STATUS OF KING CRAB STOCKS IN THE EASTERN BERING SEA IN 2003

By

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ABSTRACT

Population estimation models were used to estimate annual abundance of red king crabs in the Bristol Bay Area during 1972-2003, red king crabs in the Pribilof District during 1988-2003, blue king crabs in the St. Matthew Island Section during 1978-2003, and blue king crabs in the Pribilof District during 1975-2003. A length-based analysis (LBA) was applied to male and female red king crabs in Bristol Bay, a four-stage catch-survey analysis (CSA) was applied to males and females for the Pribilof District blue king crab stock, and a four-stage catch-survey analysis (CSA) was applied to males only, for the other two king crab stocks. The guideline harvest level (GHL) in 2003 for the Bristol Bay red king crab fishery was set at 15.7 million pounds. Both stocks of blue king crabs are in a depressed condition and classified as overfished. Both stocks of blue king crabs were closed to fishing in 2003. Red king crabs in the Pribilof District was also closed due to low precision of the abundance estimate and concerns on potential bycatch of blue king crabs.

EXECUTIVE SUMMARY

We applied population abundance estimation models to eastern Bering Sea trawl survey, catch sampling, and commercial catch data for red king crabs in Bristol Bay during 1972-2003, red king crabs in the Pribilof District during 1988-2003, blue king crabs in the St. Matthew Island section during 1978-2003, and blue king crabs in the Pribilof District during 1975-2003. A length-based analysis (LBA) was applied to male and female red king crabs in Bristol Bay, a four-stage catch-survey analysis (CSA) was applied to males and females for the Pribilof District blue king crab stock, and a four-stage CSA was applied to males only, for the other two king crab stocks.

For Bristol Bay red king crabs, abundance of large-sized crabs (> 134 mm CL) increased from last year. Abundance of mature males increased from 14.1 million crabs in 2002 to 16.4 million crabs in 2003, and legal male abundance increased from 8.3 million to 10.4 million crabs. Mature female abundance also increased from 23.0 million crabs in 2002 to 29.7 million crabs in 2003, and therefore the effective spawning biomass (ESB) increased from 47.8 to 60.7 million pounds. The ESB is above the target rebuilt level of 55 million pounds. Because the ESB is above the rebuilt level, a 15% harvest rate is applied to mature male abundance to determine the 2003 guideline harvest level (GHL). By multiplying the 15% harvest rate times mature male abundance times an average weight of 6.45 pounds per legal crab, an overall preseason GHL of 15.7 million pounds was set. A total of 7.5% of the GHL or 1.2 million pounds is reserved for the community development quota (CDQ) fishery, resulting in a GHL of 14.5 million pounds for the general fishery. The general fishery opened on October 15, 2003.

Abundance estimates for red king crabs in the Pribilof District have very poor precision. Mature male abundance of Pribilof District red king crabs is estimated at 1.5 million crabs in 2003, but precision is so poor that trends in recent years cannot be specified. Given the low precision of abundance estimates and concerns on bycatch of Pribilof District blue king crabs, the fishery was closed for the Pribilof District red king crab stock in 2003.

For St. Matthew Island Section blue king crabs, the CSA model estimated the abundance of prerecruit (sublegal males) and legal-sized male crabs. Compared to 2002, prerecruit abundance increased slightly in 2003, while mature male abundance decreased slightly. Prerecruit abundance increased to 0.80 million crabs from 0.62 million in 2002, and mature male abundance decreased from 1.47 million to 1.33 million crabs. Although the stock is above the fishery threshold of 2.9 million pounds of mature male biomass, the GHL determined by the harvest strategy (0.685 million pounds) is below the minimum GHL for a fishery opening (2.5 million pounds). This stock remains in a depressed condition and was closed in 2003.

For Pribilof District blue king crabs, the CSA model estimated both male and female abundance this year. The CSA indicated that the mature male abundance continued to decline to 0.29 million crabs in 2003 from 0.38 million crabs in 2002. Legal male abundance slightly declined to 0.28 million crabs in 2003. Similar to 2001 and 2002, very few small-sized crabs were caught during the 2003 survey and larger crabs tended to be old shelled. Similarly, the mature females have steadily declined from 3.38 million crabs in 1994 to 0.95 million crabs in 2003. The Pribilof District blue king crab stock is below the fishery threshold of 0.77 million mature males and the fishery remained closed for the 2003 season.

INTRODUCTION

The National Marine Fisheries Service (NMFS) conducts annual trawl surveys of crab and groundfish abundance in the eastern Bering Sea. For each crab stock, the Alaska Department of Fish and Game (ADF&G), in consultation with NMFS, sets preseason guideline harvest levels (GHLs). For most commercially exploited stocks in the Bering Sea, abundance is estimated by area-swept methods and reported annually by NMFS (e.g., Rugolo et al. 2003). For some stocks, ADF&G developed population estimation models to minimize the effects of annual survey measurement errors on current-year abundance estimates by incorporating survey and fishery data from prior years into the estimation process. Abundance estimates from these models are used to manage the crab fisheries and to set annual crab bycatch limits in the groundfish fisheries.

The goal of this report is to provide concise information on the stock status of Bering Sea king crab stocks. This provides the industry and public with access to information used by the agencies to evaluate status of stocks as estimated by population models. In this report we briefly review estimation methods, current stock status, implications for crab fishery management and regulation of crab bycatch in groundfish fisheries, and a brief outlook for the future. Trawl survey data used in this year's analyses were provided by Drs. Bob Otto and Lou Rugolo of NMFS, Kodiak, Alaska.

METHODS

Survey Methods

NMFS has performed annual trawl surveys of the eastern Bering Sea since 1968. Two vessels, each equipped with an eastern otter trawl with an 83-ft headrope and a 112-ft footrope, conduct this multispecies, crab-groundfish survey during summer. Stations are sampled in the center of a systematic 20 X 20 nm grid overlaid in an area of ≈140,000 nm^2. The towed area is estimated, and fish and invertebrate catches from each station are sampled, enumerated, measured, weighed and shell ages determined. Rugolo et al. (2003) provides details on the 2003 survey results for Bristol Bay and Pribilof District red king crabs, St. Matthew Island Section and Pribilof District blue king crabs, and eastern Bering Sea Tanner, snow, and hair crabs. Status of Bering Sea groundfish stocks also assessed by this survey will be reported in an update to NPFMC (2003a).

Analytical Methods

Overview

The annual trawl survey is an essential data-gathering tool on the status of crab stocks in the eastern Bering Sea. However, year-to-year variation in oceanographic conditions leads to changes in species distributions and availability to survey gear. These changes and other measurement errors can lead to unexpected shifts in area-swept abundance estimates unrelated to true changes in population size. Estimates from previous years' surveys and commercial catches provide valuable

auxiliary information to help decipher real population changes from survey measurement errors. Population estimation models were developed to incorporate crab size, sex, and shell condition data from annual surveys, commercial catches and catch samples. Model estimates of abundance are based on multiple years of data and multiple data sources are generally more accurate than area-swept estimates from current-year survey data alone. ADF&G uses these estimates for fishery management of the modeled stocks.

Because the quantity and quality of data vary among crab stocks, no single analytical model is ideally suited for all situations. Therefore, the following approaches were developed for use with eastern Bering Sea king crabs that are tailored to differing levels of information: *length-based analysis (LBA)* for stocks with high-quality size composition data; and *catch-survey analysis (CSA)* for stocks lacking detailed size composition data or where the survey catchability coefficient is unknown (Zheng et al. 1997; Collie and DeLong 1998). We apply LBA to Bristol Bay red king crabs and CSA to St. Matthew Island Section and Pribilof District blue king crabs and Pribilof District red king crabs. A brief description of these two methods and their application to king crab stocks in the eastern Bering Sea follow.

