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Regional Information Report No. 5J00-09
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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 1972-2000, red king crabs off the Pribilof Islands during 1988-2000, blue king crabs off St. Matthew Island during 1978-2000, and blue king crabs off the Pribilof Islands during 1975-2000. 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.

For Bristol Bay red king crabs, abundance of large-sized crabs decreased from last year because most of the above average 1990 year class had entered the legal-sized population by 1999. Abundance of mature males decreased from 16.0 million in 1999 to 13.7 million in 2000, and legal male abundance decreased from 9.1 to 8.8 million. Mature female abundance decreased from 20.7 million to 18.7 million crabs, and effective spawning biomass decreased from 44.6 to 39.9 million pounds. The effective spawning biomass is below the target rebuilding level of 55 million pounds; thus, a 10% harvest rate is applied. By multiplying the 10% harvest rate times mature male abundance times an average weight of 6.11 pounds per legal crab, an overall preseason guideline harvest level (GHL) of 8.35 million pounds was set. A total of 7.5% of the GHL or 626,250 pounds is reserved for the community development quota (CDQ) fishery resulting in a GHL of 7.72375 million pounds for the open access fishery. The open access fishery will open October 15, 2000.

For St. Matthew Island blue king crabs, CSA estimates the abundance of prerecruit (sublegal males) and legal-sized male crabs. Compared to 1999, prerecruit and mature population abundances increased slightly. Prerecruit abundance increased to 0.6 million crabs from 0.5 million in 1999, and mature male abundance increased from 1.1 million to 1.2 million. Although the stock is above the fishery threshold of 2.9 million pounds of mature male biomass, the estimated GHL is below the minimum GHL of 2.5 million pounds. Further, mature biomass based on area-swept estimates of both males and females was estimated as 5.2 million pounds, less than one-half the overfished level (minimum stock size threshold, MSST) of 11.0 million pounds established in the federal fishery management plan for Bering Sea/Aleutian Islands king and Tanner crabs. Thus, the fishery for this depressed stock will be closed in 2000.

For Pribilof Islands blue king crabs, changes from last year included continued decline in mature male abundance from 0.8 to 0.6 million crabs, below the fishery threshold of 0.77 million, and a decrease in legal male abundance from 0.6 to 0.5 million crabs. Survey catches of male crabs were similar between 1999 and 2000, but survey catches of female crabs declined substantially from the level in 1999. Similar to 1999, no small-sized crabs were caught this year. For Pribilof Islands red king crabs, the mature population appears temporarily stable with estimated mature males at 1.3 million during 1998-2000. Given declining and low abundance of blue king crabs, low precision of abundance estimates,

and concern for bycatch, the fishery will be closed for both Pribilof Islands blue and red king crab stocks in 2000.

INTRODUCTION

The National Marine Fisheries Service (NMFS) conducts annual trawl surveys of crab 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., Stevens et al. 2000). 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 and timely information on stock status in advance of upcoming Bering Sea king crab fisheries. 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 83 ft headrope and 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 $\approx$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 Stevens et al. (2000) will be published to provide details on the 2000 survey results for Bristol Bay and Pribilof Islands red king crabs, St. Matthew and Pribilof Islands 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 (2000).

Two surveys were conducted for Bristol Bay red king crabs in 2000: the standard survey that was performed in late May (about two weeks earlier than historic surveys) and a resurvey of 23 stations with high female density that was performed in late July. The resurvey was necessary because most females had not yet molted or mated prior to the

standard survey. Differences in area-swept estimates of abundance between the standard survey and resurvey of these 23 stations can be attributed to survey measurement errors or, possibly, to seasonal changes in distribution between survey and resurvey. The size distribution of females was significantly larger in the resurvey than during the standard survey because most mature females had not molted prior to the standard survey. Therefore, we used data from both surveys to assess male abundance but only the resurvey data, plus the standard survey data outside the 23 stations, to assess female abundance.

Analytical Methods

Overview. The annual trawl survey is an essential data-gathering tool on the status of crab stocks in the eastern Bering Sea. Yet, 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 and Pribilof Islands blue king crabs and Pribilof Islands 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 Islands stocks have been surveyed. This is the first year that we applied the CSA model to Pribilof Islands red king crabs.

CURRENT STOCK STATUS

Bristol Bay Red King Crabs

LBA estimates of Bristol Bay red king crab abundance and 95% bootstrap confidence limits for 2000 are shown in Table 1. Historical changes in mature male and female abundance are graphed in Figure 1. As most of 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 large-size groups decreased from last year. Prerecruit male abundance decreased from 9.2 million to 7.1 million crabs, mature male abundance decreased from 16.0 million to 13.7 million crabs, and legal males decreased from 9.1 million to 8.8 million from 1999 to 2000. Abundance of mature female crabs in 2000 (18.7 million) decreased by about 10% from 20.7 million crabs in 1999. Effective spawning biomass[1] (ESB) in 2000 (39.9 million pounds) was lower than that in 1999 (44.6 million pounds).

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 suggest a substantial decrease in abundance of males between 95 mm and 110 mm CL and males >155 mm CL from 1997 to 1998. The dominant mode of males at 95 to 110 mm CL in 1997 grew in size to 110 to 130 mm CL in 1998 as expected but abundance unexpectedly

[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.

declined sharply despite lower estimated natural mortality. Area-swept estimates of male abundance in 2000 were generally consistent with those in 1995, 1996, 1998, and 1999 but not with 1997.

