

**EXECUTIVE SUMMARY:  
STATUS OF KING CRAB STOCKS IN THE EASTERN BERING SEA IN 2004**

By

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The Alaska Department of Fish and Game (ADF&G) performs stock assessment analyses for the Bristol Bay red king crab *Paralithodes camtschaticus*, Pribilof red king crab, Pribilof blue king crab *P. platypus*, and St. Matthew Island blue king crab stocks using the data provided by the annual National Marine Fisheries Service (NMFS) eastern Bering Sea trawl survey (Rugolo et al. 2003), harvest data from the ADF&G fish ticket database, and ADF&G catch-sampling data. Two stock-assessment models developed by ADF&G are used: a length-based analysis (LBA) is used to estimate abundance of male and female Bristol Bay red king crabs and a catch-survey analysis (CSA) is used to estimate abundance of male Pribilof red king crabs, male and female Pribilof blue king crabs, and male St. Matthew Island blue king crabs. Both models differ from area-swept estimates of abundance in that they incorporate multiple years of trawl survey and fishery data to provide abundance estimates for the current survey year and previous survey years. The use of multiple years and sources of data in the LBA and CSA assessment methods results in abundance estimates that are generally more accurate than area-swept estimates based only on the current year's survey data. The LBA and CSA methods and their application to assessment of these stocks are reviewed in Zheng and Kruse (2000). Details on the LBA method applied to Bristol Bay red king crab in 2004 are provided in Appendix <?> to this SAFE.

Bristol Bay red king crab

The LBA estimation procedure provides estimates of abundance of males  $\geq 95$  mm carapace length (CL), abundance of females  $\geq 90$  mm CL, new recruitment of males and females to the modeled size classes, and effective spawning biomass (ESB). ESB is the biomass of mature females that the population of mature males can successfully mate in a given year. LBA estimates of small males (95-109 mm CL), prerecruit males (110-134 mm CL), mature males ( $\geq 120$  mm CL) and legal males ( $\geq 135$  mm CL), mature females ( $\geq 90$  mm CL), and ESB for the years 1972-2004 are provided in Table 1. Trends in mature male and female abundance over 1972-2004 and a comparison of LBA and annual area-swept estimates are portrayed graphically in Figure 1. LBA estimates for mature-sized females increased to 35.345-million in 2004 from 28.111-million in 2003, continuing a trend in annually increasing abundance since 2000 (Table 1, Figure 1). Although the 2004 point estimates are only slightly higher than those for 2003, the 2004 LBA estimates for effective spawning biomass (61.868-million pounds) and legal male abundance (10.358-million) are the highest since 1981 and the 2004 LBA estimates for abundance of mature-sized males (15.967-million) and females are the highest since 1982.

### Pribilof red king crab

The CSA estimation procedure for Pribilof red king crab provides estimates of the annual abundance during 1988-2004 for males in six size classes: Prerecruit 2 (105-119 mm CL), Prerecruit 1 (120-134 mm CL), Mature ( $\geq 120$  mm CL), Recruit Legal (new-shells 135-149 mm CL), Postrecruit Legal (old-shells  $\geq 135$  mm CL and all  $\geq 150$  mm CL), and Legal ( $\geq 135$  mm CL). Annual estimates of abundance for each size class for 1988-2004 are provided in Table 2; a graphical representation of the estimates of mature male abundance relative to area-swept estimates over 1988-2004 is provided in Figure 2. Estimated abundance of mature-sized and legal males for 2004 is 1.264-million and 1.244-million animals, respectively. Point estimates of abundance for mature-sized and legal males show a slight decreasing trend in recent years (Figure 2), but interpretation and reliability of such trends is difficult due to the very low precision of estimates (Table 2).

### Pribilof blue king crab

The CSA estimation procedure for Pribilof blue king crab provides estimates of the annual abundance during 1975-2004 for males in six size classes and females in four size classes (Zheng and Pengilly 2003). The six male size classes for which abundance is estimated are Prerecruit II (105-119 mm CL), Prerecruit I (120-134 mm CL), Mature ( $\geq 120$  mm CL), Recruit Legal (new-shells 135-148 mm CL), Postrecruit Legal (old-shells  $\geq 135$  mm CL and all  $\geq 149$  mm CL), and Legal ( $\geq 135$  mm CL). The four female size classes for which abundance is estimated are Group 1 (100-109 mm CL), Group 2 (110-119 mm CL), Group 3 (120-129 mm CL), and Group 4 ( $\geq 130$  mm CL). The total of the estimates for the four female size classes provides an estimate of mature-sized female abundance. Annual estimates of abundance for each size class for 1975-2004 are provided in Table 3 for males and Table 4 for females; a graphical representation of the estimates of mature-sized male and female abundance relative to area-swept estimates over 1975-2004 are provided in Figure 3. Estimated abundance of mature-sized and legal males for 2004 is 0.152-million and 0.145-million animals, respectively. Estimated abundance of mature-sized and legal males, as well as mature-sized females, have shown a declining trend since the mid-1990s. Estimated abundance of prerecruit males in 2004 is very low (0.024 million animals for combined Prerecruit I and Prerecruit II) and 0.137 million of the estimated 0.145 million legal males were accounted for by postrecruit legal males.

