $132 m. per year. The estimated returns under the current hatchery production levels were $133 m. per year, or about a million dollars a year higher. Our estimation results of Case 2 should be viewed as a lower bound prediction of net benefits for Case 2. The reason is that the simultaneous large increases in a number of species under the planned output levels forces into play a number of complex cross price effects, which our demand model is not well adapted to consider.

The distribution of net benefits under the planned hatchery production levels also changes from the current levels. Under the planned levels, Prince William Sound will gain almost seventy million dollars over thirty years, up to net benefits of $228.96 m. from net benefits of $158.36 m. under current levels.[7] Cook Inlet also gains, increasing to $481.57 m. from $441.79 m. under current levels. However, these projected gains are more than offset by the projected losses elsewhere. Western Alaska loses the most, down to $1624.56 m. from $1700.36 m. over thirty years. Southeast is projected to have net benefits under the planned case of $1151.24 m., down from $1201.76 m. under the current levels. Kodiak also loses under the planned alternative relative to the current levels since net benefits drop to $471.51 m. from $499.07 m. The regions that gain, Prince William Sound and Cook Inlet, gain by an amount less than the remaining regions lose by average of $1.45 m. per year. Thus our projection suggests that the current hatchery levels are to be preferred over the planned hatchery production levels.

It is instructive to look at what is changing under the planned hatchery levels relative to the current hatchery production levels. The thirty year sum (undiscounted) totals for each alternative are given below in Table Two.

The catch differences between the current (Case 1) and the planned (Case 2) production are that Cook Inlet, Prince William Sound, and Southeast all have larger catches under the planned than under the current case. Prince William Sound accounted for the largest share of the increase, adding 487 million pounds over the thirty year period. Cook Inlet and Southeast increase catch by about 138 and 115 million pounds, respectively. The catch in Kodiak and Western Alaska are almost unchanged. In net,

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[7]The figures we are citing are the undiscounted sums. The appropriate measure for cost-benefit analysis is the discounted figures. We found that the discounting did not affect the relative standings of the various alternatives since costs and benefits are dispersed fairly evenly over the planning horizon. Since the undiscounted numbers are the least confusing to look at, we use them in the analysis.

there is an increase of 739 million pounds of fish caught over the thirty years, or about 24.6 million pounds per year more in catch.

Table Two: Regional summaries for current (Case 1) and planned (Case 2) hatchery production

(millions of pounds and millions of 1992 dollars)

Case 1: Current Level

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.77	7078.92	1700.36	0.00	1700.36
Cook Inlet	1702.43	1572.88	508.05	66.26	441.79
Kodiak	2425.80	1466.39	548.09	49.02	499.07
Prince Wm.	5215.02	2422.53	536.05	377.69	158.36
Southeast	6153.45	3534.28	1568.25	366.48	1201.76
State Total	23332.47	16075.00	4860.79	859.45	4001.34

Case 2: Planned Level

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.79	6891.17	1624.56	0.00	1624.56
Cook Inlet	1840.07	1698.54	549.97	68.40	481.57
Kodiak	2424.90	1420.60	520.53	49.02	471.51
Prince Wm.	5702.03	2592.98	616.54	387.58	228.96
Southeast	6268.58	3506.87	1537.80	386.56	1151.24
State Total	24071.37	16110.16	4849.40	891.55	3957.84

Consider how the changes in the catch affected the changes in revenues. In net, revenues increased to $16.075 b. under the planned production levels from $16.110 b. under current production levels. This increase of $35.16 m. over thirty years is relatively small, about $1.17 m. per year. The increase in revenues was not uniform across the regions, however. Revenues in Cook Inlet and Prince William Sound increase under the planned hatchery production relative to the current, but all other areas would have a decrease in revenues. Cook Inlet revenues increase by $125.66 m., or about $4.19 m. per year. Prince William Sound revenues increased by $170.45 m., or an average of $5.68 m. per year. Western Alaska, Kodiak, and Southeast all had reductions in revenues. Western Alaska revenues decreased by $187.75 m., or an average loss in revenues of $6.26 m., per year. Kodiak revenues decreased by $45.79 m., or by $1.58 m. per year. Southeast lost an additional $27.41 m., or about $0.91 m. per year.

The revenue changes are discussed in more detail in the demand analysis report. However, the main effect on revenues of the increase in production in Prince William Sound, Cook Inlet, and Southeast is to depress revenues in three areas (Western Alaska, Kodiak, and Southeast), and increase revenues in two areas (Cook Inlet and Prince

William Sound). In net, the increases in revenues were greater than the losses. The curious finding here is that increases in Southeast, when coupled with the increases in Prince William Sound and Cook Inlet, actually lead to decreases in revenues in Southeast. It is doubtful that taken by itself, an increase in Southeast production would have depressed revenues in Southeast. However, when coupled with the increases in Prince William Sound and Cook Inlet, the net effect was a decrease in Southeast revenues.

The producer's surplus measures the net benefits (revenues minus costs) to the fishermen in each region. If the hatchery program continued at planned levels rather than at current production levels, we estimated that while gross revenues increased by $35.16 m. over the thirty year period, net revenues to the fishermen measured by producer's surplus actually *decreased* $11.39 m. As with the revenues, the distribution of gains and losses was not the same across regions. Cook Inlet and Prince William Sound each experienced gains in producer's surplus. Each of the other regions experienced losses in producer's surplus. The net gains and losses are as follows: Prince William Sound was the biggest gainer, with an increase in producer's surplus of $80.49 m., or $2.68 m. per year. Cook Inlet showed gains of $41.92 m., or $1.40 m. per year. The total gain of these two areas was $122.41 m. total over thirty years, or $4.08 m. per year. The biggest loser was Western Alaska. The losses there would be $75.80 m. over thirty years, or $2.53 m. per year. Southeast lost the next most, having a reduction in producer's surplus of $30.45 m. over thirty years, or $1.02 m. per year. Kodiak would lose producer's surplus of $27.56 m. over thirty years, or $0.92 m. per year. The totals for the three areas losing producer's surplus are losses of $133.81 m. over thirty years, or $4.46 m. per year. Compare this with the total gain per year in Cook Inlet and Prince William Sound, and there is a net loss of $0.38 m. per year relative to the current case.

While the producer's surplus net gains and losses are almost a wash, with the losers losing about $0.38 m. a year more than the winners are gaining, the true measure of the difference is in the hatchery costs. Given net losses to fishermen on the order of $11.69 m. over thirty years, we estimate that hatchery costs will *rise* by $32.10 m. dollars over the thirty year planning horizon. That is, in addition to the net losses in producer's surplus by fishermen of $11.69 m., there is also an increase in hatchery costs of $32.10 m. The total cost of the planned hatchery output relative to the current hatchery output levels is thus the sum of the reduction in producer's surplus plus the increase in hatchery costs. This sums to a net loss of $43.79 m. over the thirty year planning horizon, or a net cost of $1.46 m. per year. In present value terms at a discount rate of 4%, the difference is -$26.62 m. That is, our estimates say that if we follow the planned levels rather than the current levels, it will be as though we lost $26.62 m. today.

The direction of the changes is consistent under alternative assumptions about the prices. If prices follow the optimistic projections instead of the midpoints, the current production levels provide an estimated net return to the state over thirty years of $50.93 m. undiscounted dollars and $30.17 m. discounted dollars. Under the pessimistic price scenario, the difference is $41.26 m. undiscounted or $25.47 m. discounted dollars at a 4% rate of discount.

Comparison of eliminating entire portions of the hatchery program with maintaining current production levels

Our calculations suggest that two alternatives dominate all other alternatives in producing net economic benefits to the state. These alternatives are Case 3, elimination of the entire hatchery program, and Case 5, elimination of the entire pink salmon program. In addition, we find that the next best alternative is a reduction of the entire program by 15%. However, the order of magnitude difference between a reduction of 15% and eliminating all of the pink salmon program is over $350 m. over thirty years (undiscounted) and the difference between a 15% reduction and eliminating the entire program is over $500 m. over thirty years. These numbers suggest that large decreases in either the entire hatchery program or at least in pink salmon are warranted.

We believe that our numbers are as accurate as can be obtained under current data limitations. However, we warn that our estimates of returns to the state under the elimination alternatives must be viewed with some caution. In particular, our earlier warnings that these cases are forcing us to extrapolate beyond the data used to estimate parameters in our model is relevant for these cases. In addition, the cases in which the entire program is eliminated (Case 3) or reduced by 15% (Case 4b) involves complicated cross price effects which our demand modeling may be incapable of capturing. Thus, the results from these particular cases should be somewhat discounted.[8] In spite of this, we believe that there is a serious message in our findings: it appears to us that the hatchery program, especially with respect to pink salmon, needs to be scaled back considerably, if not entirely.

Table Three contains summary statistics for the 30 year sums (undiscounted) for the current hatchery output levels (Case 1) as well as each of the three cases where some (Case 5, elimination of pinks, and Case 6, elimination of reds) or the entire program is eliminated (Case 3). Looking at the statewide total net benefits under each program, it is clear that elimination of all or some portion of the program results in the largest net benefits to the state. In particular, the thirty year sum of undiscounted net benefits under the current hatchery output levels is estimated to be $4.001 b. Under Case 3, the eliminate the entire program alternative, we estimate net benefit to the state to be $4.621 b. dollars, or an increase of $620 million over the next thirty years, which is approximately a net increase in the wealth of the state by $20.67 m. per year over the next thirty years. Under Case 5, elimination of the entire pink salmon portion of the hatchery program, we estimate that the state receives returns of $4.461 b. dollars over the thirty year planning horizon. This is $460 m. more than under the current hatchery output levels, or an increase in welfare of the state of $15.33 m. per year. Elimination of

[8] This warning is relevant also for Case 2 and 4a. We emphasize the warning for Case 3 and 4b because it is for these cases that we find point estimates suggesting the largest gain in benefits to the state.

Table Three: Comparison of eliminating the entire hatchery program (Case 3), the entire pink salmon hatchery production (Case 5), and the entire red salmon hatchery production (Case 6)

(millions of pounds and millions of 1992 dollars)

Case 1: Current Level

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.77	7078.92	1700.36	0.00	1700.36
Cook Inlet	1702.43	1572.88	508.05	66.26	441.79
Kodiak	2425.80	1466.39	548.09	49.02	499.07
Prince Wm.	5215.02	2422.53	536.05	377.69	158.36
Southeast	6153.45	3534.28	1568.25	366.48	1201.76
State Total	23332.47	16075.00	4860.79	859.45	4001.34

Case 3: Eliminate all species in 1993

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.24	7983.52	1918.84	0.00	1918.84
Cook Inlet	1259.05	1488.38	469.45	1.94	467.50
Kodiak	1808.76	1437.73	534.75	1.38	533.37
Prince Wm.	1548.73	1190.36	237.71	7.80	229.91
Southeast	4350.53	3234.71	1482.64	11.06	1471.58
State Total	16802.32	15334.70	4643.38	22.18	4621.20

Case 5: Eliminate Pink Salmon in 1993

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.77	7252.70	1743.25	0.00	1743.25
Cook Inlet	1362.23	1506.21	480.10	66.26	413.84
Kodiak	2135.11	1543.94	580.79	49.02	531.77
Prince Wm.	2199.21	1644.75	328.74	121.85	206.90
Southeast	5920.16	3972.75	1788.10	222.22	1565.88
State Total	19452.47	15920.34	4920.99	459.34	4461.65

Case 6: Eliminate Red Salmon in 1993

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.77	7416.14	1779.38	0.00	1779.38
Cook Inlet	1604.31	1495.05	480.03	66.26	413.77
Kodiak	2266.73	1296.00	471.62	49.02	422.60
Prince Wm.	4988.08	2088.72	473.67	271.69	201.97
Southeast	6122.87	3538.60	1571.48	366.48	1205.00
State Total	22817.76	15834.51	4776.17	753.45	4022.72

the red salmon program (Case 6) is also projected to increase the net returns to the state, but elimination of the red salmon program has a much smaller effect than elimination of the pink salmon program. If the red salmon production is eliminated, the thirty year return to the state is estimated to be $4.022 b. dollars. This is only $21 m. more than under current production levels over thirty years, or about $0.70 m. per year.

The differences in total net benefits to the state cannot be explained by catch and revenue data alone. What we find is that elimination of any portion of the program causes catch to decrease. This results in a reduction in revenues relative to the current production levels. Thus the gain in net benefits is not due to a gain in revenues but to a decrease in costs of running the hatchery program. Under the eliminate all alternative (Case 3), catch decreases by 28%, down to 16.802 b. pounds over 30 years from 23.332 b. pounds under the current output level. However, revenues only decrease by 4.6%, down to $15.335 b. from $16.075 b. over thirty years. Elimination of the pink salmon program also reduces total estimated catch, although not by as much as elimination of the entire hatchery program. The reduction in the catch due to the pink salmon hatchery program would be a drop to 19.452 b. pounds over thirty years from the 23.332 b. under current output levels, or a reduction by 16.6% in catch. Revenues (undiscounted) would drop to $15.920 b. from revenues of $16.075 b. under the current output levels, or a drop of only 1.0% over the thirty years. If the red salmon hatchery production is eliminated, total catch drops by a much smaller amount, down to 22.817 b. pounds over thirty years from the 23.332 under current output levels. This drop of 2.2% causes a reduction in revenues to $15.834 b. dollars over thirty years from $16.075 under current output levels. The percentage reduction in revenues is 1.5%. The reduction in revenues appears to occur because of cross-price effects on the lower valued species.

The net return to the fishermen measured by producer's surplus is a much better measure of the value of the hatchery program to fishermen. We find that relative to the current production level of Case 1, producer's surplus actually increases by 1.2% under Case 5, the elimination of the pink salmon hatchery program. The increase is relatively small, $60.20 m. over thirty years, or $2.01 m. per year. Producer's surplus is estimated to decrease if either the red salmon program is eliminated or if the entire hatchery program is eliminated. While the producer's surplus for the entire state increases if the pink salmon program is eliminated, not every region has gains under the elimination of the pink program. In particular, producer's surplus decreases in Prince William Sound and Cook Inlet under each of the elimination alternatives relative to current levels. Western Alaska gains producer's surplus in each elimination scenario relative to the current levels, and Southeast gains big if pinks are eliminated, slightly if reds are eliminated, and loses if all species are eliminated. Kodiak gains if pinks are eliminated, but loses if reds or all species are eliminated.

It is only in the elimination of pink salmon that the net change in producer's surplus summed over all of the regions is positive. That is, in the elimination of pink salmon alternative, we estimate that the gains in producer's surplus to regions gaining are more than sufficient to compensate the losses in Prince William Sound and Cook Inlet. This is not true of either the elimination of the entire salmon hatchery program or the

elimination of the red salmon hatchery program alternatives. In each of those cases, the increase in producer's surplus benefits to the gaining regions is less than the loss in producer's surplus to the losing regions. Under elimination of the entire hatchery program, we find that undiscounted producer's surplus to fishermen over thirty years decreases to $4.643 b. from $4.860 b. under the current hatchery output alternative, for a decrease of $217.41 m., or a decrease of about $7.25 m. per year. Under the elimination of reds alternative, we find that fishermen's producer's surplus decreases to $4.776 b. from the $4.860 b. under the current hatchery output levels; or a decrease of $84.62 m. over thirty years, or $2.82 m. per year.

From a state-wide perspective, the changes in producer's surplus is only one part of the equation. The other part is the hatchery costs. Under the current production levels, to produce $4.860 b. in producer's surplus over the next thirty years, the state spends $859 m., for a net benefit of $4.001 b. In fact, we find that when changes in the hatchery costs are taken into account in addition to the changes in the producer's surplus, each elimination alternative dominates the current output level alternative. Furthermore, the net effect by region shows that each region also gains with the exception of Cook Inlet in the cases where either pink or red salmon are eliminated, and for Kodiak in the case where red salmon is eliminated. The biggest surprise in this result is our finding that when hatchery costs are included, Prince William Sound also gains in net by eliminating each of the programs. Thus if the financing for the hatchery program were to entirely be financed within the region, the best alternative to Prince William Sound would be to eliminate the hatchery program given that the same is occurring throughout the rest of the state.

Under the elimination of the entire hatchery program, the producer's surplus decreases by $217.41 m. over thirty years, but this is more than offset by a decrease in hatchery costs of $837.27 m. Thus the net gain to the state of $619.86 m. over thirty years is due to savings in the cost of the hatchery program. In essence, this tells us that the cost to provide fishermen with $217.41 m. in additional producer's surplus is an additional $837.27 m. in hatchery costs. This means that if the state wishes to increase the producer's surplus of fishermen by $217.41 m., by giving a direct subsidy to the fishermen of the $217.41 m. in lost producer's surplus instead of running the hatchery program, the state would save $619.86 m. over the next thirty years.

Under the elimination of the pink salmon program, there are two sources of gain. First, producer's surplus actually increases by $60.20 m. Secondly, the cost of the hatchery program declines by $400.11 m. over the thirty year planning horizon. This says that by saving itself $400.11 m. in hatchery costs, the state could actually increase fishermen's producer's surplus by $60.20 m over the next thirty years. Of course, not all regions gain by the increase in producer's surplus, but the losses to the regions that do lose is $60.20 m. less than the gains to regions that gain.

Under elimination of the red salmon program, the fishermen suffer net losses in producer's surplus of $84.62 m. However, this is more than offset by the $106 m. in savings from running the red salmon hatchery program. The net effect of eliminating the

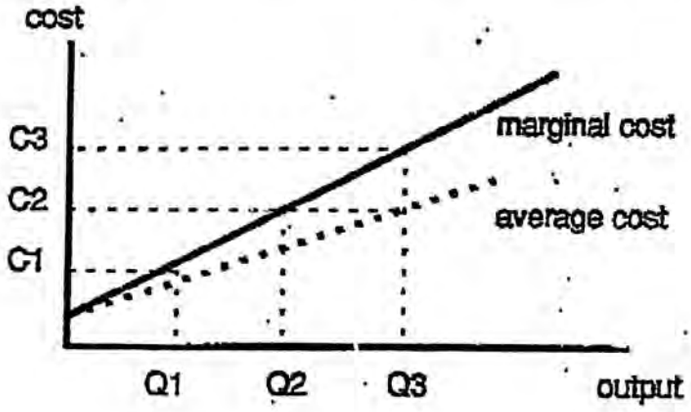
red salmon program is an increase in net benefits to the state of $21.34 m., or about $0.71 m. per year.

The cost per fish of the hatchery program

Our analysis of the potential effects of elimination of the hatchery program, or of some of its parts, reveals some interesting information about the cost per pound of fish of the hatchery program. Eliminating the pink salmon program shows that the estimated catch over thirty years will drop by 3.880 b. pounds. The reduction in hatchery costs due to eliminating the pink salmon hatchery program causes hatchery costs to decline by $400.11 m. Thus the cost per pound of the pink hatchery program is roughly 10.3 cents per pound. This is less than 2 cents per pound below the price being offered in 1991 when pink salmon were left to rot. Given that fishermen could not afford to fish at 12.1 cents per pound, it suggests that pink salmon prices have to be over 22.4 (= 10.3 + 12.1) cents a pound before producing hatchery fish is profitable.

A similar comparison can be made for the red salmon program. The reduction in catch due to eliminating the red salmon program is 514.71 m. pounds over thirty years. The estimated savings in costs due to the elimination of the red salmon program are $106.00 m. undiscounted dollars over thirty years. Thus the estimated cost of producing a hatchery raised red salmon is 20.6 cents per pound on average.

Figure One: Marginal and average hatchery costs



Two points should be made about the foregoing analysis. First, the cost of producing a pound of red salmon by the hatchery program appears to be almost twice as much as the cost of producing a pink salmon. This explains why it is that the elimination of the some red salmon hatchery production may possibly be a good idea. A second point has

to do with the way in which we have measured the change in hatchery costs. The survey filled out by hatchery producers asked the question of what would be the change in their operating costs if either the red or pink salmon programs were eliminated.

There is good reason to believe that the answers given by the hatcheries will tend to understate the cost of an additional hatchery produced fish. Consider Figure One. In Figure One, there are three different levels of output depicted. The marginal cost line measures the cost of an additional unit of output. For example, the cost of the output Q1 is C1. If output were to be increased to Q2, then the cost of the cost of the Q2th unit would be C2. The average cost if Q2 is produced would be the mean of C1 and C2. Since the average cost includes units of output that have lower marginal costs, the average cost is less than the marginal cost.

To further examine the hatchery cost per pound of various species, we collected data from each of the cases 7a, 7b through 11a, 11b, which considers increases or decreases for the particular species by 15% over current commercial catch. The data in Table Four shows a couple of things. First, the relationship between the cost per pound of an increase and a decrease in hatchery output of each species is consistent with what we would believe to be true of costs for red, chum and coho salmon. However, it does not appear to be true for king and pink salmon. For pink salmon, we have that the marginal cost (on average) of an increase by 15% is 5.6 cents per pound. However, the average cost of pink salmon already produced is 10.8 cents per pound. This is inconsistent with what we have shown to be expected in Figure One. The costs are estimated from the hatchery responses to the question of the change in costs to a 15% increase or a 100% decrease. To get a measure of the cost of a 15% decrease, we took 15% of the reported costs of a 100% decrease. The king salmon data appears to suffer from the same problem. It is our feeling that the cost associated with the increase in 15% is the more reliable figure since it is directly estimated by the hatcheries themselves. However, the figure given for the decrease is obtained by imposing the restriction that the total commercial share of costs of all species produced add up to the total commercial costs. This restriction is not imposed by the increase in production data.[9] Again, a problem only appears to occur with the pink and king salmon hatchery costs.

[9]The cost data provided by the hatcheries was not entirely reliable. We found that if we added up the total cost savings for the commercial portion of the hatchery output, we generally got a number that was somewhat less than the total cost of the current commercial portion of hatchery costs. We adjusted the figures so that the sum of the 100% reductions would add up to the current hatchery costs attributable to commercial catch (i.e., including the commercial share of the cost recovery catch). For example, the total costs reduction from eliminating all commercial hatchery programs in Prince William Sound accounted for only about 50% of the total current level of commercial hatchery costs there. Thus we increased their estimate by a factor of two to get all costs to be accounted for. This adjustment may account for our difference in estimates of cost for increases versus decreases.

Table Four: The hatchery cost per fish for a 15% change in returns by species

(millions of pounds and millions of 1992 dollars)

	CATCH	HATCHCOST	ACATCH	ACOST	$/LB
Current Level	23332.47	859.45	****	****	****
Increase Pink	23904.53	891.71	572.06	32.26	0.056
Decrease Pink	22774.95	799.44	557.52	60.01	0.108
Increase Red	23404.47	884.36	72.00	24.91	0.346
Decrease Red	23260.40	843.55	72.07	15.90	0.221
Increase Chum	23615.89	885.79	283.42	26.34	0.093
Decrease Chum	23049.04	835.32	283.43	24.13	0.085
Increase Coho	23357.68	869.71	25.21	10.26	0.407
Decrease Coho	23305.74	852.18	26.73	7.27	0.272
Increase King	23346.81	863.71	14.34	4.26	0.297
Decrease King	23318.08	837.86	14.39	21.59	1.500

Since the difference in hatchery costs has the greatest effect on our cost-benefit calculations in the pink salmon case, we consider what would happen if we have overstated our estimate of cost savings from eliminating pink salmon production. We estimated our cost savings to be about 10 cents per pound. Suppose that instead they had been only 5 cents per pound, which is being charitable to the hypothesis that we are wrong. Then under Case 5, hatchery costs would have decreased by $200 m. over thirty years instead of by $400 m. as we have estimated. Elimination of the pink salmon hatchery production would still result in an increase over current hatchery levels of $260 m. dollars over thirty years, undiscounted. Thus, even at 5 cents a pound hatchery production costs for pink salmon, the elimination of pink salmon alternative is considerably more attractive than any other alternative save the elimination of the entire program.

Comparison of current hatchery production levels with 15% increases and decreases in all hatchery produced stocks

The next set of alternatives we consider are the alternatives in which either all hatchery production is increased by 15% (Case 4a), or all hatchery production is decreased by 15% (Case 4b). Before we turn to the analysis of the actual alternatives, we want to remind the reader of the main caveat having to do with these alternatives. That is, because all hatchery production for all species are simultaneously increasing or decreasing by 15%, there are a number of complicated interaction effects that are taking place. Our demand models are very weak in this respect. Because we restricted the international level of the demand model to low and high valued species, we do not have

estimates of substitution elasticity's that were calculated within each group. To estimate prices by species we used correlation's between the species price and the aggregate price for the group. While these correlation's give us an idea about how the relative prices of the species move in relation to one another, they do not give us a measure of the substitution elasticity between species. Therefore, when all species are simultaneously increasing or decreasing, we end up with a measure of correlation's between price movements. The problem is that a salmon is not a salmon. Pink and chum salmon, for example are very different from one another, and there is no a priori reason to believe that the correlation between prices conveys much information about the actual willingness of consumers to substitute between the two as relative prices change. Not only is a salmon not a salmon to consumers, but our analysis on the cost of producing an additional salmon shows that the relative hatchery costs are much different. We will consider below the effect on a fishermen's net revenues of increases in each species.

Table Five: Comparison of current hatchery production levels with 15% increases and decreases in all hatchery produced stocks

(millions of pounds and millions of 1992 dollars)

Case 1: Current Level

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.77	7078.92	1700.36	0.00	1700.36
Cook Inlet	1702.43	1572.88	508.05	66.26	441.79
Kodiak	2425.80	1466.39	548.09	49.02	499.07
Prince Wm.	5215.02	2422.53	536.05	377.69	158.36
Southeast	6153.45	3534.28	1568.25	366.48	1201.76
State Total	23332.47	16075.00	4860.79	859.45	4001.34

Case 4(a): Increase all species by 15%

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7833.85	6957.94	1671.50	0.00	1671.50
Cook Inlet	1770.10	1574.82	509.85	73.03	436.81
Kodiak	2517.54	1450.53	541.22	61.31	479.91
Prince Wm.	5754.06	2456.17	543.22	409.11	134.11
Southeast	6423.49	3506.01	1547.67	425.29	1122.38
State Total	24301.03	15945.46	4813.45	968.74	3844.72

Case 4(b): Decrease all species by 15%

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Western AK	7835.69	7178.62	1724.08	0.00	1724.08
Cook Inlet	1635.65	1563.02	502.13	56.32	445.81
Kodiak	2336.98	1444.22	541.59	41.66	499.93
Prince Wm.	5117.45	2420.15	538.13	321.04	217.09
Southeast	5883.45	3462.62	1538.41	311.51	1226.90
State Total	22809.22	15068.62	4844.34	730.53	4113.80

Having given all of these caveats, let us consider the effect of either an increase or a decrease in the entire hatchery program. Data from Case 4a and 4b is compared with the current hatchery production levels in Table Five.

The results of Table Five can be summarized as follows. Either an increase or a decrease in all hatchery production by 15% will cause both revenues and producer's surplus to decrease. The decrease in revenues and producer's surplus is greater if the hatchery production increases (Case 4a) than if it decreases (Case 4b). If hatchery production increases by 15% for all species, then the estimated increase in hatchery costs is almost $110 m. over thirty years. The increase in hatchery costs plus the decrease in producer's surplus means that relative to current hatchery output levels, an increase by 15% across the board would cause the state to lose $156.62 m. (undiscounted) over thirty years, or about $5.22 m. per year. If all hatchery production decreases by 15%, then producer's surplus is estimated to decrease by $16.45 m. (undiscounted) over thirty years. However, hatchery costs are estimated to decrease by $128.92, for a net increase of $112.46 m. (undiscounted) over thirty years. Interestingly, about the only major distributional effect in producer's surplus has to do with Western Alaska, which stands to lose slightly less than a million dollars a year with an increase of 15% of all hatchery stocks and stands to gain less than a million a year with a decrease of 15%.