For females, the model did not fit the 1998 data very well. The large increase in abundance of mature females estimated by the survey in 1998 was not anticipated. The dominant mode of females shifted from 97.5 mm CL in 1997 to 107.5 mm in 1998 to 112.5 mm in 1999 to 117.5 mm in 2000 as crabs molted to larger sizes (Figure 2). However, in 1998, survey catches of females >117.5 mm CL (larger than those in the 1990 year class) increased about 70% from those >112.5 mm CL in 1997, yet survey catches of females >97.5 mm CL (including the 1990 year class) in 1999 fell 53% from those >92.5 mm CL in 1998. Changes in natural mortality typically do not fully account for such increases and decreases; it appears that survey measurement errors were substantial for females in both 1998 and 1999. The LBA attempts to account for measurement errors, so the LBA estimate of mature females is lower than the area-swept estimate in 1998 and higher in 1999 (Figure 1).

Abundance estimates of juvenile males <95 mm CL and females <90 mm CL have large variances and are inconsistent over time and thus are not included in the LBA. However, size frequency modes of juvenile crabs tracked the strong 1990 year class that is apparently now fully recruited to the mature stock (Figure 2). The 1999 size frequency distributions of both males and females show a mode centered about 67.5 mm CL, which seems to have grown to a mode centered at 82.5 mm CL in 2000 (Figure 2). If the survey catches in 2000 are representative of true abundance, this cohort (likely the 1994 year class) will enter the mature female stock next year and should produce the second highest recruitment during the last 10 years. However, due to unreliable survey estimates of juvenile crabs, evidence of a strong year class cannot be confirmed until we see such a mode entering the mature stock.

Just as historical survey results enter into the LBA and modify the interpretation of data from 2000, the 2000 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 1972-2000 (Table 1) differ somewhat from estimates generated with data from 1972-1999 (see Table 1 in Zheng and Kruse 1999). Estimates for recent years change the most; older estimates remain most stable. For instance, high abundance of female crabs of size 115-125 mm CL in 2000 helps boost the LBA estimates of mature females in 1997 and 1998 from the LBA estimates made in 1999 (Zheng and Kruse 1999). Likewise, next year's assessment will bring new data to bear on the status of the stock.

Pribilof Islands Red King Crabs

The survey precision is very low for Pribilof Islands red king crabs because a large majority of crabs are usually caught in one or a few 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 model estimates and 1995 for the area-swept estimates (Figure 3). Based on the model results, the mature abundance is stable during the last three years at about 1.3 million and legal crabs increased slightly from 0.8 million in 1998 to 1.1 million in 2000 (Table 2).

St. Matthew Island Blue King Crabs

Owing to extremely low survey abundances in 1999 and 2000, 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 from 1998 to 1999. To deal with this high natural mortality, we estimated two natural mortality parameters using CSA: one for year 1998/99 (that is, the year between the 1998 and 1999 surveys, called *M99* in Figure 4) and another one for all other years. As a comparison, we also conducted CSA under two other scenarios: (1) a constant natural mortality for all years and (2) the natural mortality in 1998/99 is assumed to be three times as high as that in the other years. Note that we used the second scenario in the 1999 assessment.

CSA estimates of St. Matthew Island blue king crab abundance and 95% confidence limits for 2000 are shown in Table 3. Compared to 1999, prerecruit and mature population abundances increased slightly. Prerecruit abundance (90-119 mm CL) increased to 0.6 million crabs from 0.5 million in 1999, and mature male abundance increased from 1.1 million to 1.2 million. CSA estimates of mature abundance are lower than area-swept estimates in 1996-98 and higher in 1999 and 2000 (Figure 4). The constant natural mortality scenario (M = 0.31) attributes about half of the sharp drop in 1999 to survey measurement errors whereas the scenario with two natural mortality parameters (M = 1.49 for 1998/99 & M = 0.26 for all other years) fits the data best (Figure 4). The scenario that assumed a natural mortality to be three times as high in year 1998/99 as that in the other years falls into the middle of the above two scenarios. Based on the best fit of the data, we chose the scenario with two natural mortality parameters as our best scenario. The low abundances across all size groups in 1999 and 2000 are illustrated in Figure 5.

Pribilof Islands Blue King Crabs

For blue king crabs off the Pribilof Islands, changes from last year included continued decline in mature male abundance from 0.8 to 0.6 million crabs and a decrease in legal male abundance from 0.6 to 0.5 million crabs (Table 3, Figure 4). Survey catches of male crabs were similar between 1999 and 2000 (Figure 5). While it is not shown here, survey catches of female crabs declined substantially from the level in 1999.

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 harvest rate coupled to 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, 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 rebuilding 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 2000 the estimates of mature female abundance and ESB were 18.7 million and 39.9 million pounds, respectively – both above the thresholds needed to conduct a directed commercial fishery. Because ESB is below the target rebuilding level of 55 million pounds, a 10% harvest rate is applied. Applying this harvest rate times mature male abundance of 13.66 million results in a harvest of 1.366 million crabs. Because 1.366 million is only 15.6% of the legals, the 50% cap is not required. By multiplying 1.366 million crabs times an average weight of 6.11 pounds per legal crab, a preseason GHL of 8.35 million pounds was established for the 2000 fishery. A total of 7.5% of the GHL or 626,250 pounds is reserved for the community development quota (CDQ) fishery, resulting in a GHL of 7.72375 million pounds for the open access fishery. The actual CDQ harvest level will be based on a percentage of the total catch from the open-access 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 39.9 million pounds of ESB for 2000, the red king crab PSC limit for the Bering Sea will be set at 97,000 crabs for groundfish trawl fisheries in 2001.