### St. Matthew blue king crab

The CSA estimation procedure for St. Matthew blue king crab provides estimates of the annual abundance during 1978-2004 for males in six size classes: Prerecruit II (90-104 mm CL), Prerecruit I (105-119 mm CL), Mature ( $\geq 105$  mm CL), Recruit Legal (new-shells 120-133 mm CL), Postrecruit Legal (old-shells  $\geq 120$  mm CL and all  $\geq 134$  mm CL), and Legal ( $\geq 120$  mm CL). The CSA method for St. Matthew blue king crab assumes that natural mortality for the year between the 1998 and 1999 surveys was higher than that of other years to account for the drastic reduction in stock abundance observed between 1998 and 1999. Annual estimates of abundance for each size class for 1978-2004 are provided in Table 5; a graphical representation of the estimates of mature-sized male abundance relative to area-swept estimates over 1978-2004 is provided in Figure 4. Estimated abundance of mature-sized and legal males for 2004 is 1.291-million and 0.904-million animals, respectively. This stock is showing stability relative to the low stock size observed in 1999, but remains very low relative to the levels of 1991-1998.

## Literature Cited

Rugolo, L.J., R.A. MacIntosh, C.E. Armistead, J.A. Haaga, and R.S. Otto. 2003. Report to industry on the 2003 eastern Bering Sea crab survey. National Marine Fisheries Service, Alaska Fisheries Science Center, Processed Report 2003-11, Kodiak.

Zheng, J. and G.H. Kruse. 2000. Status of king crab stocks in the eastern Bering Sea in 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J00-09, Juneau.

Zheng, J. and D. Pengilly. 2003. Evaluation of alternative rebuilding strategies for Pribilof Islands blue king crabs. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J03-10, Juneau.

Table 1. ADF&G estimates of annual abundance (millions of crabs), effective spawning biomass (ESB, millions of pounds), and 95% confidence intervals for 2004 for red king crabs in Bristol Bay estimated by length-based analysis from 1972-2004. Size measurements are mm CL.

Year mm→	Males					Females		ESB (M lbs)
	Recruits (to model)	Small (95-109)	Prerec. (110-134)	Mature (>119)	Legal (>134)	Recruits (to model)	Mature (>89)	
1972	NA	13.120	14.608	17.962	9.706	NA	59.465	53.833
1973	31.186	21.480	25.116	22.155	10.489	35.233	71.189	61.959
1974	23.006	16.309	33.797	33.826	14.968	28.883	71.981	93.023
1975	33.469	23.099	34.851	40.407	20.849	22.344	65.969	116.699
1976	45.692	31.582	44.437	48.454	25.234	34.160	74.172	128.012
1977	57.617	39.925	59.079	61.709	30.446	74.977	119.899	165.008
1978	25.185	18.526	59.814	76.460	40.132	49.568	122.040	203.999
1979	13.885	10.047	37.336	74.481	48.631	21.499	95.459	170.907
1980	25.140	17.257	25.851	59.805	44.502	36.208	94.185	167.942
1981	17.928	12.868	16.814	18.066	9.423	14.205	71.300	58.815
1982	22.069	15.427	15.017	9.691	2.911	18.166	30.342	22.963
1983	12.180	8.924	12.255	8.423	2.429	4.566	9.723	16.363
1984	18.272	12.687	11.573	7.363	2.271	7.928	9.583	14.387
1985	9.730	7.147	9.809	6.439	1.688	5.615	7.239	10.773
1986	7.096	5.134	11.887	11.216	4.290	4.038	9.036	14.338
1987	6.800	4.828	10.619	13.164	6.595	10.317	16.581	26.006
1988	7.072	4.995	9.855	13.933	8.029	6.279	17.749	29.561
1989	5.787	4.143	9.374	15.167	9.496	5.945	18.262	31.756
1990	1.620	1.304	7.145	14.960	10.123	0.938	13.616	26.238
1991	4.359	2.988	4.843	11.785	8.661	3.853	13.334	25.775
1992	5.993	4.176	5.955	9.906	6.761	3.356	12.616	24.651
1993	2.572	2.194	6.836	10.077	5.998	2.229	10.994	22.146
1994	1.187	1.042	5.311	8.586	4.893	0.404	8.047	17.552
1995	2.929	2.093	4.566	9.314	6.228	1.592	9.138	20.178
1996	3.191	2.400	5.113	10.222	7.088	4.375	12.931	26.710
1997	13.326	9.073	8.496	11.533	7.517	16.284	28.369	39.183
1998	3.283	3.332	13.109	15.306	7.817	1.774	28.210	51.427
1999	1.459	1.145	8.033	15.806	9.742	0.654	20.299	43.336
2000	3.767	2.654	5.733	12.872	8.859	4.719	18.860	39.589
2001	8.017	5.672	7.228	11.732	7.813	7.658	20.762	40.912
2002	2.368	2.294	9.289	13.552	7.943	2.632	22.027	45.900
2003	5.817	4.027	7.661	15.064	10.054	7.473	28.111	57.625
2004	15.132	10.381	11.339	15.967	10.358	9.052	35.345	61.868
95% Confidence Limits in 2004								
Lower	10.842	NA	9.035	12.332	7.630	7.176	29.276	NA
Upper	24.103	NA	14.000	18.943	12.814	14.930	45.044	NA

