STATUS OF KING CRAB STOCKS IN THE EASTERN BERING SEA IN 2002

By

Ivan Vining
and
Jie Zheng

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ABSTRACT

Population models were used to estimate annual abundance of red king crabs in the Bristol Bay area during 1972-2002, red king crabs in the Pribilof District during 1988-2002, blue king crabs in the St. Matthew Island section during 1978-2002, and blue king crabs in the Pribilof District. A length-based analysis (LBA) was applied to male and female red king crabs in Bristol Bay and a four-stage catch-survey analysis (CSA) was applied to males only, for the other three king crab stocks. The guideline harvest level (GHL) in 2002 for the Bristol Bay red king crab fishery was set at 9.27 million pounds. Both stocks of blue king crab are in a depressed condition and classified as overfished. Both stocks of blue king crab will be closed to fishing in 2002. The red king crab in the Pribilof District will also be closed due to low precision of the red king crab abundance estimate and concerns on potential bycatch of blue king crab.

EXECUTIVE SUMMARY

We applied population estimation models to eastern Bering Sea trawl survey, catch sampling, and commercial catch data for red king crabs in Bristol Bay during 1972-2002, red king crabs in the Pribilof District during 1988-2002, blue king crabs in the St. Matthew Island section during 1978-2002, and blue king crabs in the Pribilof District during 1975-2002. A length-based analysis (LBA) was applied to male and female red king crabs in Bristol Bay and a four-stage catch-survey analysis (CSA) was applied to males only, for the three king crab stocks in the St. Matthew Island section and Pribilof District.

For Bristol Bay red king crabs, abundance of large-sized crabs increased from last year. Abundance of mature males increased from 12.6 million crabs in 2001 to 14.3 million crabs in 2002, and legal male abundance increased only marginally from 8.3 million to 8.6 million crabs. Mature female abundance decreased from 21.8 million crabs in 2001 to 18.6 million crabs in 2002, and effective spawning biomass decreased slightly from 42.7 to 37.7 million pounds. The effective spawning biomass is below the target rebuilt level of 55 million pounds; thus, a 10% harvest rate is applied to mature male abundance to determine the 2002 guideline harvest level (GHL). By multiplying the 10% harvest rate times mature male abundance times an average weight of 6.5 pounds per legal crab, an overall preseason GHL of 9.27 million pounds was set. A total of 7.5% of the GHL or 695 thousand pounds is reserved for the community development quota (CDQ) fishery, resulting in a GHL of 8.575 million pounds for the general fishery. The general fishery will open October 15, 2002.

For St. Matthew Island section blue king crabs, CSA estimates the abundance of prerecruit (sublegal males) and legal-sized male crabs. Compared to 2001, prerecruit abundance decreased slightly in 2002, while mature male abundance increased slightly. Prerecruit abundance decreased to 0.5 million crabs from 0.7 million in 2001, and mature male abundance increased from 1.3 million to 1.4 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 (0.78 million pounds) is below the minimum GHL for a fishery opening (2.5 million pounds). Though there has been some increase in mature male abundance, this stock is still depressed and will be closed in 2002.

For Pribilof District blue king crabs, the CSA model indicated the mature male abundance continued to decline to 0.3 million crabs in 2002 from 0.4 million crabs in 2001. Legal male abundance also declined to 0.3 million crabs in 2002. Similar to 2001, very few small-sized crabs were caught during the 2002 survey and larger crabs tended to be old shelled. The Pribilof District blue king crab stock is below the fishery threshold of 0.77 million mature males and the fishery will remain closed for the 2002 season.

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 1.7 million crabs in 2002, 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 will be closed for the Pribilof District red king crab stock in 2002.

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. 2001). 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 stock status of Bering Sea king crab stocks. This provides the industry and public 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 Brad Stevens 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 and weighed. An update of Rugolo et al. (2001) will be published to provide details on the 2002 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 (2001).

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 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, is only applied to male crabs, and requires less detailed size composition data than the LBA. Instead of tracking multiple 5-mm size groups as the LBA does, 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.

CURRENT STOCK STATUS

Bristol Bay Red King Crabs

LBA estimates of Bristol Bay red king crab abundance and 95% bootstrap confidence limits for 2002 are shown in Table 1. Historical changes in mature male and female abundance are graphed in Figure 1. As most of the male crabs from an above-average year class (termed the 1990 year class in this report) had entered the legal-sized population during the last two years, abundance of legal males stayed relatively constant, from 8.3 million crabs in 2001 to 8.6 million crabs in 2002. Prerecruit male abundance increased from 7.8 million crabs in 2001 to 9.7 million crabs in 2002. Mature male abundance increased from 2001 as well, from 12.6 million to 14.3 million crabs. New recruits to the size-class modeled for males decreased from 2001 (7.8 million crabs) to 2002 (2.3 million crabs). However, there has been a decrease in the number of smaller-sized males from 5.5 million crabs in 2001 to 2.3 million crabs in 2002. Abundance of mature female crabs in 2002 (18.6 million) decreased from 21.8 million crabs in 2001. Effective spawning biomass[1] (ESB) in 2002 (37.7 million pounds) decreased from 2001 (42.7 million pounds), due to the decrease in mature females in 2002.