A portion of the year-round closure to non-pelagic trawling in the Red King Crab Savings Area (162° to 164° W, 56° to 57° 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° to 56° 10' N latitude will remain open to the rock sole fishery in 2001. 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.

Blue King Crabs and Pribilof Islands Red King Crabs

For St. Matthew Island, the Alaska Board of Fisheries adopted a new harvest strategy 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 4.5 million pounds in 2000, above threshold. However, the estimated GHL of 0.62 million pounds was below the minimum GHL. Thus, the fishery for this stock will be closed in 2000.

For the Pribilof Islands, the fishery management plan specifies a threshold of 0.77 million mature male blue king crabs; no threshold is specified for red king crabs (Pengilly and Schmidt 1995). 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. The mature male abundance of Pribilof Islands blue king crabs was 0.64 million in 2000, below the fishery threshold, so the fishery for this stock will be closed in 2000. The fishery for Pribilof red king crabs will also be closed in 2000, due primarily to the small population, low precision of abundance estimates, fishery closure for blue king crabs, and concern for bycatch.

FUTURE OUTLOOK

The future outlook for the Bristol Bay red king crab stock is not optimistic. Almost all red king crabs from the 1990 year class have entered the mature population, and it appears that the mature male red king crab abundance will decrease in the next one to two years. A small, slow-growing portion of male red king crabs from the 1990 year class have yet to attain legal size; they will likely sustain harvest of Bristol Bay red king crabs in the near future. However, with the aging cohort, the mortality for the 1990 year class will likely increase in the near future. With a decreasing mature population, the GHL will likely gradually decrease in the next one to two years. The near-term hope is for the materialization of a good 1994 year class. If this cohort can come through relatively strong, it can help make up the loss of the 1990 year class. The trawl survey next year will help determine the strength of the 1994 year class and improve our ability to project the stock status in the next few years.

The status of both eastern Bering Sea blue king crab stocks is depressed. The mature biomass based on area-swept estimates of both males and females was estimated as 5.2 million pounds for the St. Matthew blue king crab stock. This is the second year in a row below the overfished level (minimum stock size threshold, MSST) of 11.0 million pounds established 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 stock, the low survey abundance this year greatly strengthens the argument for the high natural mortality. Next year's survey should help us to estimate the level of this high natural mortality with a greater confidence. The mature biomass for the Pribilof Islands blue king crab stock was estimated as 7.4 million pounds, just above the MSST of 6.6 million lbs. Based on trends in prerecruits and recruits for blue king crabs at the Pribilof Islands, the stock will likely drop below the MSST by next year and is not expected to improve in the near term.

It appears that the mature population of Pribilof Islands red king crabs is temporarily stable. The high abundance of small red king crabs caught by last year's trawl survey at the Pribilof Islands did not show up in the survey this year. Due to low survey precision, usually cohort strength cannot be confirmed from the survey data until the cohort reaches the postrecruit stage.

ACKNOWLEDGMENTS

Thanks are extended to Bob Otto and Brad Stevens of NMFS-Kodiak for providing survey data and supporting analyses. We thank Doug Pengilly and Shareef Siddeek for their review of a draft of this report. This work is funded in part by a cooperative agreement NA97FN0129 from the National Oceanic and Atmospheric Administration. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

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Table 1. Annual abundance estimates (millions of crabs), effective spawning biomass (ESB, millions of pounds), and 95% confidence intervals for 2000 for red king crabs in Bristol Bay estimated by length-based analysis from 1972-2000. Size measurements are 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	13.523	15.056	18.514	10.004	NA	59.744	55.486
1973	31.654	21.095	27.279	23.017	10.638	33.304	70.090	64.181
1974	21.325	14.959	35.895	34.949	14.950	28.268	71.468	95.383
1975	32.207	21.433	36.734	42.062	20.894	21.780	65.866	116.391
1976	46.085	30.722	46.529	49.905	25.746	34.048	74.706	128.465
1977	54.271	36.542	61.892	63.398	30.567	72.886	118.940	167.913
1978	20.184	15.243	59.721	76.498	40.061	47.008	120.206	200.606
1979	12.592	8.935	37.066	74.013	47.607	18.920	93.075	167.173
1980	24.465	16.121	26.216	59.534	43.951	36.032	93.566	166.421
1981	17.265	11.990	17.378	18.397	9.469	13.613	71.337	59.307
1982	23.195	15.497	16.411	10.412	2.942	17.481	30.002	24.409
1983	13.012	9.247	13.679	9.050	2.483	4.698	9.941	16.631
1984	18.122	12.098	12.897	8.249	2.347	11.821	13.561	16.702
1985	10.148	7.212	10.683	6.926	1.794	5.142	7.505	11.224
1986	6.149	4.487	12.735	11.701	4.280	4.079	9.370	14.889
1987	6.613	4.555	11.212	13.682	6.556	9.610	16.235	25.528
1988	6.258	4.343	10.189	14.281	8.086	5.796	17.254	28.820
1989	5.151	3.621	9.368	15.290	9.522	5.511	17.721	30.905
1990	1.431	1.197	7.096	14.837	10.025	0.897	13.442	25.947
1991	4.062	2.671	5.090	11.873	8.487	3.600	13.141	25.470
1992	6.071	4.078	6.171	9.999	6.756	3.229	12.535	24.520
1993	2.342	2.063	7.072	10.141	6.008	2.051	10.930	22.096
1994	1.101	0.984	5.605	8.789	4.878	0.405	8.153	17.809
1995	2.904	1.992	4.815	9.454	6.163	1.546	9.365	20.728
1996	3.217	2.347	5.271	10.181	6.983	4.266	13.237	27.485
1997	14.004	9.103	9.365	11.673	7.190	15.349	28.008	38.993
1998	3.174	3.407	13.614	14.897	7.447	1.626	28.346	49.935
1999	1.473	1.181	9.198	16.011	9.060	0.595	20.716	44.566
2000	5.238	3.493	7.148	13.663	8.764	3.973	18.682	39.936
			95% Confidence Limits in 2000					
Lower	3.889	NA	5.887	10.817	6.746	3.015	15.102	NA
Upper	8.604	NA	8.537	15.972	10.541	6.228	23.924	NA

