Options for Potential Female Red Crab Harvest
to be Incorporated into the ABC and ACL
Prepared by the Red Crab PDT for Consideration by the SSC
June, 2010

The reauthorized Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires fishery management plans (FMPs) to account for all removals from a fished stock. Female red crab are caught in red crab traps in varying amounts as a normal part of fishing. Until recently, essentially all female red crab were discarded because most females were smaller than the marketable size, which was based on the needs of processors. Some portion of the discarded female crabs suffered from discard mortality, discussed below. In 2002, the Red Crab FMP included a prohibition on landing more than one standard tote (100 lb) of female crab per trip. In 2009, buyers expressed interest in female red crab for specialty markets. In response to a request from the red crab industry and from red crab researchers, on June 23, 2009 the National Marine Fisheries Service approved an exempted fishery permit (EFP) that exempts four vessels from the prohibition on landing more than one standard tote of female crab per trip. The EFP allows for landing of no more than 1 million lb of female red crab over two years.

According to the Federal Register announcement of the EFP, the primary goal of the exempted fishing is to begin harvesting non-egg-bearing females to expand the red crab market and increase efficiency in the harvesting process. In addition, the EFP provides an opportunity and funding to conduct at-sea sampling, renew tagging efforts, and to develop models to better evaluate the growth and reproductive performance of the population, as well as the impact of current and proposed harvesting on yields and egg production. The experimental design calls for the females to be taken in the course of normal commercial fishing operations. The research would occur within the constraints of the current management measures, including possession limits and days-at-sea limits.

Under the new requirements of the MSA, because some female crab will die in the normal course of fishing, either from discard mortality or from being retained for sale, the allowable biological catch (ABC) must include female red crab. This document provides options for calculating the ABC for female red crab.

The long-term average landings of male red crab were used as the basis for the interim ABC for red crab. The New England Fishery Management Council's (Council's) Scientific and Statistical Committee (SSC) noted that historical landings of male red crab and historical discarding practices appear to be sustainable and that the recommended ABC would have to be increased to include discards if it were intended to include total catch. An estimate of historical discard rates was not available at the time the SSC established the interim ABC, and so it was not included. A companion paper provides options for including an estimate of the dead discards or both sexes that were likely to have been associated with the long-term landings of male crabs that formed the basis for the interim ABC. This paper addresses the issue of female landings as a component of the ABC.

Scientific Background

Two surveys of red crab abundance have been conducted, one in 1974 and one in 2003-2005.

The SSC considered the available scientific information on red crab during multiple meetings in 2009 and 2010. The SSC then recommended that "landings of male red crabs should be limited to an interim ABC of 1,775 mt." The SSC noted that "the two survey estimates of abundance and their variance do not provide evidence of significant depletion from 1974 to 2003-2005." The SSC also concluded that "an interim ABC based on long-term landings is safely below an overfishing threshold and adequately accounts for scientific uncertainty."

Total removals from the red crab stock during the period used to calculate the long-term historical landings have included some level of discard mortality inflicted by both the directed fishery for red crab and by fisheries directed at other species. The PDT has prepared a separate document that addresses discard mortality caused by other fisheries. An estimate of total annual mortality due to red crab fishing is presented in Table 1, which is taken from the report of the Northeast Data Poor Species Working Group (2009) (DPSWG). The DPSWG reported that, "based on limited log book, sea- and port sample information, discards of female and undersize male red crabs appear to average about 30% of total catch but can range from about 10% to 69% of total red crab catch." The DPSWG also reported that discard mortality from being brought to the surface and handled on deck averages about 5% (Tallack 2007), but noted that discard mortality is a major uncertainty. For purposes of estimating total annual mortality associated with landings, the DPSWG used a discard mortality rate of 0.50 in its peer-reviewed report. NMFS scientists have pointed out that the Tallack study may not represent typical commercial fishing operations covering a range of seasonal conditions.

Discard rates used in Table 1 were from sea- and port samples during 2003-2004 (Table D4.5 in NEFSC 2006a).

Table 1- Total annual mortality due to fishing (landings and mortal discard) during 2003-2005 by sex. (Table 1 from Data Poor Species Working Group Report. The label "5 x best estimate" is in the original table and should read "10 x best estimate.")