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 1998 suggest a mode between 105-mm and 130-mm CL in the male population representing the 1990 year-class. This year-class can be followed for the last 5 years, with a mode in 2002 between 145-mm and 160-mm CL. A smaller year-class was first observed in 1999, between 50-mm and 75-mm CL (likely the 1994 year-class), but has not produced as well as the 1990 year-class. The mode observed between 50-mm and 85-mm CL in 2002 suggest good potential for future recruitment; however, it is too early to speculate how much it will add to the mature and legal stock in the future.

As with the male crabs, the female crabs from the 1990 year-class have been dominant from 1998 to 2000 (Figure 2). The 1990 year-class has been decreasing since 1998 when the mode was between 90-mm and 120-mm CL. In 2000, a mode between 85-mm and 105-mm CL became apparent (likely the 1994 year-class) and grew to a mode between 95-mm and 115-mm CL in 2002. Again, as with the male crabs, female crabs show a high abundance of small crabs between 50-mm and 80-mm CL in 2002 that could represent a large recruitment to mature females in the future.

Just as historical survey results enter into the LBA and modify the interpretation of data from 2002, the 2002 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 1972-2002 (Table 1) differ somewhat from estimates generated with data from 1972-2001 (see Table 1 in Vining and Zheng 2001). 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 2002.

[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.

Pribilof District Red King Crabs

The survey precision is very low for Pribilof District red king crabs because the majority of crabs are caught in one or a few survey tows. The survey abundance by length is not very consistent over time. A large number of prerecruit-2 crabs in 1990 and postrecruit crabs in 1993 and 1995 were caught, but low numbers of prerecruit-1 crabs in 1991 and recruits in 1992 were caught during the survey. Because of this inconsistency, the CSA model and area-swept estimates of mature males peak at different times: 1991 for the CSA estimates and 2001 for the area-swept estimates (Figure 3). Based on the model results, the mature male abundance has increased during the last six years from 1.0 million crabs in 1997 to 1.7 million crabs in 2002. Likewise, the legal abundance has increased in the last five years from 0.8 million in 1998 to 1.4 million in 2002 (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 2002.

St. Matthew Island Blue King Crabs

Owing to extremely low survey abundances in 1999, 2000, 2001, and 2002, 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 deal with this high natural mortality, 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 2001-2002.

CSA estimates of St. Matthew Island section blue king crab abundance and 95% confidence limits for 2002 are shown in Table 3. Little change in male abundance between 2001 and 2002 is indicated. Prerecruit abundance (90-119 mm CL) decreased to 0.5 million crabs in 2002 from 0.7 million in 2001, and mature male abundance increased slightly from 1.3 million to 1.4 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, and higher in 1999, 2000, and 2002 (Figure 4). However, the scenario with two natural mortality parameters fits the data best (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 2002. The low abundances across all male size groups continued from 1999 through 2002, with no sign of significant recruitment (Figure 5).

Pribilof District Blue King Crabs

For blue king crabs in the Pribilof District, changes from last year included a continued decline in mature male abundance from 0.43 to 0.34 million crabs and a decrease in legal male abundance from 0.38 to 0.31 million crabs (Table 3, Figure 4). Survey catches of male crabs were similar between 2001 and 2002 (Figure 5), with virtually no male crabs less than 120-mm CL caught.

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 1999). 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 threshold, the GHL is determined by the ESB and abundance of mature and legal-sized males. A mature male harvest rate of 10% 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 2002, the estimates of mature female abundance and ESB were 18.61 million crabs and 37.71 million pounds, respectively – both above the thresholds needed to conduct a directed commercial fishery. Because ESB is below the target rebuilt level of 55 million pounds, a 10% harvest rate is applied. Applying this harvest rate to the mature male abundance of 14.26 million crabs results in a harvest of 1.426 million crabs. Because 1.426 million is only 16.7% of the legals, the 50% cap is not required. By multiplying 1.426 million crabs times an average weight of 6.5 pounds per legal crab, a preseason GHL of 9.27 million pounds was established for the 2002 fishery. A total of 7.5% of the GHL or 695 thousand pounds is reserved for the community development quota (CDQ) fishery, resulting in a GHL of 8.575 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. When ESB exceeds 14.5 million pounds but is less than 55 million pounds, the PSC is 97,000 crabs. When ESB exceeds 55 million pounds, the PSC is 197,000 crabs. Given the estimate of 37.71 million pounds of ESB for 2002, the red king crab PSC limit for the Bering Sea will be set at 97,000 crabs for groundfish trawl fisheries in 2003.

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 2002. 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 at 5.3 million pounds in 2002, above threshold. However, application of the harvest strategy specifies a GHL of 0.78 million pounds for the 2002 season, which is below the minimum GHL. Thus, the fishery for this stock will be closed in 2002.

Pribilof District King Crabs

The fishery management plan for the Pribilof District blue king crab 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 have 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 was closed in 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 2002 is at 0.34 million crabs, below the fishery threshold. So the fishery for this stock will be closed in 2002. The fishery for Pribilof District red king crabs will also be closed in 2002, due primarily to low precision of abundance estimates, the fishery closure for blue king crabs, and concern for bycatch of blue king crabs.