Table 2. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2000 for male red king crabs off the Pribilof Islands by four-stage catch-survey analysis from 1988 to 2000. Survey catchability is fixed at 1.0 for legals. Relative abundance estimates of prerecruits are scaled to area-swept estimates. Recruits are newshell males of size 135-149 mm CL. All other legal males are postrecruits. Size measurements are mm CL.

Year	Prerec. II	Prerec. I	Mature	Recruit newshell	Post. oldshell	Legal
mm→	(105-119)	(120-134)	(≥120)	(135-149)	(≥135)	(≥135)
1988	0.312	0.043	0.066	0.023	0.000	0.023
1989	0.295	0.210	0.278	0.046	0.022	0.068
1990	2.194	0.241	0.450	0.141	0.068	0.209
1991	0.372	1.508	1.996	0.299	0.189	0.488
1992	0.069	0.603	1.997	0.906	0.489	1.394
1993	0.570	0.193	1.755	0.352	1.210	1.562
1994	0.165	0.419	1.574	0.154	1.001	1.155
1995	0.145	0.206	1.318	0.259	0.853	1.112
1996	0.040	0.144	1.129	0.128	0.858	0.985
1997	0.804	0.062	0.966	0.085	0.819	0.904
1998	0.382	0.530	1.310	0.091	0.690	0.780
1999	0.210	0.375	1.337	0.334	0.628	0.962
2000	0.123	0.227	1.291	0.231	0.833	1.063
			95% Confidence Limits in 2000			
Lower	NA	NA	0.533	NA	NA	0.376
Upper	NA	NA	2.049	NA	NA	1.751

Table 3. Annual abundance estimates (millions of crabs) and 95% confidence intervals for 2000 for male blue king crabs off St. Matthew and Pribilof Islands by four-stage catch-survey analysis from 1975 to 2000. Survey catchability is fixed at 1.0 for legals. Relative abundance estimates of prerecruits are scaled to area-swept estimates. St. Matthew Island recruits are newshell males of size 120-133 mm CL, and Pribilof Island recruits are newshell males of size 135-148 mm CL. All other legal males are postrecruits. Size measurements are mm CL. Natural mortality during the year between the 1998 and 1999 assessments was estimated separately from other years for the St. Matthew Island stock.

	St. Matthew Island					Pribilof Islands				
Year	Prerec.	Mature	Recruit newshell	Post. oldshell	Legal	Prerec.	Mature	Recruit newshell	Post. oldshell	Legal
mm→	(90-119)	(≥105)	(120-133)	(≥120)	(≥120)	(105-134)	(≥120)	(135-148)	(≥135)	(≥135)
1975	NA	NA	NA	NA	NA	6.087	11.676	3.611	4.247	7.858
1976	NA	NA	NA	NA	NA	3.640	10.299	2.064	5.696	7.760
1977	NA	NA	NA	NA	NA	4.320	8.133	1.548	5.170	6.717
1978	2.820	3.341	1.043	0.515	1.558	4.672	7.698	1.051	4.399	5.450
1979	3.408	3.609	1.192	0.927	2.119	2.504	7.197	1.550	3.489	5.040
1980	4.307	5.219	1.104	1.653	2.757	1.381	5.313	1.325	3.163	4.488
1981	3.501	6.422	1.710	2.197	3.907	1.050	3.272	0.534	2.161	2.695
1982	2.427	5.481	1.721	2.297	4.018	0.941	1.888	0.373	1.058	1.431
1983	1.753	3.985	1.072	1.641	2.713	0.793	1.333	0.289	0.618	0.907
1984	0.959	2.196	0.910	0.609	1.519	0.438	1.082	0.264	0.472	0.735
1985	0.893	1.411	0.467	0.534	1.001	0.182	0.896	0.215	0.526	0.741
1986	1.045	1.326	0.297	0.401	0.697	0.055	0.657	0.109	0.495	0.604
1987	1.243	1.397	0.439	0.387	0.827	0.016	0.470	0.036	0.421	0.457
1988	1.535	1.762	0.437	0.474	0.911	0.003	0.278	0.012	0.263	0.275
1989	2.313	2.016	0.636	0.497	1.133	1.166	0.207	0.002	0.204	0.206
1990	2.911	3.198	0.715	0.714	1.428	1.465	1.053	0.071	0.153	0.224
1991	2.640	3.666	1.290	0.862	2.151	1.205	1.446	0.615	0.201	0.816
1992	2.653	3.723	1.113	1.136	2.249	1.201	1.604	0.436	0.629	1.065
1993	2.753	3.982	1.080	1.360	2.440	0.966	1.727	0.357	0.809	1.166
1994	2.787	4.152	1.117	1.436	2.554	0.892	1.629	0.336	0.883	1.219
1995	3.127	4.097	1.143	1.366	2.510	0.948	1.571	0.249	0.917	1.166
1996	3.404	4.629	1.193	1.463	2.656	0.770	1.402	0.232	0.741	0.973
1997	2.881	4.922	1.444	1.597	3.041	0.432	1.195	0.227	0.637	0.864
1998	2.115	4.375	1.316	1.663	2.979	0.349	0.932	0.160	0.597	0.756
1999	0.545	1.082	0.273	0.505	0.778	0.280	0.752	0.089	0.512	0.601
2000	0.630	1.151	0.213	0.613	0.826	0.159	0.644	0.075	0.450	0.524
95% Confidence Limits in 2000										
Lower	NA	0.661	NA	NA	0.445	NA	0.387	NA	NA	0.289
Upper	NA	1.641	NA	NA	1.206	NA	0.902	NA	NA	0.760