Again, we want to emphasize that neither of these alternatives are very appealing. The idea of an across the board increase or decrease ignores the fact that the effect of a change in the quantity of one species may be considerably different than for another species both for consumers and hence for ex vessel prices, and for production since hatchery costs are not identical across species.

Comparison of current hatchery production levels with 15% increases and decreases by species for hatchery produced stocks

We now turn to the consideration of changes in individual species. We find in net that a 15% increase or a 15% decrease of a particular species has a very small effect (less than 1%) on net benefits for all cases except pink salmon. Even for pink salmon a 15% increase or decrease in hatchery output has only about a 2% effect on net benefits. Although we have not calculated variance parameters for our estimates, it is likely that none of these is a statistically significant change from the current hatchery output levels. The summary data for the entire state is given in Table Six. We have not included regional data since the total effect is so small. However, this data can be found in Appendix One.

Table Six: Comparison of current hatchery production levels with 15% increases and decreases by species for hatchery produced stocks

(millions of pounds and millions of 1992 dollars)

	CATCH	REVENUES	SURPLUS	HATCHCOST	NET BENEFIT
Case 1					
current level	23332.47	16075.00	4860.79	859.45	4001.34
Case 7					
Increase Pink	23904.53	15997.97	4823.10	891.71	3931.39
Decrease Pink	22774.95	16126.83	4890.49	799.44	4091.06
Case 8					
Increase Red	23404.47	16105.51	4871.04	884.36	3986.68
Decrease Red	23260.40	16043.79	4849.71	843.55	4006.16
Case 9					
Increase Chum	23615.89	16136.18	4887.74	885.79	4001.95
Decrease Chum	23049.04	16006.04	4831.22	835.32	3995.90
Case 10					
Increase Coho	23357.68	16094.85	4868.94	869.71	3999.22
Decrease Coho	23305.74	16052.27	4851.17	852.18	3999.00
Case 11					
Increase King	23346.81	16102.67	4873.08	863.71	4009.37
Decrease King	23318.08	16047.68	4848.88	837.86	4011.01

A more interesting comparison is contained in Table Seven. There we calculate the change in producer's surplus resulting from either an increase or decrease in the quantity of salmon produced by the hatcheries. Our numbers suggest that on average, each pound of pink salmon provides between 5.3 and 6.6 cents of producer's surplus to fishermen. Recall our earlier estimate (Table Four) of the cost per pound to produce a pound of hatchery raised pink salmon was 5.6 and 10.8 cents per pound. Thus it appears that the cost per pound of producing pink salmon by hatchery production is greater than the producer's surplus it generates to fishermen.

This result seems to be true of red salmon also. Our estimate of the cost per pound to raise red salmon in hatcheries ranged from 22.1 to 34.6 cents per pound. However, our estimate of the average producer's surplus gained by this production is only 14.2 to 15.4 cents per pound. Before too much credence is placed on these numbers, however, it must be mentioned that our estimate of producer's surplus for red salmon is mainly from Bristol Bay (recorded as Western Alaska in our tables). Recall that our estimates for producer's surplus for Bristol Bay were made using average data from similar fisheries elsewhere in the state. We have no way of knowing how accurate these predictions are given that they are extrapolating well beyond the data available from fisheries elsewhere in Alaska.

Chum salmon also appears to have hatchery production costs that are roughly equal to the producer's surplus generated by an extra pound produced. We estimate that it costs between 8.5 and 9.3 cents to produce another pound of hatchery raised chum salmon, but fishermen receive producer's surplus of only about 9.5 to 10.4 cents per pound.

Coho is similar. Coho are estimated to cost between 27.2 and 40.7 cents per pound to produce, but generate producer's surplus on the order of between 32.3 and 36.0 cents per pound.

King salmon may be the best bet. If the marginal cost of king salmon based on an increase of 15% is accurate, then the cost of a king salmon is estimated to be about 29.7 cents per pound. Our estimate of the return in producer's surplus per pound of king salmon is between 82.8 and 85.7 cents per pound. However, if the marginal cost of king salmon based on a decrease is correct, then king salmon costs about $1.50 per pound to produce. If this is true, then even king salmon fails to produce net benefits.

Table Seven: Estimates of producer's surplus created by an additional pound of salmon by species

(millions of pounds and millions of 1992 dollars)

	CATCH	SURPLUS	ΔCATCH	ΔSURPLUS	SURPLUS $/LB
Case 1 current level	23332.47	4860.79	****	****	****
Case 7					
Increase Pink	23904.53	4823.10	572.06	37.69	0.066
Decrease Pink	22774.95	4890.49	-557.52	-29.70	0.053
Case 8					
Increase Red	23404.47	4871.04	72.00	10.25	0.142
Decrease Red	23260.40	4849.71	-72.07	-11.08	0.154
Case 9					
Increase Chum	23615.89	4887.74	283.42	26.95	0.095
Decrease Chum	23049.04	4831.22	-283.43	-29.57	0.104
Case 10					
Increase Coho	23357.68	4868.94	25.21	8.15	0.323
Decrease Coho	23305.74	4851.17	-26.73	-9.62	0.360
Case 11					
Increase King	23346.81	4873.08	14.34	12.29	0.857
Decrease King	23318.08	4848.88	-14.39	-11.91	0.828

Conclusions and Recommendations

bad sentence

Our results do not paint a very encouraging picture for the hatchery program. Based on our point estimates for the alternatives we believe our models were able to generate accurate results, the best alternative is to actually close the pink salmon hatcheries. However, we would not recommend that the state force all hatcheries to shut down. We would recommend that if a region wants to continue with a hatchery program, that it should be funded by the local user groups rather than by the state.

If the fishermen themselves fund the hatchery program, they will only choose projects which are cost-effective within their own region. There may still be regional effects in that production in one region causes prices to decline elsewhere, but whatever hatchery production remains will be cost effective. Table Eight compares the thirty year returns (undiscounted) for each alternative by region. Because we believe that our estimates of net benefits for Cases 2, 3, 4a, and 4b must be viewed with a great deal of caution, we separate them out in Table Eight.

Table Eight: Net Benefits by Region, By Alternative

(millions of 1992 dollars)

CASE	WESTERN	COOK INLET	KODIAK	PWS	SOUTHEAST	TOTAL
1	1700.36	441.79	499.07	158.36	1201.76	4001.34
5	1743.25	413.84	531.77	206.90	1565.88	4461.65
6	1779.38	413.77	422.60	201.97	1205.00	4022.72
7a	1694.53	443.16	485.68	152.87	1155.14	3931.39
7b	1706.17	439.39	506.20	182.35	1256.94	4091.06
8a	1689.64	441.46	506.79	157.25	1191.55	3986.68
8b	1711.29	437.49	488.84	166.35	1202.19	4006.16
9a	1698.72	441.04	494.97	155.98	1211.24	4001.95
9b	1702.31	442.96	498.74	158.16	1193.73	3995.90
10a	1698.45	440.36	498.31	157.17	1204.94	3999.22
10b	1701.52	444.58	499.33	157.63	1195.93	3999.00
11a	1699.54	443.07	498.68	157.80	1210.27	4009.37
11b	1701.42	448.25	506.80	158.31	1196.23	4011.01
2	1624.56	481.57	471.51	228.96	1151.24	3957.84
3	1918.84	467.50	533.37	229.91	1471.58	4621.20
4a	1671.50	436.81	479.91	134.11	1122.38	3844.72
4b	1724.08	445.81	499.93	217.09	1226.90	4113.80

The net benefit figures in each row of Table Eight are the returns for each region given that all regions are following the same hatchery production alternative. That is, for

the region to get the estimated net benefits listed for a particular alternative, every region has to be following the same alternative.

We have bolded the number in each column that corresponds to the best alternative for the region under the assumption that the region is financing its own hatchery program. In the subset of alternatives for which we express confidence in our net benefits estimates (Cases 1, and 5-11), alternative 5, shutting down the entire pink salmon hatchery production, is the best alternative for Kodiak, Prince William Sound, and Southeast. That is, if these regions could get the rest of the state to agree to following alternative 5, they would get the highest returns under a self-financed hatchery program.

The question is would the other two regions want also to follow alternative 5? While Western Alaska would benefit if the pink salmon program be shut down, their first preference would be that the red salmon hatchery production be shut down (Alternative 6). This is because red salmon dominates Western Alaska catch, so if everyone else shuts down red salmon hatchery production, Western Alaska red salmon prices rise at no additional cost to them. However, since Western Alaska only has one hatchery, and it produces only chum, it cannot independently influence the behavior of the other regions.

Cook Inlet is the odd one of the regions. Under a self-financing program, our estimates indicate that Cook Inlet would prefer everyone else shut down their king salmon programs. But since no other region will prefer this option, this alternative is not a feasible solution. If every other region is scaling back pink salmon hatchery production, Cook Inlet is made worse off relative to the current production levels. The question is could Cook Inlet by itself influence the actions of the other regions? The answer is probably, though not definitely, "no." The reason is this: Prince William Sound is producing currently 124 m. pounds of pink salmon. Cook Inlet is currently producing under 7 m. pounds, of which less than half comes from hatchery production. Thus, even if Cook Inlet felt that it could produce pink salmon at a net benefit to its fishermen, it is doubtful that it would have enough of an impact on prices to warrant the other regions changing their minds about scaling back their own pink salmon programs.

Notice that when Alternatives 2, 3, 4a and 4b are included, Kodiak, Southeast, Prince William Sound and Western Alaska all prefer shutting down either all of the pink salmon or shutting down the entire program. This suggests that if the hatcheries are to be self-financed, they will on their own choose to scale back their operations.[10] Thus, we view turning over the financing of the hatcheries entirely to the regions as the best alternative to the state. The actions we predict the regions to take assumes that our point estimates are correct. If they are not correct, self-financing is still a better idea than continued state

[10]There may be a problem with the information gained by the hatcheries under a self-financing operation. Since the hatcheries generally take fish that are higher quality (because of less handling) and are cheap to harvest (because they are taken right at the hatchery), the price and cost information may be biased. However, as long as the fishermen themselves have a say in the quantity produced by the hatcheries, this bias should not be a problem.

funding because it makes the regions themselves decide what levels of hatchery production give them the highest returns.

If our recommendations are followed, hatchery production of fish for sport and subsistence purposes will most likely not continue without some state funding. We have made no effort to analyze the net benefits from hatchery production on other user groups. The way that we have calculated hatchery costs suggests that the same per pound costs obtained in our study are a reasonable approximation in the range of small changes in hatchery production to the hatchery costs for fish no matter what their use. To estimate more fully the benefits and costs to other user groups, the state would have to determine the net benefits to those groups.

There also may be some strategic reasons for maintaining some hatchery production. For example, it appears that hatchery exports of pink salmon may be starting in the former Soviet Union. Chile also appears to have room for expansion of its farmed salmon program. If these countries are able to produce fish less expensively than Alaska, then there will be no way to stop them from entering in the long run. However, by maintaining some hatchery production, prices may remain depressed enough to prevent expansions in those areas. As long as the price is not driven down to the level that it would reach if those areas do enter the market, the hatchery dollars spent on prevention of entry may be well spent. However, this is not a strategy which can remain viable over the long run.

There are a number of other things that the state might do with monies saved from the hatchery program. One obvious area is to engage in demand enhancing activities, such as increased attention to quality and seeking out new product forms. Again, we emphasize that if such activities are truely profitable, then the fishing industry itself should be willing to finance them rather than the state.

Another area that appears to be fruitfull for future exploration is the allocation among gear groups. In the cost study we observed that the different gear groups have vastly different levels of producer's surplus. The gear group that does the best is the set net fleets. This is mainly because these fleets have such low capital costs. The bottom line is it is more efficient to let the fish come to the fisherman than to have the fisherman go to the fish.

Finally, let us re-emphasize that our estimates of net benefit are based on parameters estimated from relatively short time periods and were extrapolated well beyond the time horizon for which accurate estimates may be obtained. There are also a number of exogenous factors, such as what is happening in the rest of the salmon supplier's markets, that have changed far to rapidly over the last decade to allow precise estimates of where the industry will be in one, two or three decades. In spite of this, given our predictions of trends in the rest of the markets, we believe that the hatchery program, and especially the pink salmon program, should be scaled back. Our estimates suggest that to do so could result in an increase of net benefits to the state on the order of almost a half billion dollars over thirty years relative to current and planned production levels.

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Overview of the Benefit-Cost Analysis of the Alaska Salmon Enhancement Program

Introduction

Prompted by a request from the Alaska Board of Fish for additional policy direction regarding the management and allocation of enhanced salmon stocks, the Senate Special Committee on Domestic and International Commercial Fisheries initiated a review of the salmon enhancement program. This review included an economic benefit-cost analysis of the program. Given recent low Alaska salmon prices and relatively dismal international salmon markets, the economic analysis was conducted to address questions such as whether Alaska enhanced salmon was over-produced ~~given current international salmon markets~~, the impact on Alaska regional salmon prices of additional enhanced production, the optimal species production mix, and the appropriate level of continued state fiscal support.

It is important to note that this review was by no means initiated as a result of legislative concerns regarding the overall management of Alaska's salmon stocks. Alaska's salmon fisheries are undoubted the most well managed in the world and the enhancement program is the most successful in the world. However, the enhancement program has been in place for over 20 years without an extensive review. In addition, after a decade of dramatic growth in international farmed-salmon production, world salmon markets and prices have been significantly altered. While Alaska's fisheries managers and the enhancement program are not the cause of these market changes, they and the commercial salmon fishing fleets must adapt to these changes to continue to be successful. In this light, the results of the economic review provide an opportunity to adjust fisheries management, enhancement, and marketing strategies to keep Alaska's salmon fisheries competitive.

Methods

The benefit-cost analysis was conducted in four parts--a biological population/exploitation analysis, a international salmon demand analysis, a fishing cost analysis, and an enhancement production cost analysis. The results of these four parts were then combined for conducting the benefit-

cost analysis incorporating the public policy alternatives and sensitivity analyses.

The net benefits of the salmon enhancement program were ultimately measured by two variables. The first was the net benefits to fishermen from the hatchery program. This was determined by estimating the revenue to fishermen above their fishing costs that occurs under different hatchery production levels. Second, the cost of producing these benefits to fishermen, which is the cost of running the hatchery program, was estimated. Using the estimates of these two variables, the benefits of the program were calculated by taking the net benefits to fishermen minus the costs, including hatchery and the Alaska Department of Fish and Game, Divisions of FRED and Commercial Fisheries, of producing enhanced stocks.

As specified in the request for proposals, enhancement program benefits were estimated for seventeen different public policy alternatives. These alternatives included maintaining current production, increasing production to levels planned by hatchery operators, eliminating the entire program, eliminating pink salmon production, eliminating sockeye salmon production, and increasing/decreasing entire production or individual species production by 15 percent. These cases are shown in Table 1. In addition, for each of these alternatives, benefits were calculated using an optimistic (high price), pessimistic (low price), and mid-case sensitivity analysis. Net benefits were also calculated by fishing region. Therefore, for each public policy alternative, the "winner" and/ "loser" regions were identified.

Table 1. Program Alternatives Considered in the Policy Analysis

Case 1	Maintain current hatchery production
Case 2	Planned hatchery production levels
Case 3	Eliminate entire hatchery
Case 4a	Increase entire hatchery production level by 15%
Case 4b	Decrease entire hatchery production level by 15%
Case 5	Eliminate entire pink salmon production
Case 6	Eliminate entire sockeye salmon production
Case 7a	Increase pink salmon hatchery production level by 15%
Case 7b	Decrease pink salmon hatchery production level by 15%
Case 8a	Increase sockeye salmon hatchery production level by 15%
Case 8b	Decrease sockeye salmon hatchery production by 15%
Case 9a	Increase chum salmon hatchery production by 15%
Case 9b	Decrease chum salmon hatchery production by 15%
Case 10a	Increase coho salmon hatchery production level by 15%
Case 10b	Decrease coho salmon hatchery production by 15%
Case 11a	Increase king salmon hatchery production by 15%
Case 11b	Decrease king salmon hatchery production by 15%

Assumptions and Limitations of the Analysis

While this benefit-cost analysis is rigorous and incorporates the most extensive international salmon demand model developed to date, there are limitations to the modeling capabilities and the scope of the study. First, the analysis only measures the direct benefits of the program. Indirect and secondary benefits to communities such as fish processing employment and other indirect activities are not measured. The analysis excluded program benefits (and costs) to the sport and subsistence fisheries. Therefore, this study should be considered a partial analysis of the program.

Second, the demand analysis uses quarterly data from 1982 to 1991. The fishing cost analysis was done using only 1990 data. Projections for 15 or 30 years based on these relatively short time series are risky. In addition, the salmon demand model analyzes pink and chum demand together as "low-valued species" and sockeye, coho, and king together as "high-valued species." As a result of these aggregations, the cross-price effect within the groups (the effect changes in pink production has on chum prices, for example) are overstated, and revenues assigned to cases 2, 3, and 4a will be understated. The results for these cases should be considered a worse case scenario.

Third, the production levels under each of the "elimination" alternatives (Cases 3, 5, and 6) are vastly different from the production levels in the historical time period used to estimate the demand and cost models. Therefore, especially for Cases 3 and 5, the models were forced to extrapolate well beyond the data in the analysis which could result in prediction of prices above their historical levels. As a result, the "elimination" alternatives should be viewed as a worse case scenario (e.g., benefits of eliminating the entire program or parts of the program may be overestimated). In other words, all of the most drastic public policy alternatives results should be considered worse case scenarios.

Fourth, fishing cost modeling efforts were limited to a representative sample of commercial fishing gear types across the regions of the state (Prince William Sound seine and drift net, Cook Inlet seine and drift and set net, Kodiak purse seine and set net, and Southeast power and hand troll). The gear-type specific modeling parameters of these efforts were then extrapolated to other fisheries in the state. To the extent to which fishing costs vary between regions, fishing cost estimates may be inaccurate. **These caveats imply that the results of the analysis should be interpreted and applied cautiously.**

Results

This section provides the results of the policy alternative simulation. A discussion of the implications of these results are in the following section.

Under current hatchery production levels (Case 1), the direct net benefits of the Alaska salmon fishery were estimated to be $109.71 million in 1992. The annual net benefits were projected to rise steadily in real (1992, inflation adjusted) dollars over the 30-year planning horizon. Over the 30-year period, the researchers estimated that the salmon fishery with hatchery production at current levels would bring in $4.0 billion in net benefits ($2.3 billion in present value discounted a 4% discount rate) to the Alaska economy on revenues of $16.1 billion. The difference between gross revenues and net benefits were hatchery costs ($859 million) and fishing costs ($11.2 billion). These results are based on the midpoint price estimates of the salmon demand model.

Table 2 shows the estimated total and regional net benefits of the Alaska salmon fishery under current hatchery production as well as the 16 other policy alternatives. Western Alaska includes the Bristol Bay salmon

fisheries and is net of fishing costs; hatchery costs for the region are zero. All regions of the state are included in the analysis regardless of the level of enhanced production because salmon production levels in one region affect salmon prices and, thus, revenues and net benefits in other regions.

Table 3 and Chart 1 show the change in estimated total and regional net benefits over the 30-year period of altering enhanced salmon production from current levels. The **largest increases** in potential net benefits result from 1) eliminating the entire program (Case 3, $619.9 million increase), 2) eliminating the pink program (Case 5, $460.3 million increase), 3) decreasing the entire program production by 15% (Case 4b, $112.5 million increase), 4) decreasing the pink program production by 15% (Case 7b, $90.7 million increase), and 5) eliminating the sockeye program (Case 6, $21.4 million increase).

The **largest decreases** in potential net benefits resulted from 1) increasing enhanced production by 15% (Case 4a, $156.6 million decrease), 2) increasing pink production by 15% (Case 7a, $70.0 million decrease), 3) increasing production to planned levels (Case 2, $43.5 million decrease), and 4) increasing sockeye production by 15% (Case 8a, $14.7 million decrease). For the most part, 15% production changes from current production levels of chum, coho, and king salmon have relatively small changes in program net benefits.

Other significant results include:

- farmed salmon is a perfect substitute for the higher-valued Alaska salmon species (chinook, coho, and sockeye),
- expansion of sockeye salmon enhanced production would not result in increases in total net benefits primarily because of offsetting losses in Western (primarily Bristol Bay) and Southeast Alaska, and
- similarly, increasing production to levels the hatcheries currently "plan" would result in net losses because of losses in Western, Kodiak, and Southeast Alaska.

Discussion

As noted by the study's researchers, these are not encouraging results for the Alaska salmon enhancement program. In general, these results are caused by three primary factors--price elasticities, the cost of producing

enhanced stocks, and the cost of fishing. First (in economic jargon), the price elasticities for Alaska salmon are approaching unitary elasticities. This means that for a 1% increase in price, a 1% decrease in revenue occurs (or visa versa). **This suggests that there is sufficient supply in current Alaska salmon markets and any increase in supply will tend to decrease prices.**

In addition, it appears that enhanced stock production costs and fishing costs are at best marginally covered under currently depressed ex-vessel fish prices, especially for pink salmon. It is unlikely that the situation could be sustained without continued state subsidies such as salmon enhancement loans. For example, the research estimates that the average cost of the pink salmon hatchery program is roughly 10.3 cents per pound. Given that fishermen could not afford to fish with prices at 12.1 cents per pound (research results for Prince William Sound), it suggests that pink salmon prices have to be over 22.4 (=10.3+12.1) cents per pound before hatchery fish production is profitable. Note, for example, that Case 4a in Table 3 (15% increase in enhanced pink salmon production) results in net revenue losses even in Prince William Sound.

Government subsidies tend to insulate an industry or a portion of industry activity from market signals. For example, the salmon enhancement loan program lowers the cost of enhanced salmon production. This may encourage expansion of production beyond sustainable levels given world salmon prices, especially if loans are used to fund operating costs as well as capital costs. Subsidies can also discourage quick response to rapidly changing market conditions. **It is possible that the results of this analysis are so dramatic because the enhancement loan program has unintentionally insulated the hatcheries from the markets they serve. These factors should be kept in mind so the state does not merely shift from subsidizing production to subsidizing marketing efforts.**

There are two critical considerations regarding these results. First, the **benefit-cost analysis assumes that the benefits from shifting output or reducing enhanced salmon production can be captured by the Alaska fisheries.** In reality, a decrease in Alaska's enhanced production may result in increased salmon prices. These increased prices may, in turn, allow for the expansion of farmed-salmon production which would dampen the price increase and absorb Alaska's vacated market share.

As noted by the study's researchers, **this may provide a strategic reason for maintaining some level of enhanced production.** Hatchery exports of pink salmon production may be starting in the former Soviet Union and Chile appears to have room for expansion of its farmed-salmon program. If these countries are able to produce fish less expensively than Alaska, it is impossible to prevent them from entering in the long-run. However, by maintaining hatchery production, prices may remain depressed and prevent or postpone market entry. As long as prices are not depressed to the level that would result from the farmed-salmon production market entry, the dollars spent to prevent the entry may be well spent. This is a short-run strategy, however, that would not be viable over the long run.

The other important consideration is that the benefit-cost analysis assumes that the international salmon markets continue to reflect the characteristics of the study period---1982 through 1991. While this can be viewed as a weakness of economic analyses, in this study it shows the bleak future for Alaska salmon fisheries, regardless of whether they are enhanced or wild stocks, if market expansion and changes do not occur. Efforts are currently underway to develop new pink salmon products lines and to pre-sale cost-recovery harvests. Increased attention to market development rather than increased production is in the best interest of the industry.

Options

- While the research results suggest either eliminating the entire enhancement program or the entire pink salmon program as a mechanism for maximizing net benefits, either of these actions would have significant impacts on Alaska's coastal communities, especially in Prince William Sound. These options should not be considered without more analysis of the sport and subsistence fishing benefits and indirect benefits of the program.

- Impose a moratorium on ADF&G permits on new or increased enhanced production of pink salmon stocks.

- Impose a moratorium on enhancement loans for new or expansion of pink production capacity.

- Restrict the use of salmon enhancement tax and cost recovery funds for new or expansion of pink production capacity.

- Consider a temporary moratorium on ADF&G permits and salmon enhancement loans for new or expansion of sockeye salmon production until more research can be conducted on increased wild stock production in Cook Inlet through increased escapement goals. Increased wild stock production, as suggested by Dr. Collie's research, would be dramatically more cost effective and impose fewer management conflicts than increased enhanced production.

- Restrict the use of salmon enhancement tax funds to the production of species that generated the funds. This would encourage a more cost-effective production mix and would be most equitable to the gear group paying the tax.

- Consider no further funding of the salmon enhancement loan fund for new or expansion of all enhanced salmon production to ensure that any program expansions are cost effective.

- Consider developing a statewide planning process because study results clearly show that enhanced production in one region affects prices and, thus, net benefits to fishermen and hatcheries in other regions.

- Consider increasing state support of research and development for the new salmon product development. This should be carefully tailored to minimize market distortions.

- Consider reviewing Alaska salmon fishing regulations to determine potential changes in regulations to decrease fishing costs and increasing product quality of wild and enhanced stocks while still maintaining maximum sustainable yield of wild salmon stocks.