FUTURE OUTLOOK

Given the 2002 survey results, no increases in mature or legal abundance in the Bristol Bay red king crab stock are expected in the short-term future. Almost all red king crabs from the 1990 year class have entered the mature population, and it appears that the 1994 year class is not as strong as hoped. The GHL will likely be stable or slightly decreasing in the next one to two years. There could be substantial increase in the mature population in two to three years, if the high abundance of small crabs observed during the 2002 EBS NMFS trawl survey (Figure 2) track 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 4.7 million pounds for the St. Matthew Island section blue king crab stock (NPFMC 2002). This is the fourth year in a row below the overfished level (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 2002 greatly strengthens the argument for the high natural mortality. The mature biomass for the Pribilof District blue king crab stock was estimated as 4.5 million pounds, which is below the MSST of 6.6 million pounds (NPFMC 2002). The NMFS declared this stock overfished this

year on September 25, 2002. Based on trends in prerecruits and recruits for blue king crabs at the Pribilof District, the stock will not likely be above the MSST in the near term future.

It appears that the mature population of Pribilof District red king crabs remains high relative to pre-1990s levels, and perhaps increasing slightly from 1996. However, population trends since the early 1990s are difficult to specify due to the low precision of annual abundance estimate. In 2002, 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 2002 red king crabs in Bristol Bay estimated by length-based analysis from 1972-2002. 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	13.546	15.083	18.546	10.022	NA	59.618	55.583
1973	30.780	21.443	26.276	22.560	10.787	32.640	69.328	63.730
1974	20.900	15.370	35.301	34.257	14.798	28.084	70.790	94.234
1975	32.469	22.564	36.402	41.389	20.627	21.885	65.522	115.941
1976	44.343	30.986	45.825	49.141	25.543	34.056	74.470	128.252
1977	51.464	36.294	59.869	62.072	30.373	71.144	117.023	165.825
1978	19.309	15.346	58.357	75.040	39.523	47.047	119.039	199.110
1979	12.359	9.182	36.638	73.075	47.024	19.043	92.424	166.240
1980	24.076	16.576	25.716	58.919	43.714	36.164	93.240	166.010
1981	17.462	12.609	17.234	18.185	9.457	13.786	71.267	58.733
1982	23.187	16.151	16.108	10.109	2.947	17.625	30.010	23.774
1983	13.158	9.731	13.690	8.914	2.457	4.667	9.863	16.520
1984	18.797	13.060	12.922	8.100	2.349	11.639	13.349	16.457
1985	9.072	6.829	10.503	6.840	1.794	5.130	7.435	11.142
1986	6.047	4.581	12.249	11.469	4.281	4.118	9.339	14.858
1987	6.333	4.575	10.852	13.309	6.476	9.694	16.269	25.613
1988	6.019	4.375	9.912	13.942	7.935	5.862	17.298	28.923
1989	4.836	3.573	9.107	14.991	9.390	5.646	17.835	31.102
1990	1.385	1.216	6.959	14.647	9.927	0.914	13.484	26.026
1991	4.077	2.796	4.985	11.746	8.454	3.681	13.207	25.573
1992	5.603	3.955	5.947	9.865	6.755	3.237	12.548	24.543
1993	2.236	2.033	6.860	10.033	6.007	2.141	10.990	22.168
1994	1.061	0.979	5.502	8.725	4.871	0.408	8.163	17.801
1995	2.845	2.029	4.759	9.507	6.236	1.611	9.314	20.530
1996	3.277	2.480	5.311	10.379	7.166	4.404	13.184	27.171
1997	13.217	8.985	8.936	11.780	7.530	15.912	28.322	39.551
1998	2.728	3.180	13.340	15.106	7.784	1.725	28.325	50.830
1999	1.340	1.124	8.893	16.165	9.365	0.656	20.668	44.155
2000	3.903	2.739	6.446	13.615	9.002	4.364	18.969	40.077
2001	7.756	5.522	7.782	12.619	8.322	8.460	21.840	42.679
2002	2.266	2.341	9.653	14.262	8.552	3.224	18.606	37.705
95% Confidence Limits in 2002								
Lower	1.560	NA	7.567	11.297	6.458	2.538	15.684	NA
Upper	4.608	NA	11.715	16.689	10.285	5.720	23.833	NA

Table 2. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2002 male red king crabs in the Pribilof District estimated by a 4-stage catch-survey analysis from 1988-2002. 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	0.292	0.040	0.061	0.021	0.000	0.021
1989	0.292	0.209	0.274	0.046	0.020	0.065
1990	2.125	0.242	0.454	0.145	0.067	0.212
1991	0.352	1.481	1.970	0.295	0.195	0.490
1992	0.066	0.589	1.973	0.890	0.494	1.384
1993	0.560	0.190	1.754	0.345	1.219	1.564
1994	0.163	0.414	1.584	0.151	1.019	1.170
1995	0.151	0.204	1.341	0.258	0.879	1.137
1996	0.029	0.148	1.170	0.129	0.893	1.021
1997	0.784	0.055	1.007	0.089	0.863	0.953
1998	0.408	0.541	1.372	0.088	0.742	0.831
1999	0.358	0.392	1.443	0.368	0.683	1.051
2000	0.360	0.327	1.529	0.276	0.925	1.201
2001	0.362	0.318	1.609	0.240	1.051	1.291
2002	0.045	0.317	1.675	0.230	1.128	1.358
			95% Confidence Intervals			
Lower	NA	NA	0.849	NA	NA	0.680
Upper	NA	NA	2.500	NA	NA	2.036

Table 3. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2002 of male blue king crabs in the St. Matthew Island section and Pribilof District estimated by 4-stage catch-survey analysis from 1978-2002 and 1975-2002 respectively. The estimates for St. Matthew Island section are from the CSA model with two natural mortalities. Size measurements are in mm CL.