Table 2. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2004 of Pribilof male red king crabs by 4-stage catch-survey analysis (CSA) from 1988-2004. Recruit legals are new-shelled males 135-149-mm CL. All other legal males are postrecruits. Size ranges are in mm CL.

Year	PreRec. II (105-119)	PreRec I (120-134)	Mature (≥120)	Recruit newshell (135-149)	Post Oldshell (≥135)	Legal (≥135)
1988	0.2891	0.0417	0.0625	0.0209	0.0000	0.0209
1989	0.2895	0.2158	0.2815	0.0457	0.0199	0.0657
1990	2.1309	0.2509	0.4631	0.1455	0.0667	0.2121
1991	0.3486	1.5540	2.0458	0.2982	0.1936	0.4918
1992	0.0655	0.6155	2.0087	0.8991	0.4941	1.3932
1993	0.6174	0.2037	1.7640	0.3415	1.2188	1.5603
1994	0.1267	0.4609	1.6226	0.1530	1.0087	1.1617
1995	0.1499	0.2010	1.3328	0.2647	0.8671	1.1318
1996	0.0310	0.1513	1.1533	0.1200	0.8819	1.0019
1997	0.7777	0.0581	0.9862	0.0871	0.8410	0.9281
1998	0.4014	0.5573	1.3624	0.0889	0.7163	0.8051
1999	0.3487	0.4036	1.4248	0.3648	0.6564	1.0212
2000	0.3647	0.3341	1.5015	0.2739	0.8934	1.1673
2001	0.3930	0.3339	1.5869	0.2378	1.0151	1.2529
2002	0.0437	0.3514	1.6834	0.2435	1.0886	1.3321
2003	0.0048	0.0883	1.4748	0.2293	1.1572	1.3865
2004	0.0006	0.0201	1.2641	0.0548	1.1893	1.2441
Lower 95%	NA	NA	0.5575	NA	NA	0.5434
Upper 95%	NA	NA	1.9708	NA	NA	1.9447

Table 3. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2004 of Pribilof blue king crab males by 4-stage catch-survey analysis (CSA) from 1975-2004. Recruit legals are new-shelled males 135-148-mm CL; all other legal males are postrecruits. Size ranges are in mm CL.