Kodiak Island Sockeye Salmon Releases

FRY RELEASES (thousands)

Year	Pillar Creek	Spirodon Lake	Kitoi Hatchery	Upper Thumb	Russell Creek
1986				23400	
1987					
1988					
1989					932
1990	0	0	2141		
1991	3314		1250		
1992	5700	8000	304		
1993	5700	8000	304		
1994	2660	11000	304		
1995	2660	11000	304		
1996	2660	11000	304		
1997	2660	11000	304		
1998	2660	11000	304		
1999	2660	11000	304		
2000	2660	11000	304		
2001	2660	11000	304		
2002	2660	11000	304		
2003	2660	11000	304		
2004	2660	11000	304		
2005	2660	11000	304		
2006	2660	11000	304		
2007	2660	11000	304		
2008	2660	11000	304		
2009	2660	11000	304		
2010	2660	11000	304		
2011	2660	11000	304		
2012	2660	11000	304		
2013	2660	11000	304		
2014	2660	11000	304		
2015	2660	11000	304		
2016	2660	11000	304		
2017	2660	11000	304		
2018	2660	11000	304		
2019	2660	11000	304		
2020	2660	11000	304		
2021	2660	11000	304		
Egg-rel.	0.76	0.76	0.76		
Rel.-adult	0.03	0.03	0.03		
Weight (lb)	5.2	5.3	5.3		

Spawners per egg: 0.000733
Fry per spawner: 1036.835
Smolts per spawner: 1009.550

CURRENT RELEASES

Year	Total Fry Releases	Brood Stock Required year t-1	0-SMOLT Kitoi Bay	Brood Stock Required year t-1
1986	23400.0	0.000	0.0	0.000
1987	0.0	0.000	0.0	0.000
1988	0.0	0.899	0.0	0.000
1989	932.0	2.065	0.0	0.845
1990	2141.0	4.402	853.0	0.000
1991	4563.8	13.506	0.0	4.953
1992	14004.0	13.506	5000.0	4.953
1993	14004.0	13.468	5000.0	4.953
1994	13964.0	13.468	5000.0	4.953
1995	13964.0	13.468	5000.0	4.953
1996	13964.0	13.468	5000.0	4.953
1997	13964.0	13.468	5000.0	4.953
1998	13964.0	13.468	5000.0	4.953
1999	13964.0	13.468	5000.0	4.953
2000	13964.0	13.468	5000.0	4.953
2001	13964.0	13.468	5000.0	4.953
2002	13964.0	13.468	5000.0	4.953
2003	13964.0	13.468	5000.0	4.953
2004	13964.0	13.468	5000.0	4.953
2005	13964.0	13.468	5000.0	4.953
2006	13964.0	13.468	5000.0	4.953
2007	13964.0	13.468	5000.0	4.953
2008	13964.0	13.468	5000.0	4.953
2009	13964.0	13.468	5000.0	4.953
2010	13964.0	13.468	5000.0	4.953
2011	13964.0	13.468	5000.0	4.953
2012	13964.0	13.468	5000.0	4.953
2013	13964.0	13.468	5000.0	4.953
2014	13964.0	13.468	5000.0	4.953
2015	13964.0	13.468	5000.0	4.953
2016	13964.0	13.468	5000.0	4.953
2017	13964.0	13.468	5000.0	4.953
2018	13964.0	13.468	5000.0	4.953
2019	13964.0	13.468	5000.0	4.953
2020	13964.0	13.468	5000.0	4.953
2021	13964.0	13.468	5000.0	4.953
			0.74	
			0.05	
			5.2	

Weighted mean %survival rates

	Fry	Smolts
Hatchery Managers	3.00%	5.00%
Collie	2.19%	15.10%

To convert fry to smolt, average marine survival rate.

FRY RELEASES (thousands)

	------ Prince William Sound ------				Kodiak
Year	Port San Juan-AFK	Cannery Creek	Esther Lake	Solomon Gulch	Kitoi Bay
1990	113840	143660	233260	122200	84908
1991					124148
1992	116916	134799	173817	230000	156000
1993	116916	134799	173817	230000	156000
1994	116916	134799	173817	230000	156000
1995	116916	134799	173817	230000	156000
1996	116916	134799	173817	230000	156000
1997	116916	134799	173817	230000	156000
1998	116916	134799	173817	230000	156000
1999	116916	134799	173817	230000	156000
2000	116916	134799	173817	230000	156000
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2002	116916	134799	173817	230000	156000
2003	116916	134799	173817	230000	156000
2004	116916	134799	173817	230000	156000
2005	116916	134799	173817	230000	156000
2006	116916	134799	173817	230000	156000
2007	116916	134799	173817	230000	156000
2008	116916	134799	173817	230000	156000
2009	116916	134799	173817	230000	156000
2010	116916	134799	173817	230000	156000
2011	116916	134799	173817	230000	156000
2012	116916	134799	173817	230000	156000
2013	116916	134799	173817	230000	156000
2014	116916	134799	173817	230000	156000
2015	116916	134799	173817	230000	156000
2016	116916	134799	173817	230000	156000
2017	116916	134799	173817	230000	156000
2018	116916	134799	173817	230000	156000
2019	116916	134799	173817	230000	156000
2020	116916	134799	173817	230000	156000
2021	116916	134799	173817	230000	156000

Egg-rel.	0.927	0.917	0.922	0.90	0.78
Rel.-adult	0.053	0.045	0.053	0.05	0.032
Weight lb	3.3	3.3	3.4	3.3	3.5
Weight kg	1.50	1.50	1.54	1.50	1.59
Fecundity (avg)		1500			
Sex ratio:		0.5			
Holding mortaliy:		10%			
Spawners per egg:		0.001481			

	Total Fry Releases PWS	Brood-stock required PWS	Total Fry Releases Kodiak	Brood-stock required Kodiak
1990	612960.0	1200.000	93207.6	168.650
1991	603520.0	1062.519	127648.0	296.296
1992	655532.0	1062.519	156000.0	296.296
1993	655532.0	1062.519	156000.0	296.296
1994	655532.0	1062.519	156000.0	296.296
1995	655532.0	1062.519	156000.0	296.296
1996	655532.0	1062.519	156000.0	296.296
1997	655532.0	1062.519	156000.0	296.296
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2001	655532.0	1062.519	156000.0	296.296
2002	655532.0	1062.519	156000.0	296.296
2003	655532.0	1062.519	156000.0	296.296
2004	655532.0	1062.519	156000.0	296.296
2005	655532.0	1062.519	156000.0	296.296
2006	655532.0	1062.519	156000.0	296.296
2007	655532.0	1062.519	156000.0	296.296
2008	655532.0	1062.519	156000.0	296.296
2009	655532.0	1062.519	156000.0	296.296
2010	655532.0	1062.519	156000.0	296.296
2011	655532.0	1062.519	156000.0	296.296
2012	655532.0	1062.519	156000.0	296.296
2013	655532.0	1062.519	156000.0	296.296
2014	655532.0	1062.519	156000.0	296.296
2015	655532.0	1062.519	156000.0	296.296
2016	655532.0	1062.519	156000.0	296.296
2017	655532.0	1062.519	156000.0	296.296
2018	655532.0	1062.519	156000.0	296.296
2019	655532.0	1062.519	156000.0	296.296
2020	655532.0	1062.519	156000.0	296.296
2021	655532.0	1062.519	156000.0	296.296

Weighted mean % survival rates

	PWS	Kodiak
hatchery Managers	5.03%	3.20%
Collie	5.00%	2.00%

Year	Meadow Creek	Kirchner Lake	Bruin Lake	Hazel Lake	Chenik Lake	Tustumena Lake	Packers Lake	Hidden Lake	Bear Lake	Chelatna Lake	Paint Lake	Leisure Lake	P. Dick Lake	Elusival Lake	Thumb Cove	Bear Lake	Coal Creek	Eklutna Hatchery
1986	15056				838	13560					820	2250			0	0	0	0
1987	11866	887			1005	15200		3718				2022	705		0	0	0	0
1988	14482	521		783	2601	6270	2989	6085			1655	2100	222	552	0	0	0	0
1989	13206	250		1000	3500	6010					1500	2000	430	500	0	0	0	0
1990	10815	250	500	1500	3250	6014					1500	2000		500	0	59	0	0
1991	10037	250	250	1300	2100	6000					750	2000			0	75	0	0
1992	5475	250	250	1250	2220	6000	3200	2000	2200	1600					0	800	100	0
1993	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1994	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1995	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1996	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1997	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1998	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1999	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
2000	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2001	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2002	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2003	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2004	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2005	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2006	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2007	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2008	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2009	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2010	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2011	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2012	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2013	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2014	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2015	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2016	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2017	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2018	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2019	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2020	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2021	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
Egg-rel.	0.75	0.94	0.94	0.94	0.94	0.94	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	?	?
Rel.-adult	0.01	0.0?	0.08	0.08	0.08	0.025	0.046	0.05	0.037	0.04					0.2	0.2	0.2	0.33
Weight (lb)	4.2	4.1	4.1	4.1	4.1	4.1	5.5	5.5	6.5	5.5					6.5	6.5	5.0	5.0
Fecundity (Tustumena)		3271																
Sex ratio:		0.5																
Holding mortality:		10%																

Year	Fry Releases	stock required	Smolt Releases	stock required
1986	32527.0	28.560	0.0	0.000
1987	35382.9	32.033	0.0	0.000
1988	38270.3	23.501	0.0	0.000
1989	26395.8	21.515	0.0	0.050
1990	26328.6	18.582	56.8	0.149
1991	22687.3	19.808	74.9	1.614
1992	24445.0	14.849	900.0	1.359
1993	18970.0	14.849	1600.0	1.359
1994	18970.0	14.849	1600.0	1.359
1995	18970.0	14.849	1600.0	1.359
1996	18970.0	14.849	1600.0	1.359
1997	18970.0	14.849	1600.0	1.359
1998	18970.0	14.849	1600.0	1.359
1999	18970.0	15.783	1600.0	1.359
2000	20070.0	15.783	1600.0	1.359
2001	20070.0	15.783	1600.0	1.359
2002	20070.0	15.783	1600.0	1.359
2003	20070.0	15.783	1600.0	1.359
2004	20070.0	15.783	1600.0	1.359
2005	20070.0	15.783	1600.0	1.359
2006	20070.0	15.783	1600.0	1.359
2007	20070.0	15.783	1600.0	1.359
2008	20070.0	15.783	1600.0	1.359
2009	20070.0	15.783	1600.0	1.359
2010	20070.0	15.783	1600.0	1.359
2011	20070.0	15.783	1600.0	1.359
2012	20070.0	15.783	1600.0	1.359
2013	20070.0	15.783	1600.0	1.359
2014	20070.0	15.783	1600.0	1.359
2015	20070.0	15.783	1600.0	1.359
2016	20070.0	15.783	1600.0	1.359
2017	20070.0	15.783	1600.0	1.359
2018	20070.0	15.783	1600.0	1.359
2019	20070.0	15.783	1600.0	1.359
2020	20070.0	15.783	1600.0	1.359
2021	20070.0	15.783	1600.0	1.359

Weighted mean %survival rates	Fry	Smolts
Managers	5.97%	28.13%
Collie	2.19%	15.10%

	CURRENT RELEASES									1-SMOLT RELEASES						
Release Year	Snettisha Juneau Remote	Deer Mt. Ketchikan Creek	Crystal Lake Hatchery	Earl West	Burnett Inlet	NSRAA Hidden Falls	NSRAA Medvejie Creek	Sheldon Jackson	Port Armstrong	SSRAA Neets Bay	SSRAA Whitman Lake	SSRAA Carroll Inlet	Little Port Walter	Tamgas	Gastineau Hatchery	Brood-stock year t-2
20	15															
1986	387.2	46.4	552.0	98.0	0.0	92.1	108.0	54.2	0.0	1115.0	119.0	51.0	213.0	573.4	0.0	2.487
1987	1047.0	42.1	427.0	251.0	0.0	98.0	227.5	47.0	0.0	734.2	98.0	816.6	205.0	1445.7	0.0	3.882
1988	430.4	121.0	550.0	483.0	0.0	155.6	174.6	32.0	0.0	708.2	151.0	892.3	286.7	164.4	0.0	5.499
1989	1224.0	191.0	708.0	394.0	170.0	343.8	743.8	96.7	89.9	699.2	55.0	702.5	161.8	888.9	0.0	3.335
1990	1631.0	121.0	1141.0	486.5	193.0	351.5	911.3	100.5	144.0	1608.0	75.4	1004.8	166.0	1131.8	101.5	5.765
1991	400.0	160.0	456.4	399.6	125.0	184.4	866.9	35.0	100.0	900.0	73.7	1102.1	209.5	674.0	42.0	6.070
1992	300.0	100.0	800.0	500.0	65.0	1700.0	1100.0	99.5	2400.0	995.0	73.7	1000.0	270.0	600.0	150.0	4.955
1993	300.0	100.0	800.0	500.0	0.0	2145.0	1215.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
1994	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	0.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
1995	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
1996	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
1997	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
1998	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
1999	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
2000	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
2001	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
2002	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
2003	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
2004	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
2005	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.288
	-4.00717	-3.59417	-3.58317	-3.04717	-4.00717	-5.52717	-4.93717	-5.50717	-4.00717	-3.26317	-2.72917	-2.88717	-3.50317	-4.00717	-4.00717	
Egg-rel.	0.62	0.75	0.75	0.75	0.81	0.8	0.9	0.85	0.8	0.75	0.75	0.75	0.75	0.75	0.95	
S-A Model	1.82%	2.75%	2.78%	4.75%	1.82%	0.40%	0.72%	0.41%	1.82%	3.83%	6.53%	5.57%	3.01%	1.82%	1.82%	
S-A Surve	2.00%	3.50%		4.50%	4.00%	1.00%	2.00%	0.92%	5.00%	3.98%	5.66%	3.53%			3.00%	
Weight (lb	25.5	21.5	17.5	17.5	16.0	14.7	15.5	19.6	20.0	?	?	?			25.5	
Fecundity	5000															
Sex ratio:	0.5															
Holding m	10%															

November 25, 1992

John Boyce
Mark Herrmann
Department of Economics
University of Alaska Fairbanks
Fairbanks, Alaska 99775

Dear Mark and John:

As I mentioned in my recent phone conversation with Mark, Kurt Schelle, Ben Muse, Jeff Hartman, and I have been reviewing your demand, fishing cost and benefit-cost reports. We have identified some areas in which we need additional information before we can fully evaluate the research results. These comments and information requests are by no means complete, but many of the other concerns can be addressed when editing the final benefit-cost analysis report. The information requested is need before I can send editorial comments on the benefit-cost report.

As I am sure you are as anxious as I am to have this work completed, please provide me with this information as soon as possible. I would like to have you send the information and then set up a conference call time no later than next Friday, December 4. If there is any problem with this schedule, please let me know.

Sincerely,

Ginny Fay

c.c. Mary McDowell
Molly McCammon
Kurt Schelle
Ben Muse
Jeff Hartman

Benefit - Cost Analysis Review

International Salmon Demand Model

Need a clear and detailed explanation of how elasticities estimates from high- and low-valued species aggregations are transferred to single-species estimates. Specifically, how were cross-price elasticities within the aggregate groups calculated. Report states that single-species estimates are "ad hoc" estimates that are adjusted by "one quarter." Does this mean 25% or 0.25? The final combined report suggests that these ad hoc estimates are more reliable than the those empirically derived. Thus, the results to cases 5-11 are more reliable than cases 2-4. Need a clear understanding to evaluate these results and their policy implications.

Need a table or listing of assumptions regarding exogenous variables--exchange rates, population and income growth rates, farmed salmon production and growth rates (especially Chile's 12% annual growth, is this a reasonable assumption?). Need this information to evaluate report results. Assumptions should be separated into values for mid-point, optimistic, and pessimistic cases. If specific assumptions were not altered to attain low-, mid-, and high-price scenarios, explain how this was done.

Page 24 and 25- Are these price flexibilities and elasticities correct?

Unfortunately (or fortunately???), none of us are Bayesian Bootstrap Technique experts so we need a more complete set of summary statistics for evaluating how well the model performed. We are assuming that the statistics on page 87 are for the whole system (bloc 1 and 2) operating together. We would also like to see the 1) rms error, 2) rms % error, 3) mean error, and 4) mean % error.

Fishing Cost Model

Comments on the earlier draft were not addressed. Specifically, what is the potential bias in the fishing cost estimates from using only one year of data and, specifically, using 1990 when ex-vessel prices were relatively low. Are producer surplus figures probably on the hide side because of 1) lower prices, 2) short-term analysis, and 3) earnings to non-residents are not segregated?

We have also had quite a bit of discussion within our review group regarding which costs your analysis captures. Is it very short-run capturing only variable

costs or to what extent are fixed costs captured? We would like time with a conference call for a detailed explanation.

Was there any discussions with fishermen regarding results? One discussion I had suggested the Cook Inlet Drift Net fishery producer surplus estimates are low; that drift net fleets should be more efficient than purse seine fleets.

Benefit - Cost Final Report

Need to delete recommendations and limit the report to results of economic and biological analyses firmly couched in appropriate caveats and clearly identified assumptions as well as the impact of altering key assumptions.

Many of the conclusions/results and policy recommendations are rather bold given the warnings and caveats provided earlier in the report. While removing recommendations will alleviate some of these problems, limitations and effects of key assumptions must be noted with reporting of results. Editing suggestions will be provided.

Similar to demand model, final report needs a complete summary of values and assumptions regarding exogenous variables including production of wild and enhanced stocks, and farmed salmon by appropriate species, region, and/or country; income and population growth rates, and exchange rates. Most of these were part of the demand study so probably one appendix be used for the final report and the demand analysis. If it is only located in one location, however, it is imperative that it be attached to the final report.

I need an explanation of footnote 9. Sounds a bit drastic. Did you remember to remove Valdez production number since we did not have their costs? Could this be the source of the problem? Also, did you remember that Gulkana costs and production were reported by the state and not PWSAC?

Need an explanation of footnote 6. Why was this done? Why were revenues higher in year 15?

Would be simplest if results were presented as discounted net present values as is standard methodology. Also, must have high- and low-price scenarios presented with mid-point results.

Important to point out that analysis is limited to direct benefits, no indirect benefits to communities of fishing and fish processing. Also, no analysis of direct

net benefits to fishermen based on residency of fishermen, especially non-resident fishermen.

FRY RELEASES (thousands)

Year	Pillar Creek	Spirodon Lake	Kitoi Hatchery	Upper Thumb	Russell Creek
1986				23400	
1987					
1988					
1989					932
1990	0	0	2141		
1991	3314		1250		
1992	5700	8000	304		
1993	5700	8000	304		
1994	2660	11000	304		
1995	2660	11000	304		
1996	2660	11000	304		
1997	2660	11000	304		
1998	2660	11000	304		
1999	2660	11000	304		
2000	2660	11000	304		
2001	2660	11000	304		
2002	2660	11000	304		
2003	2660	11000	304		
2004	2660	11000	304		
2005	2660	11000	304		
2006	2660	11000	304		
2007	2660	11000	304		
2008	2660	11000	304		
2009	2660	11000	304		
2010	2660	11000	304		
2011	2660	11000	304		
2012	2660	11000	304		
2013	2660	11000	304		
2014	2660	11000	304		
2015	2660	11000	304		
2016	2660	11000	304		
2017	2660	11000	304		
2018	2660	11000	304		
2019	2660	11000	304		
2020	2660	11000	304		
2021	2660	11000	304		
Egg-rel.	0.76	0.76	0.76		
Rel.-adult	0.03	0.03	0.03		
Weight (lb)	5.2	5.3	5.3		

Year	Total Fry Releases	Brood Stock Required year t-1	0-SMOLT Kitoi Bay	Brood Stock Required year t-1
1986	23400.0	0.000	0.0	0.000
1987	0.0	0.000	0.0	0.000
1988	0.0	0.899	0.0	0.000
1989	932.0	2.065	0.0	0.845
1990	2141.0	4.402	853.0	0.000
1991	4563.8	13.506	0.0	4.953
1992	14004.0	13.506	5000.0	4.953
1993	14004.0	13.468	5000.0	4.953
1994	13964.0	13.468	5000.0	4.953
1995	13964.0	13.468	5000.0	4.953
1996	13964.0	13.468	5000.0	4.953
1997	13964.0	13.468	5000.0	4.953
1998	13964.0	13.468	5000.0	4.953
1999	13964.0	13.468	5000.0	4.953
2000	13964.0	13.468	5000.0	4.953
2001	13964.0	13.468	5000.0	4.953
2002	13964.0	13.468	5000.0	4.953
2003	13964.0	13.468	5000.0	4.953
2004	13964.0	13.468	5000.0	4.953
2005	13964.0	13.468	5000.0	4.953
2006	13964.0	13.468	5000.0	4.953
2007	13964.0	13.468	5000.0	4.953
2008	13964.0	13.468	5000.0	4.953
2009	13964.0	13.468	5000.0	4.953
2010	13964.0	13.468	5000.0	4.953
2011	13964.0	13.468	5000.0	4.953
2012	13964.0	13.468	5000.0	4.953
2013	13964.0	13.468	5000.0	4.953
2014	13964.0	13.468	5000.0	4.953
2015	13964.0	13.468	5000.0	4.953
2016	13964.0	13.468	5000.0	4.953
2017	13964.0	13.468	5000.0	4.953
2018	13964.0	13.468	5000.0	4.953
2019	13964.0	13.468	5000.0	4.953
2020	13964.0	13.468	5000.0	4.953
2021	13964.0	13.468	5000.0	4.953
			0.74	
			0.05	
			5.2	

Spawners per egg: 0.000733
Fry per spawner: 1036.835
Smolts per spawner: 1009.550

Weighted mean %survival rates

	Fry	Smolts
Managers	3.00%	5.00%
Collie	2.19%	15.10%

"Managers" = hatchery managers who filled out surveys

	FRY RELEASES (thousands)								
	------ Prince William Sound ------				Kodiak		Total Fry	Brood-stock	Total Fry
	Port San	Cannery	Esther	Solomon	Kitoi		Releases	required	Releases
Year	Juan-AFK	Creek	Lake	Gulch	Bay		PWS	PWS	Kodiak
1990	113840	143660	233260	122200	84908	1990	612960.0	1200.000	93207.6
1991					124148	1991	603520.0	1062.519	127648.0
1992	116916	134799	173817	230000	156000	1992	655532.0	1062.519	156000.0
1993	116916	134799	173817	230000	156000	1993	655532.0	1062.519	156000.0
1994	116916	134799	173817	230000	156000	1994	655532.0	1062.519	156000.0
1995	116916	134799	173817	230000	156000	1995	655532.0	1062.519	156000.0
1996	116916	134799	173817	230000	156000	1996	655532.0	1062.519	156000.0
1997	116916	134799	173817	230000	156000	1997	655532.0	1062.519	156000.0
1998	116916	134799	173817	230000	156000	1998	655532.0	1062.519	156000.0
1999	116916	134799	173817	230000	156000	1999	655532.0	1062.519	156000.0
2000	116916	134799	173817	230000	156000	2000	655532.0	1062.519	156000.0
2001	116916	134799	173817	230000	156000	2001	655532.0	1062.519	156000.0
2002	116916	134799	173817	230000	156000	2002	655532.0	1062.519	156000.0
2003	116916	134799	173817	230000	156000	2003	655532.0	1062.519	156000.0
2004	116916	134799	173817	230000	156000	2004	655532.0	1062.519	156000.0
2005	116916	134799	173817	230000	156000	2005	655532.0	1062.519	156000.0
2006	116916	134799	173817	230000	156000	2006	655532.0	1062.519	156000.0
2007	116916	134799	173817	230000	156000	2007	655532.0	1062.519	156000.0
2008	116916	134799	173817	230000	156000	2008	655532.0	1062.519	156000.0
2009	116916	134799	173817	230000	156000	2009	655532.0	1062.519	156000.0
2010	116916	134799	173817	230000	156000	2010	655532.0	1062.519	156000.0
2011	116916	134799	173817	230000	156000	2011	655532.0	1062.519	156000.0
2012	116916	134799	173817	230000	156000	2012	655532.0	1062.519	156000.0
2013	116916	134799	173817	230000	156000	2013	655532.0	1062.519	156000.0
2014	116916	134799	173817	230000	156000	2014	655532.0	1062.519	156000.0
2015	116916	134799	173817	230000	156000	2015	655532.0	1062.519	156000.0
2016	116916	134799	173817	230000	156000	2016	655532.0	1062.519	156000.0
2017	116916	134799	173817	230000	156000	2017	655532.0	1062.519	156000.0
2018	116916	134799	173817	230000	156000	2018	655532.0	1062.519	156000.0
2019	116916	134799	173817	230000	156000	2019	655532.0	1062.519	156000.0
2020	116916	134799	173817	230000	156000	2020	655532.0	1062.519	156000.0
2021	116916	134799	173817	230000	156000	2021	655532.0	1062.519	156000.0

Egg-rel.	0.927	0.917	0.922	0.90	0.78
Rel.-adult	0.053	0.045	0.053	0.05	0.032
Weight lb	3.3	3.3	3.4	3.3	3.5
Weight kg	1.50	1.50	1.54	1.50	1.59
Fecundity (avg)		1500			
Sex ratio:		0.5			
Holding mortally:		10%			
Spawners per egg:		0.001481			

Weighted mean % survival rates		
	PWS	Kodiak
Managers	5.03%	3.20%
Collie	5.00%	2.00%

Year	Meadow Creek	Kirchner Lake	Bruin Lake	Hazel Lake	Chenik Lake	Tustumena Lake	Packers Lake	Hidden Lake	Bear Lake	Chelatna Lake	Paint Lake	Leisure Lake	P. Dick Lake	Elusivak Lake	Thumb Cove	Bear Lake	Coal Creek	Eklutna Hatchery
1986	15058				839	13560					820	2250			0	0	0	0
1987	11866	867			1005	15200		3718				2022	705		0	0	0	0
1988	14492	521		783	2601	6270	2989	6085			1655	2100	222	552	0	0	0	0
1989	13206	250		1000	3500	6010					1500	2000	430	500	0	0	0	0
1990	10815	250	500	1500	3250	6014					1500	2000		500	0	59	0	0
1991	10037	250	250	1300	2100	6000					750	2000			0	75	0	0
19	5475	250	250	1250	2220	6000	3200	2000	2200	1600					0	800	100	0
199	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1994	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1995	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1996	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1997	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1998	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
1999	0	250	250	1250	2220	6000	3200	2000	2200	1600					250	250	100	1000
2000	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2001	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2002	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2003	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2004	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2005	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2006	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2007	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2008	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2009	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2010	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2011	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2012	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2013	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2014	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2015	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2016	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2017	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2018	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2019	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2020	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
2021	0	250	250	1250	2220	6000	3200	2000	3300	1600					250	250	100	1000
Egg-rel.	0.75	0.94	0.94	0.94	0.94	0.94	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	?	?
Rel.-adult	0.01	0.08	0.08	0.08	0.08	0.025	0.046	0.05	0.037	0.04					0.2	0.2	0.2	0.33
Weight (lb)	4.2	4.1	4.1	4.1	4.1	4.1	5.5	5.5	6.5	5.5					6.5	6.5	5.0	5.0

Fecundity (Tustumena) 3271
Sex ratio: 0.5
Holding mortality: 10%

Year	Fry Releases	stock required	Smolt Releases	stoc require
1986	32527.0	28.560	0.0	0.00
1987	35382.9	32.033	0.0	0.00
1988	38270.3	23.501	0.0	0.00
1989	28395.8	21.515	0.0	0.05
1990	26328.8	18.582	56.8	0.14
1991	22887.3	19.806	74.9	1.61
1992	24445.0	14.849	900.0	1.35
1993	18970.0	14.849	1600.0	1.35
1994	18970.0	14.849	1600.0	1.35
1995	18970.0	14.849	1600.0	1.35
1996	18970.0	14.849	1600.0	1.35
1997	18970.0	14.849	1600.0	1.35
1998	18970.0	14.849	1600.0	1.35
1999	18970.0	15.783	1600.0	1.35
2000	20070.0	15.783	1600.0	1.35
2001	20070.0	15.783	1600.0	1.35
2002	20070.0	15.783	1600.0	1.35
2003	20070.0	15.783	1600.0	1.35
2004	20070.0	15.783	1600.0	1.35
2005	20070.0	15.783	1600.0	1.35
2006	20070.0	15.783	1600.0	1.35
2007	20070.0	15.783	1600.0	1.35
2008	20070.0	15.783	1600.0	1.35
2009	20070.0	15.783	1600.0	1.35
2010	20070.0	15.783	1600.0	1.35
2011	20070.0	15.783	1600.0	1.35
2012	20070.0	15.783	1600.0	1.35
2013	20070.0	15.783	1600.0	1.35
2014	20070.0	15.783	1600.0	1.35
2015	20070.0	15.783	1600.0	1.35
2016	20070.0	15.783	1600.0	1.35
2017	20070.0	15.783	1600.0	1.35
2018	20070.0	15.783	1600.0	1.35
2019	20070.0	15.783	1600.0	1.35
2020	20070.0	15.783	1600.0	1.35
2021	20070.0	15.783	1600.0	1.35

Weighted mean %survival rates	Fry	Smolts
Managers	5.97%	28.13%
Collie	2.19%	15.10%

	CURRENT RELEASES									1-SMOLT RELEASES						
Release Year	Snettisha Juneau Remote	Deer Mt. Ketchikan Creek	Crystal Lake Hatchery	Earl West	Burnett Inlet	NSRAA Hidden Falls	NSRAA Medvejie Creek	Sheldon Jackson	Port Armstrong	SSRAA Neets Bay	SSRAA Whitman Lake	SSRAA Carroll Inlet	Little Port Walter	Tamgas	Gastineau Hatchery	Brood stock year t
20	15															
1986	387.2	46.4	552.0	98.0	0.0	92.1	108.0	54.2	0.0	1115.0	119.0	51.0	213.0	573.4	0.0	2.48
1987	1047.0	42.1	427.0	251.0	0.0	98.0	227.5	47.0	0.0	734.2	98.0	816.6	205.0	1445.7	0.0	3.88
1988	430.4	121.0	550.0	483.0	0.0	155.6	174.6	32.0	0.0	708.2	151.0	892.3	286.7	164.4	0.0	5.49
1989	1224.0	191.0	708.0	394.0	170.0	343.8	743.8	96.7	89.9	699.2	55.0	702.5	161.8	888.9	0.0	3.33
1990	1631.0	121.0	1141.0	486.5	193.0	351.5	911.3	100.5	144.0	1608.0	75.4	1004.8	166.0	1131.8	101.5	5.76
1991	400.0	160.0	456.4	399.6	125.0	184.4	866.9	35.0	100.0	900.0	73.7	1102.1	209.5	674.0	42.0	6.07
1992	300.0	100.0	800.0	500.0	65.0	1700.0	1100.0	99.5	2400.0	995.0	73.7	1000.0	270.0	600.0	150.0	4.95
1993	300.0	100.0	800.0	500.0	0.0	2145.0	1215.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
1994	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	0.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
1995	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
1996	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
1997	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
1998	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
1999	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
2000	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
2001	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
2002	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
2003	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
2004	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
2005	300.0	100.0	800.0	500.0	0.0	2400.0	1370.0	99.5	2400.0	995.0	73.7	1000.0	300.0	600.0	190.0	6.28
	-4.00717	-3.59417	-3.58317	-3.04717	-4.00717	-5.52717	-4.93717	-5.50717	-4.00717	-3.26317	-2.72917	-2.88717	-3.50317	-4.00717	-4.00717	
Egg-rel.	0.62	0.75	0.75	0.75	0.81	0.8	0.9	0.85	0.8	0.75	0.75	0.75	0.75	0.75	0.95	
S-A Model	1.82%	2.75%	2.78%	4.75%	1.82%	0.40%	0.72%	0.41%	1.82%	3.63%	6.53%	5.57%	3.01%	1.82%	1.82%	
S-A Survey	2.00%	3.50%		4.50%	4.00%	1.00%	2.00%	0.92%	5.00%	3.98%	5.66%	3.53%			3.00%	
Weight (lb	25.5	21.5	17.5	17.5	16.0	14.7	15.5	19.6	20.0	?	?	?			25.5	
Fecundity	5000															
Sex ratio:	0.5															
Holding m	10%															

"S-A" = survey-to-adult

Alaska State Legislature

SENATE

Official Business

P.O. Box V
State Capitol
Juneau, Alaska 99811

July 16, 1992

To: Gordon Harrison, Director
Legislative Research Agency

From: Senator Dick Eliason, President
Alaska State Senate

RE.: **Alaska Salmon Enhancement Program Review Project**

As you know, the Senate Special Committee on Domestic and International Commercial Fisheries is conducting a review of the Alaska salmon enhancement program. Part of this review includes an economic analysis of the program. Your agency has been involved in this economic review through your assistance with enhancement project survey production and mailings.