Length-based Analysis

The LBA is an analytical procedure to estimate annual abundance of crab stocks for which extensive high-quality data are available, such as Bristol Bay red king crabs. The LBA makes use of detailed annual data on size, sex, and shell condition from trawl surveys, onboard and dockside catch samples, and annual commercial harvests. Males and females are modeled separately by 5-mm carapace length (CL) intervals as newshell (i.e., those that molted within the past year) and oldshell crabs (i.e., those that have not molted within the past year). The annual abundance of crabs at each length group is a combined result of recruitment, growth, natural mortality, and harvest. Collie and Kruse (1998) estimated the trawl survey catchability coefficient *(q)* to be near unity for legal-sized red king crabs in Bristol Bay and $q = 1$ is assumed for area-swept and LBA methods. An overview of the approach is provided in Zheng et al. (1996).

Catch-survey Analysis

Collie and DeLong (1998) updated the two-stage CSA model (Collie and Kruse 1998) to a three-stage (i.e., three age-size groups) approach. Zheng and Kruse (2000) extended it to a four-stage CSA by adding a second prerecruit size group. As with the LBA, the CSA estimates survey measurement errors and "true" stock abundance. The CSA model is less complex, and requires less detailed size composition data than the LBA. For male crabs, instead of tracking multiple 5-mm size groups as the LBA does, the four-stage CSA considers only four age-size groups of crabs: *prerecruit two*, immature crabs that are one molt away from mature; *prerecruit one*, mature crabs that are one molt away from attaining legal size; *recruits*, mature newshell crabs that molted to legal size within the past year; and *postrecruits*, crabs that have been legal for more than one year. The previous three-stage CSA considered only prerecruit one, recruit and postrecruit crabs. In the four-stage version, more historical data are used to smooth abundance estimates of the current mature and legal crabs. The updated model provides a new series of abundance estimates over the years that the St. Matthew and Pribilof District stocks have been surveyed.

This year the four-stage CSA was also used to estimate mature female blue king crab relative abundance in the Pribilof District. The mature female crabs were grouped into four size groups: Group 1, 100-109 mm CL, Group 2, 110-119 mm CL, Group 3, 120-129 mm CL, and Group 4, > 129 mm CL. There are no plans to use CSA models to estimate relative abundance of female red king crabs in the Pribilof District or female blue king crabs in the St. Matthew Island Section due to low survey catchability and the high uncertainty in selectivity of these crabs in the EBS trawl survey.

CURRENT STOCK STATUS

Bristol Bay Red King Crabs

LBA estimates of Bristol Bay red king crab abundance and 95% bootstrap confidence limits for 2003 are shown in Table 1. Historical changes in mature male and female abundance are graphed in Figure 1. The magnitude of an above-average year class (termed the 1990 year class in this report) appears larger than originally presumed, and coupled with another above-average year class, the estimated abundance of legal males increased from 8.3 million crabs in 2002 to 10.4 million crabs in 2003. Prerecruit-male estimated abundance decreased, however, from 10.0 million crabs in 2002 to 9.0 million crabs in 2003. Mature male abundance increased from 2002 as well, from an estimate of 14.1 million to an estimate of 16.4 million crabs. New recruits to the size-class modeled for males increased from 2002 (2.3 million crabs) to 2003 (6.5 million crabs). There has also been an increase in the estimated number of smaller-sized males from 2.4 million crabs in 2002 to 4.5 million crabs in 2003. Estimated abundance of mature female crabs increased in 2003 to 29.7 million crabs from 23.0 million crabs in 2002. Effective spawning biomass[1] (ESB) in 2003 (estimated 60.7 million pounds) increased substantially from 2002 (estimated 47.8 million pounds), due to the increase in mature males and females in 2003.

Insights into changes in annual survey results can be gained by examining the size frequency distributions over the past five years (Figure 2). Area-swept estimates for 2000 suggest a mode between 75-mm and 90-mm CL in the male population (possibly the 1994 year-class). This year-class can be followed for the last 4 years, with a mode in 2003 between 130-mm and 150-mm CL. As with the male crabs, the female crabs from the 1994 year-class have been supplementing the 1990 year-class in recent years. A large year-class of males and females that was first observed in 2002 between 60-mm and 85-mm CL has tracked to a mode between 80-mm and 100-mm CL. However, it is still early to speculate how much that apparent recruitment to the stock will add to the mature and legal stock in the future.

Just as historical survey results enter into the LBA and modify the interpretation of data from 2003, the 2003 survey results also provide additional information about reconstructed stock size in recent years. This is a common feature of contemporary estimation procedures for fish and invertebrate populations. Thus, historical abundance estimates generated with data from 1972-2003 (Table 1) differ somewhat from estimates generated with data from 1972-2002 (see Table 1 in Vining and

[1] ***Effective spawning biomass*** is the estimated biomass of mature female crabs that the population of mature male crabs successfully mate in a given year.

Zheng 2003). Estimates for recent years change the most; older estimates remain most stable. Likewise, next year's assessment will bring new data to bear on the status of the stock in 2003.

Pribilof District Red King Crabs

The survey precision is very low for Pribilof District red king crabs and, as such, the CSA model and area-swept estimates of mature males can be quite different. For example, the CSA estimated peak abundance in 1991, while the area-swept estimates indicate a peak in 2001 (Figure 3). Based on the model results, the mature male abundance has increased during the previous six years from 1.0 million crabs in 1997 to 1.8 million crabs in 2002. However, in 2003 a decrease to 1.5 million crabs was estimated. Legal abundance estimates have increased in the last six years from 0.8 million in 1998 to 1.4 million crabs in 2003 (Table 2). However, the precision of the estimates for mature and legal male abundance is poor; the 95% confidence intervals include the point estimates for annual abundance back to the early 1990s. Hence, it is difficult to specify any trends in abundance from the early 1990s to 2003.

St. Matthew Island Section Blue King Crabs

Owing to low survey abundances in 1999 through 2003, poor in-season fishery performance in 1998, and low catch rates from the ADF&G nearshore pot survey in 1999, we suspect that natural mortality may have increased dramatically between 1998 and 1999 compared to other years. To accommodate this apparent high natural mortality in the assessment model, we estimated two natural mortality parameters using CSA: M = 1.50 for 1998/99 (that is, the year between the 1998 and 1999 surveys) and M = 0.26 for all other years. We also conducted a CSA under a model that estimated constant natural mortality (M = 0.37) for all years. The two models produce disparate estimates of mature male abundance over 1996-2000 (Figure 4). However, the two models seem to be converging for the estimates of more recent years, with little difference in estimates of mature male abundance between the two models in 2001-2003.

CSA estimates of St. Matthew Island Section blue king crab abundance and 95% confidence limits for 2003 are shown in Table 3. Little change in male abundance between 2001 through 2003 is indicated. Prerecruit abundance (90-119 mm CL) and mature male abundance have remained fairly stable from 1999 to 2003 with prerecruit abundance ranging from 0.6 – 0.8 million crabs, and mature male abundance ranging from 1.0 million to 1.5 million crabs. Under both the constant natural mortality scenario and the scenario with two natural mortality parameters, CSA estimates of mature male abundance are lower than area-swept estimates in 1996-98 and 2001, but higher than area-swept estimates in 1999, 2000, 2002, and 2003 (Figure 4). However, the scenario with two natural mortality parameters fits the data better (Figure 4). Based on the best fit of the data, we chose the scenario with two natural mortality parameters to estimate abundance trends and abundance in 2003. The low abundances across all male size groups continued from 1999 through 2003 (Figure 5). The highest number of small crabs (65 – 80 mm CL) in 5 years was observed in 2003. However, the number of small crabs is still very low compared to levels before 1995. There have only been 3 pot surveys of the St. Matthew Island Section; it is premature to assess a trend (Figure 4).