Year	PreRec. II (105-119)	PreRec I (120-134)	Mature (≥120)	Recruit newshell (135-148)	Post oldshell (≥135)	Legal (≥135)
1975	2.1538	3.8783	12.2488	3.8466	4.5238	8.3704
1976	1.1055	2.5245	10.5942	2.1236	5.9462	8.0698
1977	2.9061	1.4291	8.2844	1.5758	5.2795	6.8553
1978	2.4442	2.3282	7.8263	1.0967	4.4013	5.4981
1979	0.3412	2.2513	7.3545	1.6528	3.4503	5.1031
1980	0.5507	0.8391	5.4080	1.4258	3.1431	4.5689
1981	0.4623	0.5889	3.3165	0.5606	2.1670	2.7276
1982	0.4742	0.4625	1.9085	0.3912	1.0548	1.4460
1983	0.3573	0.4312	1.3465	0.3014	0.6139	0.9153
1984	0.0899	0.3491	1.0902	0.2740	0.4671	0.7411
1985	0.0283	0.1545	0.8968	0.2226	0.5197	0.7423
1986	0.0023	0.0536	0.6505	0.1120	0.4849	0.5969
1987	0.0022	0.0134	0.4571	0.0376	0.4061	0.4437
1988	0.0002	0.0027	0.2619	0.0121	0.2471	0.2592
1989	2.5449	0.0008	0.1907	0.0019	0.1880	0.1899
1990	0.6481	1.3812	1.6428	0.1239	0.1377	0.2616
1991	0.2008	0.8543	1.7431	0.6610	0.2278	0.8887
1992	0.8801	0.4314	1.5022	0.4027	0.6680	1.0708
1993	0.4389	0.6039	1.6386	0.2460	0.7887	1.0347
1994	0.5228	0.4483	1.5203	0.3047	0.7673	1.0720
1995	0.5369	0.4298	1.4540	0.2343	0.7899	1.0242
1996	0.3020	0.4215	1.2527	0.2106	0.6207	0.8312
1997	0.1054	0.3101	1.0149	0.1870	0.5178	0.7048
1998	0.1501	0.1824	0.7667	0.1190	0.4652	0.5843
1999	0.0759	0.1407	0.5812	0.0658	0.3747	0.4405
2000	0.0349	0.0954	0.4606	0.0434	0.3218	0.3652
2001	0.0165	0.0601	0.3541	0.0276	0.2664	0.2940
2002	0.0063	0.0336	0.2714	0.0233	0.2145	0.2378
2003	0.0020	0.0163	0.2052	0.0156	0.1733	0.1889
2004	0.0170	0.0073	0.1523	0.0076	0.1374	0.1450
Lower 95%	NA	NA	0.0789	NA	NA	0.0722
Upper 95%	NA	NA	0.2258	NA	NA	0.2178

Table 4. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2004 of Pribilof blue king crab females by 4-stage catch-survey analysis (CSA) from 1975-2004. Size ranges are in mm CL.

Year	Group 1 (100-109)	Group 2 (110-119)	Group 3 (120-129)	Group 4 (≥120)	Total Mature (≥100)
1975	1.6781	2.2892	1.5026	0.7802	6.2501
1976	3.6040	1.7893	1.5298	0.7679	7.6910
1977	2.7691	2.2936	1.4485	0.7860	7.2971
1978	1.9481	2.1145	1.5634	0.7936	6.4196
1979	0.9239	1.7163	1.5583	0.8059	5.0044
1980	1.9760	1.1583	1.4239	0.8030	5.3612
1981	0.9551	1.3179	1.1796	0.7717	4.2244
1982	0.5089	1.0242	1.0582	0.7090	3.3003
1983	0.5528	0.7191	0.9056	0.6435	2.8210
1984	0.2469	0.5870	0.7379	0.5776	2.1495
1985	0.1194	0.3960	0.6032	0.5126	1.6312
1986	0.0735	0.2420	0.4747	0.4537	1.2439
1987	0.0418	0.1439	0.3560	0.3987	0.9404
1988	0.0468	0.0837	0.2563	0.3439	0.7307
1989	0.6028	0.0593	0.1789	0.2897	1.1307
1990	0.8620	0.3088	0.1250	0.2393	1.5350
1991	0.9190	0.5459	0.1658	0.1948	1.8255
1992	1.4561	0.6754	0.2631	0.1681	2.5626
1993	0.9436	0.9798	0.3657	0.1635	2.4526
1994	1.8042	0.8545	0.5326	0.1778	3.3691
1995	1.1111	1.2039	0.5908	0.2147	3.1206
1996	0.6326	1.0321	0.7328	0.2493	2.6467
1997	0.3640	0.7537	0.7483	0.2899	2.1558
1998	0.2489	0.5135	0.6689	0.3178	1.7491
1999	0.4090	0.3516	0.5511	0.3266	1.6383
2000	0.2382	0.3493	0.4344	0.3195	1.3414
2001	0.1501	0.2631	0.3660	0.3011	1.0804
2002	0.0610	0.1781	0.3008	0.2815	0.8214
2003	0.0233	0.0978	0.2351	0.2593	0.6156
2004	0.0082	0.0500	0.1692	0.2306	0.4580
Lower 95%	NA	NA	NA	NA	0.3406
Upper 95%	NA	NA	NA	NA	0.5754

Table 5. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2004 of St. Matthew Island male blue king crabs by 4-stage catch-survey analysis (CSA) from 1978-2004. Natural mortality in year 1998/99 was estimated separately from other years ("2-*m* CSA model). Recruit legals are new-shelled males 120-133 mm CL. All other legal males are postrecruits. Size ranges are in mm CL.