St. Matthew Island Blue King Crabs						Pribilof Islands Blue King Crabs					
Year	PreRec (90-119)	Mature (≥105)	Recruit newshell (120-133)	Post oldshell (≥120)	Legal (≥120)	Year	PreRec (105-134)	Mature (≥120)	Recruit newshell (135-148)	Post oldshell (≥135)	Legal (≥135)
1975	NA	NA	NA	NA	NA	1975	6.779	11.353	3.303	3.885	7.188
1976	NA	NA	NA	NA	NA	1976	3.910	10.353	2.393	5.254	7.647
1977	NA	NA	NA	NA	NA	1977	4.548	8.169	1.633	5.127	6.760
1978	2.838	3.357	1.048	0.518	1.566	1978	5.349	7.874	0.979	4.459	5.438
1979	3.428	3.615	1.206	0.931	2.137	1979	2.792	7.490	1.510	3.503	5.013
1980	4.337	5.229	1.106	1.660	2.766	1980	1.459	5.358	1.353	3.168	4.521
1981	3.520	6.430	1.727	2.197	3.924	1981	1.111	3.300	0.495	2.201	2.696
1982	2.442	5.495	1.735	2.302	4.037	1982	1.010	1.900	0.358	1.067	1.426
1983	1.764	3.999	1.072	1.649	2.721	1983	0.874	1.349	0.275	0.618	0.893
1984	0.963	2.201	0.911	0.612	1.523	1984	0.477	1.095	0.253	0.464	0.717
1985	0.897	1.412	0.469	0.535	1.004	1985	0.192	0.882	0.203	0.516	0.719
1986	1.051	1.325	0.297	0.401	0.698	1986	0.057	0.633	0.097	0.481	0.578
1987	1.252	1.398	0.441	0.386	0.827	1987	0.017	0.450	0.032	0.404	0.436
1988	1.543	1.762	0.438	0.472	0.910	1988	0.003	0.262	0.010	0.249	0.260
1989	2.327	2.012	0.635	0.494	1.130	1989	1.331	0.196	0.002	0.194	0.196
1990	2.925	3.189	0.713	0.708	1.421	1990	1.595	1.114	0.065	0.146	0.211
1991	2.655	3.657	1.289	0.853	2.142	1991	1.245	1.424	0.598	0.192	0.789
1992	2.668	3.711	1.115	1.124	2.239	1992	1.231	1.566	0.402	0.612	1.014
1993	2.765	3.971	1.082	1.346	2.429	1993	0.991	1.688	0.340	0.776	1.115
1994	2.787	4.134	1.122	1.422	2.544	1994	0.903	1.583	0.322	0.851	1.173
1995	3.128	4.071	1.142	1.354	2.496	1995	0.970	1.535	0.235	0.889	1.124
1996	3.398	4.596	1.193	1.447	2.640	1996	0.768	1.379	0.222	0.715	0.937
1997	2.866	4.882	1.449	1.578	3.027	1997	0.415	1.154	0.219	0.615	0.834
1998	2.097	4.334	1.321	1.646	2.966	1998	0.281	0.882	0.144	0.577	0.721
1999	0.569	1.068	0.274	0.499	0.773	1999	0.177	0.678	0.072	0.489	0.561
2000	0.646	1.176	0.217	0.607	0.824	2000	0.112	0.542	0.048	0.421	0.469
2001	0.678	1.285	0.256	0.648	0.903	2001	0.069	0.427	0.029	0.352	0.381
2002	0.528	1.372	0.268	0.709	0.977	2002	0.030	0.338	0.025	0.286	0.311
				95% Confidence Intervals							
Lower	NA	0.812	NA	NA	0.564	Lower	NA	0.189	NA	NA	0.165
Upper	NA	1.933	NA	NA	1.391	Upper	NA	0.487	NA	NA	0.458