Now that the results of these surveys have been received, they are being reviewed by Alaska Department of Fish and Game (ADF&G) staff. The ADF&G staff are also developing a computerized database system for the survey results. I would like to request your agency's assistance with data entry. ADF&G anticipates that the database system will be ready in early August and will probably take approximately two person-weeks to enter the data. The ADG&G will loan your agency a copy of the necessary software to be installed by the Legislative Affairs Agency data processing section. We need to have the completed database sent to the University of Alaska researchers by September 1 Ginny Fay (465-3711) will be coordinating this aspect of the project and can answer any specific questions.

Please let me know if you anticipate any problems with this schedule. Thank you for your kind assistance.

c.c.
Jeff Koenings
Bob Clasby
Molly McCammon
Ginny Fay

Alaska State Legislature

SENATE

Official Business

P.O. Box V
State Capitol
Juneau, Alaska 99811

July 16, 1992

To: Bob Clasby, Director
Division of Commercial Fisheries
Alaska Department of Fish and Game

From: Senator Dick Eliason, President
Alaska State Senate

RE.: **Alaska Salmon Enhancement Review Project Management Costs**

As you know, the Senate Special Committee on Domestic and International Commercial Fisheries is conducting a review of the Alaska salmon enhancement program. Part of this project includes an economic analysis of the program. Your division has been involved in this economic review through your assistance with the development of the study plan, provision of data for population modeling, and review of the enhancement project production survey results.

One of the Division of Commercial Fisheries comments regarding the economic review of the Alaska salmon enhancement program was that insufficient management costs resulting from enhanced fish stocks have been incorporated into prior benefit - cost analyses. Therefore, the legislative study enhancement cost survey explicitly requests information on ADF&G management costs. In the next couple weeks, the FRED Division will provide the completed enhancement facility cost surveys for your Division's review and management cost estimates. While we understand that this is the busy fishing season, we would appreciate your cooperation in expediting this review so the data can be entered onto computer and transferred to University of Alaska researchers.

In addition, it has been brought to my attention that Dr. Jeremy Collie, who is conducting the population modeling research for the project, is waiting for additional data from your division. To ensure that the project can be completed in a timely manner, please encourage your staff to provide these data as soon as possible.

Thank you for your assistance and continued cooperation with this project.

c.c.
Jeff Koenings
Jeremy Collie
Molly McCammon
Ginny Fay

Alaska State Legislature

SENATE

Official Business

P.O. Box V
State Capitol
Juneau, Alaska 99811

Status of the Legislative Review of the Salmon Enhancement Program Economic Projects

This provides a brief status report on the economic projects being completed primarily by the University of Alaska Fairbanks for the Senate Special Committee on Domestic and International Commercial Fisheries (see the attachment for a description of the studies). Four of the studies are being conducted via RSAs; one is being completed by Alaska Department of Fish and Game (ADF&G) and legislative staff, and the Legislative Research Agency. For the four RSAs, half of the funding was paid when the project was initiated with the remainder to be paid when the projects are reviewed and accepted by the Committee as complete. Each of the following descriptions identifies the project, principal researcher, total project funds, expected date of completion, and reasons for delay.

Population and Exploitation Model, Dr. Jeremy Collie, $10,000, August 15, 1992. This project is late as a result of delays in the transfer of data by ADF&G because the data were not in a form readily transferable to Dr. Collie. ADF&G staff had to compile the information in addition to their usual assignments. Unfortunately, this resulted in Dr. Collie compiling a significant portion of the data himself, although the RSA specified that the data would be provided by ADF&G.

International Salmon Demand Model, Drs. Mark Herrmann and Joshua Greenberg, $18,000, September 15, 1992. This project is awaiting 1991 Alaska salmon price, gross earnings, and harvest data that will be provided by the Commercial Fisheries Entry Commission (CFEC) when it becomes available in August. Preliminary review of the May 1992 report on work completed to date indicates that the study is going well and will provide the legislature and ADF&G with valuable information on Alaska's salmon fisheries. The researchers requested a time extension in order to use the 1991 data and make the results more meaningful.

Salmon Fishing Cost Model, Dr. John Boyce, $20,000, September 1, 1992 ??? The final completion date on this project is uncertain as a result of countless frustrating and futile attempts to contact the researcher.

Initially, the project was delayed because of the transfer of large data sets from CFEC and the time required for their analysis. The researcher provided an inadequate progress report to the Committee in May. All attempts to solicit additional information on research progress have gone unanswered.

Enhancement Production and Cost Surveys and Model, legislative and ADF&G staff and the Legislative Research Agency (LRA), August 15, 1992. This portion of the research is composed of a number of activities coordinated between legislative and ADF&G staff and university researchers. The primary activity is the development of the enhancement project production and cost surveys. Four production and two cost surveys were developed (legislative and ADF&G staff) and mailed (LRA and ADF&G) to obtain information on all salmon enhancement projects in Alaska. Different surveys were required depending on whether a project was part of a state or PNP facility. The results of the production survey were used for the population modeling, by Dr. Collie, which is nearing completion. At this time, two-thirds of the PNP cost surveys and less than half of the state-facility cost surveys have been returned. When all surveys are returned, they must be reviewed (legislative and ADF&G staff), data entered on to computer (LRA), and transferred to university researchers to incorporate into the combined model. This aspect of the research has been delayed because of the legislative session workload, delays in survey result reviews by ADF&G, and delays in returning of surveys including the Southern Southeast Regional Aquaculture Association, which thus far has not completed any surveys.

Model Combining and Benefit - Cost Analyses, Drs. John Boyce, Diane Bischak, and Mark Herrmann, $10,000, November 1, 1992. This final portion of the research is delayed because all four other research pieces must be completed before it can be initiated.

There are two primary tasks remaining for the economic review project manager. The first is to coordinate the enhancement project survey data collection, review, and data entry and transfer to university researchers. The population modeling project used only approximately half of the fisheries production survey data collected. The remaining half will be less intensively model by ADF&G staff (this approach was done based on the contribution of enhancement projects to fisheries).

In addition to this remaining population data, the production cost survey results need to be reviewed, ADF&G management cost must be estimated, and the final data must be organized on a computer database for analysis by

university researchers. While ADF&G staff will conduct most of the data review, estimation of management costs, and design the database, and the Legislative Research Agency will enter the data, coordination is needed to ensure that the tasks proceed in a timely manner. In addition, technical oversight is required so the resulting products are compatible with the combined modeling effort. This coordination and review effort should take approximately two weeks of time between July and September.

The second task is the 1) review of individual work projects to ensure they fulfill the RSA specifications and provide necessary output data for the combined model, 2) provide technical trouble-shooting advice during combined model development and policy simulations, and 3) review and/or edit the final report executive summary to ensure that it is understandable to legislators and other non-economists (this was done for the preliminary results given to the Committee in May). This task should require approximately two to three weeks of time between August and October.

July 16, 1992

UNIVERSITY OF ALASKA FAIRBANKS
School of Management
Fairbanks, Alaska 99775-1070

DATE: **July 22, 1992**

TO: **Ginny Fay**

FROM **Mark L. Herrmann**
Department of Economics

Re. **Salmon Progress Report**

I received your report on the status of the Legislative Review of the Salmon Enhancement Program. The report looks fine to me. On the progress on the salmon demand model, it is moving slowly but not because of lack of effort. I have been putting in 80 hour weeks on it for the last three months. Despite, the lack of speed the modelling effort will be done by the end of August and given to John to use in the simulation analysis. I will have the reports to you in draft form by the middle of September and will wait for your comments before I finalize it.

Again, much of the delay is because of the slowness in receiving the 1991 data. I finally realized that I will not be able to wait on all the 1991 data for the entire modelling effort. For the exvessel price equations, I have just asked DFO (Vancouver) and CFEC for the preliminary data since neither department will have the final exvessel price data finished by August. Nevertheless, the preliminary exvessel price data should be fairly good. I have also had problems obtaining enough memory in my computer to simulate the entire set of equations. But I have just recently cleared this up.

John says his cost model is making excellent progress. I do not know the details. Diane B. and John B. will do the final simulations. My part will be to program the demand part of the model simulations into SAS and to make sure the results make sense. I also may supply them with predicted future values of the exogenous variables. However, the bulk of the simulation will be done by Diane and John. I don't see a problem making the final deadline if the runs from Dr. Collie will be in by the end of August.

One thing that I do not remember how we resolved was getting an estimate on Canadian harvests in the future. When I was in France last week at the IIFET conference I was able to get a better handle on the farmed salmon situation.

If you have any questions feel free to call me at my office (907) 474-7116 or home (907) 455-9073. Hope your having a nice summer, it has been absolutely beautiful here.

DRAFT

Salmon Population and Exploitation Modeling

by

Dr. Jeremy S. Collie
University of Alaska Fairbanks
Juneau Center, School of Fisheries And Ocean Sciences
11120 Glacier Highway
Juneau, Alaska 99801

For the
Alaska State Legislature
Senate Special Committee on Domestic and
International Commercial Fisheries

As part of the
Legislative Review of the Alaska Salmon Enhancement Program
Benefit-Cost Analysis

November 1992

DRAFT: Do not quote without permission of the author.

Introduction

The objectives of the salmon population and exploitation modeling was to project Alaska salmon production levels by region to the year 2022. For each region, projections were made of expected wild and enhanced production based on current facility capacity. Estimates of commercial salmon harvests are based on present fisheries management practices.

Background

In the early 1970s, the state of Alaska initiated a salmon enhancement and rehabilitation program through the Alaska Department of Fish and Game (ADF&G), Division of Fisheries Rehabilitation, Enhancement, and Development (FRED). Salmon production through enhancement efforts was to compensate for extremely low wild salmon returns in the 1970s.

The hatchery (or ocean ranching) component is the largest part of the enhancement program. There are two categories of hatcheries: 1) state hatcheries, which are state funded and operated by FRED, and 2) private non-profit (PNP) hatcheries. Private PNP hatcheries include regional aquaculture association facilities which can collect salmon enhancement tax receipts from fishermen in the region and "mom and pop" operations that are independent from the regional associations. The independent operations can not collect enhancement taxes. All PNPs can sell cost-recovery harvest fish to pay for operating costs and apply for state enhancement loans through the Alaska Department of Commerce and Economic Development, Division of Investments.

During the last 20 years, the state of Alaska has invested extensively in hatcheries by providing capital construction costs and operating costs to state facilities and loans to PNPs. In addition, FRED provides administrative, technical, research, and planning support to PNP facilities. As a result of declining state revenues, there is an increasing trend towards privatization of state owned and operated facilities. This has primarily been accomplished through contracts with regional aquaculture associations for the operation of state-owned facilities. Support to PNPs through FRED and salmon enhancement loans have also declined.

In general, the enhancement program has been very successful in producing more fish. Recent annual harvests from the hatchery program range from 15-23 million fish.

Enhancement Program Review

In May 1991 the Senate Special Committee on Domestic and Ir national Commercial Fisheries initiated an extensive review of the Alaska salmon hatchery and enhancement program. The purpose of the study is to:

1) Review the history and legislative intent of the program.
2) Analyze the current status of the program.
3) Consider future options for the program ranging from fine tuning to possible redirection.

Part of the program review is an economic analysis. An economics study group was formed to address questions raised by the Committee including:

- if the present levels of Alaska salmon harvest are over- or under-supplied from a world market perspective, and

- if increased enhanced salmon production will raise or lower prices, fishing revenues, and the total net benefits of Alaska's salmon fisheries.

A benefit-cost analysis is required to answer these two questions. This salmon population and exploitation modeling project is one part of this benefit-cost analysis.

Fisheries Modeled

To bound the modeling project, a subset of regions and species was jointly selected by legislative and FRED representatives and the author. These fisheries were to be intensively modeled:

- Kodiak pink salmon
- Kodiak sockeye
- Cook Inlet sockeye
- Prince William Sound pink salmon
- Southeast Alaska chinook salmon

This set was selected because it includes most of enhanced salmon production harvested by commercial fleets (Figure 1). The models developed aggregate production over the region of interest. It was also agreed that the remainder of the commercial salmon population and exploitation estimates (the non-intensively modeled set) would be based on projections of state and PNP hatchery managers and ADF&G, Division of Commercial Fisheries estimates of wild stock historical harvests. Only the intensively modeled fisheries are discussed in this report.

Modeling Methodology

The modeling effort followed the standard approach to estimating the catch of enhanced fish:

Hatchery Catch = Fry released * Survival * Exploitation Rate

Improvements were made to the model by:

- estimating survival rates and variance from past releases and
- considering constraints on the exploitation rate imposed by mixed fisheries.

The first step in developing a Salmon Simulation Model (Figure 2) is to estimate the model parameters from historical data. If there are insufficient data or no data exist to quantify a relationship, the effect can not be included in the model. Initial considerations regarding the intensive modeling of the Prince William Sound chum salmon fishery and the Southeast Alaska coho salmon fishery were discontinued based on inadequate data.

Release data for enhanced stocks were obtained by surveying hatchery managers. The survey of hatchery managers was conducted as a joint legislative and FRED effort. Survey results were provided to the author. Most of the survey results indicate that current capacity estimates change very little after the initial survey years. This suggests that the hatchery managers' planning horizon is relatively short despite the fact that investment decisions must be made using a longer planning horizon. In most cases, planned releases are the same as current releases. The exception was Cook Inlet sockeye salmon; managers are planning significant production expansion.

Wild stock historical escapement data, future escapement targets, and mixed-fisheries management constraints were provided by ADF&G, Division of Commercial Fisheries.

Monte Carlo Simulations

The inputs for the Monte Carlo simulations included enhanced fry and smolt releases, wild stock escapements during the initialization years, and the escapement target for future years. Random variability was introduced into the survival rates to indicate the level of natural variability to expect around the median estimates. Mean survival rates ane their variances were calculated from spawner recruitment data for wild stocks, and from historical release data for hatchery stocks. Wild-stock preference was built into the exploitation sub-model such that the harvest rate of hatchery fish in the mixed-stock fishery was conditional on the escapement target for the wild stock. Excess hatchery fish were assumed to be harvested in the

terminal areas.

The simulation outputs were adult returns, divided into the various harvest and escapement boxes (Figure 2). One hundred stochastic replicates of the 30-year simulations were run. The 100 replicates were then sorted by total return for each year to obtain median, 10%, and 90% quantiles. The quantiles of the return distribution provide an empirical confidence interval around the median; 80% of the replicates lie between the 10% and 90% quantiles.

As part of the benefit-cost analysis public policy simulation, enhanced production was hypothetically altered to estimate how net benefits would change under different production scenarios. To develop accurate population and exploitation estimates for these simulations, the population models were run using the production scenarios listed below. Changes in production refer to numbers of returning adult salmon available for harvest by commercial fisheries. The first five changes were specified by the legislature. The sixth was added to compare enhanced production with increased wild salmon production through increased escapement targets. The results of the latter scenario are referred to as the "management" option in the figures. Only the first five scenarios were included in the complete benefit-cost analysis.

Production Scenarios

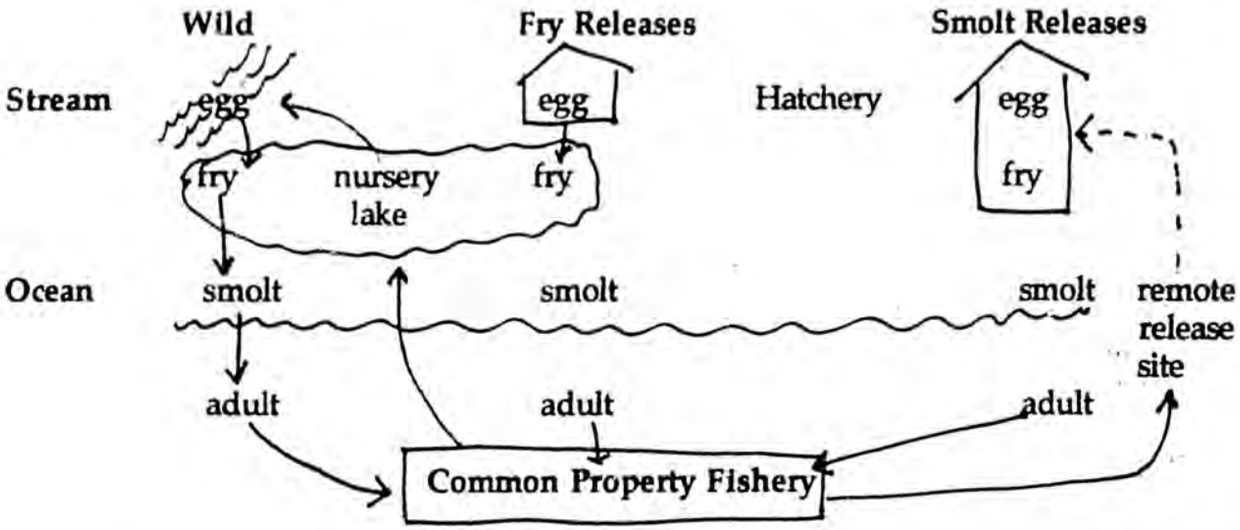
1. Hatchery production continues at current permitted levels (Base Case)
2. Hatchery production continues at planned (unconstrained) levels.
3. Hatchery production is eliminated (no egg take in 1993)
4. Hatchery production is increased 15% over the Base Case
5. Hatchery production is decreased 15% from the Base Case
6. Hatchery production is eliminated and escapement target are increased.

The next sections provide information on modeling methodology and results for the Cook Inlet sockeye, Prince William Sound pink, and Southeast Alaska chinook salmon fisheries. Results for Kodiak pink and sockeye salmon are not included in this draft report. Methods for Kodiak ere the same as for Cook Inlet sockeye and Prince William Sound pink salmon. In fact, the Kodiak and Prince William Sound simulations were combined in a single program.

Cook Inlet Sockeye Salmon

Considerable research has been conducted in Alaska on sockeye salmon dynamics. During a visit to Kenai in May 1992, ADF&G limnologist, Dana Schmidt, provided the information needed for the Cook Inlet and Kodiak regions. Cook Inlet is the region of Alaska producing the most enhanced sockeye. The Cook Inlet Regional Salmon Enhancement Plan projects a harvest of 1 million enhanced sockeye by the year 2000. Cook Inlet also supports large natural runs of sockeye. From 1968 through 1985, the median return of wild sockeye was 4 million fish

Figure 3. Sockeye salmon life history



Sockeye enhancement, consisting primarily of fry lake releases, fish passes, and lake fertilization has until recently been relatively "benign." This is for the most part because the enhanced stocks are from wild egg takes that are transported to nursery lakes and harvested with wild stocks rather than creating a new separate stock. These enhancement methods, however, provide no mechanism for generating cost recovery revenue because the fry releases do not return to a hatchery facility. For this reason, most of the initial sockeye fry enhancement in Cook Inlet was conducted by FRED. In contrast, smolts released in remote release sites return as adults to the release sites. Cost recovery harvests can be conducted in those locations. It is likely that smolt remote release will provide for cost-recovery sales harvest but it will also complicate management.

Spawner-Recruitment Data

Escapement targets and returns have both increased since 1971 (Figure 4). The fitted spawner-recruit curve is a straight line. It is uncertain where the curve begins to bend such that increased escapement result in proportionally fewer adult returns. However, the 1992 return of approximately 10 million adult salmon primarily from the 1987 escapement of 2.3 million might provide an indication. (Incidentally, the 1989 escapement, which has caused concerns, was also 2.3 million.)

Sockeye life stage survivals are summarized in Figure 5 from Koenings and Kyle (1991). Many of the observations are from Lake Tustumena where there has been fry tagging and smolt enumeration.

Residuals from log survival rates are used to estimate the variance of the random deviations in survival (Figure 6). Note the increasing trend for wild stocks. Deviations in survival at other life stages are not in phase. In fact, there may be compensatory survival, or measurement error.

Cook Inlet Sockeye Releases

Fry are released into about a dozen lakes. Figure 7 shows historic fry releases as well as current, planned, and the 15% increase and decrease production scenarios. Changes in releases are assumed to begin with 1994 releases. Planned releases would be almost double the currently permitted levels.

Smolt releases are the latest trend in sockeye salmon enhancement (Figure 8). Smolts are being released both at age-O and age-1. There are plans to release 5 million sockeye smolts.

Results

Figure 9 shows commercial catch from current releases and wild stocks with 10%, median, 90% levels, and the actual 1992 catch. The distance between the 90 and 10 percent levels represents an approximately ±1-2 million fish from the median estimate. Projected catches are initially high because of high escapements in the late 1980s. Escapement was 2.3 million in 1987 and 1989. In the model, escapement is maintained at the ADF&G target of 1 million so there are approximately half as many fish returning. It appears that high catches in the 1990s are realistic--the model predicted exactly the 1992 catch.

Commercial Catch Estimates for Production Scenarios

Planned increases in hatchery fry and smolt releases add about 1 million returning adult salmon to be harvested by the common property commercial fishery by the year 2000 (Figure 10). Eliminating hatchery production reduces catches by approximately 1/2 million annually. Doubling the escapement target to 2 million results in an initial decrease of 1 million salmon annually (a total reduction in harvests of 4 million sockeye over the four year period 1993-1996). This increased escapement would result in an eventual annual payoff of 3.5 million sockeye salmon. The management option exceeds harvest levels of planned sockeye enhancement by approximately 2.5 million annually.

Terminal sockeye harvests will increase with increases in smolt production (Figure 11). If hatcheries close, there would be a short burst of terminal catch followed by declines. The number of sockeye harvestes in the terminal areas is about two orders of magnitude lower than the number harested i the common property fishery. It is assumed that under "optimal" management there would be no remote releases of smolts. This is because management for a cost-recovery sales harvest of sockeye salmon would further complicate fisheries managment in Cook Inlet, which is already adversarial.

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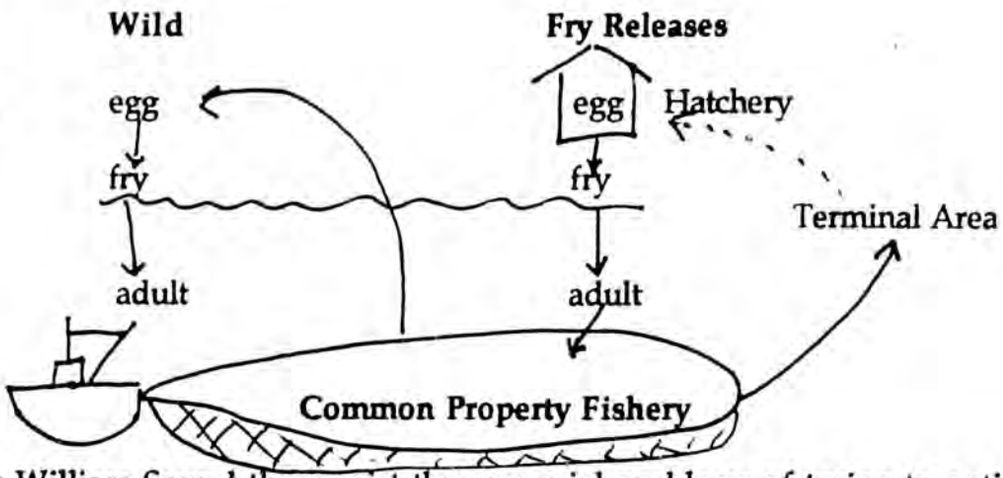
Prince William Sound Pink Salmon

This pink salmon model is based on a 1991 paper by Eggers, Peltz, Bue and Willette titled, "Trends in abundance of hatchery and wild stocks of pink salmon in Cook Inlet, Prince William Sound, and Kodiak, Alaska." The relationships described in this paper were used to estimate salmon abundance in the future.