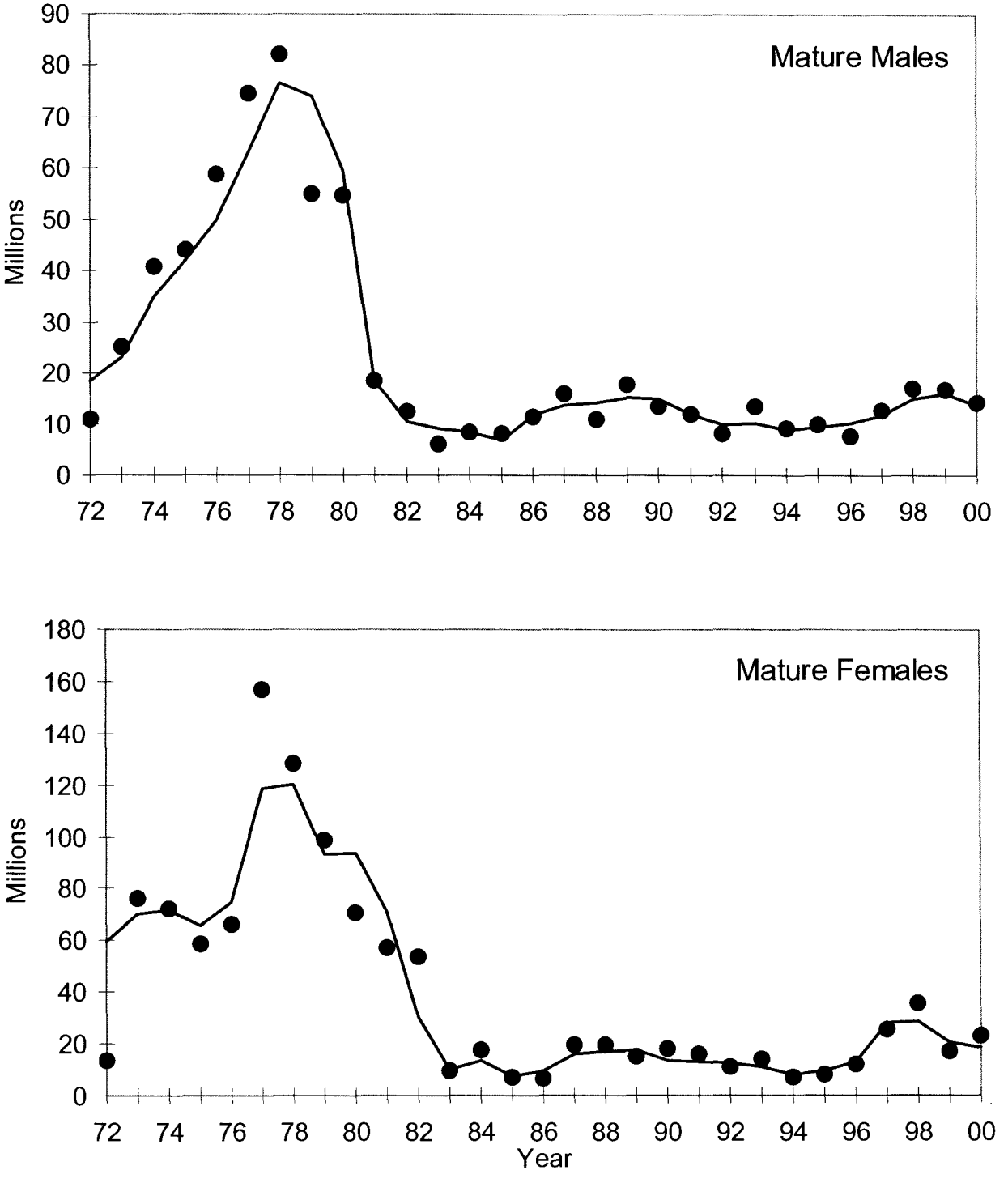

Figure 1. The length-based analysis fit (line) to area-swept estimates (dots) of mature male (top panel) and mature female (bottom panel) Bristol Bay red king crab abundance (millions of crabs).