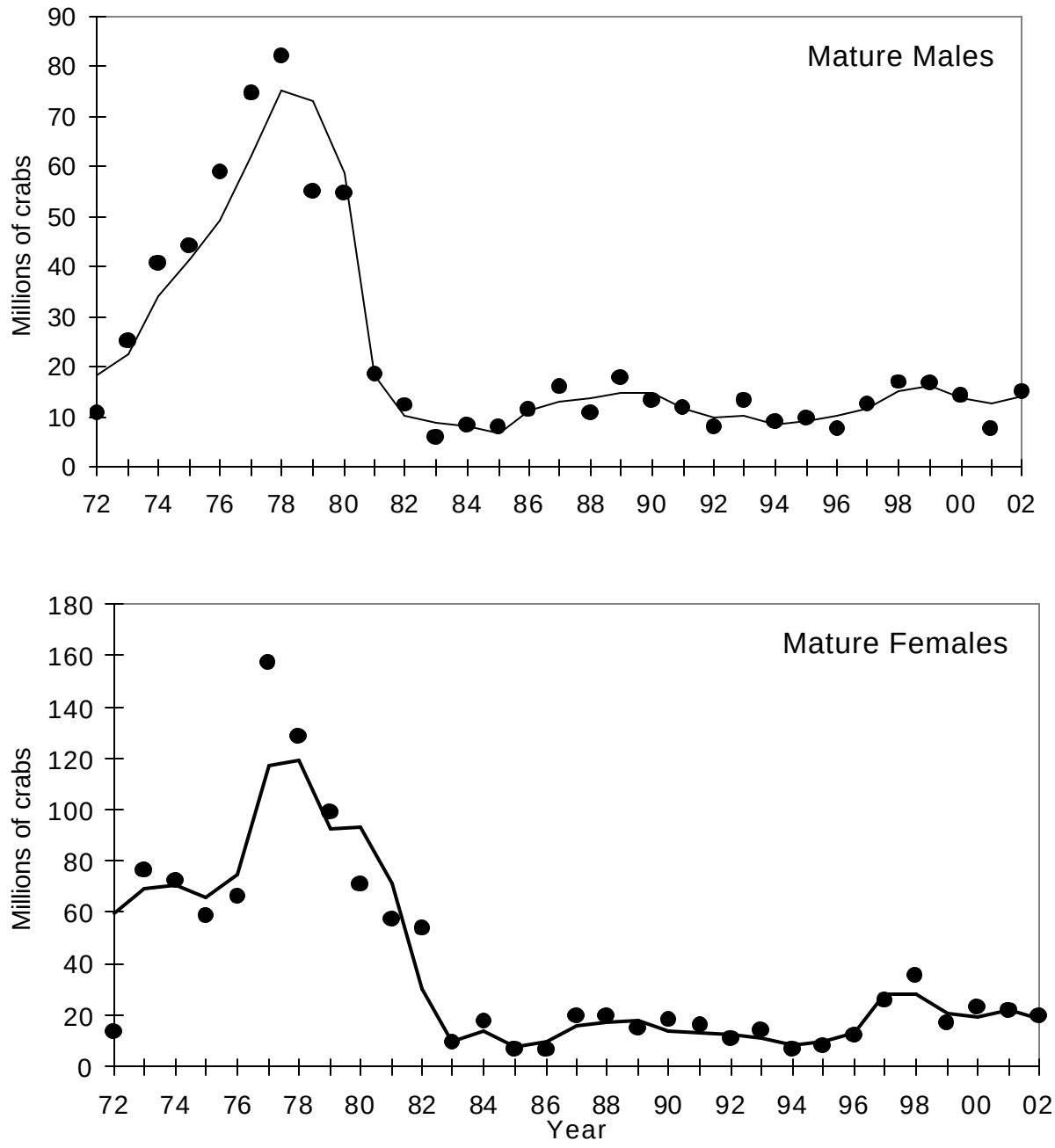


Figure 1. The length-based analysis fit (line) to area-swept estimates (dots) of mature male (top panel) and mature female (bottom panel) Bristol Bay red king crab abundance (millions of crabs), 1972-2002.