Year	PreRec. II (90-104)	PreRec I (105-119)	Mature (≥105)	Recruit Newshell (120-133)	Post oldshell (≥120)	Legal (≥120)
1978	1.0269	1.4817	3.4180	1.2959	0.6404	1.9363
1979	2.3013	1.3592	3.5722	1.0643	1.1487	2.2130
1980	2.1005	2.5218	5.3061	1.1551	1.6293	2.7843
1981	0.8321	2.6579	6.6806	1.9090	2.1137	4.0227
1982	0.9484	1.4818	5.6681	1.9113	2.2751	4.1863
1983	0.4724	1.2803	4.0657	1.1137	1.6717	2.7854
1984	0.2821	0.8015	2.2907	0.8674	0.6218	1.4892
1985	0.5227	0.4934	1.4980	0.5188	0.4858	1.0046
1986	0.3884	0.6051	1.3458	0.3580	0.3827	0.7407
1987	0.7238	0.5301	1.3751	0.4456	0.3995	0.8450
1988	0.6523	0.8027	1.7250	0.4602	0.4621	0.9223
1989	1.6059	0.7819	1.9443	0.6790	0.4833	1.1624
1990	1.1591	1.6611	3.1323	0.7733	0.6979	1.4712
1991	1.1544	1.4491	3.6797	1.3715	0.8591	2.2307
1992	1.2022	1.4082	3.7400	1.1960	1.1357	2.3318
1993	1.2598	1.4567	3.9572	1.1511	1.3494	2.5005
1994	1.1677	1.5355	4.1106	1.1723	1.4028	2.5751
1995	1.4395	1.4777	3.9921	1.2056	1.3087	2.5143
1996	1.4332	1.6911	4.3104	1.2319	1.3873	2.6193
1997	0.9385	1.7303	4.6049	1.3950	1.4795	2.8745
1998	0.6027	1.3133	4.0807	1.3184	1.4490	2.7674
1999	0.3511	0.2855	1.0340	0.2900	0.4586	0.7486
2000	0.3087	0.4065	1.1907	0.2283	0.5559	0.7843
2001	0.3773	0.3972	1.2792	0.2949	0.5870	0.8819
2002	0.1514	0.4397	1.3619	0.2667	0.6555	0.9222
2003	0.3532	0.2706	1.2254	0.2685	0.6863	0.9548
2004	0.2813	0.3872	1.2914	0.2007	0.7035	0.9042
Lower 95%	NA	NA	0.7432	NA	NA	0.5096
Upper 95%	NA	NA	1.8395	NA	NA	1.2987