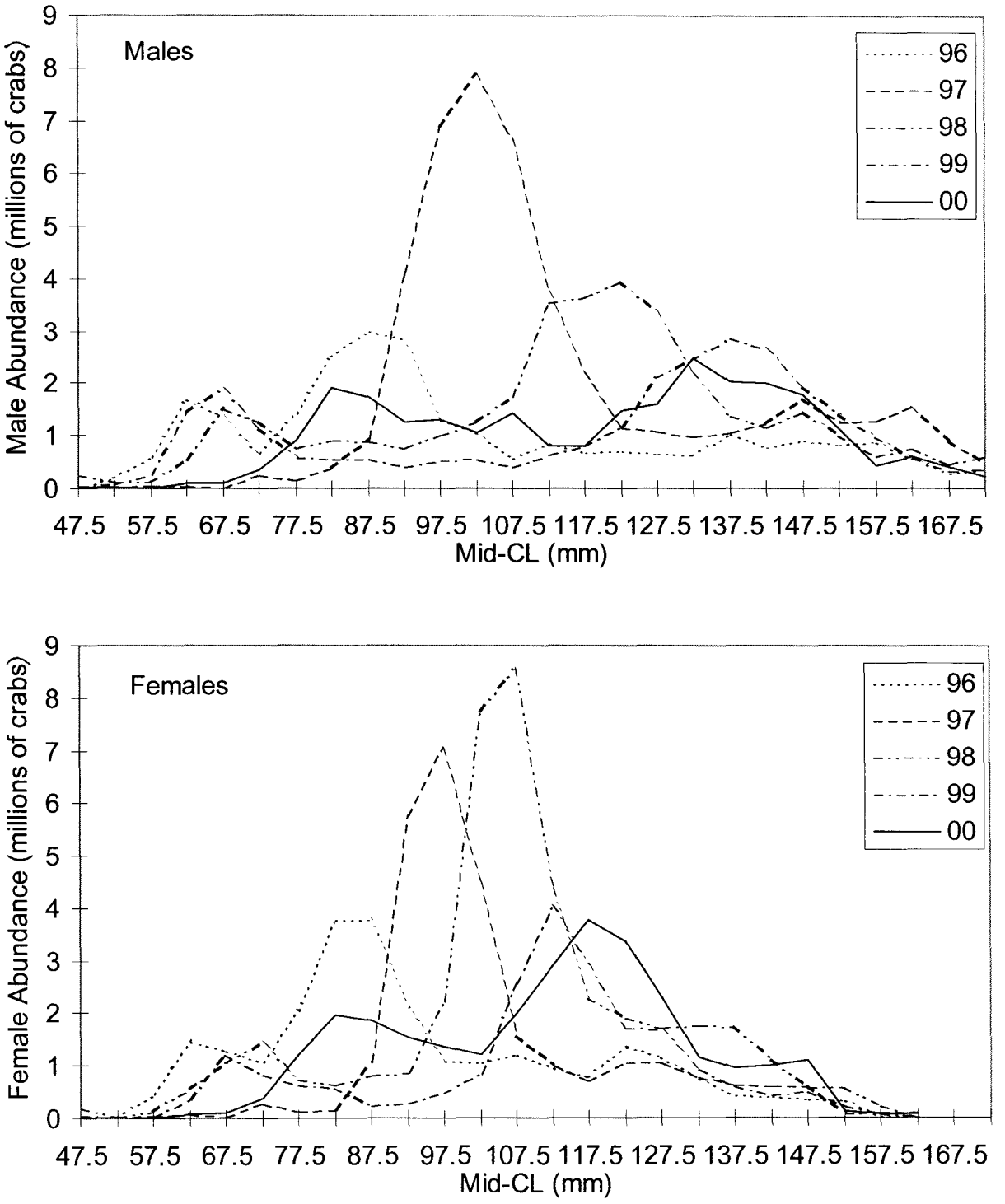

Figure 2. Length frequency distributions of male (top panel) and female (bottom panel) red king crabs in Bristol Bay from NMFS trawl surveys during 1996-2000. For purposes of these graphs, abundance estimates are based on area-swept methods not LBA because the LBA is confined to males ≥95 mm CL and females ≥90 mm CL.