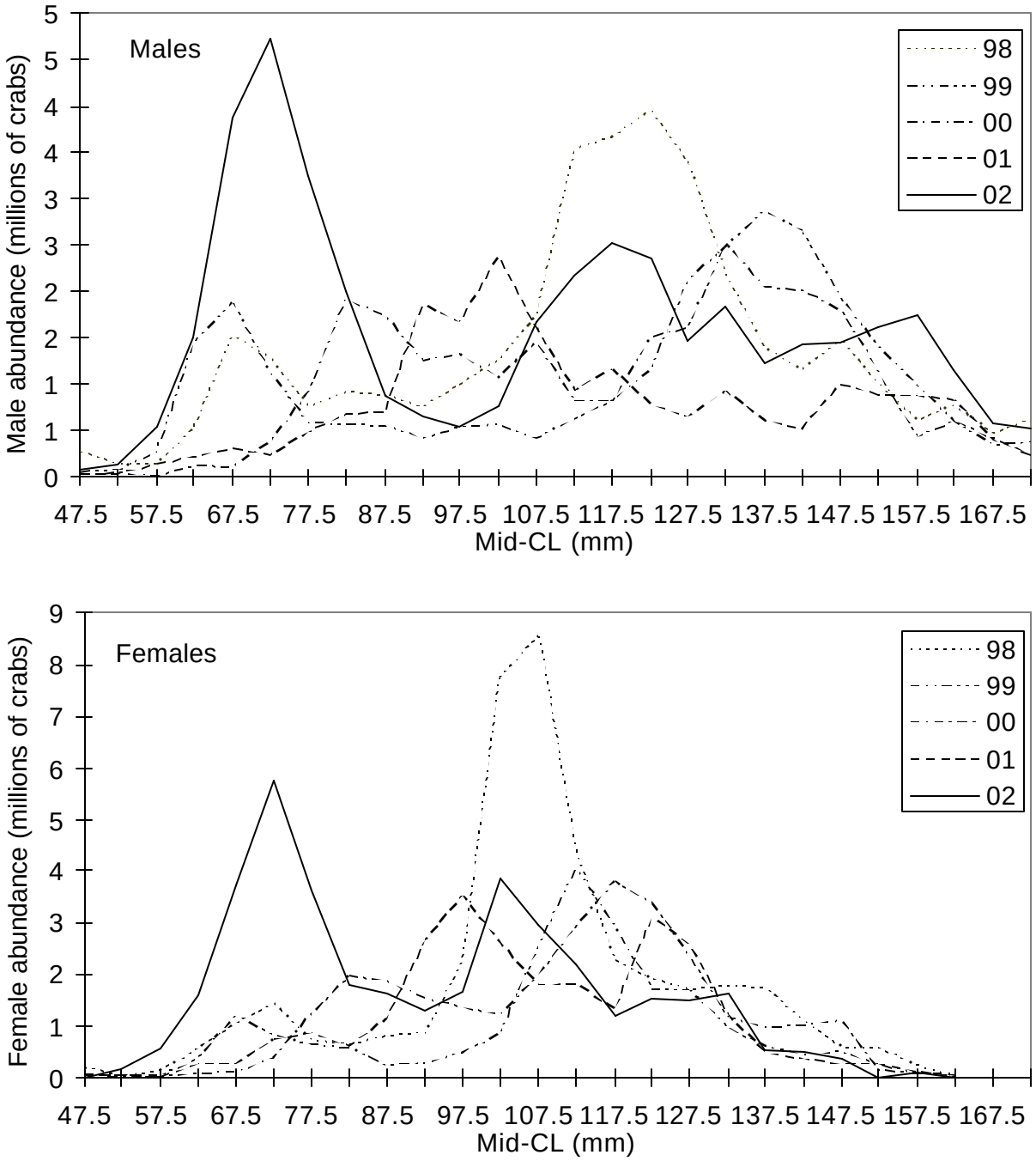


Figure 2. Length frequency distributions of male (top panel) and female (bottom panel) red king crabs in Bristol Bay from NMFS trawl surveys during 1998-2002. For purposes of these