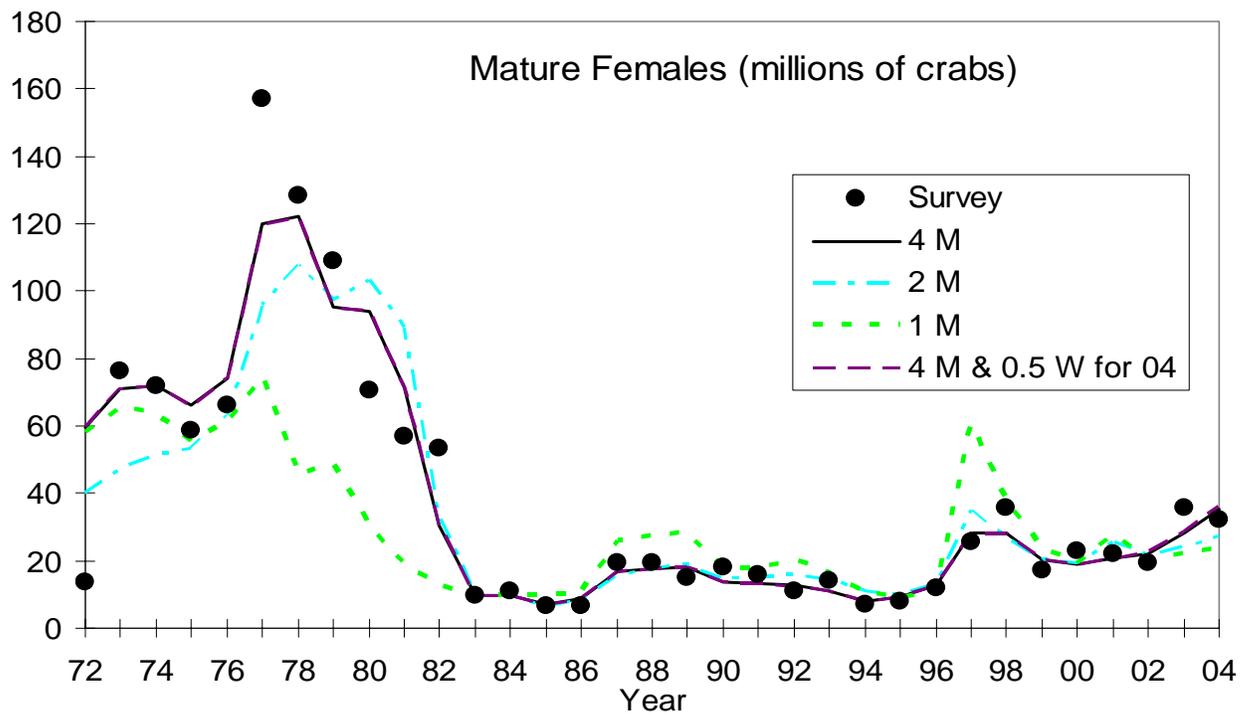
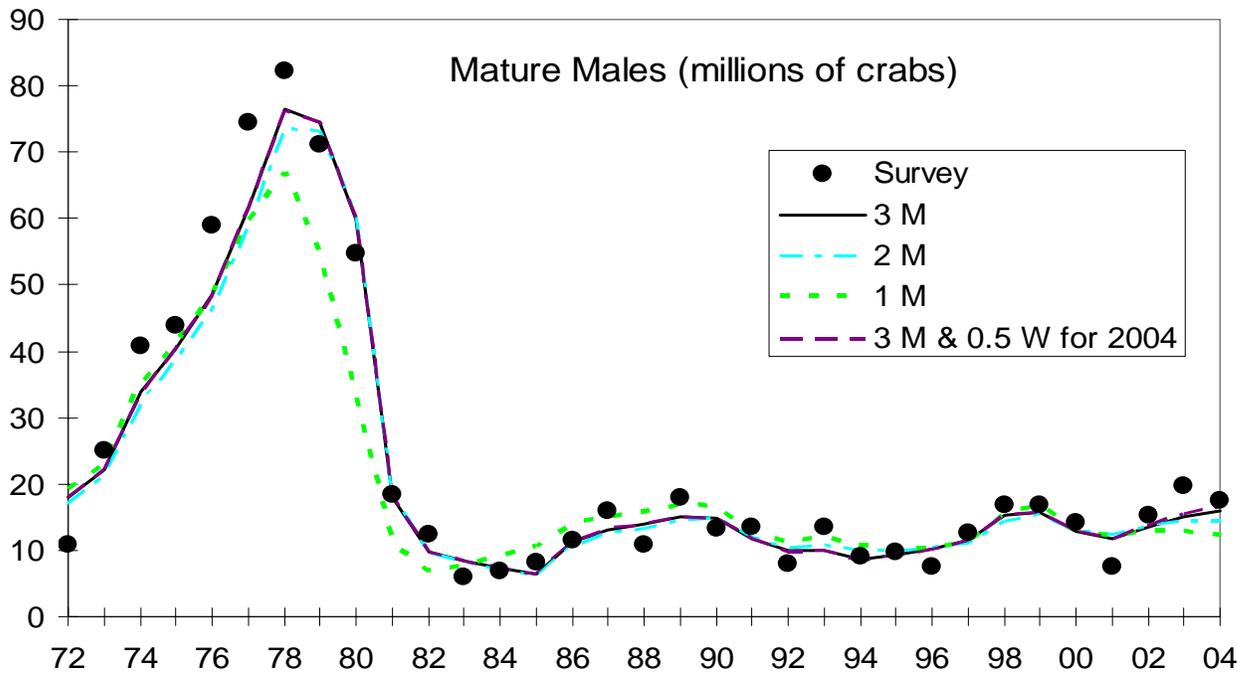


Figure 1. The LBA fit (line) to area-swept estimates (dots) of mature male (top panel) and mature female (bottom panel) Bristol Bay red king crab abundance (millions of crabs), 1972-2004 (ADF&G estimates). Four scenarios of LBA with different levels of natural mortality are compared; GHL calculations for 2004 use results from the male 3-*m* and female 4-*m* models are the models (see Appendix <?>).