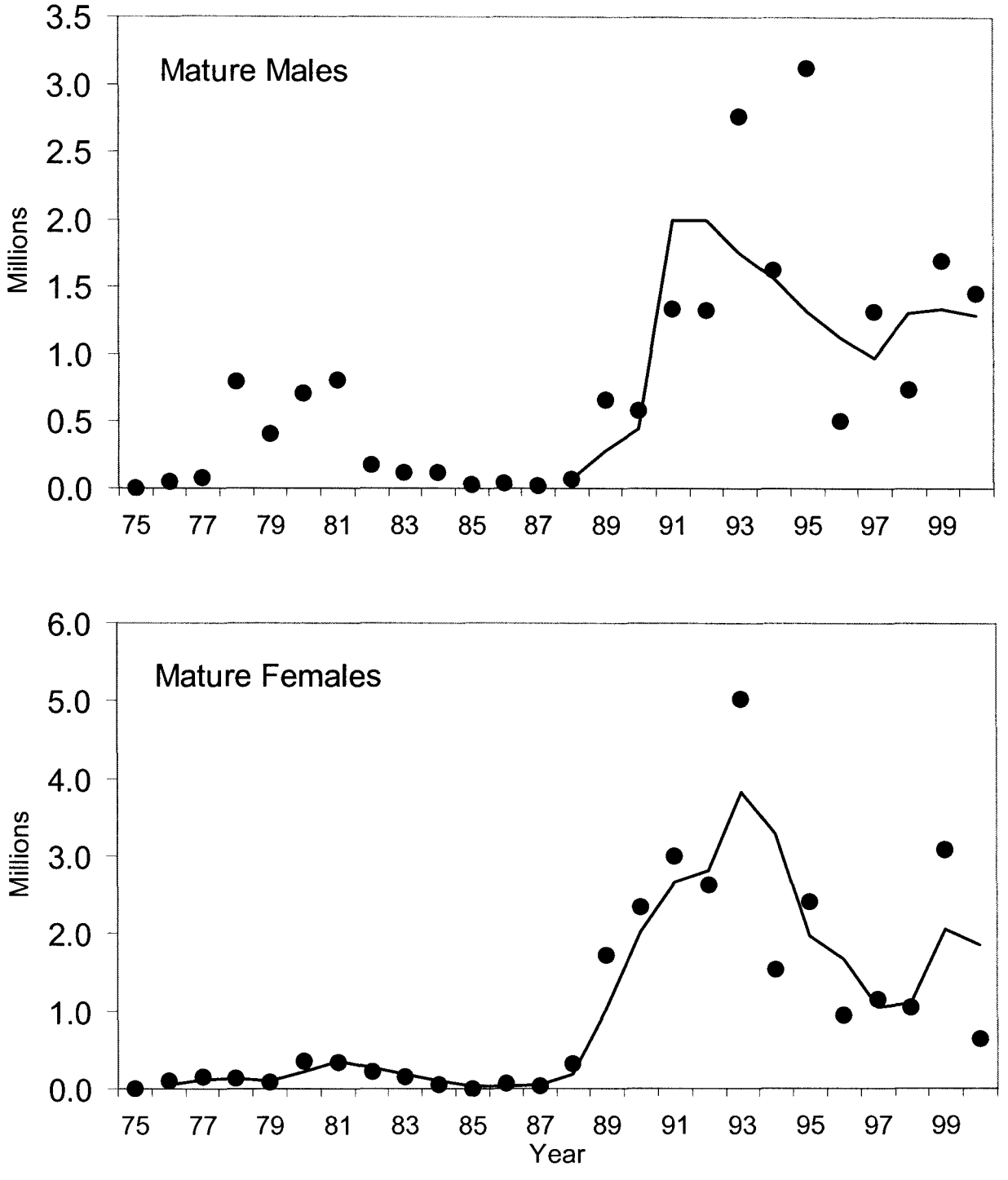

Figure 3. The catch-survey analysis fit (line) to area-swept estimates (dots) of mature male red king crab abundance (millions of crabs; top panel) and area-swept estimates (dots) and their moving averages (line) of mature female red king crab abundance (bottom panel) off the Pribilof Islands.