graphs, abundance estimates are based on area-swept methods, not LBA, because the LBA is confined to males ≥95 mm CL and females ≥90 mm CL.

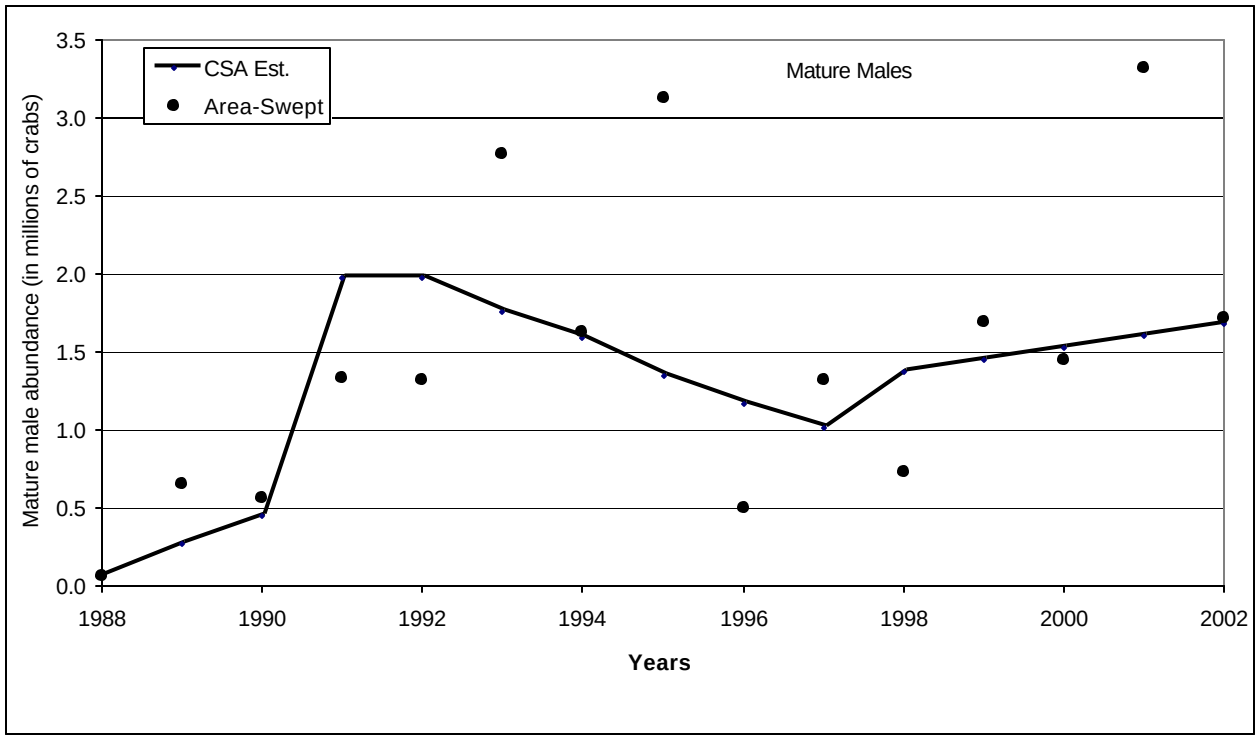
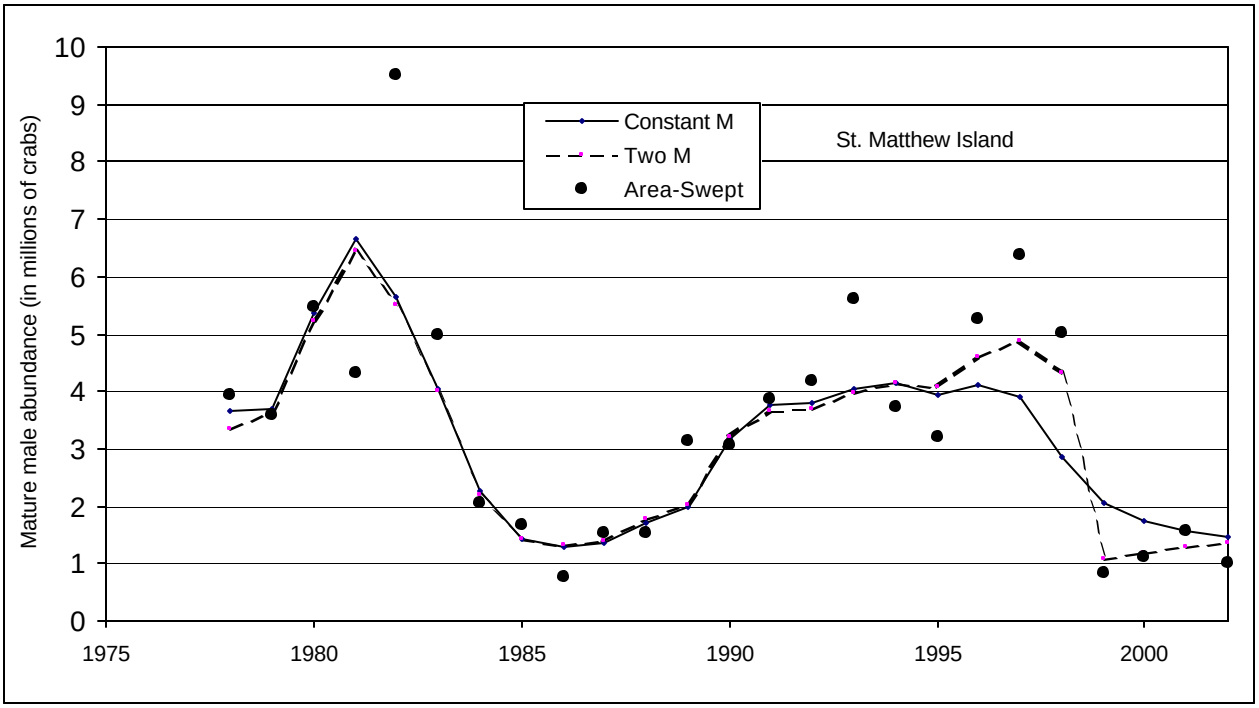