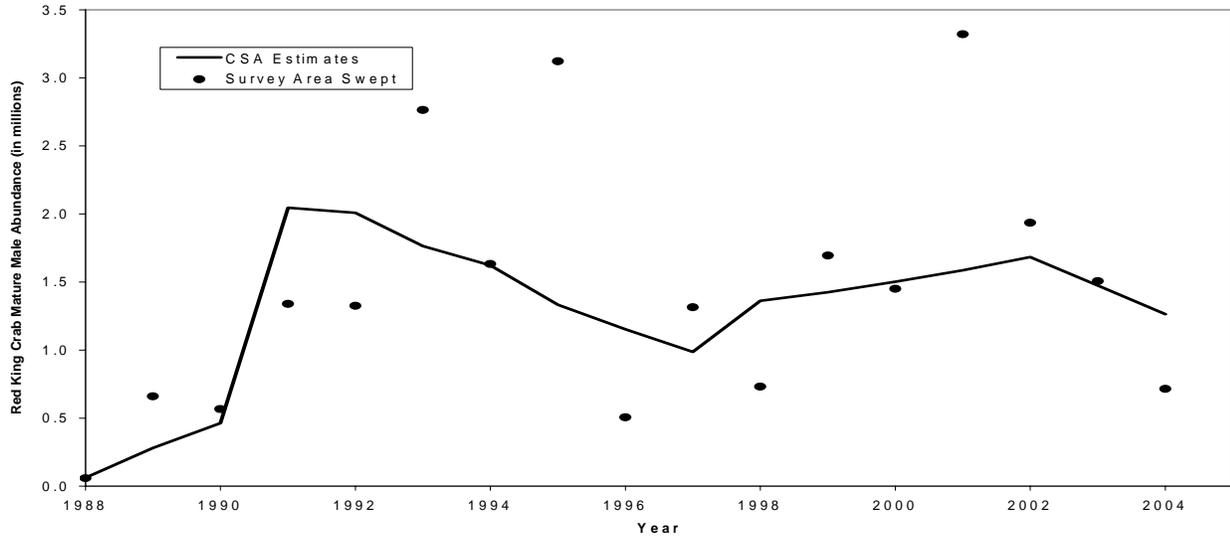


Figure 2. Annual estimates of abundance of mature male Pribilof red king crab. Solid line is the CSA estimate for 1988-2004. Dots are the area-swept estimates for 1978-2004.

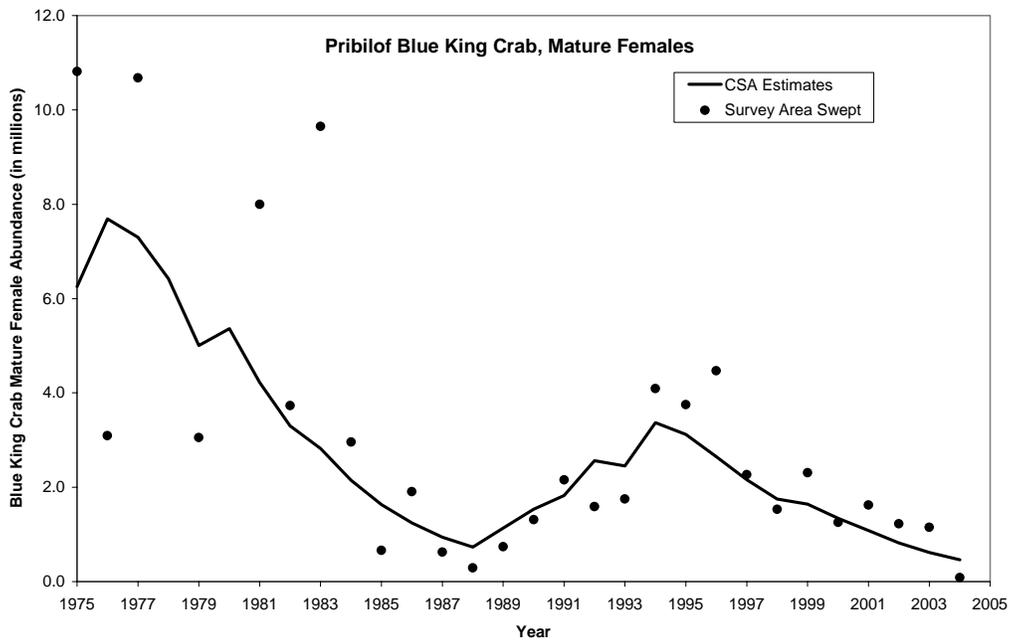
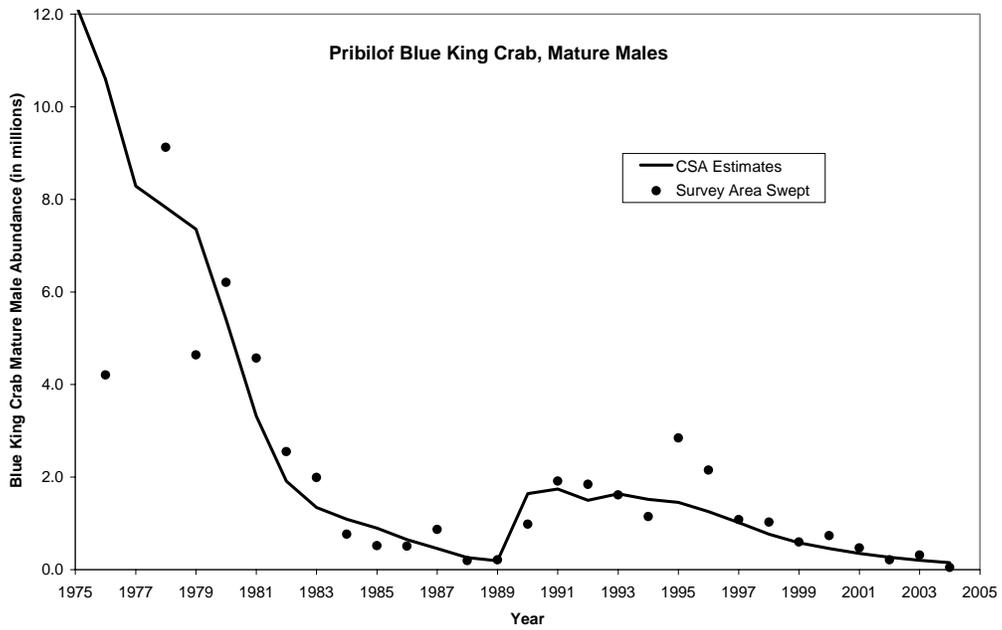