Pribilof District Blue King Crabs

For blue king crabs in the Pribilof District, there has been a decline in mature male estimated abundance from 1.68 million crabs in 1993 to 0.29 million crabs in 2003. A similar decrease in legal male estimated abundance has occurred of 1.16 million crabs in 1994 to 0.28 million crabs in 2003 (Table 4, Figure 6). Survey catches of male crabs were similar between 2001 and 2002 (Figure 7), with very few male crabs less than 140-mm CL caught.

This was the first year that abundance of female blue king crabs from the Pribilof District was estimated using the CSA model. The abundance of mature females follows a similar trend as the legal male abundance with an estimate of 3.38 million crabs in 1994 and 0.95 million crabs in 2003 (Table 4, Figure 6). The model abundance estimate decline is steeper for mature female blue king crabs than either legal or mature male blue king crabs.

FISHERY MANAGEMENT IMPLICATIONS

Bristol Bay Red King Crabs

Directed Crab Fishery

The Alaska Board of Fisheries harvest strategy for Bristol Bay red king crabs sets a GHL by a harvest rate coupled with a fishery threshold (ADF&G 2003). When the stock is not above the threshold of 8.4 million mature females (>89-mm CL) and 14.5 million pounds of ESB, the fishery is closed. When the stock is above the threshold, the GHL is determined by the ESB and abundance of mature and legal-sized males. A mature male harvest rate of 10% or 12.5% is applied to promote stock rebuilding when ESB is below the target rebuilt level of 55 million pounds. Once the stock is at or above 55 million pounds of ESB, a 15% harvest rate is applied to mature male abundance. To prevent a disproportionate harvest of large male crabs, the GHL is capped so that no more than 50% of the legal-male crabs may be harvested in any one year.

In 2003, the estimates of mature female abundance and ESB were 29.69 million crabs and 60.70 million pounds, respectively – both above the thresholds needed to conduct a directed commercial fishery. The ESB is above the target rebuilt level of 55 million pounds, so a 15% harvest rate is applied. Applying this harvest rate to the mature male abundance of 16.37 million crabs results in a harvest of 2.455 million crabs. Because 2.455 million is only 23.6% of the number of legal crabs, the application of 50% cap is not required. By multiplying 2.455 million crabs by an average weight of 6.45 pounds per legal crab, a preseason GHL of 15.71 million pounds was established for the 2003 fishery. A total of 7.5% of the GHL or 1.178 million pounds is reserved for the community development quota (CDQ) fishery, resulting in a GHL of 14.535 million pounds for the general fishery. The actual CDQ harvest level will be based on a percentage of the total catch from the general commercial fishery.

Implications on the Bering Sea Groundfish Trawl Fisheries

Prohibited species catch (PSC) limits for red king crabs caught during groundfish trawl fisheries are set annually as a function of estimated ESB of Bristol Bay red king crabs (NPFMC 1998). When ESB exceeds 14.5 million pounds but is less than 55 million pounds, the PSC is 100,000 crabs. When ESB exceeds 55 million pounds, the PSC is 200,000 crabs. Given the estimate of 60.70 million pounds of ESB for 2003, the red king crab PSC limit for the Bering Sea will be set at 200,000 crabs for groundfish trawl fisheries in 2004.

A portion of the year-round closure to non-pelagic trawling in the Red King Crab Savings Area (162^{o} to 164^{o} W, 56^{o} to 57^{o} N) is open to the rock sole fishery in years when there is a red king crab fishery in Bristol Bay (Witherell and Roberts 1996). Thus, the portion of the Red King Crab Savings Area bounded by 56^{o} to 56^{o} 10' N latitude will remain open to the rock sole fishery in 2004. A separate bycatch limit is established for this area not to exceed 35% of the red king crab PSC limits apportioned to the rock sole fishery by the NPFMC.

St. Matthew Island Section Blue King Crabs

The Alaska Board of Fisheries adopted a new harvest strategy for St. Matthew Island Section blue king crabs in March 2000. The new harvest strategy has four components: (1) a minimum stock threshold of 2.9 million pounds of mature male (≥105-mm CL) biomass, (2) a minimum GHL of 2.5 million pounds, (3) variable mature male harvest rates based on the mature male biomass level, and (4) a cap of legal male harvest rate at 40% (Zheng and Kruse 2000). The mature male biomass was estimated to be above threshold at 5.4 million pounds in 2003. However, application of the harvest strategy specifies a GHL of 0.685 million pounds for the 2003 season, which is below the minimum GHL. Thus, the fishery for this stock was closed in 2003.

Pribilof District King Crabs

The fishery management plan before October, 2003, for Pribilof District blue king crabs specifies a threshold of 0.77 million mature male blue king crabs (≥120-mm CL; Pengilly and Schmidt 1995). No threshold is specified for Pribilof District red king crabs. During 1995-1998, trends in survey and fishery performance data had been used to set an aggregate GHL for a combined blue and red king crab fishery to avoid bycatch problems that would occur if each stock were harvested with separate fisheries. The fishery for these two stocks has been closed since 1999 based on a number of factors: declining abundance, low level of prerecruits, low precision of abundance estimates, and past fishery performance below expectations (Zheng and Kruse 1999). The mature male abundance of Pribilof District blue king crabs in 2003 is estimated at 0.29 million crabs, below the fishery threshold. So the fishery for this stock was closed in 2003. The fishery for Pribilof District red king crabs was also closed in 2003, due primarily to low precision of abundance estimates, the fishery closure for blue king crabs, and concern for bycatch of blue king crabs. The Alaska Board of Fisheries adopted a new harvest strategy for Pribilof District blue king crabs in October, 2003, to rebuild the stock. We will describe in details the new harvest strategy in our report next year.

FUTURE OUTLOOK

Even though there was an increase in mature and legal abundance in the Bristol Bay red king crab stock between 2002 and 2003, it is unlikely there will be any large increase in legal abundance in 2004 given the abundance level of prerecruit crabs in 2003. The GHL will likely be stable or decrease for the next one to two years. However, there could be a substantial increase in the mature population in one to two years, if the high abundance of small crabs observed during the 2002 and 2003 EBS NMFS trawl survey (Figure 2) tracks into the future.

Both eastern Bering Sea blue king crab stocks are depressed. The mature biomass based on area-swept estimates of both male and female crabs was estimated as 12.8 million pounds for the St. Matthew Island Section blue king crab stock (NPFMC 2003b). This is the first year in five years that this stock has been above minimum stock size threshold (MSST) of 11.0 million pounds, established for this stock in the federal fishery management plan for Bering Sea/Aleutian Islands king and Tanner crabs (NPFMC 1998). Although we are still not certain about the level of high natural mortality from 1998 to 1999 for the St. Matthew blue king crab stock, the low survey abundance from 1999 through 2003 greatly strengthens the argument for the high natural mortality. The mature biomass for the Pribilof District blue king crab stock was estimated as 4.1 million pounds, which is below the MSST of 6.6 million pounds (NPFMC 2003b). The NMFS declared this stock overfished in 2002. Based on trends in prerecruits and recruits for blue king crabs at the Pribilof District, the stock will not likely increase above the MSST in the near term future.