Figure 12. Pink salmon life history



In Prince William Sound there exist the perennial problems of trying to optimize the escapement of wild and hatchery fish in the common property fishery. In the model simulations the harvest rate is conditioned on the strength of the wild stock.

Spawner-Recruitment Data

Increased escapement results in greater returns of adult pink salmon with the exception of 1984 (Figure 14). The Ricker curve passes through the center of the data which fall into two clusters--good years and bad years. The Ricker curve gives fairly conservative predictions of adult returns. The present escapement target is 1.5 million; the apparent optimum is 5 million.

Hatchery Survival Rates have averaged 5% until the 1990 releases (Figure 14). There is not yet evidence of density-dependent survival.

Deviations in survival rates are correlated between 1) Prince William Sound hatchery and wild pink salmon and 2) Prince William Sound hatchery and Kodiak hatchery survival (Figure 16). This covariance structure was programmed into the model simulations.

Average body weight appears to decrease as a function of the combined run of pink salmon (Figure 16). However, there is plenty of scatter because the weights were derived from fish ticket data, not measurements of individual fish. This body weight relationship was modeled with a log-log function so that body weight

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decreases asymptotically with changing run size.

Fry Releases were initiated in 1976, and jumped to over 1/2 million in 1988 (Figure 17). Current Prince William Sound fry production capacity is 650 million. Planned capacity is approximately 700 million. It does not appear that releases will reach the 1 billion level.

Results

Total annual adult returns of hatchery and wild salmon are projected at approximately 40 million, which is consistent with the 1990-91 returns (Figure 18). Eighty percent of the model realizations fall between the upper and lower broken lines. Actual 1992 adult returns were only approximately 10 million fish.

Common Property Catch is highly variable because if the wild stock return is weak the fishery is closed which results in lower harvest of hatchery stocks (Figure 19). This relationship is apparent for the current and increase cases. In these cases, the extra fish are harvested in the hatchery terminal areas where the enhanced stocks are no longer mixed with wild stocks. In the case of decreased production, median catches are more constant across years. If hatcheries are eliminated the wild stocks produce a median catch of about 4 million annually. If the escapement goal was raised to 5 million(the "manage" scenario), a annual catch of 7.5 million could be obtained. This is still a fraction of the harvest level with hatchery production.

Terminal cost recovery harvests are equal in magnitude to common property harvest. As fry releases increase, more of the salmon must be caught in terminal areas to protect wild stocks.

Southeast Alaska Chinook Salmon

The chinook salmon model was the most challenging to construct because of the more complex life history and the trans-boundary nature of the fisheries. This fishery was modeled using an existing coastwide chinook model that reconstructs all the chinook stocks except the Alaska hatchery stocks. Estimates of non-Alaska hatchery chinook abundance were provided by John Carlile (ADFG, Douglas, AK), for the years 1979 through 2005. For this reason, projections of chinook production end in 2005.

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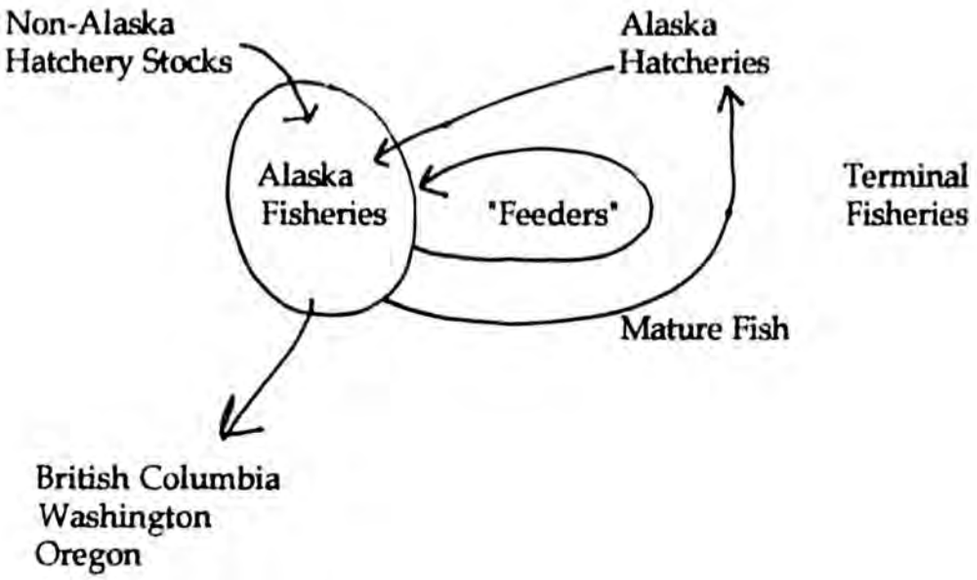
Figure 20. Chinook Salmon Life History



Fisheries Management

The chinook salmon fishery is governed by the US-Canada treaty. Provisions of the treaty include a quota of chinook salmon to be caught in waters adjacent to Southeast Alaska of 263,000 non-AK hatchery fish. This quota applies to all commercial gear types, and user groups. Alaska hatchery fish can be taken in excess of the quota provided that their contribution is estimated in-season from coded-wire tags (CWT). This Alaska hatchery "add on" is calculated as the lower 90% confidence interval of the estimated hatchery contribution. The original plan was to produce 100,000 harvestable chinook as the Alaska hatchery add on. Under treaty stipulation, even if the hatchery fish are produced, they may not be harvestable if the treaty quota is exceeded.

The treaty "pie" was allocated by the Alaska Board of Fish in March 1992. Each gear group (troll, net and sport) can increase its catch according to its hatchery contribution rate. The hatchery contribution rate depends on the production of AK-hatchery chinook P_H and the abundance of non-Alaska-hatchery chinook P_N.

$$\frac{CH_g}{CN_g} = a_g + b_g \frac{P_H}{P_N}$$

$$CN_g = A_g Q$$

$$CH_g = \left[a_g + b_g \frac{P_H}{P_N}\right] A_g Q$$

where:

g = gear type
CH = Alaska hatchery catch
CN = Non-Alaska hatchery catch
a, b = parameters
A_g = gear allocation
Q = Treaty Quota

Hatchery contribution rates have increased as hatchery production increased (Figure 21) . The sport fishery has the highest hatchery catch ratio, because the effort is in inside waters where the hatchery chinook are concentrated. The troll fleet has the lowest contribution because much of the effort is in outside waters where they intercept more non-Alaska hatchery fish and it is more difficult for the fleet to target the hatchery fish. The relationship for commercial net gear does not appear to be linear.

Given the coastwise abundance index and hatchery production, hatchery contribution rate can be calculated for each fishery. Hatchery production is estimated from releases and marine survival rates. A mean marine survival rate and variance are required for the stochastic simulation.

Marine Survival of Chinook Salmon was estimated from coded-wire tag data. Data were compiled from 128 tag lots from 11 hatcheries and 10 release years to examine factors affecting marine survival rates. General linear models were then fitted with the response variable being log survival. The variables--size at release, hatchery, and release year--are apparently all significant with a total r^2 of 0.78.

The simulation model included only the hatchery and release year effects because the future sizes at release are not known. The year effects suggest a temporal pattern (Figure 22). Hatcheries are plotted in rank order according to the estimated hatchery effects (Figure 23). Adding the constant back into the hatchery effects, the mean marine survival rate of each hatchery was calculated with year effects removed (Figure 24).

The survival model is:

$$S_{hy} = S_h * T_y * R_{yt}$$

h is hatchery
y is year
t is random shared-year effect
R is random effect not shared by hatcheries

Chinook Salmon Releases

Smolt releases increase and become constant after 1995 (Figure 25). This production is a doubling from the 1988 levels. Most chinook spend 3 or 4 years at sea, so we are just beginning to see the returns from the large releases.

Note that the coastwise index is also increasing (although it is exaggerated in Figure 25). This means it harder to catch the Alaska hatchery fish without overrunning the treaty quota.

Results

For all gear types, total catch is expected to increase as the large releases begin to return (Figure 26). The total 1991 catch was slightly overestimated by the model.

The troll harvest is expected to increase to about 300 thousand fish annually (Figure 27). Without hatchery production, the treaty harvest is approximately 200 thousand. The trollers are estimated to receive about 100 thousand additional chinook by 1996 under current production scenarios. In general, two hatchery chinook are required for the trollers to catch one. The 1991 troll catch was well predicted by the model.

Sport harvests are estimated to increase to 100 thousand by 1995 (Figure 28). Without hatchery production the sport fishing treaty allocation is 40 thousand. The model over-estimated the 1991 sport harvest. Terminal cost-recovery harvest is also estimated to increase to 100 thousand (Figure 29).

Conclusions

Alaska's hatchery program has been very successful in producing fish. If survival rates continue to be high, we can expect lots more hatchery fish in the future. While lower than hatchery managers' estimates, these simulation results are, if anything, over optimistic.

Status of wild stocks has changed dramatically since inception of Alaska's salmon enhancement program.

Given a wild stock preference and the US-Canada Treaty, increases in hatchery production will increasingly have to be harvested by ~~sport~~ fish user groups in terminal areas.

Privatization of hatcheries complicates management, which is likely to make it more costly and contentious.

In some regions, substantial yield increases may be obtainable by increasing the escapement targets of wild salmon stocks.

Maximizing yield is not the only important management objective. There is also a need to minimize the variance of yield to develop markets for Alaska salmon.

With the legislature's proposed merger of the Division of Commercial Fisheries and FRED, management and enhancement should be given common direction.

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Salmon Population and Exploitation Modeling

LIST OF FIGURES

new#	old#	
1	2	Map of Alaska Hatcheries
2	3	Model flow Chart
~~3~~	~~4~~	~~Production scenarios (retrospective)~~
3	5.	Sockeye life history (in text)
4	6.	sockeye. S-R data
5	7.	Sockeye life-stage survival rates.
6	7.	Residuals from log survival rates.
7	8.	CI fry releases
8	9.	CI smolt releases.
9	10.	CI commercial catches.
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	21.	Hatchery contribution rates.
	22.	year effects
	23	hatchery effects
	24	mean marine survival rates.
	25	Chinook releases.
	26.	returns, all gear types.
	27.	Troll catch
	28.	Sport harvest
	29.	Terminal harvest

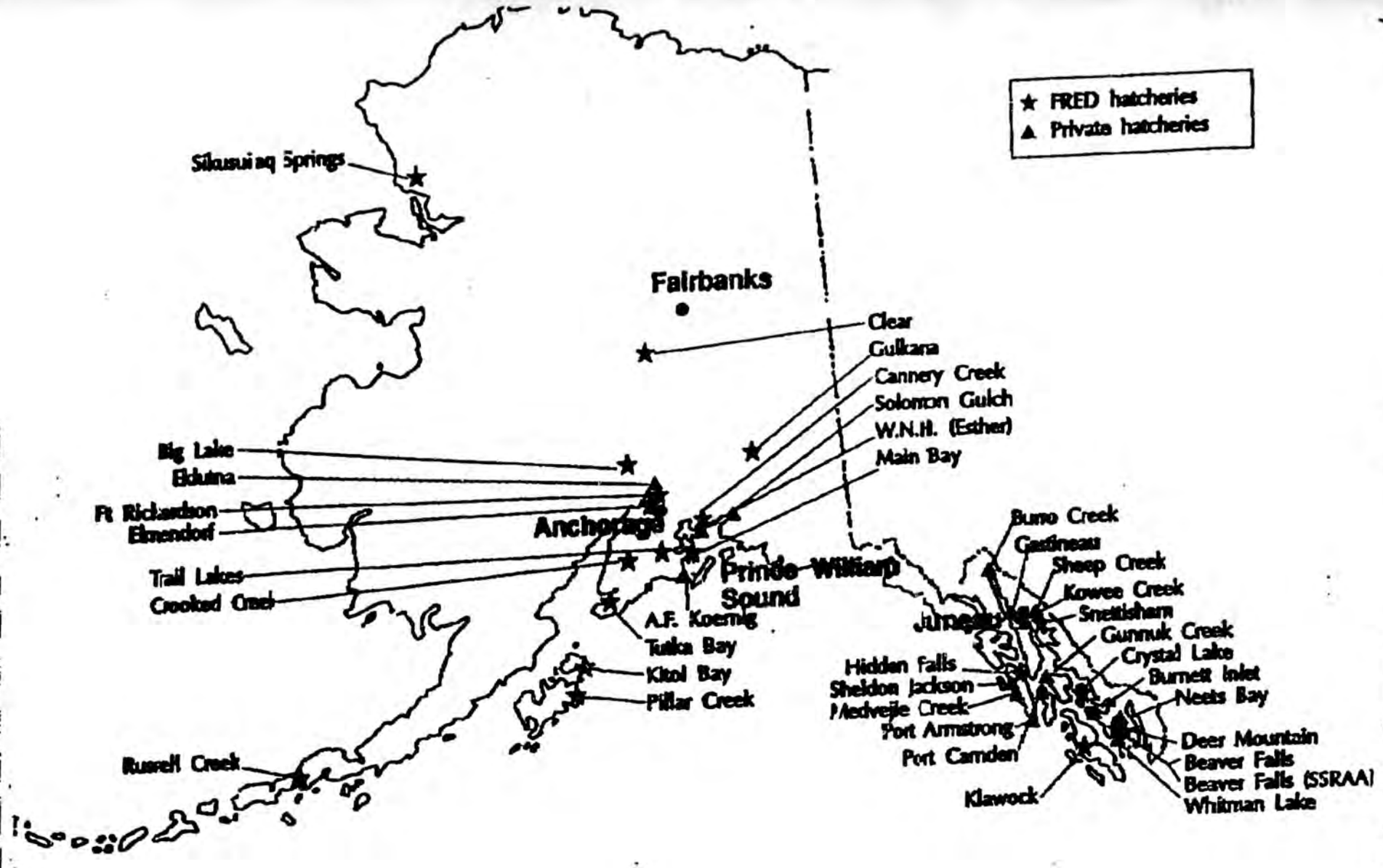
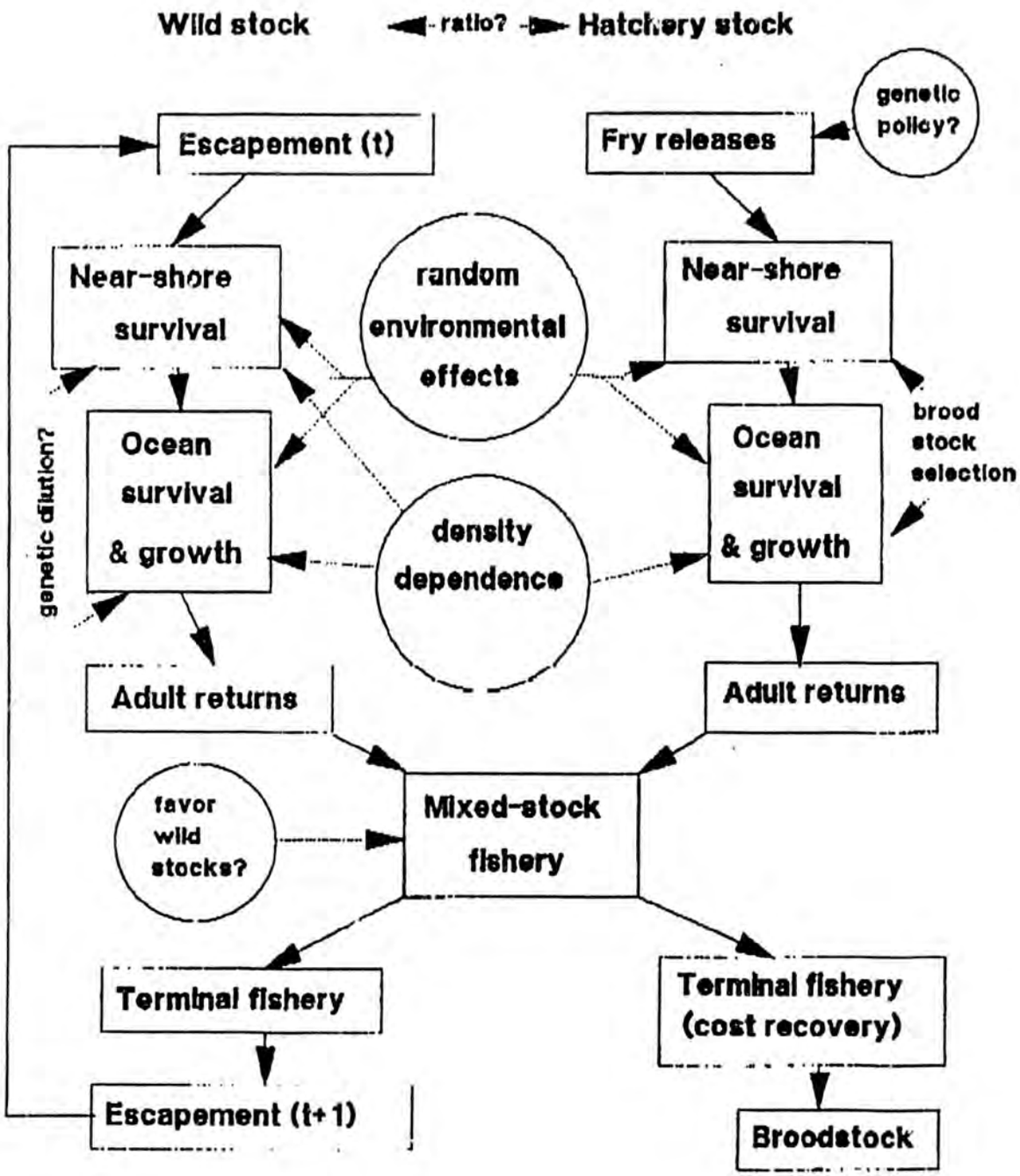

★ FRED hatcheries
▲ Private hatcheries
Silusuiaq Springs
Fairbanks
Clear
Gulkana
Cannery Creek
Solomon Gulch
W.N.H. (Esther)
Main Bay
Big Lake
Eklutna
Ft Richardson
Elmendorf
Anchorage
Trail Lakes
Crooked Creek
Prince William Sound
A.F. Koerng
Tutka Bay
Kitoi Bay
Pillar Creek
Russell Creek
Juneau
Burro Creek
Gastineau
Sheep Creek
Kowee Creek
Snettisham
Gunnuk Creek
Crystal Lake
Burnett Inlet
Neets Bay
Hidden Falls
Sheldon Jackson
Medvejie Creek
Port Armstrong
Port Camden
Klawock
Deer Mountain
Beaver Falls
Beaver Falls (SSRAA)
Whitman Lake

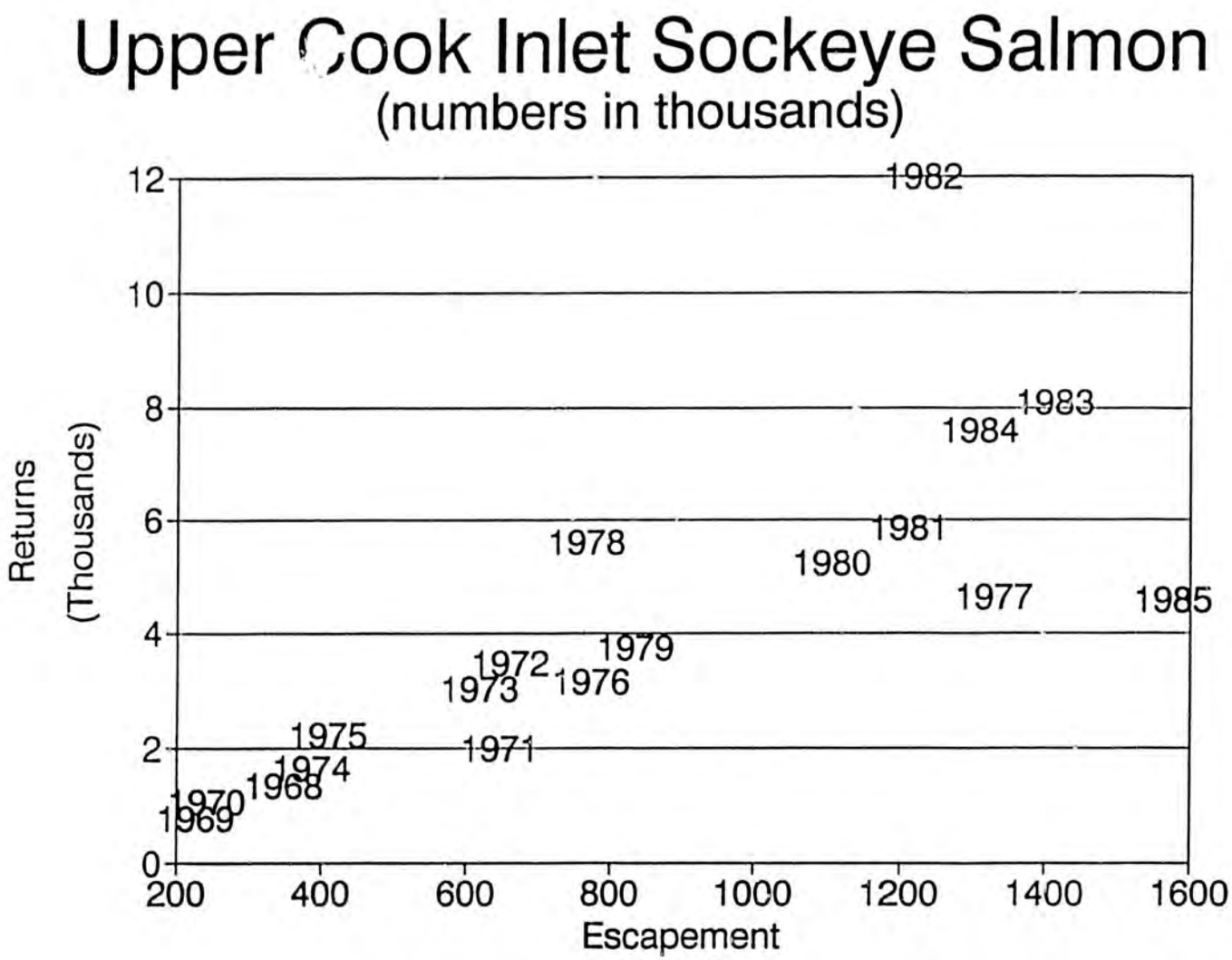
Figure 1

Fig. 2

Salmon Simulation Model



Stock-recruit relationship



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Sockeye Salmon Life-Stage Survivals at Rearing Limitation Based on Euphotic Volume (EV)