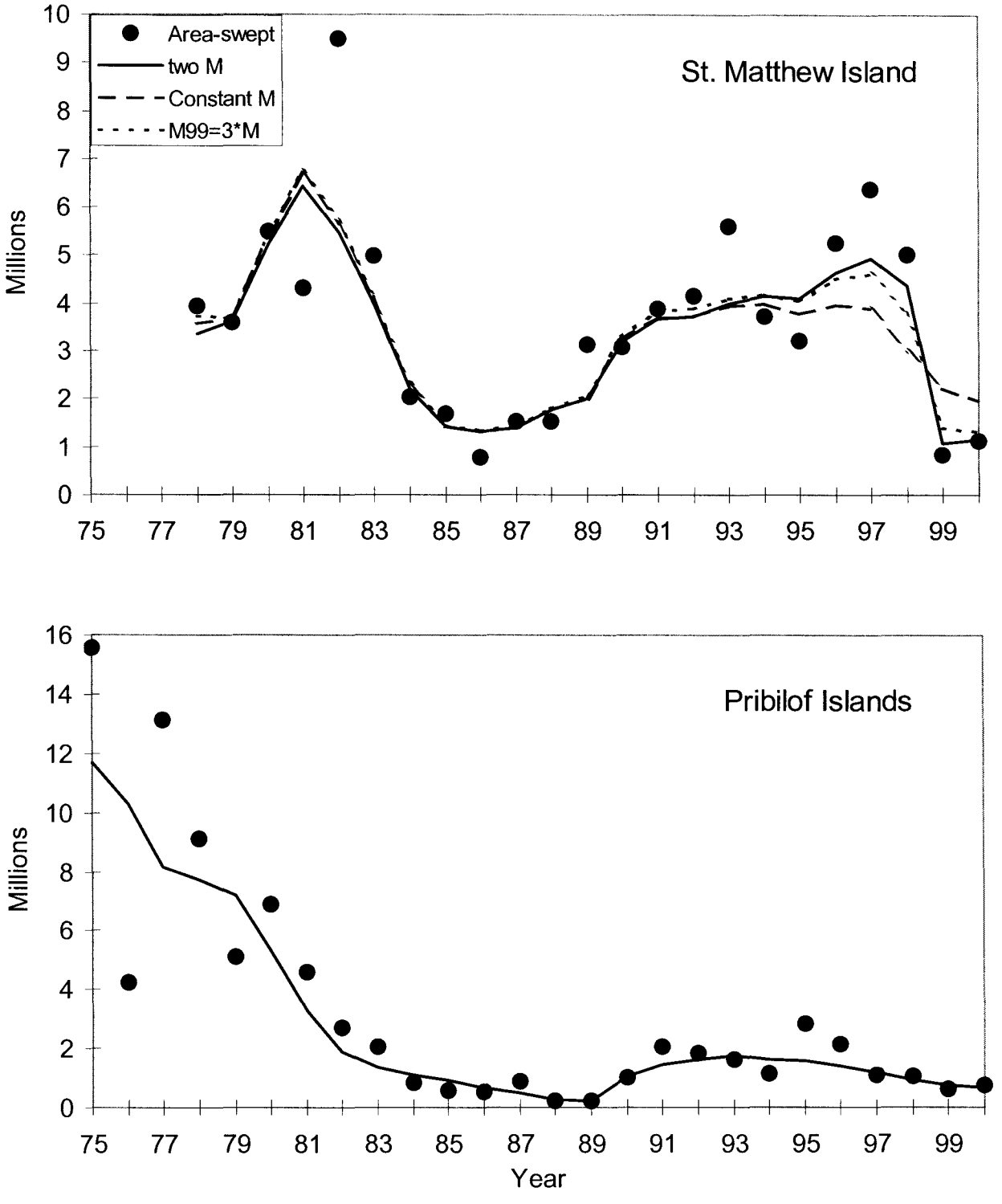

Figure 4. The catch-survey analysis fit (line) to area-swept estimates (dots) of mature male blue king crab abundance (millions of crabs) for St. Matthew (top panel) and Pribilof Islands stocks (bottom panel).

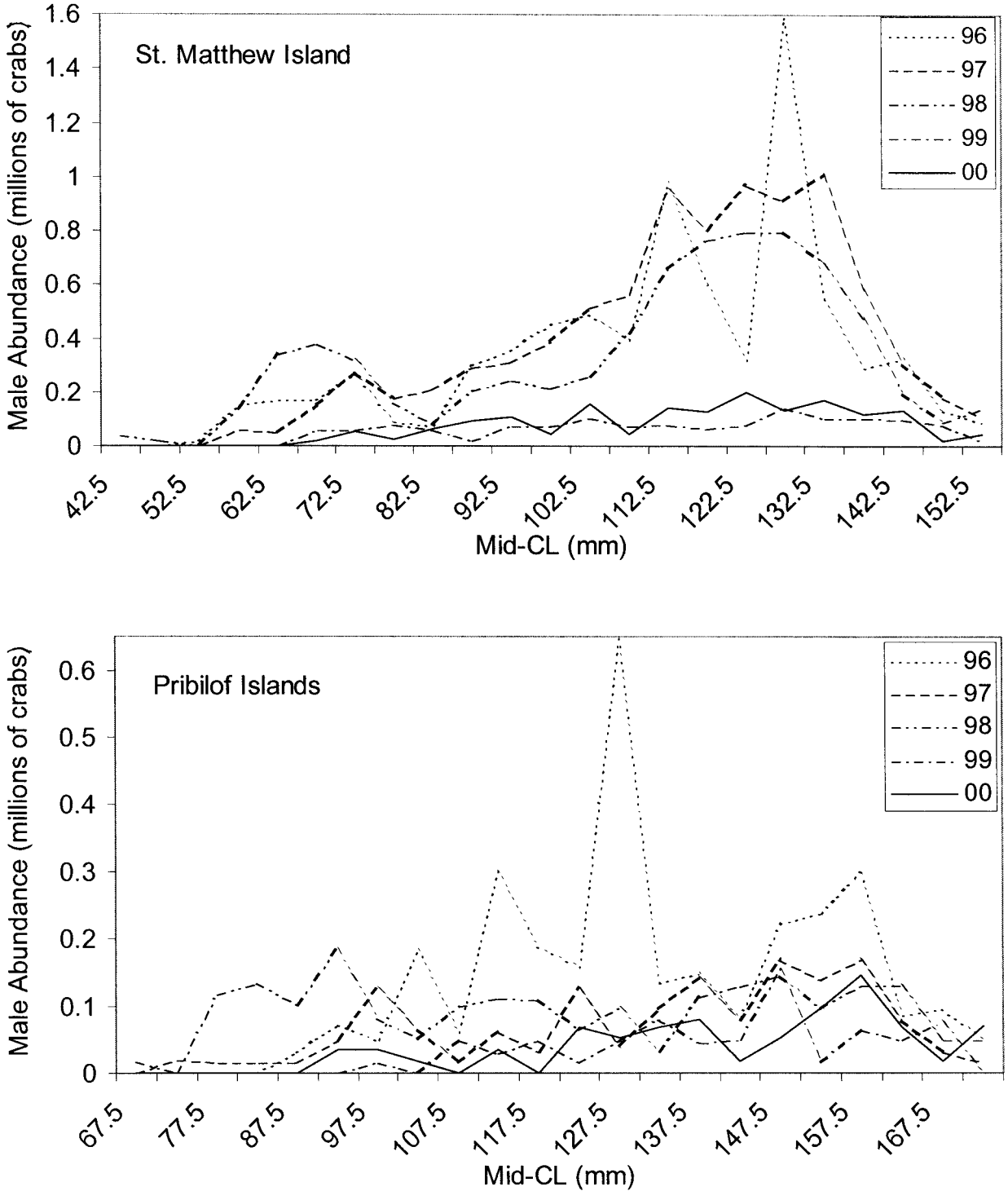

Figure 5. Length frequency distributions of male blue king crabs for St. Matthew (top panel) and Pribilof Islands stocks (bottom panel) from NMFS trawl surveys during 1996-2000. Abundance estimates are based on area-swept methods.