Population trends for Pribilof District red king crab since the early 1990s are difficult to specify due to the low precision of annual abundance estimate. In 2003, as in previous years, most of the abundance estimate is based on the catch occurring in only one or two tows during the survey.

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Table 1. Annual abundance estimates (millions of crabs), effective spawning biomass (ESB, millions of pounds), and 95% confidence intervals for 2003 red king crabs in Bristol Bay estimated by length-based analysis from 1972-2003. *Size measurements are in mm CL.*

	Males					Females		
Year	Recruits	Small	Prerec.	Mature	Legal	Recruits	Mature	ESB
mm→	(to model)	(95-109)	(110-134)	(>119)	(>134)	(to model)	(>89)	(M lbs)
1972	NA	13.625	15.170	18.653	10.080	NA	59.860	55.905
1973	31.453	21.833	26.566	22.710	10.817	33.106	69.884	64.028
1974	21.080	15.482	35.663	34.506	14.851	28.201	71.180	94.753
1975	32.948	22.822	36.714	41.659	20.714	21.973	65.780	116.384
1976	45.195	31.480	46.334	49.450	25.619	34.025	74.533	128.399
1977	52.221	36.731	60.580	62.531	30.461	72.061	117.907	166.596
1978	19.385	15.403	58.729	75.463	39.675	46.935	119.353	199.663
1979	12.400	9.190	36.639	73.166	47.095	19.199	92.657	166.629
1980	24.062	16.517	25.660	58.709	43.540	36.201	93.328	166.161
1981	17.386	12.521	17.145	18.114	9.426	13.904	71.347	58.501
1982	23.080	16.026	16.030	10.090	2.951	17.756	30.155	23.730
1983	13.086	9.651	13.593	8.899	2.475	4.611	9.832	16.485
1984	18.905	13.087	12.917	8.113	2.368	11.685	13.389	16.518
1985	9.261	6.940	10.562	6.885	1.818	5.174	7.486	11.219
1986	6.130	4.632	12.338	11.532	4.304	4.123	9.357	14.887
1987	6.437	4.633	10.923	13.371	6.500	9.804	16.361	25.739
1988	6.099	4.419	9.972	13.985	7.949	5.903	17.350	28.992
1989	4.885	3.598	9.144	15.004	9.382	5.728	17.898	31.170
1990	1.372	1.207	6.948	14.607	9.892	0.926	13.482	25.989
1991	4.063	2.776	4.949	11.650	8.380	3.684	13.165	25.460
1992	5.551	3.906	5.884	9.726	6.648	3.175	12.414	24.281
1993	2.205	2.001	6.726	9.845	5.894	2.128	10.842	21.859
1994	1.039	0.958	5.342	8.485	4.743	0.411	8.026	17.489
1995	2.771	1.973	4.649	9.367	6.173	1.575	9.229	20.350
1996	3.197	2.416	5.209	10.343	7.188	4.340	13.130	27.114
1997	12.389	8.406	8.629	11.777	7.613	15.571	28.059	39.994
1998	2.636	3.049	12.764	15.002	7.942	1.724	28.354	51.325
1999	1.303	1.086	8.438	15.743	9.297	0.640	20.580	44.102
2000	3.678	2.576	6.057	13.129	8.806	4.531	19.008	40.100
2001	8.480	5.960	7.677	12.149	8.034	8.186	21.532	42.178
2002	2.272	2.424	10.038	14.112	8.281	2.506	22.975	47.754
2003	6.456	4.466	9.032	16.368	10.401	7.791	29.687	60.698
				95% Confidence Limits in 2003				
Lower	4.726	NA	6.941	12.506	7.821	6.061	24.215	NA
Upper	10.906	NA	10.944	19.249	12.616	12.172	37.227	NA

Table 2. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2003 male red king crabs in the Pribilof District estimated by a 4-stage catch-survey analysis from 1988-2003. *Size measurements 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	0.280	0.041	0.062	0.021	0.000	0.021
1989	0.283	0.214	0.279	0.045	0.020	0.065
1990	2.018	0.250	0.462	0.146	0.066	0.212
1991	0.331	1.524	2.016	0.298	0.194	0.492
1992	0.087	0.572	1.986	0.918	0.496	1.414
1993	0.522	0.190	1.766	0.340	1.237	1.577
1994	0.165	0.424	1.601	0.153	1.023	1.177
1995	0.131	0.206	1.356	0.270	0.880	1.150
1996	0.053	0.138	1.170	0.132	0.899	1.031
1997	0.728	0.067	1.021	0.087	0.866	0.954
1998	0.398	0.557	1.392	0.096	0.739	0.835
1999	0.350	0.404	1.464	0.377	0.683	1.060
2000	0.368	0.340	1.547	0.280	0.927	1.207
2001	0.421	0.343	1.635	0.242	1.050	1.292
2002	0.054	0.384	1.755	0.248	1.123	1.371
2003	0.021	0.112	1.545	0.241	1.192	1.433
			95% Confidence Intervals			
Lower	NA	NA	0.709	NA	NA	0.631
Upper	NA	NA	2.381	NA	NA	2.235

Table 3. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2003 male blue king crabs in the St. Matthew Island Section estimated by 4-stage catch-survey analysis from 1978-2003. *The estimates are from the CSA model with two natural mortalities. Size measurements are in mm CL.*

St. Matthew Island Blue King Crabs					
Year	PreRec (90-119)	Mature (≥105)	Recruit newshell (120-133)	Post oldshell (≥120)	Legal (≥120)
1978	2.810	3.429	1.095	0.541	1.637
1979	3.462	3.649	1.178	0.965	2.143
1980	4.388	5.281	1.120	1.633	2.753
1981	3.548	6.475	1.778	2.149	3.926
1982	2.440	5.521	1.791	2.263	4.055
1983	1.753	4.010	1.106	1.631	2.737
1984	0.955	2.215	0.931	0.610	1.541
1985	0.887	1.421	0.477	0.538	1.015
1986	1.043	1.326	0.303	0.401	0.704
1987	1.245	1.402	0.449	0.384	0.833
1988	1.534	1.768	0.449	0.468	0.917
1989	2.311	2.021	0.651	0.490	1.142
1990	2.914	3.202	0.731	0.704	1.435
1991	2.640	3.683	1.320	0.849	2.169
1992	2.646	3.732	1.142	1.123	2.265
1993	2.719	3.980	1.106	1.341	2.447
1994	2.699	4.108	1.142	1.408	2.551
1995	2.931	3.993	1.146	1.331	2.477
1996	3.222	4.378	1.175	1.403	2.578
1997	2.784	4.703	1.376	1.495	2.871
1998	1.940	4.133	1.330	1.495	2.826
1999	0.609	1.007	0.271	0.468	0.739
2000	0.743	1.208	0.209	0.568	0.777
2001	0.758	1.335	0.316	0.603	0.920
2002	0.619	1.466	0.290	0.709	0.999
2003	0.800	1.326	0.291	0.770	1.061
95% Confidence Intervals					
Lower	NA	0.821	NA	NA	0.596
Upper	NA	1.831	NA	NA	1.525

Table 4. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2003 male and female blue king crabs in the Pribilof District estimated by 4-stage catch-survey analysis from 1975-2003. *Size measurements are in mm CL.*