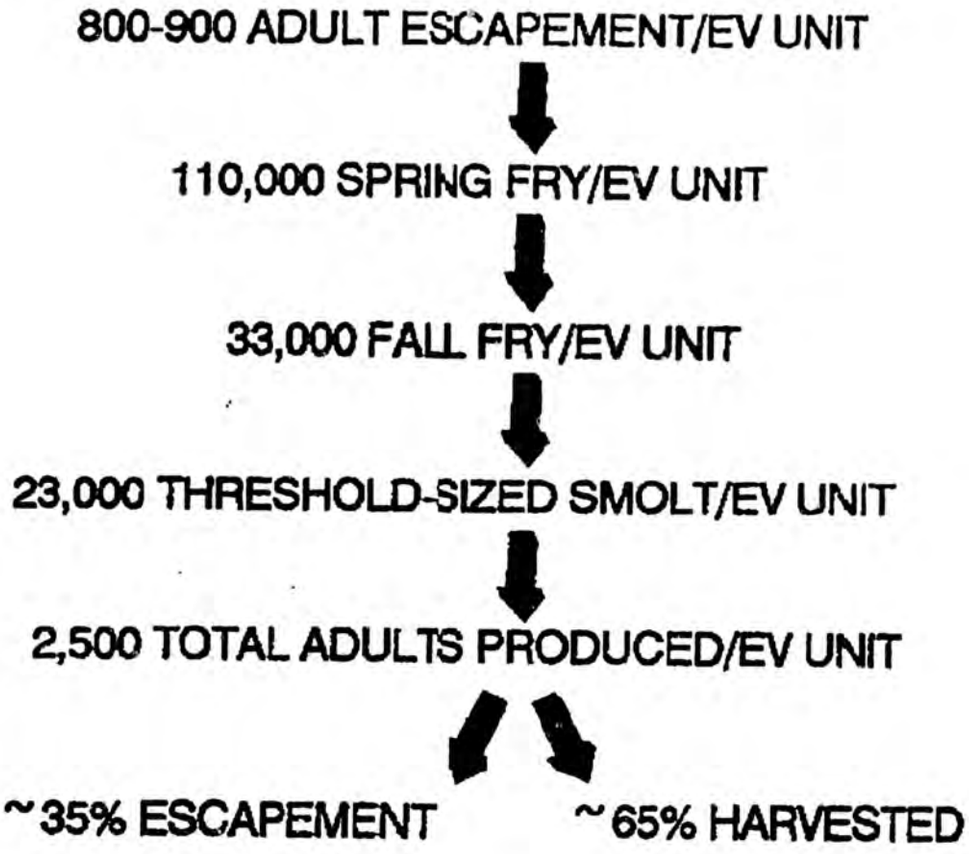
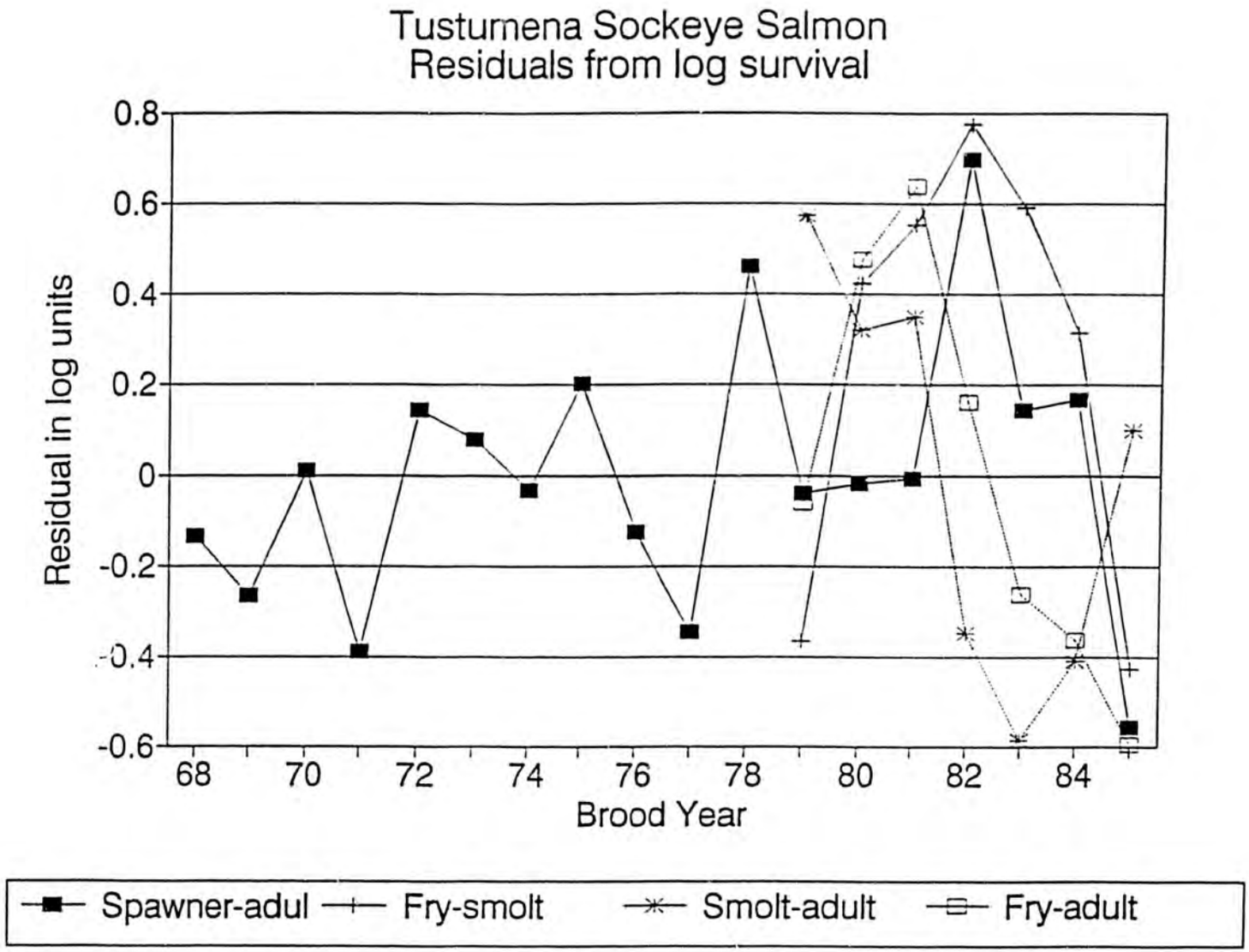
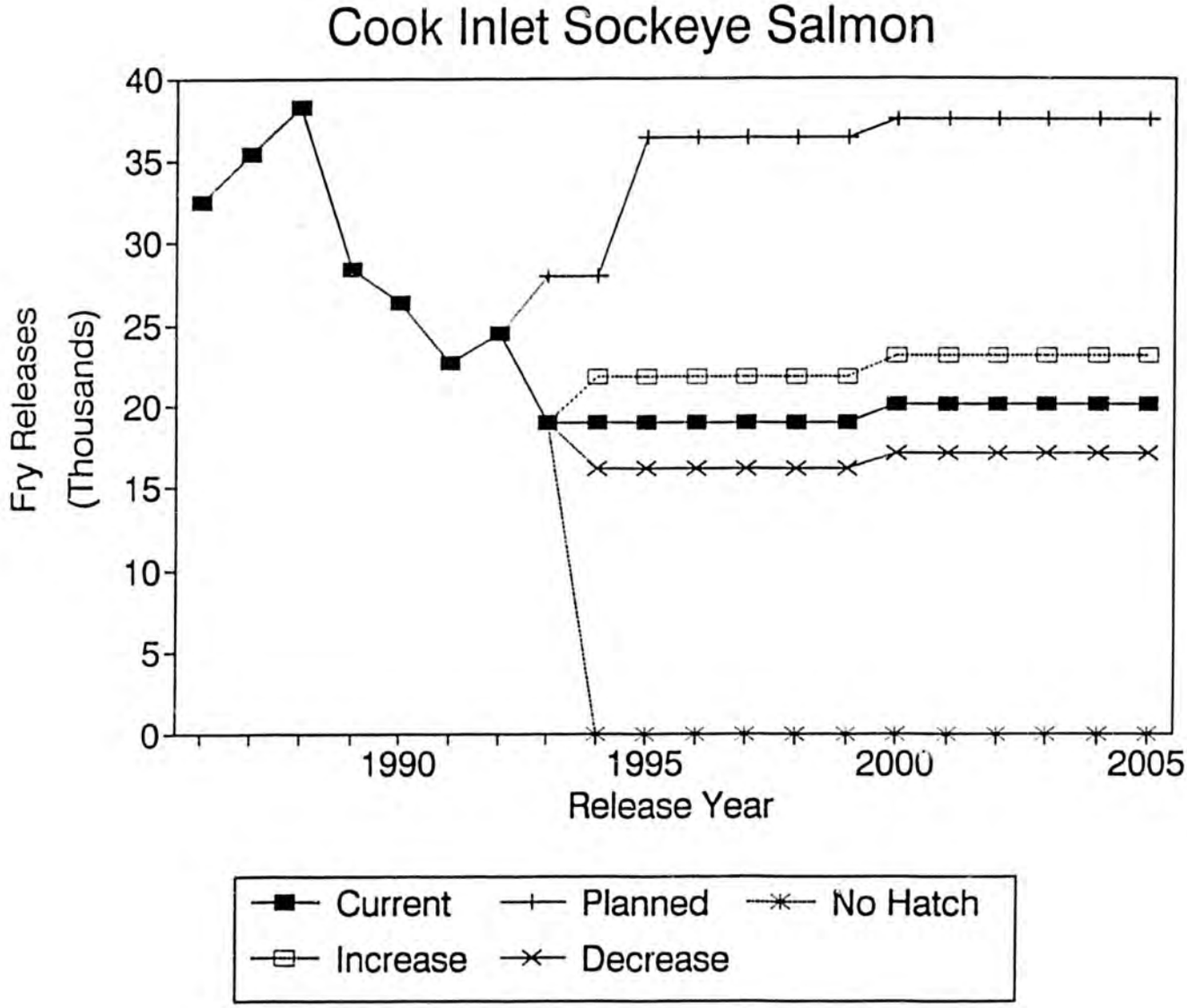
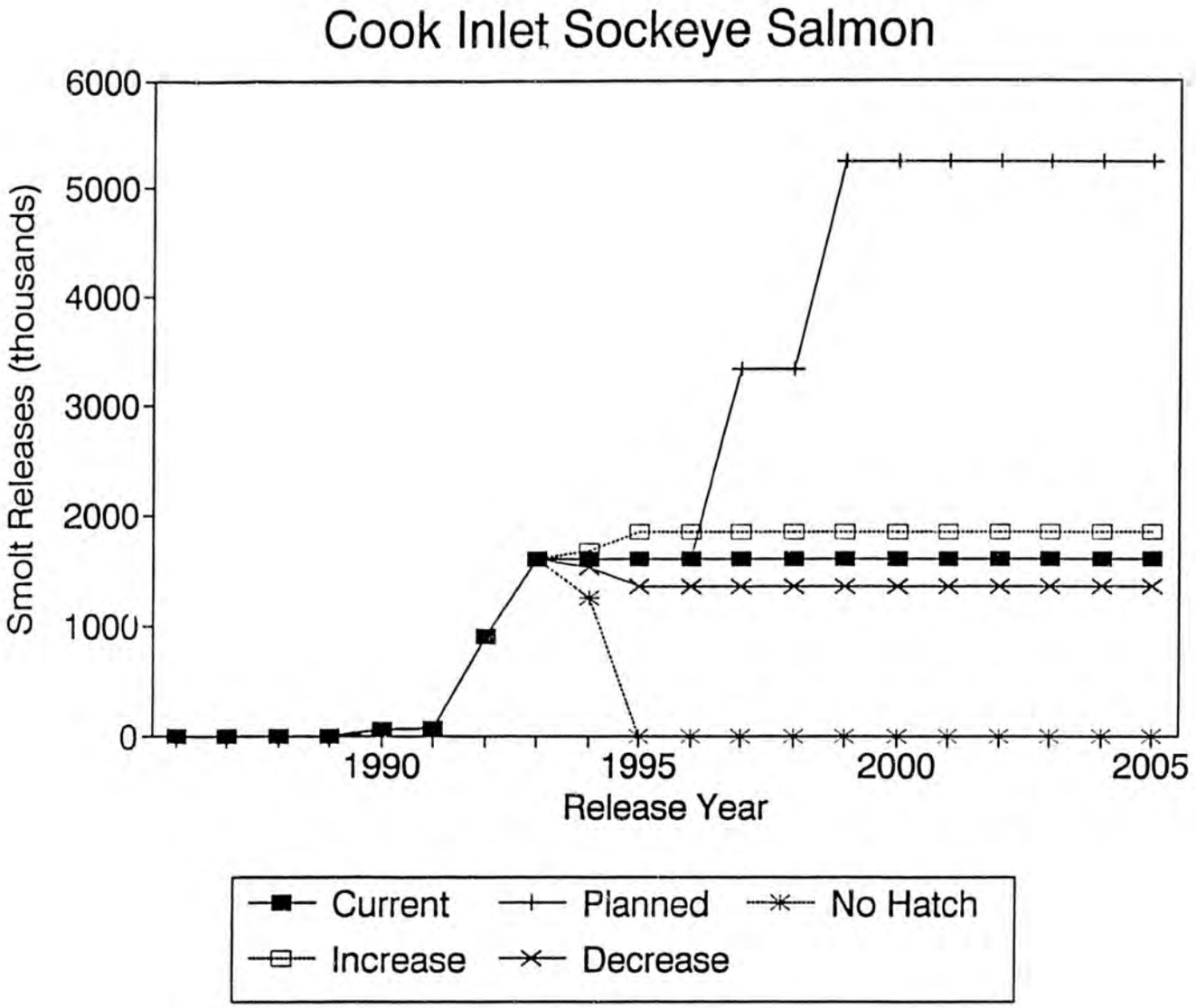


Fig. 7

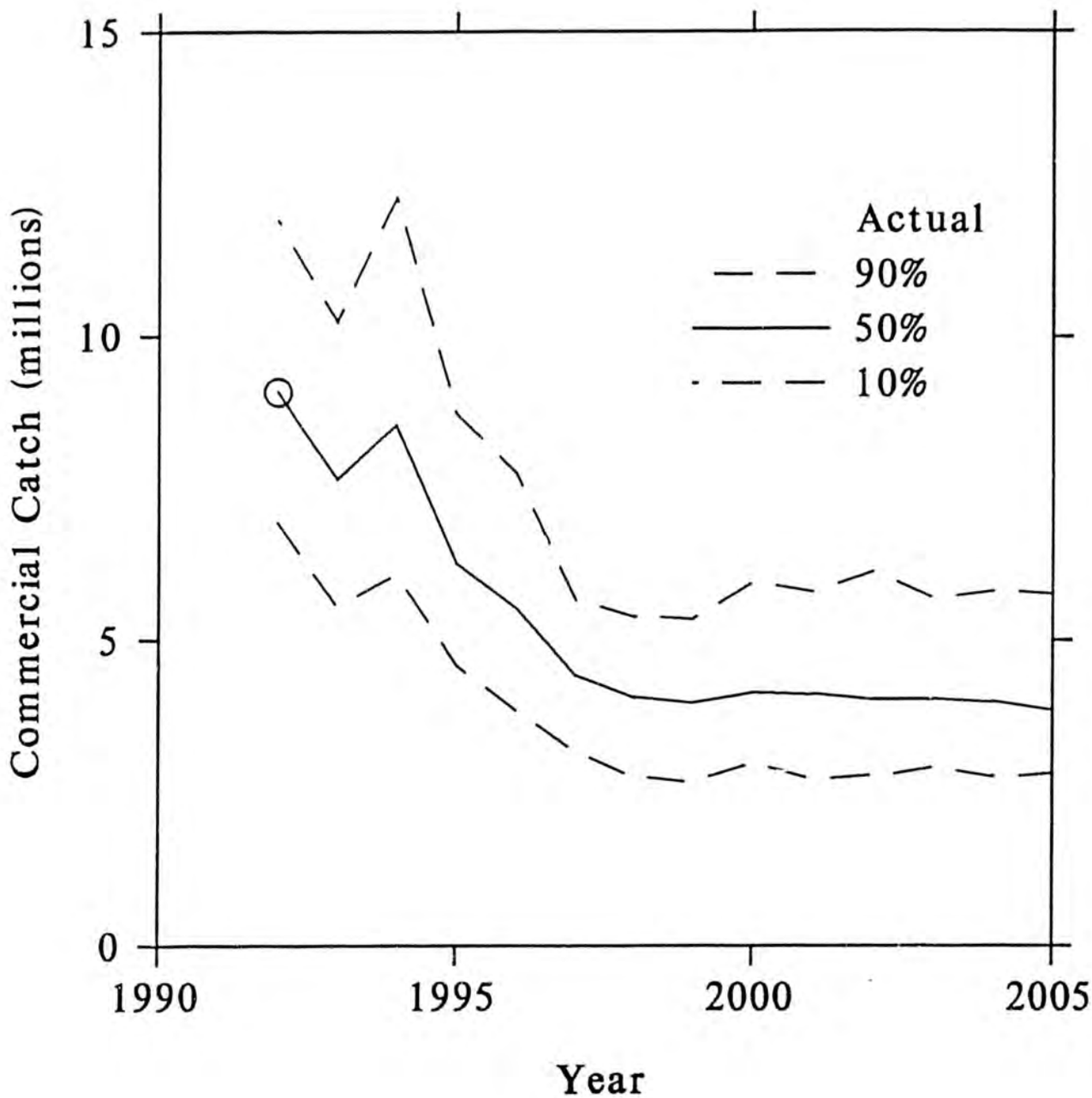
Residual variability included in stochastic model



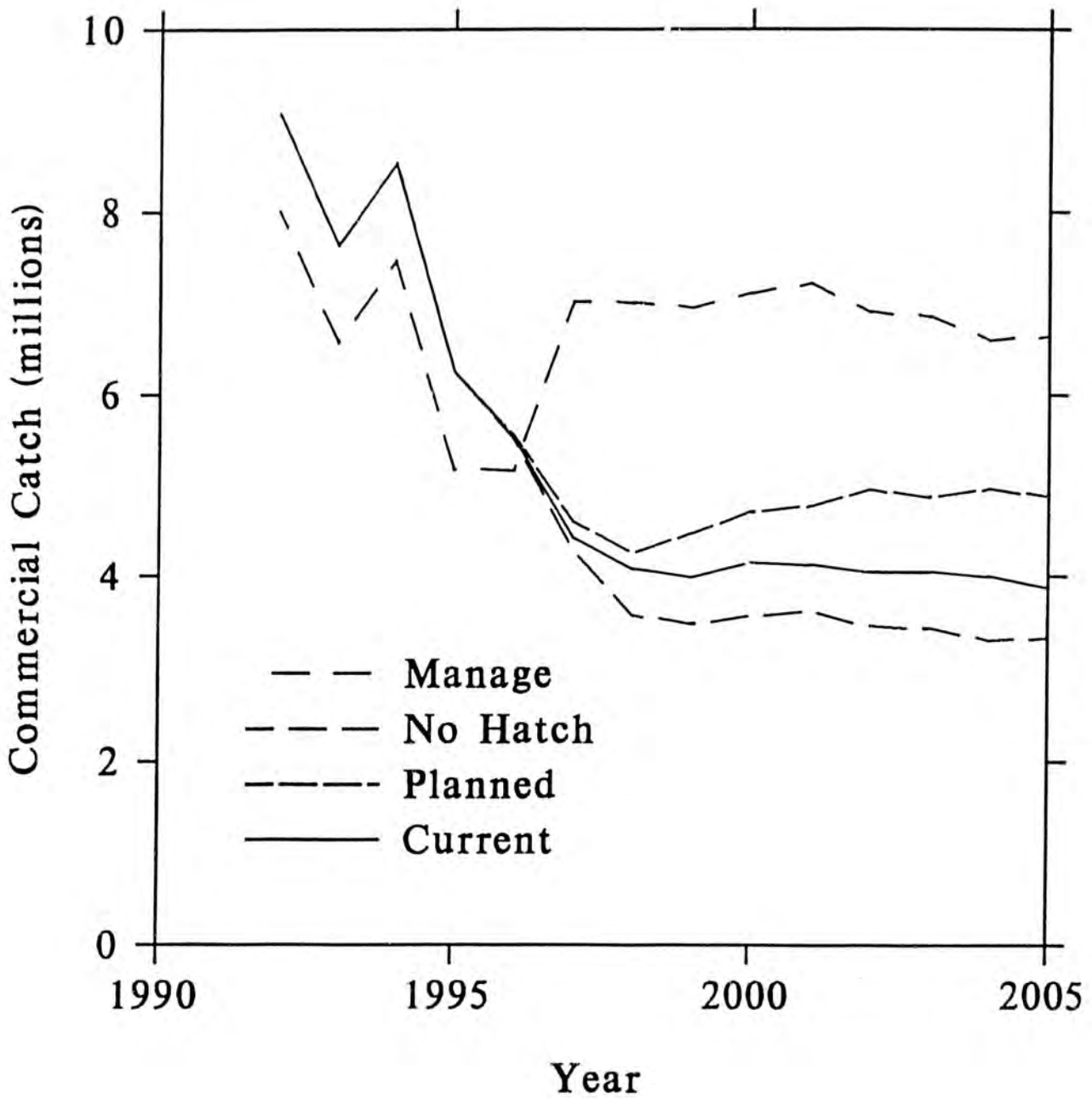

Cook Inlet Sockeye Salmon
Fry Releases
(Thousands)
40
35
30
25
20
15
10
5
0
1990
1995
2000
2005
Release Year
Current
Planned
No Hatch
Increase
Decrease


Cook Inlet Sockeye Salmon
Smolt Releases (thousands)
6000
5000
4000
3000
2000
1000
0
1990
1995
2000
2005
Release Year
Current
Planned
No Hatch
Increase
Decrease

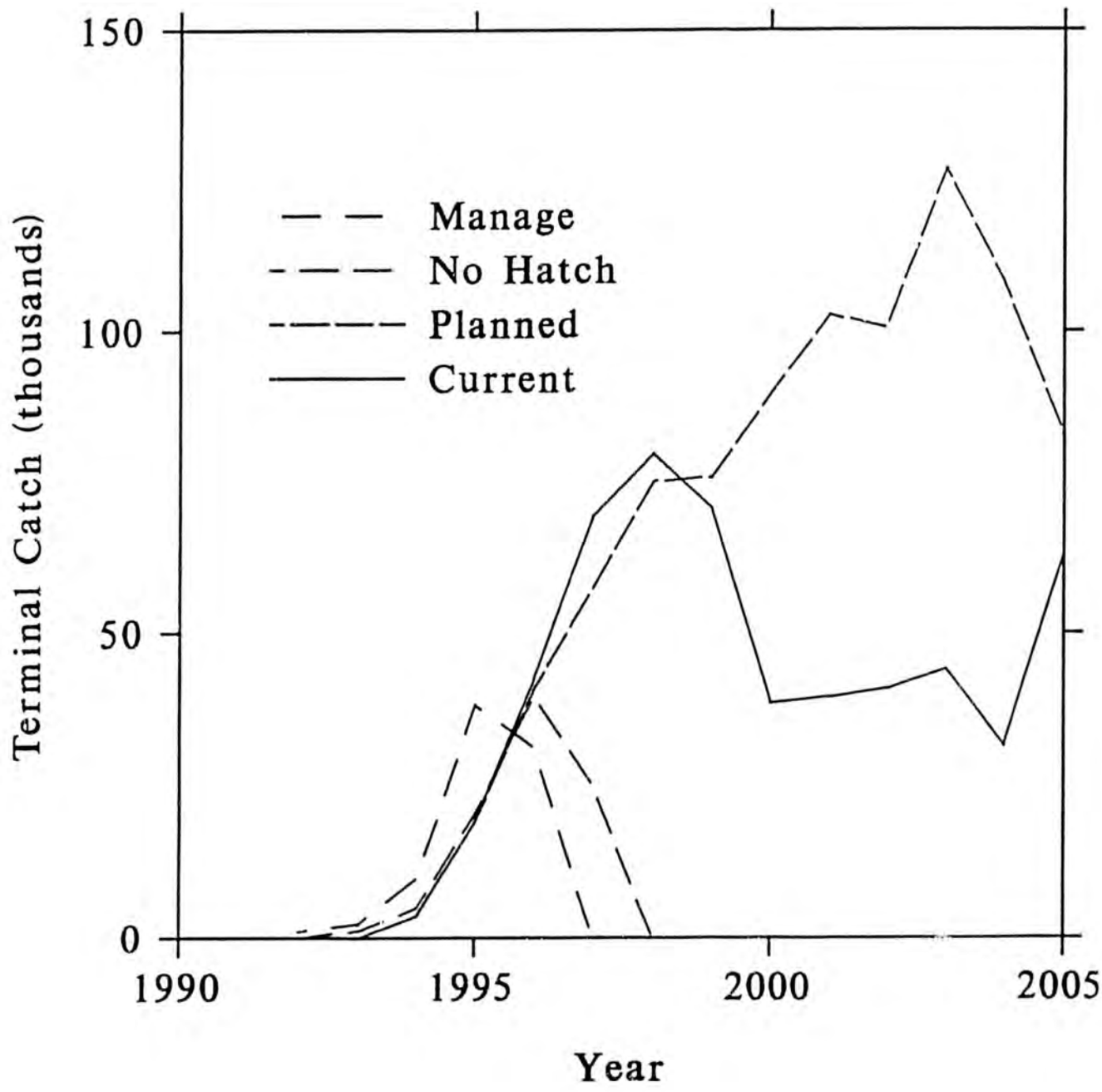
Cook Inlet sockeye catch with "Current" releases.



Cook Inlet sockeye catch

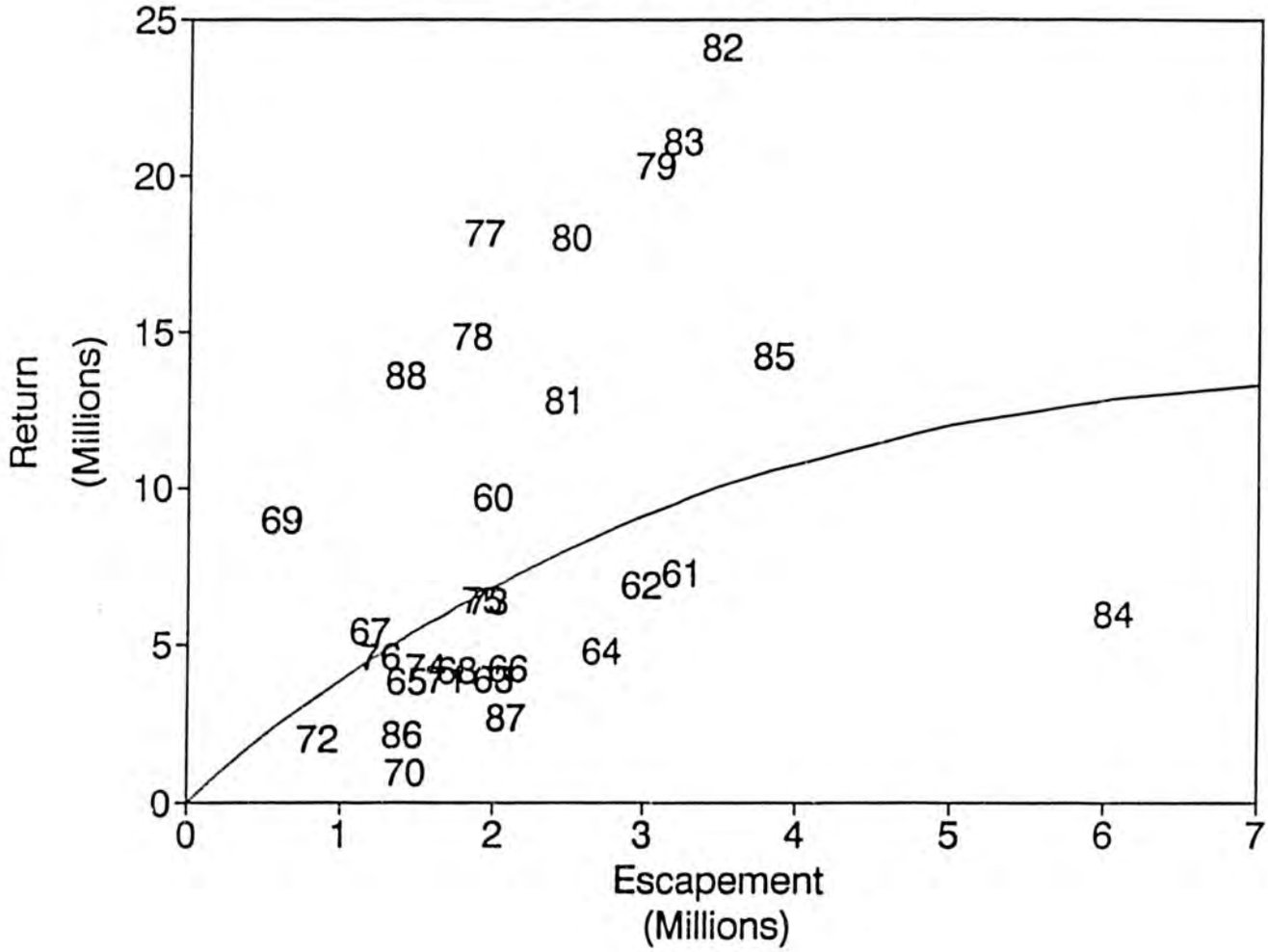


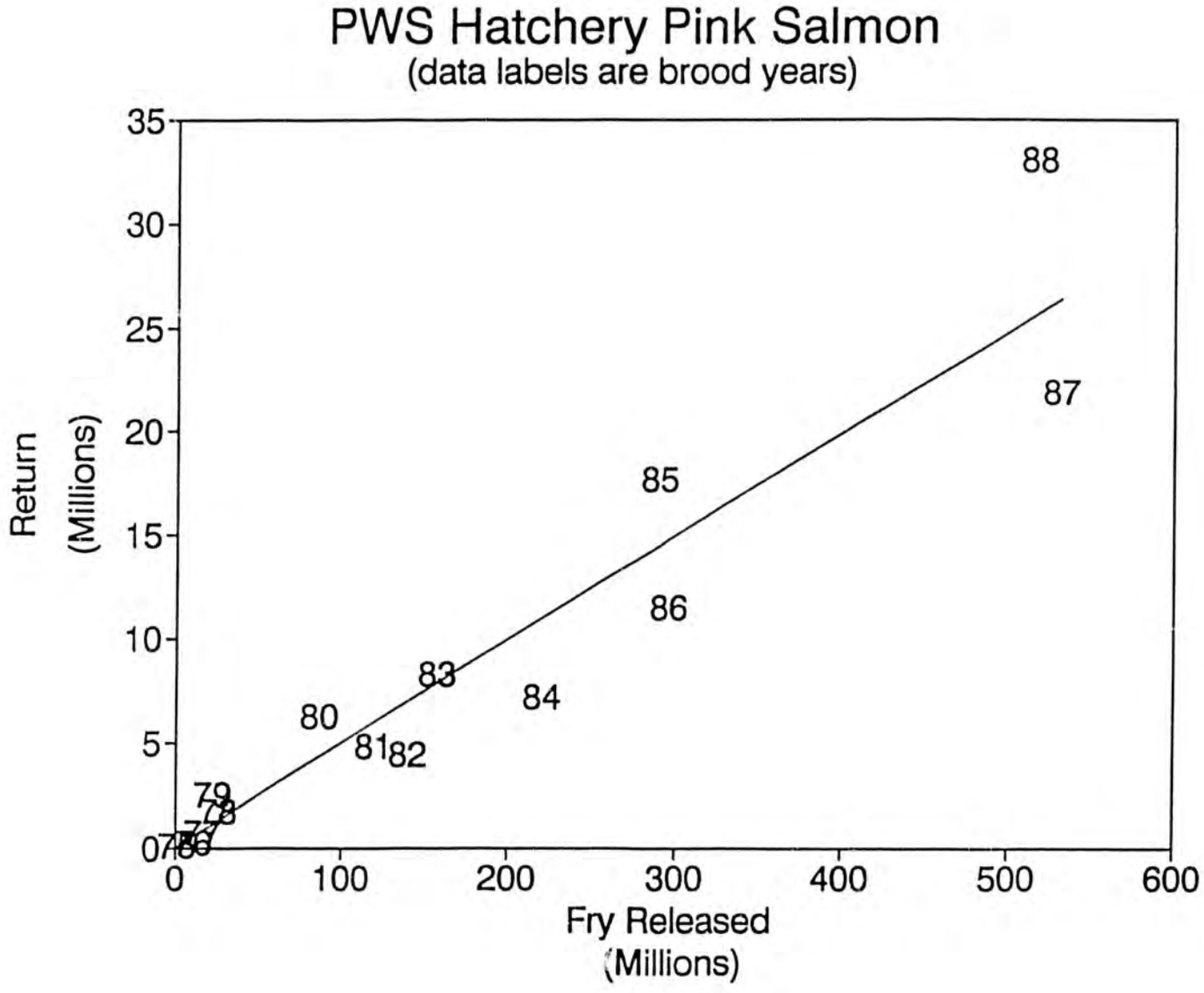
Cook Inlet sockeye catch of smolt release returns