Figure 3. The CSA fit (line) to area-swept estimates (dots) of mature male (top panel) and mature female (bottom panel) Pribilof blue king crab abundance (millions of crabs), 1978-2004.

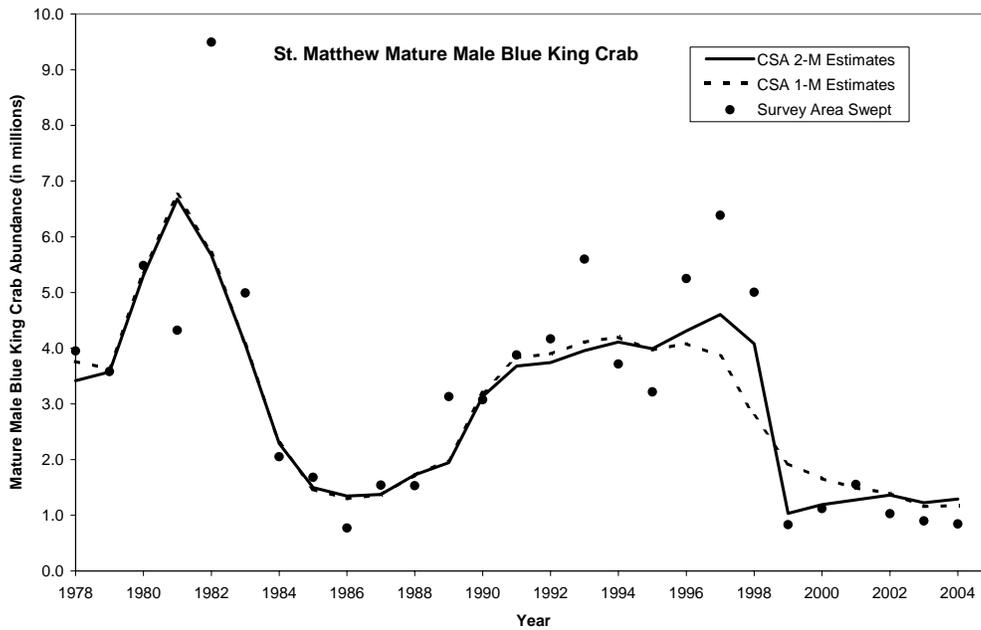


Figure 4. Annual estimates of abundance of mature male St. Matthew Island blue king crab for 1978-2004. Dashed line is the “2-*m*” catch-survey analysis (CSA) estimate that allows for increased natural mortality between 1998 and 1999. Solid line is the CSA estimate with constant natural mortality. Dots are the area-swept estimates. GHL computations for 2004 use the “2-*m*” CSA estimate.