Pribilof Islands Male Blue King Crabs						Pribilof Islands Female Blue King Crabs					
Year	PreRec (105-134)	Mature (≥120)	Recruit newshell (135-148)	Post Oldshell (≥135)	Legal (≥135)	Year	Group 1 (100-109)	Group 2 (110-119)	Group 3 (120-129)	Group 4 (≥130)	Mature (≥100)
1975	6.021	11.163	3.306	3.888	7.194	1975	1.435	2.297	1.506	0.782	6.021
1976	3.400	10.240	2.795	5.181	7.976	1976	3.357	1.775	1.524	0.779	7.435
1977	3.853	8.120	1.604	5.263	6.867	1977	2.611	2.364	1.426	0.801	7.202
1978	4.554	7.739	1.000	4.448	5.448	1978	1.794	2.212	1.552	0.808	6.366
1979	2.589	7.293	1.615	3.445	5.060	1979	0.950	1.787	1.559	0.820	5.117
1980	1.299	5.274	1.390	3.140	4.530	1980	1.630	1.251	1.427	0.818	5.126
1981	1.000	3.252	0.516	2.159	2.675	1981	0.899	1.300	1.193	0.788	4.180
1982	0.863	1.874	0.417	1.030	1.447	1982	0.509	1.034	1.052	0.726	3.322
1983	0.729	1.351	0.305	0.621	0.926	1983	0.498	0.747	0.896	0.660	2.801
1984	0.418	1.092	0.286	0.480	0.766	1984	0.238	0.601	0.733	0.592	2.164
1985	0.183	0.888	0.204	0.541	0.746	1985	0.120	0.410	0.599	0.526	1.655
1986	0.072	0.643	0.092	0.491	0.583	1986	0.073	0.256	0.472	0.466	1.266
1987	0.027	0.460	0.040	0.400	0.439	1987	0.043	0.154	0.355	0.409	0.962
1988	0.011	0.270	0.016	0.247	0.263	1988	0.047	0.092	0.256	0.353	0.748
1989	1.057	0.202	0.005	0.193	0.198	1989	0.560	0.066	0.180	0.297	1.103
1990	1.453	1.062	0.067	0.145	0.212	1990	0.792	0.324	0.127	0.245	1.488
1991	1.160	1.411	0.589	0.188	0.777	1991	0.859	0.578	0.168	0.200	1.805
1992	1.139	1.566	0.415	0.592	1.006	1992	1.298	0.732	0.267	0.172	2.469
1993	0.943	1.684	0.352	0.756	1.108	1993	0.917	1.044	0.377	0.168	2.506
1994	0.839	1.581	0.333	0.829	1.162	1994	1.693	0.955	0.548	0.183	3.379
1995	0.886	1.526	0.247	0.864	1.111	1995	1.077	1.345	0.622	0.223	3.267
1996	0.717	1.370	0.235	0.692	0.927	1996	0.632	1.176	0.782	0.262	2.852
1997	0.425	1.150	0.238	0.596	0.834	1997	0.371	0.880	0.808	0.308	2.367
1998	0.289	0.894	0.157	0.566	0.724	1998	0.258	0.615	0.730	0.340	1.943
1999	0.198	0.698	0.087	0.482	0.568	1999	0.485	0.434	0.608	0.350	1.876
2000	0.129	0.568	0.063	0.419	0.482	2000	0.319	0.474	0.485	0.340	1.619
2001	0.101	0.453	0.043	0.355	0.398	2001	0.313	0.402	0.421	0.317	1.453
2002	0.057	0.378	0.036	0.293	0.330	2002	0.166	0.361	0.363	0.291	1.182
2003	0.021	0.291	0.032	0.243	0.276	2003	0.112	0.257	0.317	0.264	0.950
						95% Confidence Intervals					
Lower	NA	0.141	NA	NA	0.564	Lower	NA	NA	NA	NA	NA
Upper	NA	0.410	NA	NA	1.391	Upper	NA	NA	NA	NA	NA

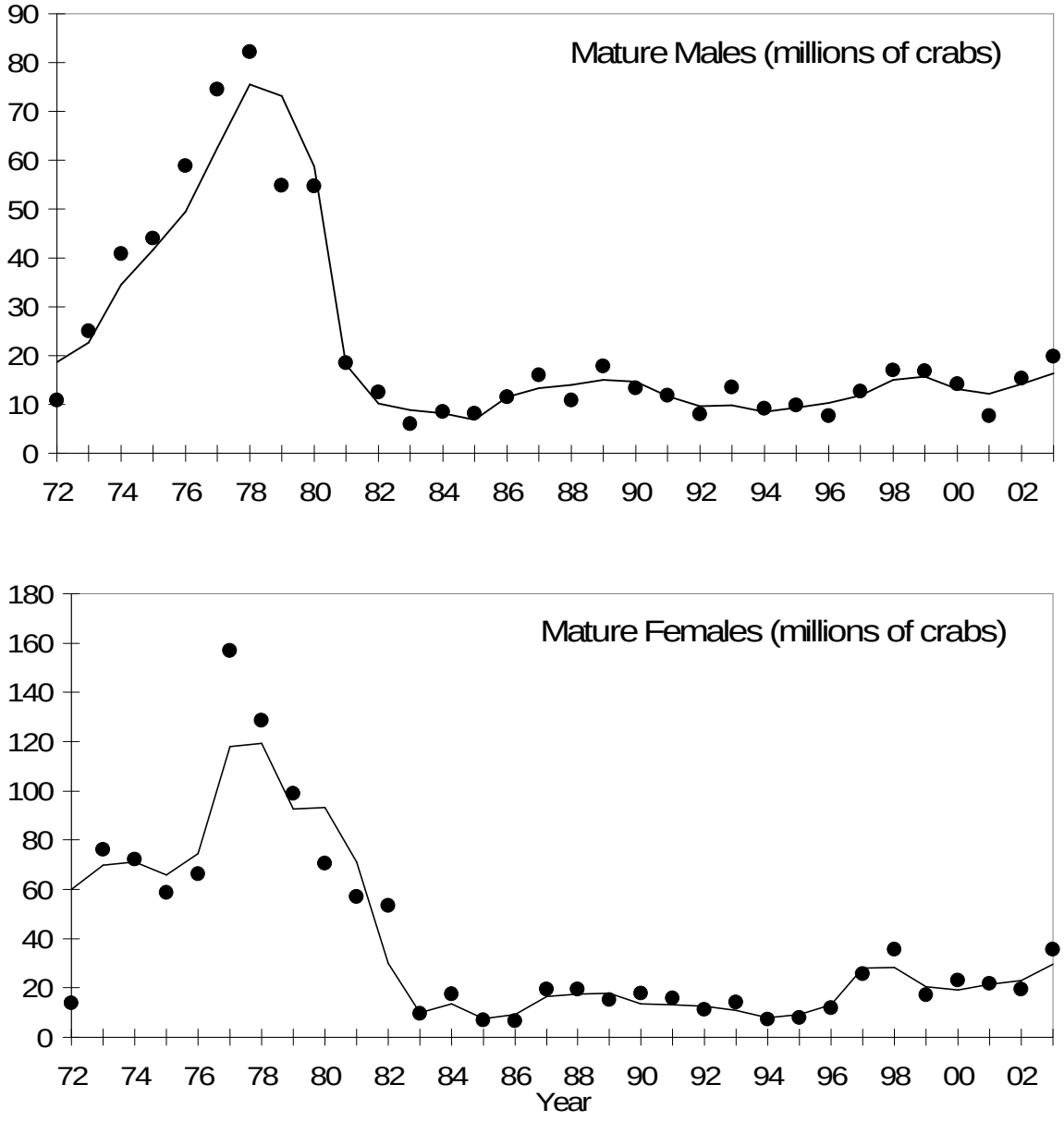
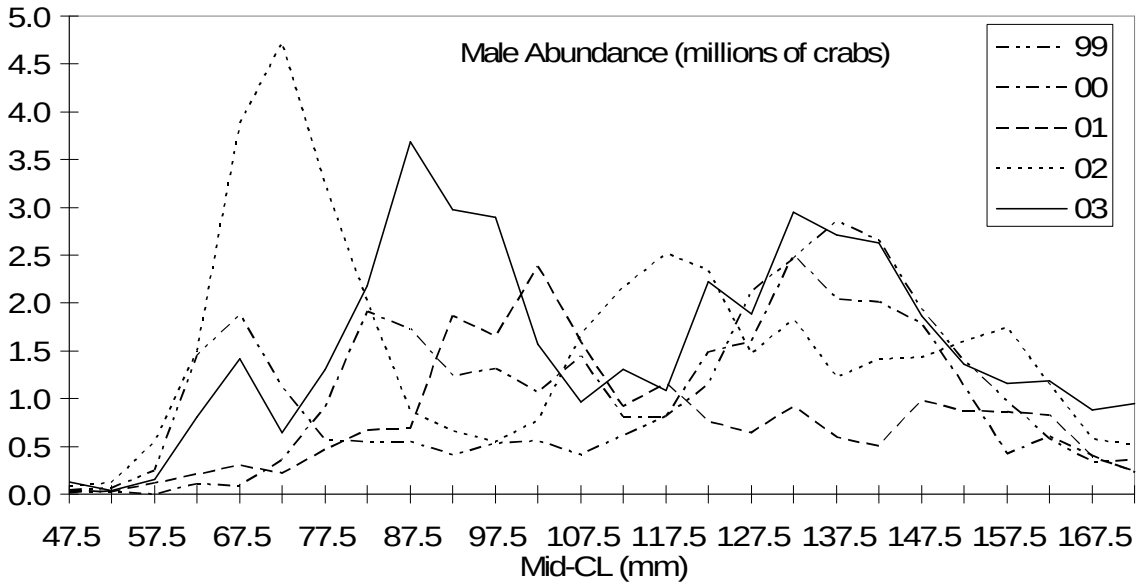