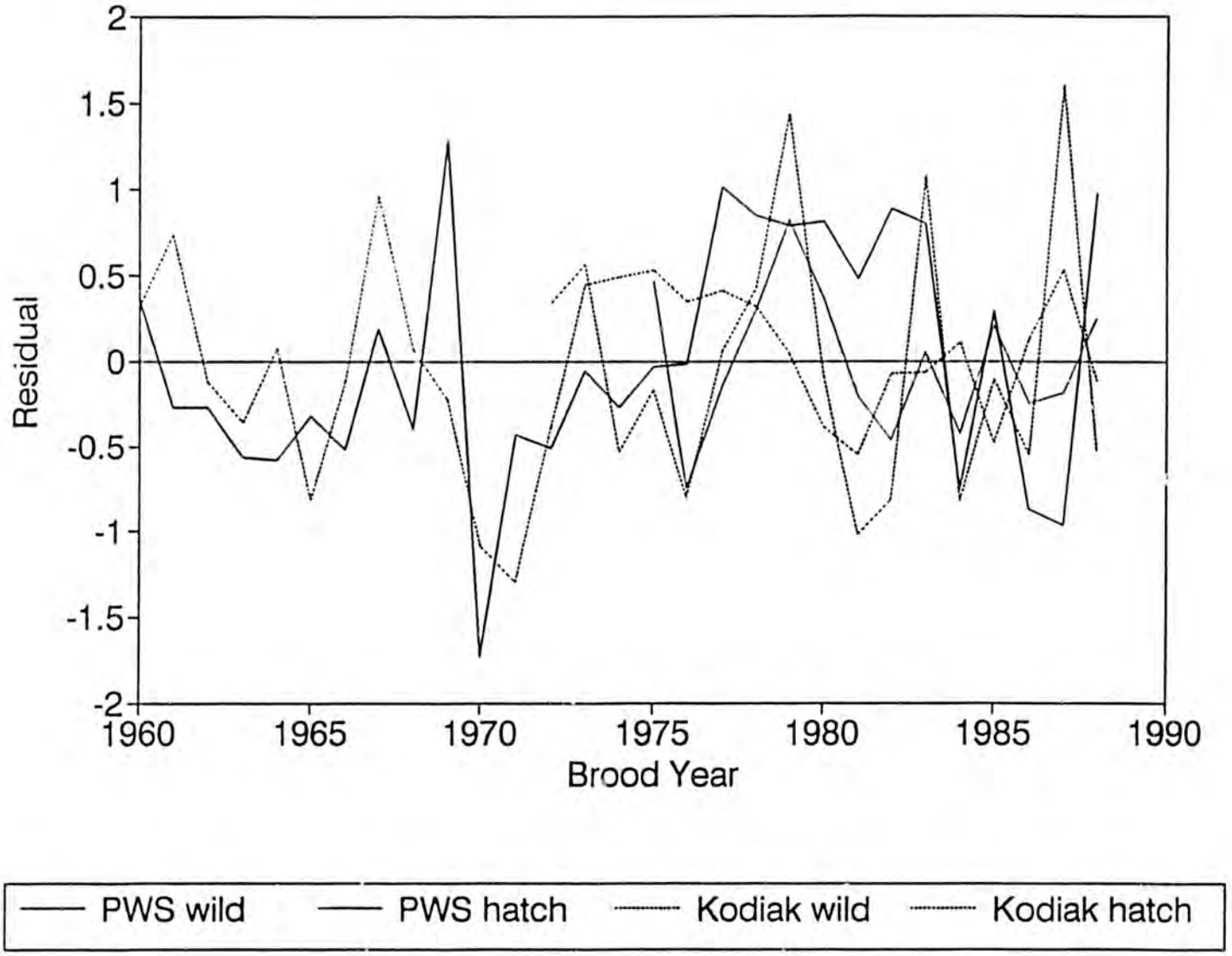
Prince William Sound Wild Pink Salmon

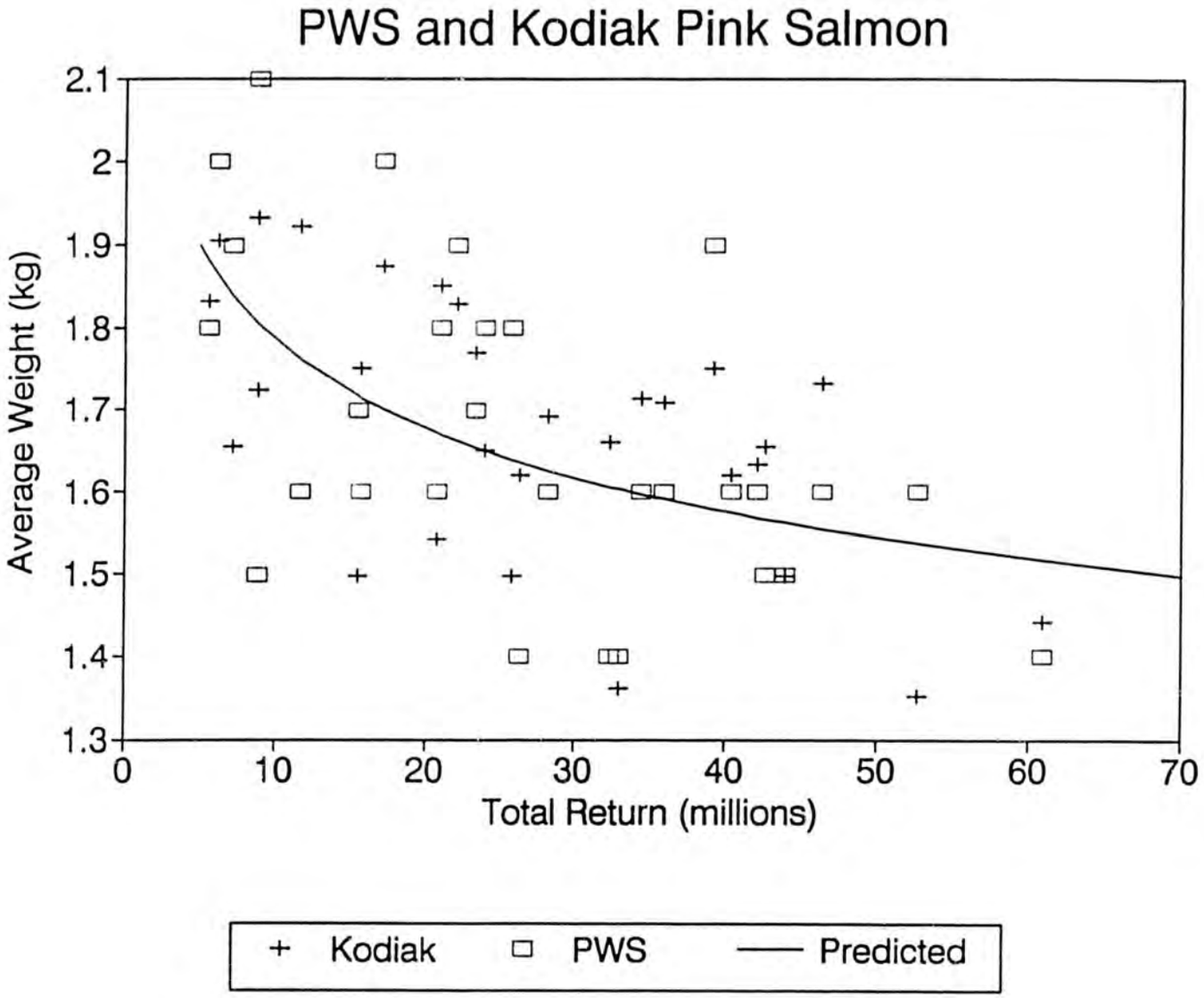
(data labels are brood years)

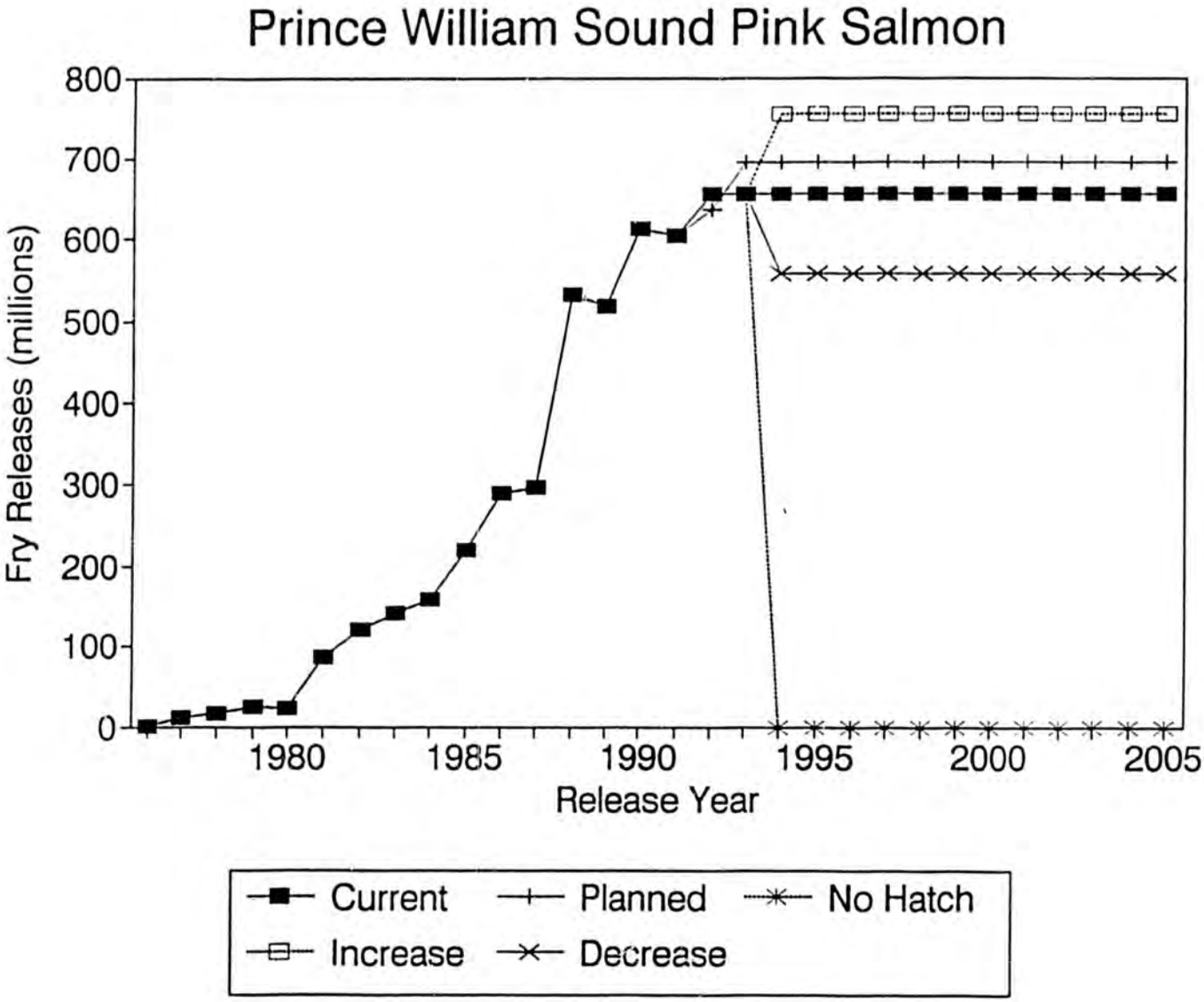



PWS Hatchery Pink Salmon
(data labels are brood years)
Return
(Millions)
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
Fry Released
(Millions)
88
87
85
86
83
84
80
81
82
79
78
77
76

Residual variability to incorporate into stochastic model

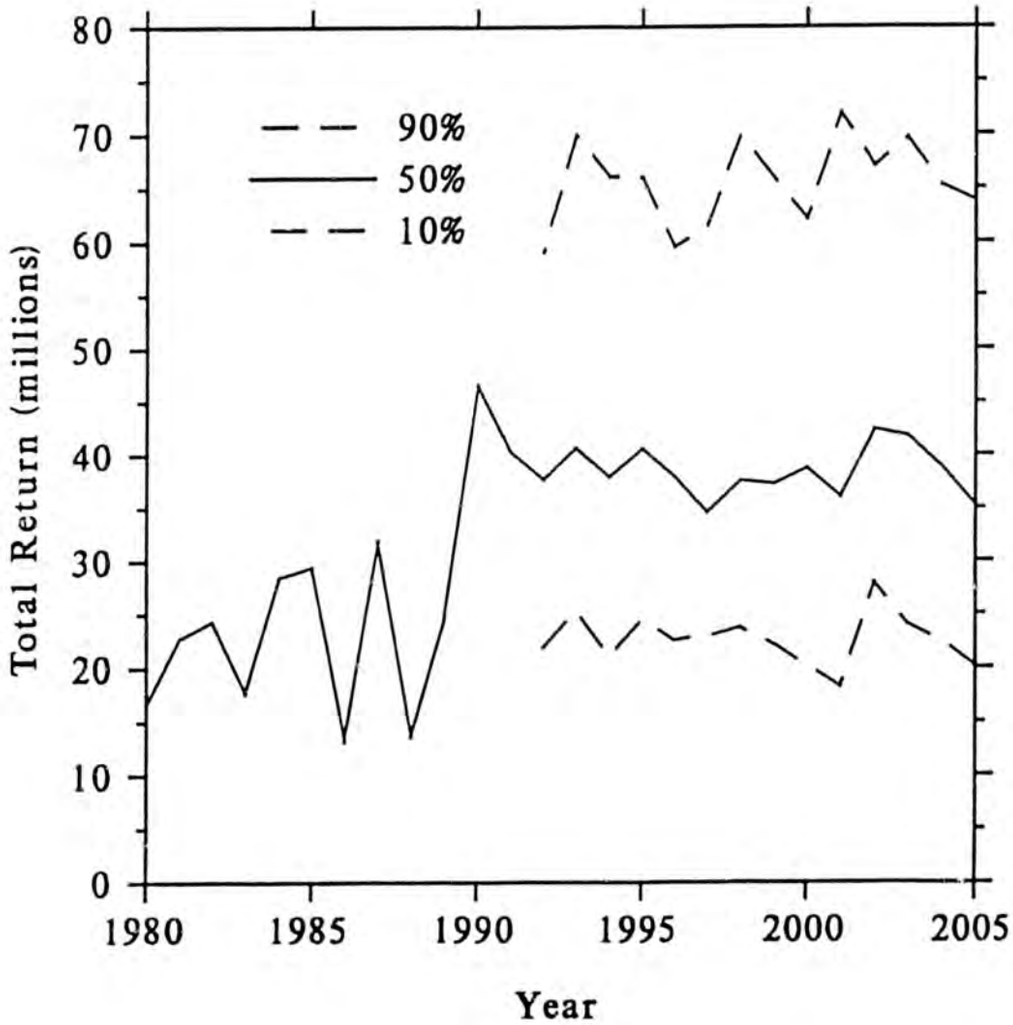


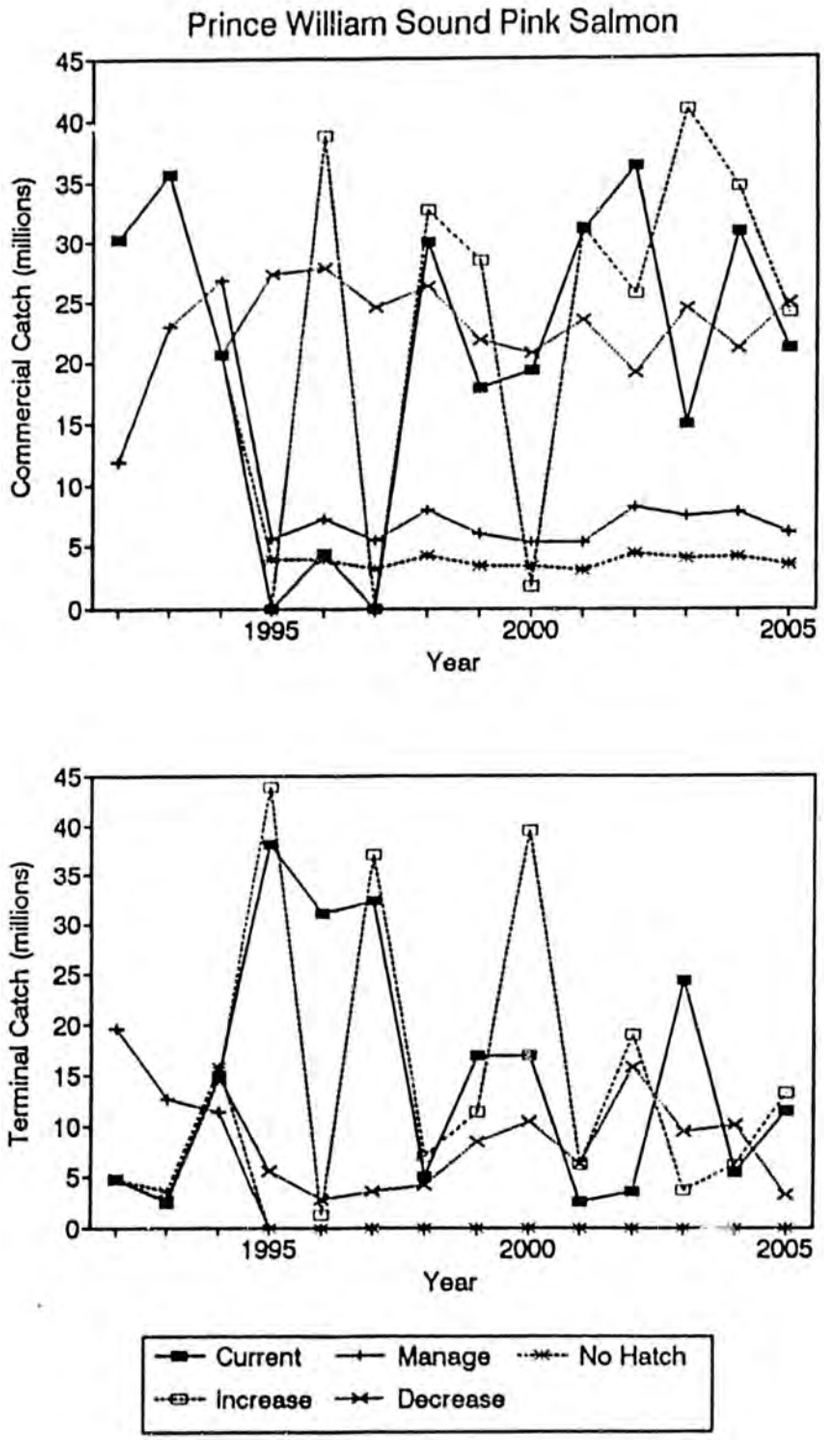

PWS and Kodiak Pink Salmon
Average Weight (kg)
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
0
10
20
30
40
50
60
70
Total Return (millions)
Kodiak
PWS
Predicted

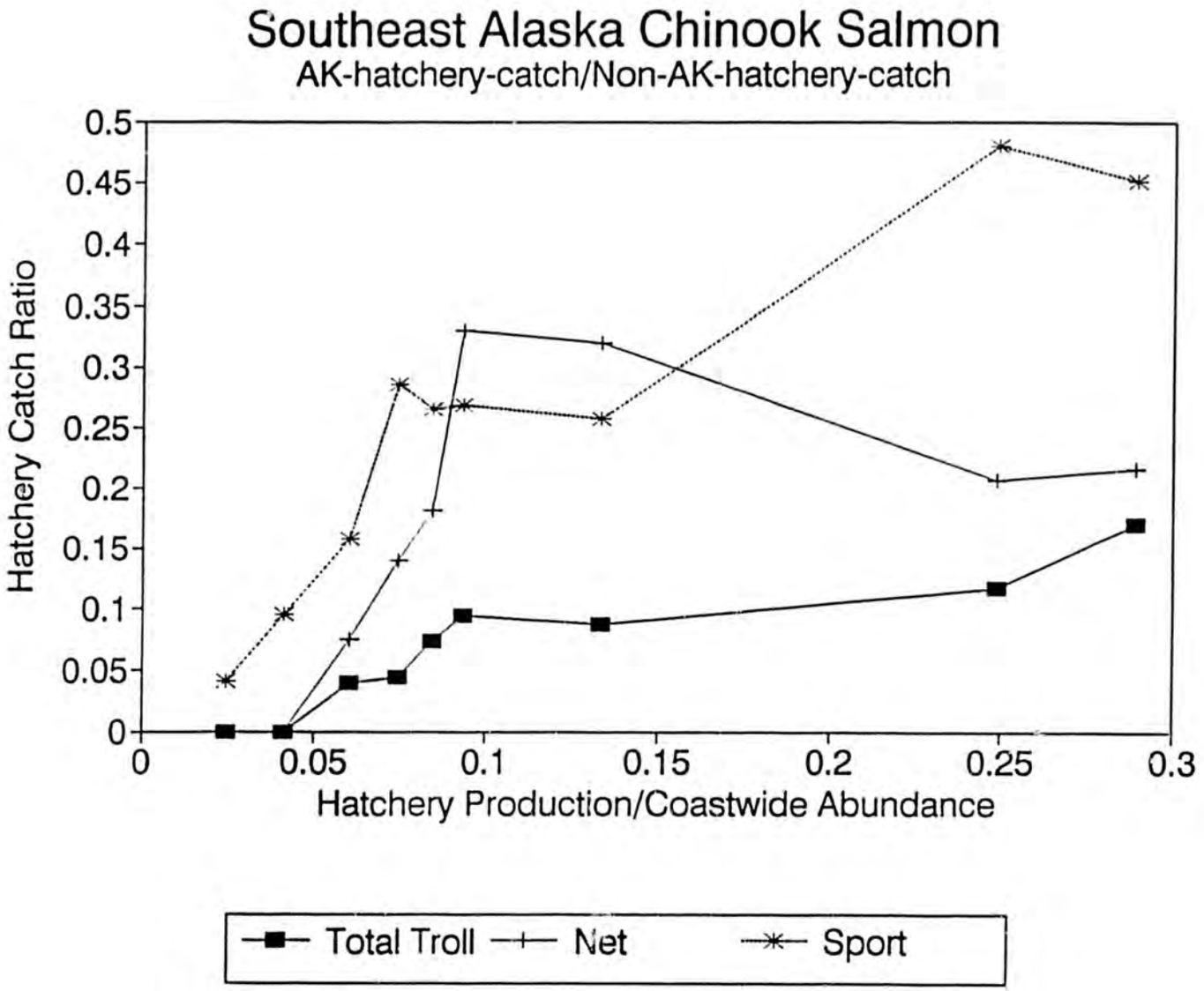

Prince William Sound Pink Salmon
Fry Releases (millions)
800
700
600
500
400
300
200
100
0
1980
1985
1990
1995
2000
2005
Release Year
Current
Planned
No Hatch
Increase
Decrease

Total returns with CURRENT releases.