Figure 3. The catch survey analysis fit (line) to area-swept estimates (dots) of mature male red king crab abundance (millions of crabs) for the Pribilof District stock.



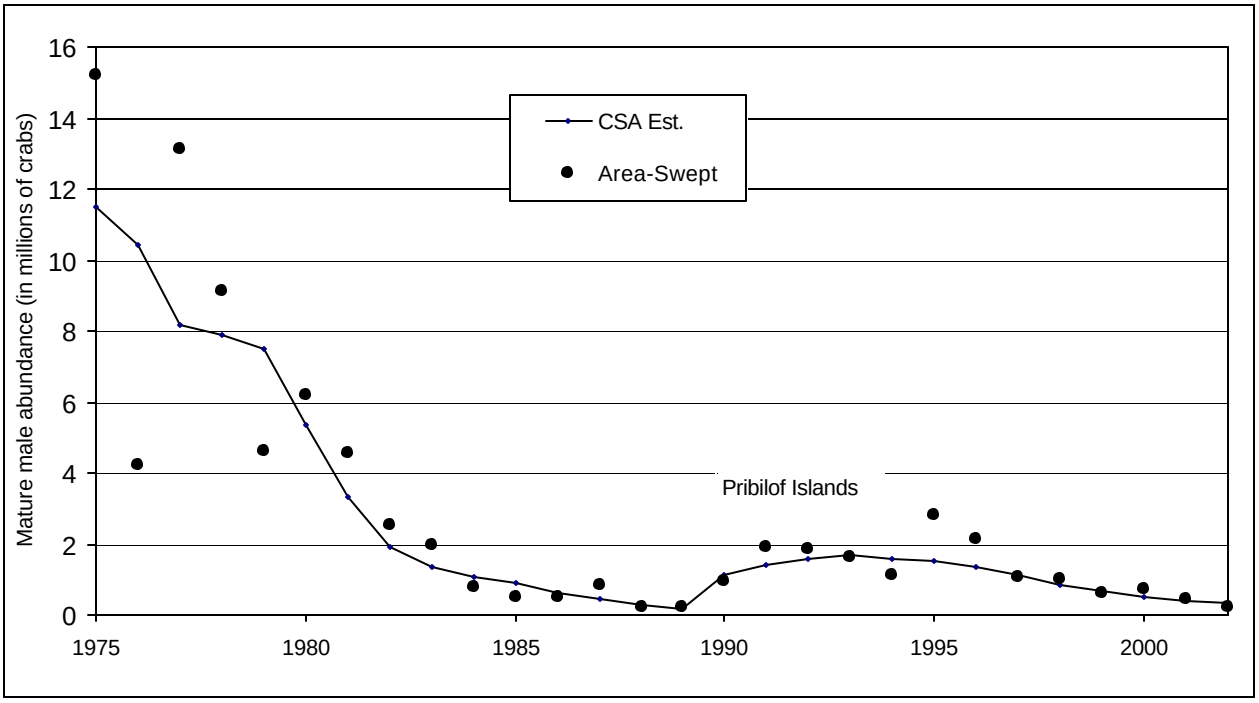


Figure 4. The catch-survey analysis fit (lines) to area-swept estimates (dots) of mature blue king crab abundance (millions of crabs) for St. Matthew Island section (top panel) and Pribiliof District stocks (bottom panel). The constant-M model estimates a single constant natural mortality for all years, and the-two M model estimates a natural mortality for 1998/1999 and another for all other years.

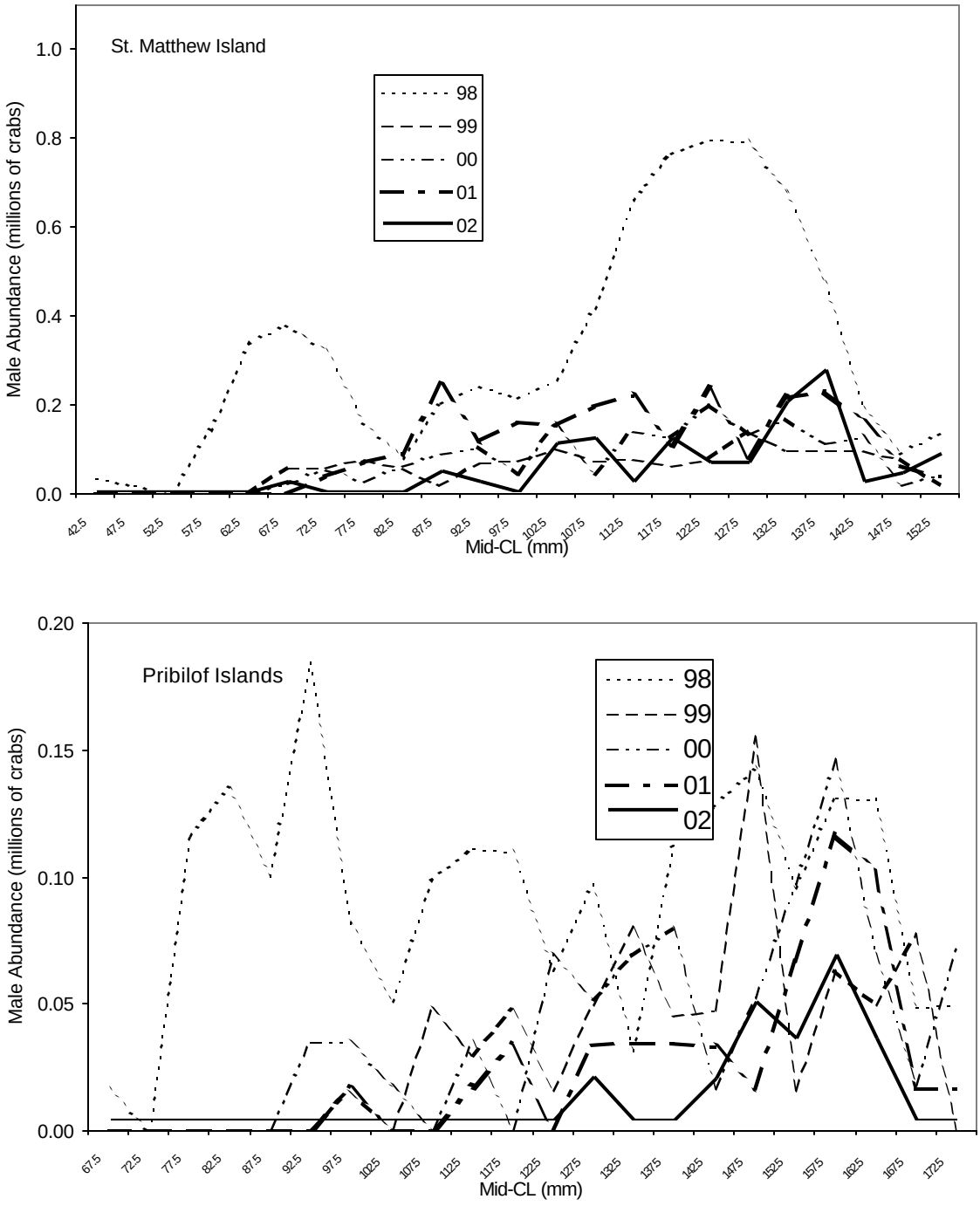


Figure 5. Length frequency distributions of male blue king crabs for St. Matthew Island section (top panel) and Pribilof District (bottom panel) from NMFS trawl surveys during 1998-2002. Abundance estimates are based on area-swept methods.