Figure 1. The length-based analysis model fit (line) to area-swept estimates (dots) of mature male (top panel) and mature female (bottom panel) Bristol Bay red king crab abundance (millions of crabs), 1972-2003.



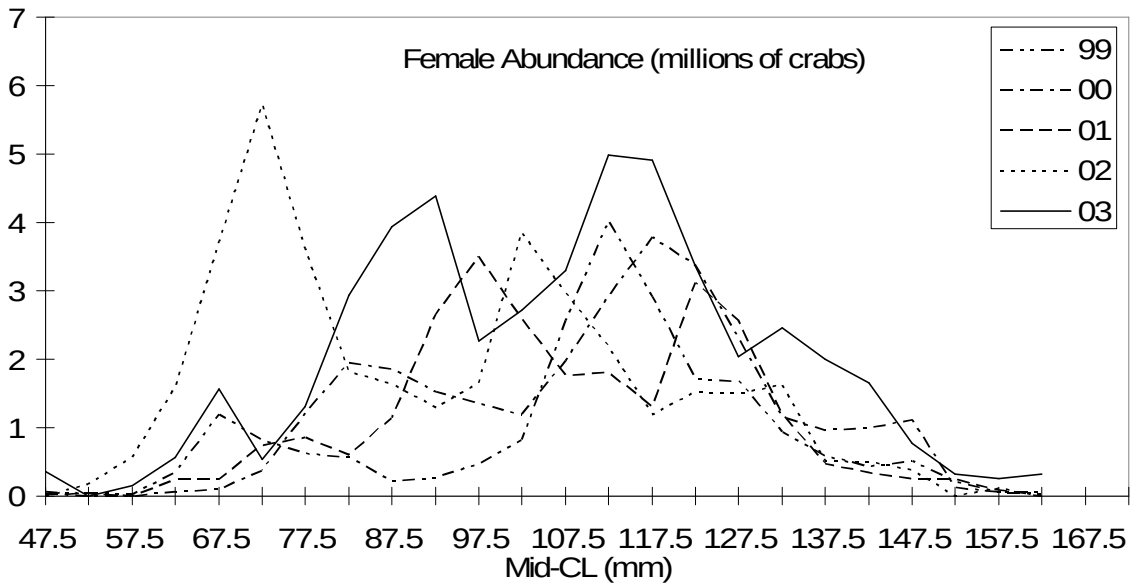


Figure 2. Length frequency distributions of male (top panel) and female (bottom panel) red king crabs in Bristol Bay from NMFS trawl surveys during 1999-2003. *For purposes of these graphs, abundance estimates are based on area-swept methods, not LBA, because the LBA is confined to males ³95 mm CL and females ³90 mm CL.*

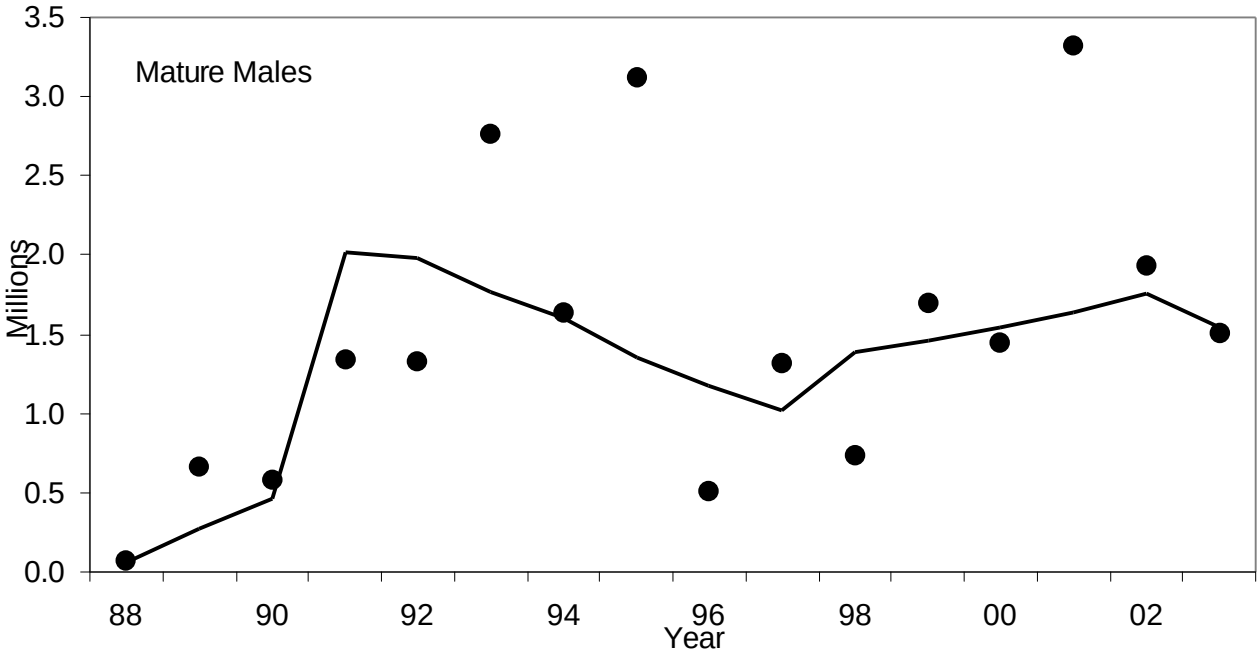


Figure 3. The catch survey analysis model fit (line) to area-swept estimates (dots) of mature male red king crab abundance (millions of crabs) for the Pribilof District, 1988-2003.