	Males	Females	Total
Average 2003-2005 landings (mt)	1,992	0	1,992
Discard/(total male + female catch)	0.11	0.18	0.29
Catch (mt, includes all discards)	2,238	2,429	4,667
Discard (mt)	246	2,429	2,675
Discard mortality rate (5 x best estimate)		0.5	
Mortal discard (mt)	123	1,215	1,338
Landings + mortal discard (mt)	2,115	1,215	3,330
Total biomass (mt)	56,443	74,689	131,132
90+ CW biomass (mt)	38,220	55,279	93,499
F relative to total biomass	0.04	0.02	0.03
F relative to 90+ biomass	0.06	0.02	0.04

Biomass estimates from the 1974 and 2003-2005 surveys for both male and female crab are given in Table 2. If the 90+ mm CW male biomass estimate from the 2003-2005 survey represents current abundance, and if the discard rate and discard mortality indicated in Table 1 of the DPSWG Report are added to the male landings ABC to get total removals by the directed red crab fishery with landings of 1,775 mt, the resulting fishing mortality rate on males is 0.049 when applied to the male biomass over 90 mm CW (Table 3).

Table 2- Biomass estimates, standard errors and CVs from deep-sea red crab camera/bottom trawl surveys. The standard errors fro 1974 estimates are approximations based on the assumption that CVs for variability among samples was the same during 1974 as during 2003 to 2005. The differences in CVs between the two periods are due to differences in assumed effective sample size. (From table 2 in the DPSWG Report.)

Year Size Groups (mm CW)	Males			Females			Total		
	Biomass (mt)	SE (mt)	CV (mt)	Biomass (mt)	SE (mt)	CV (mt)	Biomass (mt)	SE	CV
1974									
90+	29,991	6,298	0.21	15,654	3,719	0.24	45,645	7,314	0.16
114+	23,794	4,303	0.18	2,106	433	0.21	25,900	4,325	0.17
Fishable	30,302	6,363	0.21	NA	NA	NA	NA	NA	NA
All	32,190	5,001	0.16	20,674	5,221	0.25	52,864	7,230	0.14
2003 to 2005									
90+	38,220	4,298	0.11	55,279	7,033	0.13	93,499	8,242	0.09
114	13,770	1,334	0.1	5,224	576	0.11	18,994	1,453	0.08
Fishable	36,247	4,612	0.13	NA	NA	NA	NA	NA	NA
All	56,443	4,646	0.08	74,689	10,102	0.14	131,132	11,119	0.08

Table 3- Total annual mortality associated with male landings of 1,775 mt based on Table 1 from the DPSWG Report. Discards are for directed fishery only.

	Males	Females	Total
Total Allowable Landings*	1775	0	1775
Discard Rate	0.11	0.18	0.57
Catch (mt, includes all discards)	1994	2165	4159
Discard (mt)	219	2165	2384
Discard mortality rate (10x best estimate)	0.5	0.5	
Mortal discard (mt)	110	1082	1192
Landings + mortal discard (mt)	1885	1082	2967
Total biomass (mt)	56443	74689	131132
90+ CW biomass (mt)	38220	55279	93499
F relative to total biomass	0.033	0.014	0.023
F relative to 90+ biomass	0.049	0.020	0.032

*Total allowable landings (TAL) refers to the portion of the annual catch limit that the fleet is allowed to land and does not include dead discards.

Female Option 1 – No Retained Females

Table 3 shows that the expected female catch associated with 1,775 mt male landings would be 2,165 mt using the sex ratio from table 1 in the DPSWG Report. With no female landings, 2165 mt of females would be discarded. We would also expect 219 mt of male discards from the directed fishery. If we also use the 0.50 discard mortality rate

from table 1 in the DPSWG Report, we would expect 1082 mt of dead female discards and the fishing mortality rate on females over 90 mm would be 0.02 if the 2003-2005 survey abundance estimate represents current abundance.

Female Option 2 – Retain 75% of Females Expected to be Caught Using DPSWG Sex Ratio

Tallack (2007) provides data that indicates that approximately 75% of the female crabs that are caught by traps with 9 cm escape rings will be larger than 95 mm CW. Tallack did not note whether the female crabs were carrying external eggs. The experimental fishery permit for female red crab specifies that non-egg-bearing females will be taken in the course of normal fishing operations. If we use the ratio of kept males to females from table 1 in the DPSWG Report, and 75% of the female catch were retained, the resulting fishing mortality rate on females would be 0.034 and the fishing mortality rate on the sexes combined would be 0.040 (Table 4) with a female TAL of 1,625 mt..