Prince William Sound Pink Salmon

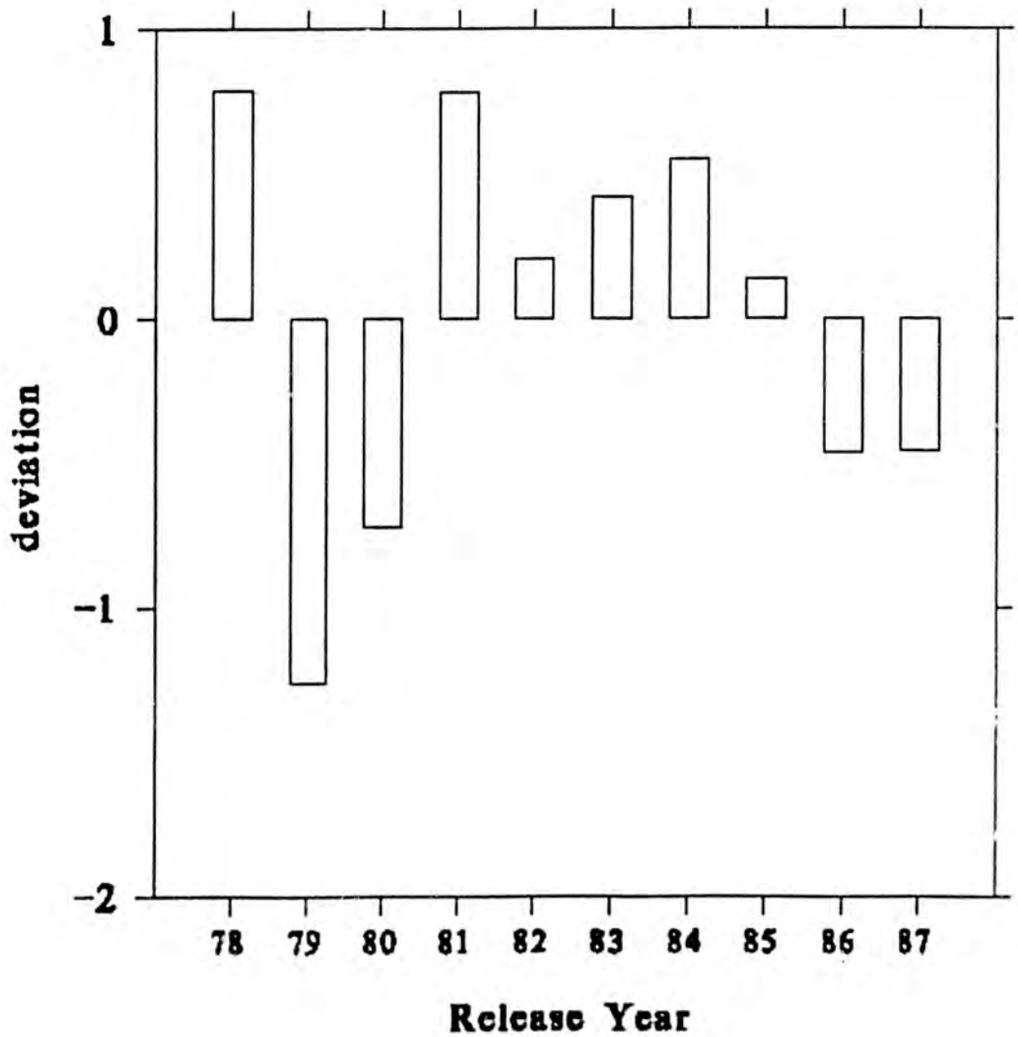



Prince William Sound Pink Salmon
Commercial Catch (millions)
Terminal Catch (millions)
Year
0
5
10
15
20
25
30
35
40
45
1995
2000
2005
Current
Manage
No Hatch
Increase
Decrease


Southeast Alaska Chinook Salmon
AK-hatchery-catch/Non-AK-hatchery-catch
Hatchery Catch Ratio
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
0.2
0.25
0.3
Hatchery Production/Coastwide Abundance
Total Troll
Net
Sport

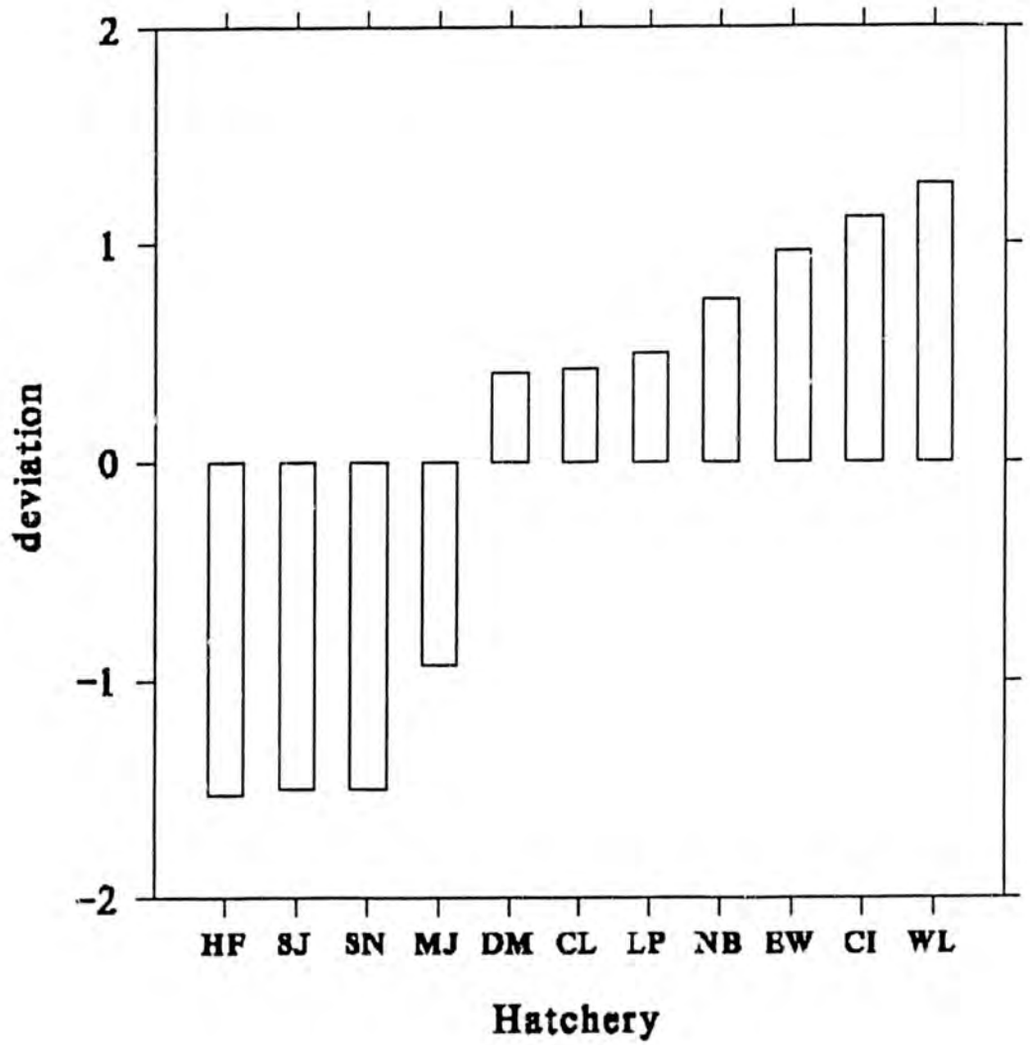
EFFECTS.SYS
VERTEF.CMD

Year Effects on Smolt Survival

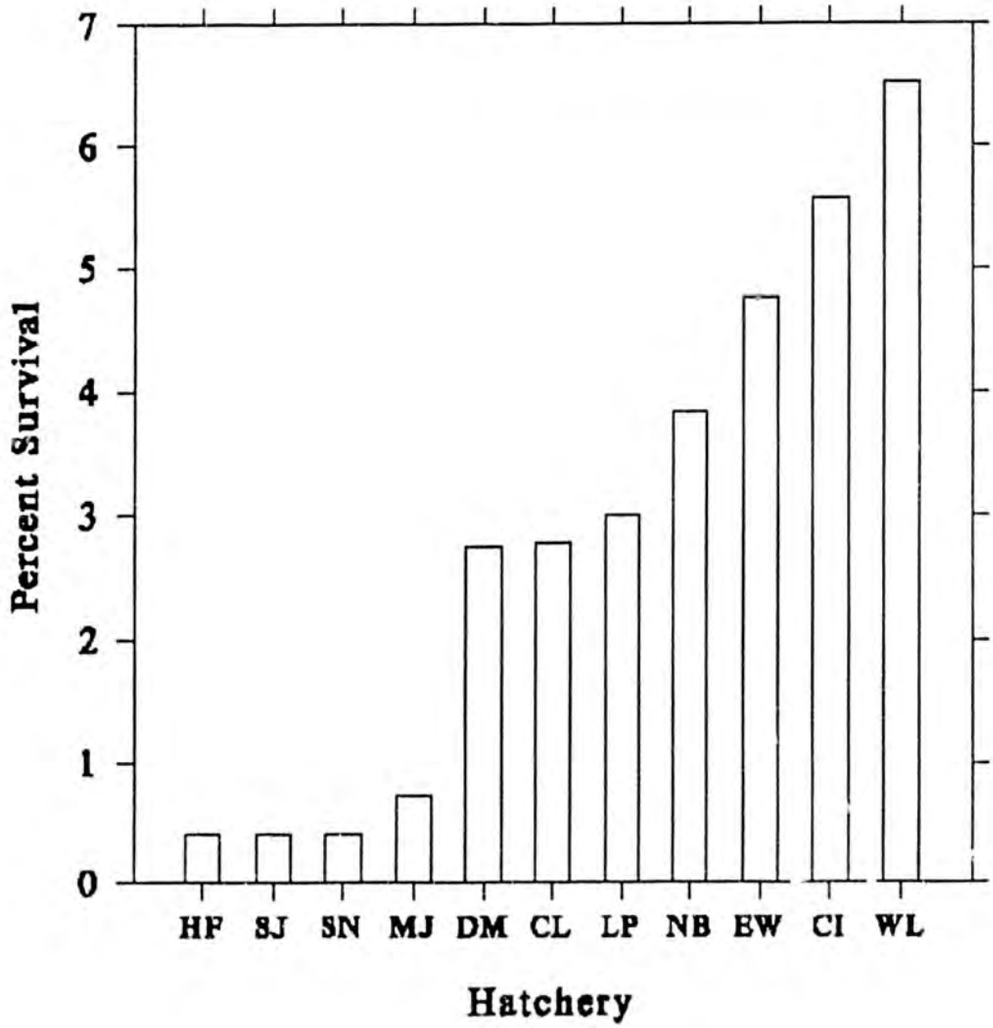


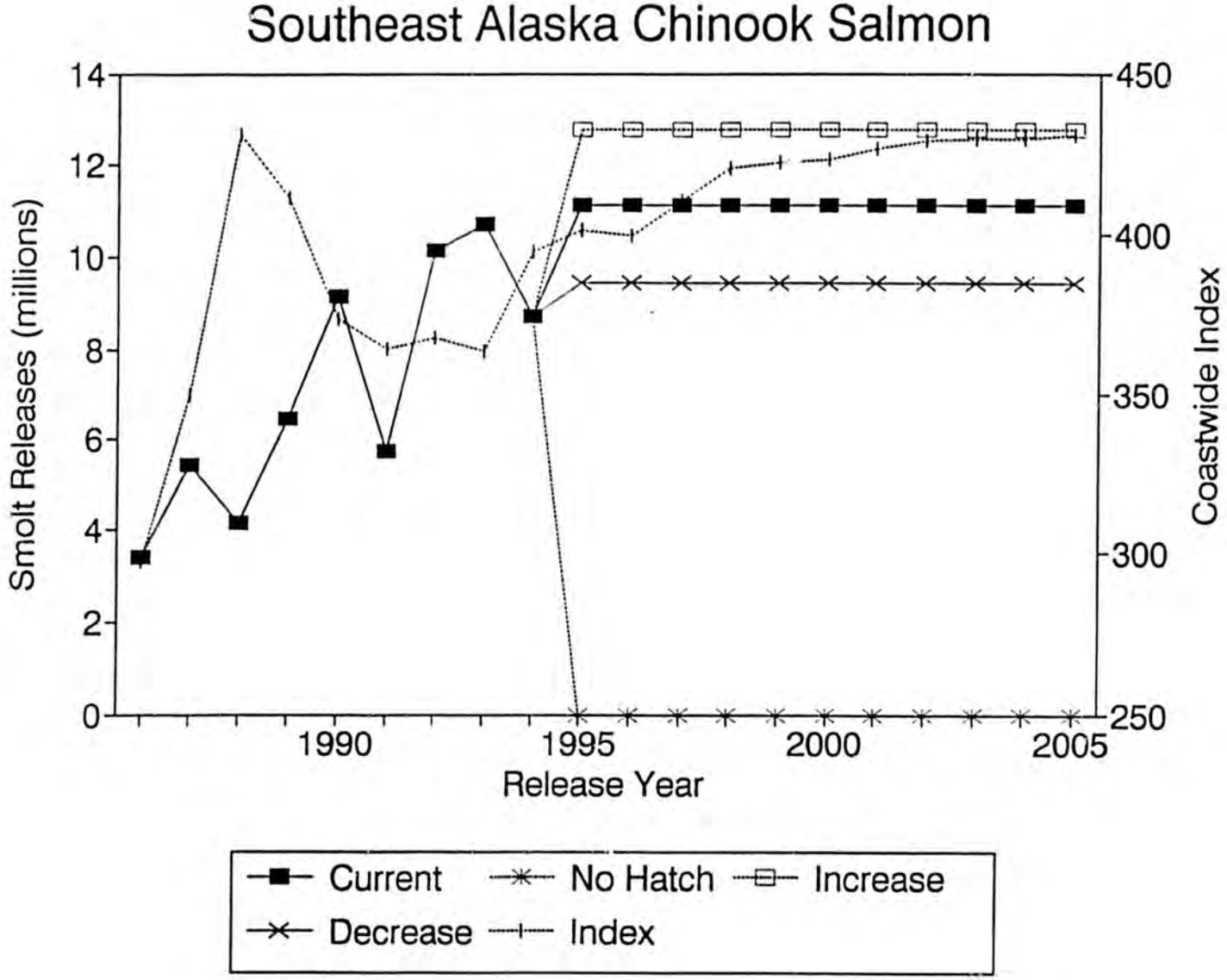
LEFFECT.CMD

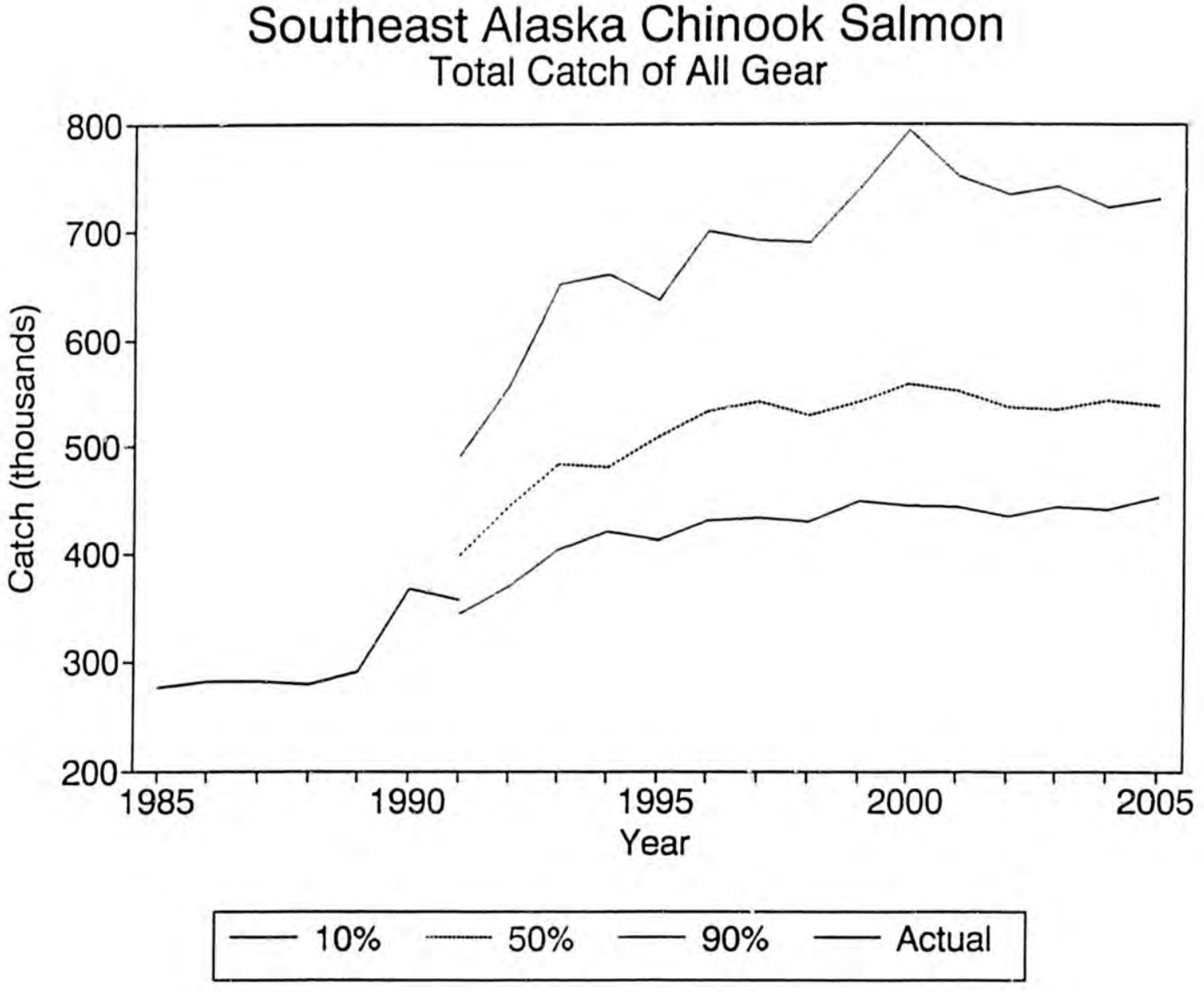
Location Effects on Smolt Survival

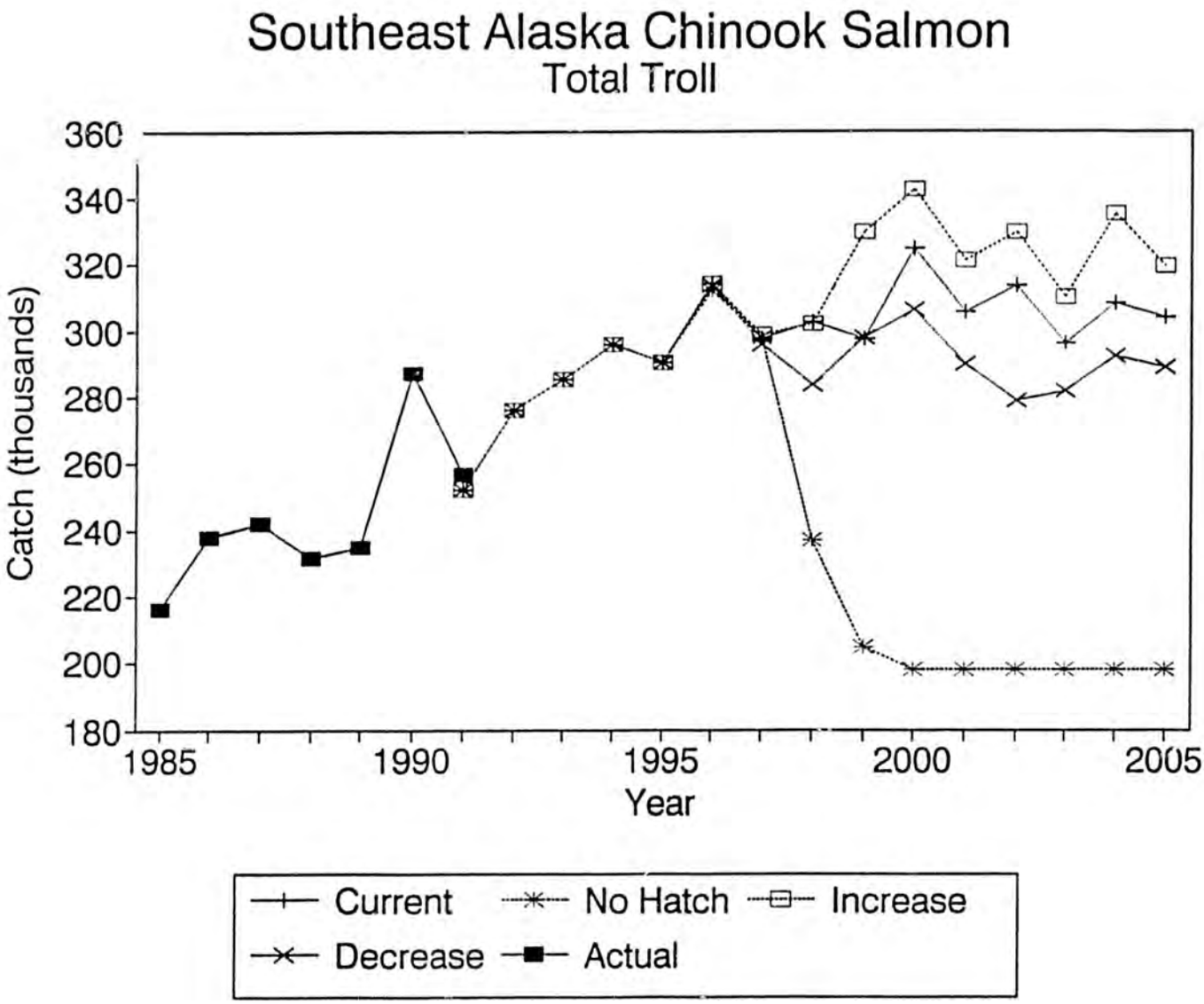


Smolt Marine Survival



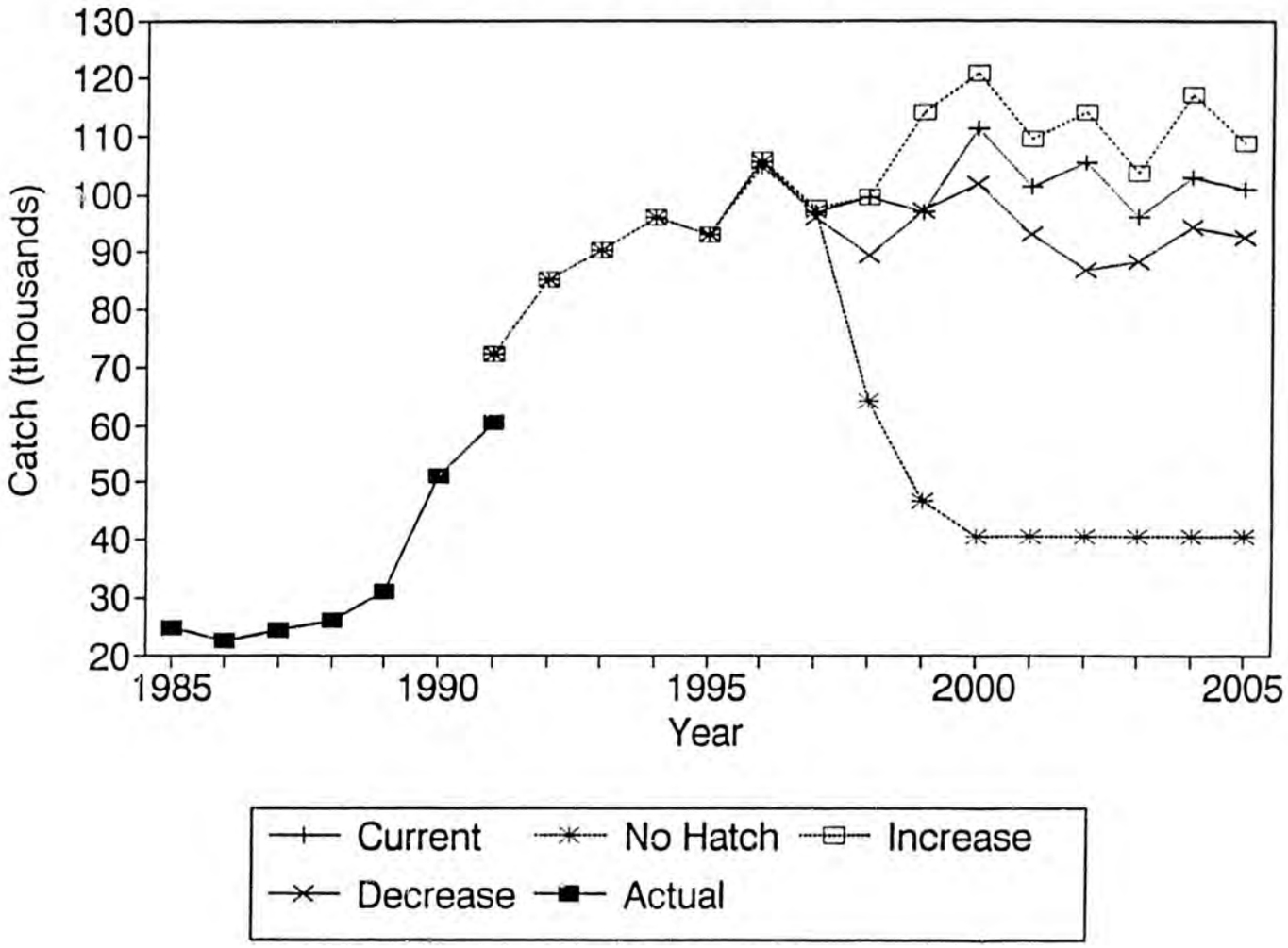

Southeast Alaska Chinook Salmon
Smolt Releases (millions)
Coastwide Index
Release Year
0
2
4
6
8
10
12
14
250
300
350
400
450
1990
1995
2000
2005
Current
No Hatch
Increase
Decrease
Index

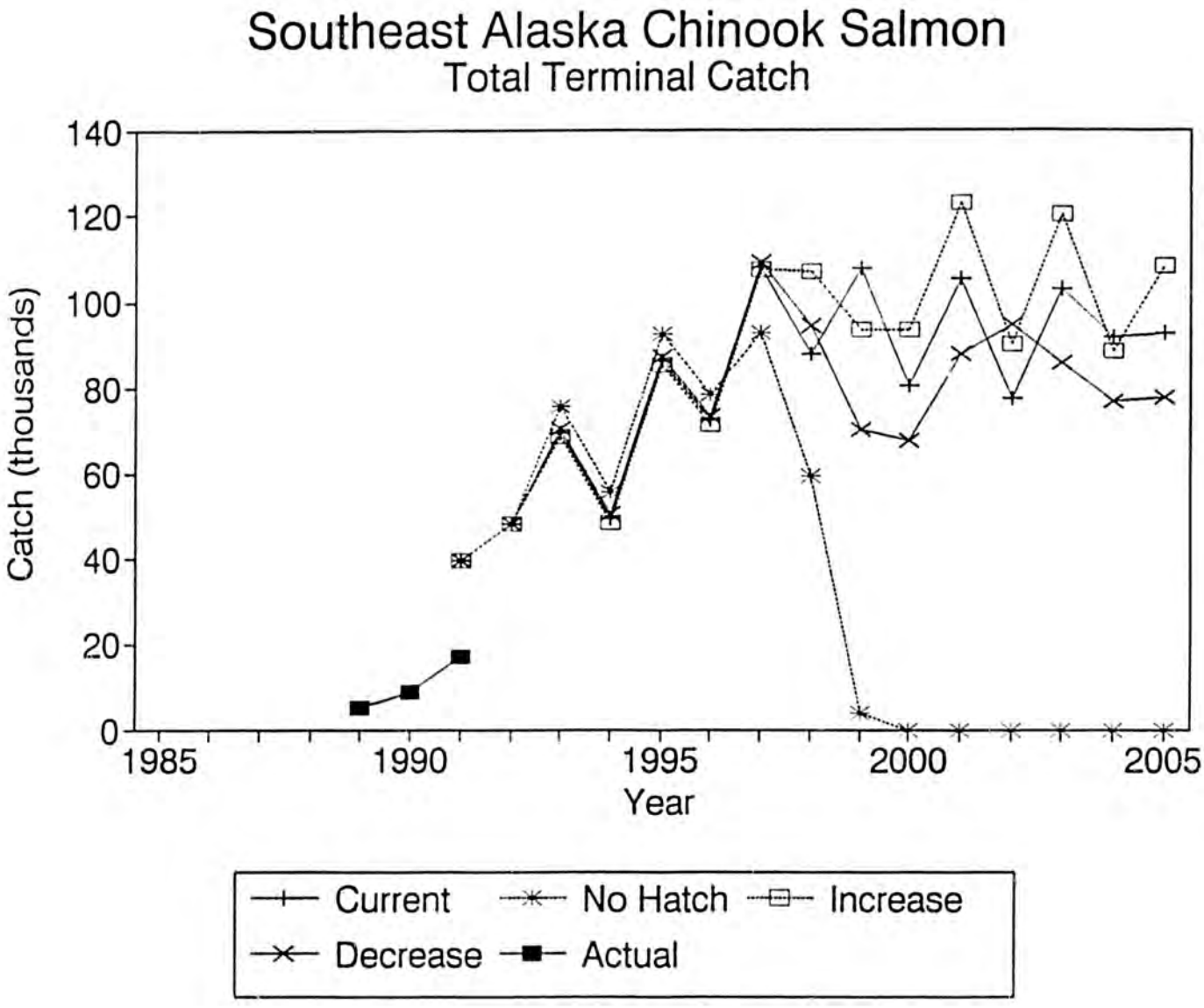

Southeast Alaska Chinook Salmon
Total Catch of All Gear
Catch (thousands)
800
700
600
500
400
300
200
1985
1990
1995
2000
2005
Year
10%
50%
90%
Actual


Southeast Alaska Chinook Salmon
Total Troll
Catch (thousands)
360
340
320
300
280
260
240
220
200
180
1985
1990
1995
2000
2005
Year
Current
No Hatch
Increase
Decrease
Actual

Southeast Alaska Chinook Salmon

Total Sport Catch




Southeast Alaska Chinook Salmon
Total Terminal Catch
Catch (thousands)
140
120
100
80
60
40
20
0
1985
1990
1995
2000
2005
Year
Current
No Hatch
Increase
Decrease
Actual