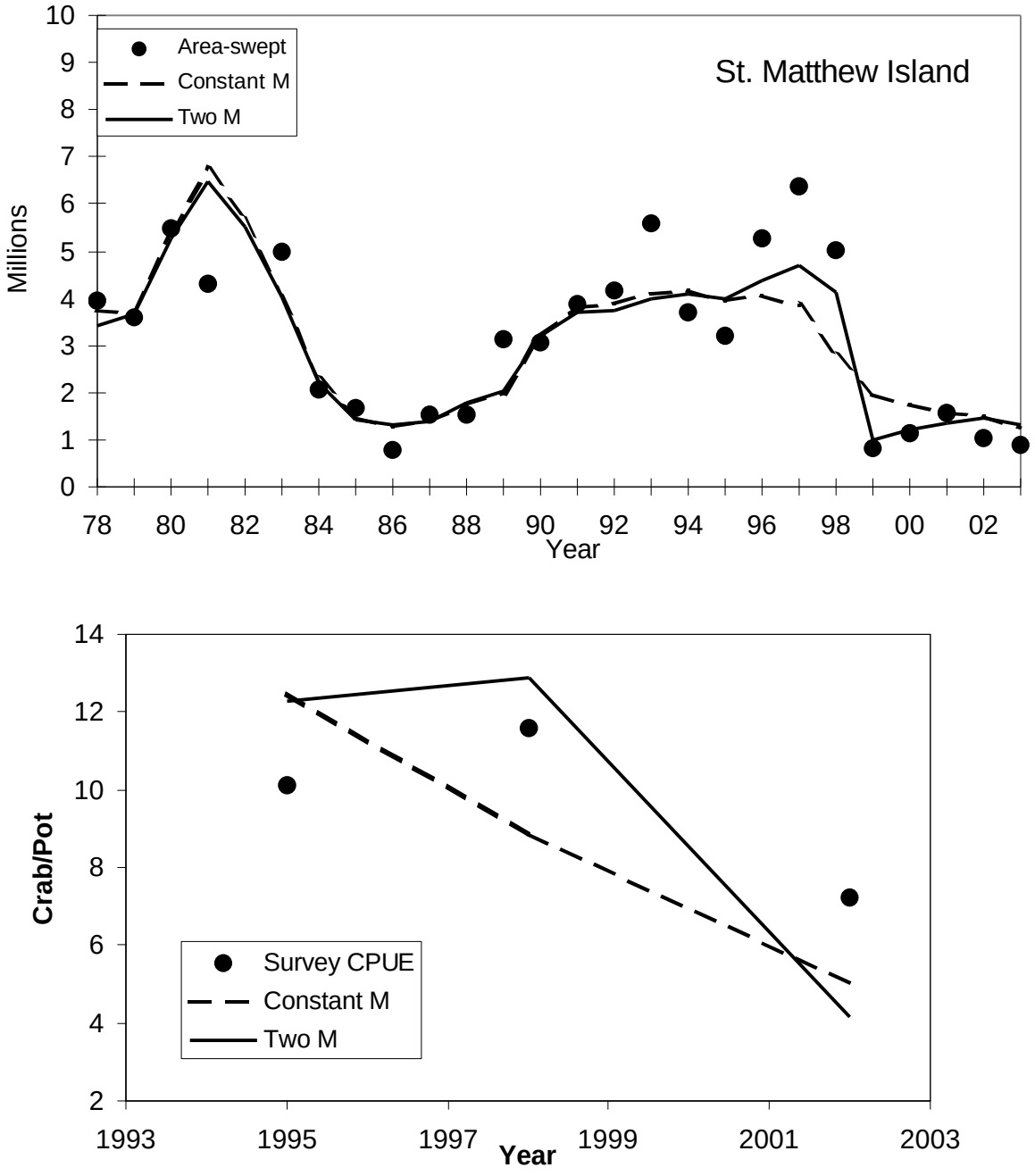


Figure 4. The catch-survey analysis model fit (lines) to the 1978-2003 area-swept (top panel) and 1995, 1998, and 2002 pot CPUE (bottom panel) estimates (dots) of mature male blue king crab abundance (millions of crabs) for St. Matthew Island Section. *The constant-M model estimates a single constant natural mortality for all years, and the two-M model estimates a natural mortality for 1998/1999 and another for all other years (solid line).*

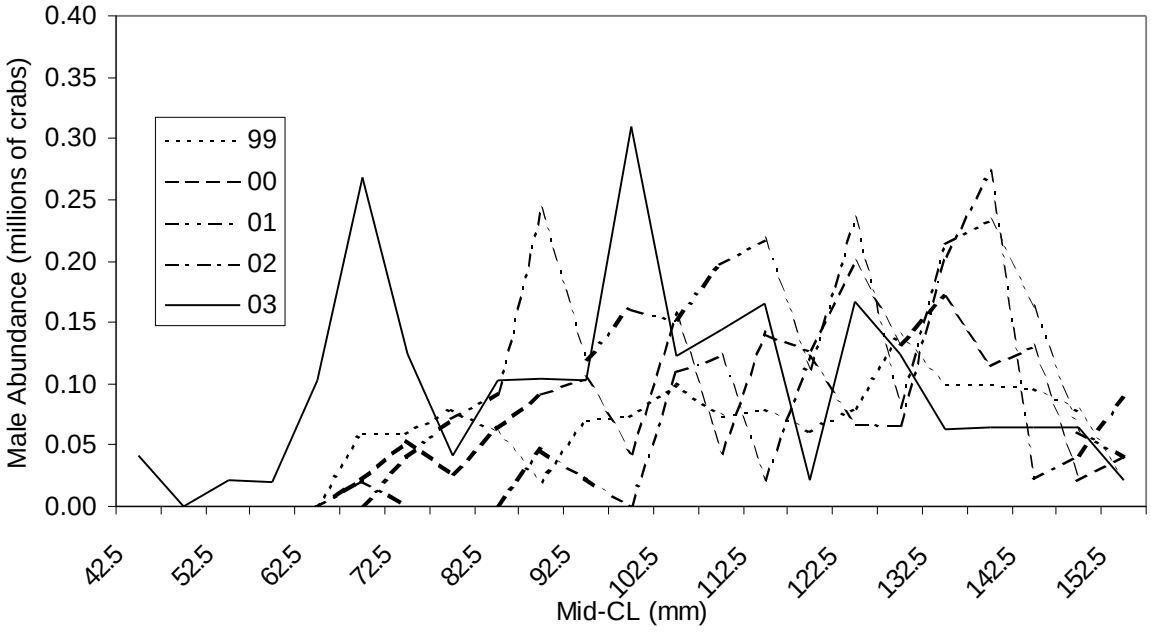


Figure 5. Length frequency distributions of male blue king crabs for the St. Matthew Island Section from NMFS trawl surveys during 1999-2003. *Abundance estimates are based on area-swept methods.*