Table 4- Fishing mortality rate if 75% of caught females are retained, using the sex ratio and discard rates from table 1 in the DPSWG Report. Discards are for directed fishery only (Metric tons).

	Males	Females	Total
TAL	1775	1625	3400
Discard Rate by gender	0.11	0.25	
Catch (mt, includes all discards)	1994	2166	4160
Discard (mt)	219	542	761
Discard mortality rate (10x best estimate	0.5	0.5	
Mortal discard (mt)	110	271	380
Landings + mortal discard (mt)	1885	1895	3780
Total biomass (mt)	56443	74689	131132
90+ CW biomass (mt)	38220	55279	93499
F relative to total biomass	0.033	0.025	0.029
F relative to 90+ biomass	0.049	0.034	0.040

Female Option 3 – Retain 75% of Females Expected to be Caught Using Sex Ratio from Observed Trips

Data from five observed red crab trips with 81 hauls in 2007 and 2008 indicate that the catch of females averaged 35% of the catch of kept males and females combined with a 95% confidence interval of 0.058. (This contrasts with a ratio of females to kept males of 1.22:1 used in table 1 in the DPSWG Report.) If the ratio of females to kept males from the observed trip data is applied to the 1,775 mt ABC for male landings, we would expect the total catch of females to be 959 mt. If 75% of those females were kept and 25% were discarded, the resulting landings of female crab would be 719 mt and the fishing mortality rate on female crab would be 0.015, based on a biomass of 55,279 female crabs over 90 mm CW. The overall fishing mortality rate on both sexes would be 0.029.

Table 5- Total annual mortality associated with a male TAL of 1775 mt with retention of 75% of female crab caught incidentally while directing on male crab using sex ratio from observed trips. Discards are for directed fishery only.

07-08 Obs Trip Sex Ratio	Males	Females	Total
Total Allowable Landings	1775	719	2494
Discard Rate	0.11	0.25	
Catch (mt, includes all discards)	1994	959	2953
Discard (mt)	219	240	459
Discard mortality rate (10x best estimate)	0.5	0.5	
Mortal discard (mt)	110	120	230
Landings + mortal discard (mt)	1885	839	2723
Total biomass (mt)	56443	74689	131132
90+ CW biomass (mt)	38220	55279	93499
F relative to total biomass	0.033	0.011	0.021
F relative to 90+ biomass	0.049	0.015	0.029

Female Option 4 – Retain 719 mt Females with Expected Female Catch from Sex Ratio in DPSWG Report

If the sex ratio from table 1 in the DPSWG Report is used to estimate the female catch that will accompany male landings of 1,775 mt, the female catch will be 2,166 mt. If, rather than retaining 75% of those females, the fleet were to retain the 719 mt female landings that were suggested by the use of the sex ratio from the observed trips, the resulting fishing mortality rate on females over 90 mm would be 0.026 and the fishing mortality rate on the total biomass over 90 mm would be 0.036.

Table 6- Fishing mortality rates resulting from female retention based on sex ratio from most recent observed trips but applied to expected female catch based on sex ratio used in the DPSWG Report. Discards are for directed fishery only.

	Males	Females	Total
Total Allowable Landings	1775	719	2494
Discard Rate by gender	0.11	0.67	
Catch (mt, includes all discards)	1994	2166	4160
Discard (mt)	219	1447	1666
Discard mortality rate (10x best estimate)	0.5	0.5	
Mortal discard (mt)	110	724	833
Landings + mortal discard (mt)	1885	1443	3327
Total biomass (mt)	56443	74689	131132
90+ CW biomass (mt)	38220	55279	93499
F relative to total biomass	0.033	0.019	0.025
F relative to 90+ biomass	0.049	0.026	0.036

Female Option 4 is a conservative approach to the retention of female crabs caught incidentally in the course of normal fishing directed at large male crabs. Option 4 uses a higher ratio of females to males than has been indicated in the most recently observed trips, which has the effect of increasing the calculated fishing mortality rate. By combining the higher estimate of the expected female catch with the female retention that would result from the lower estimate of the female catch, we avoid overestimating the appropriate female retention.

References

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