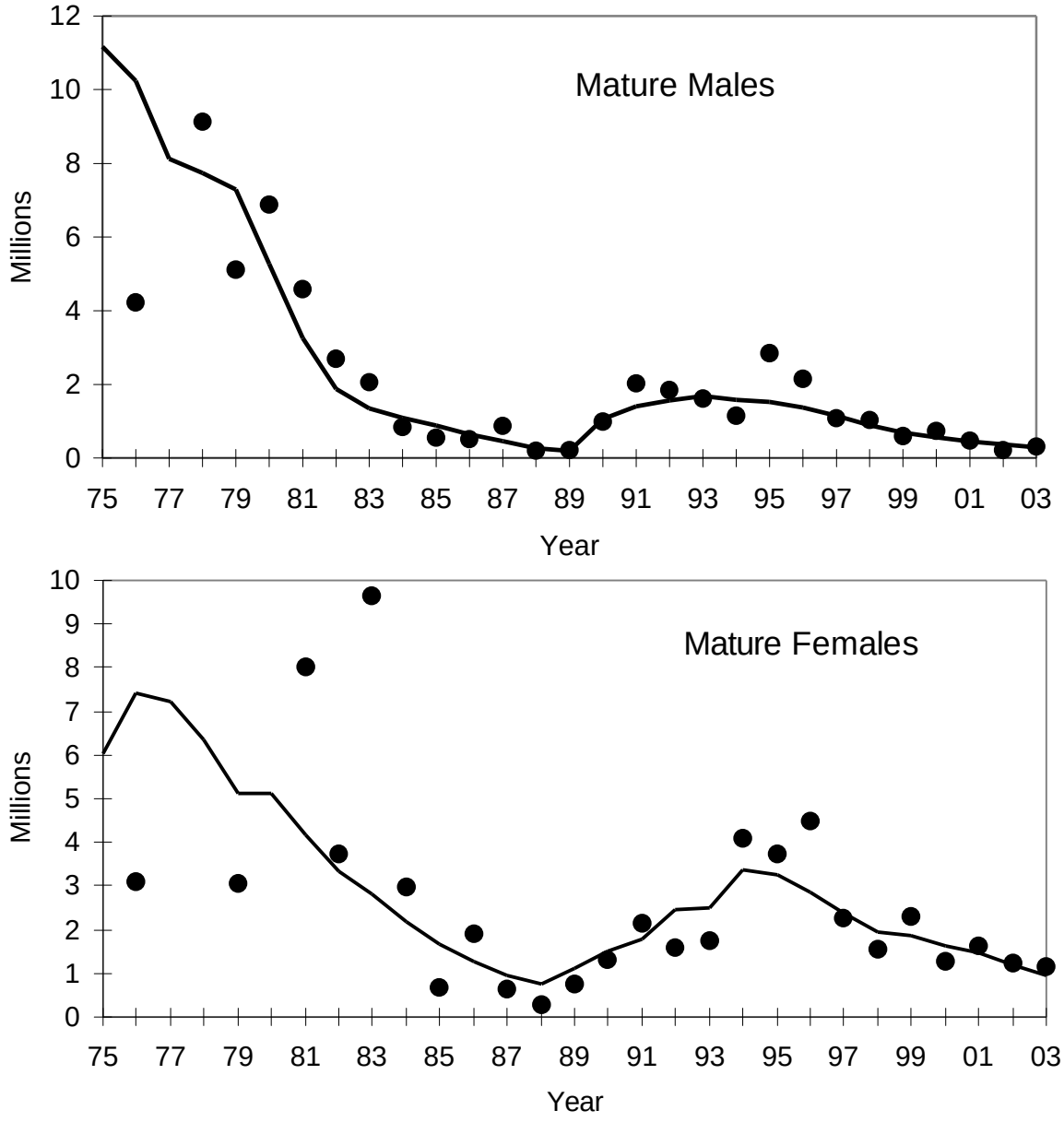


Figure 6. The catch-survey analysis model fit (lines) to area-swept estimates (dots) of mature blue king crab abundance (millions of crabs) for the Pribilof District male (top panel) and female stocks (bottom panel), 1975-2003.

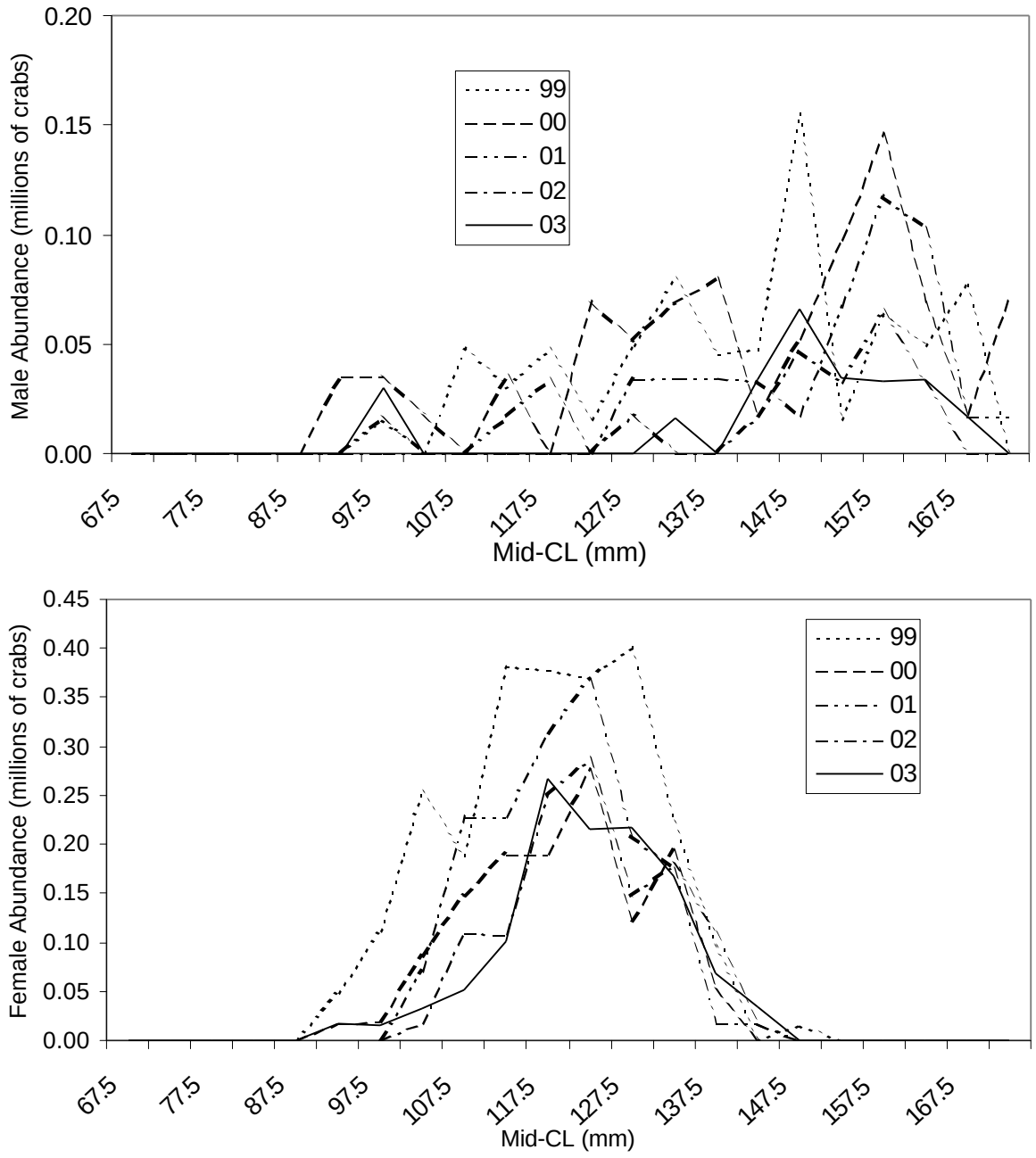


Figure 7. Length frequency distributions of male (top panel) and female (bottom panel) blue king crabs for the Pribilof District from NMFS trawl surveys during 1999-2003. *Abundance estimates are based on area-swept methods.*