Estimates of Historical Discards and Discard Mortality Rates in Fisheries for which Red Crab Is Caught Incidentally
Prepared for the Red Crab PDT
by
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The staff of the Northeast Fisheries Science Center set out to determine a relatively straightforward and simple way to estimate red crab discards using data that are readily available. This method uses observer data from 1991-2009 to estimate rates of red crab discard from several different fisheries that bycatch red crab. Those estimated rates of discard can then be applied to landings from those fisheries for any given year to estimate total biomass of red crab discards.

Methods:

All estimates of discards were calculated using aggregated observer data from 1991 through 2009, and VTR landings data for each individual year. The reason VTR landings data were used instead of dealer data was that there was a statistical area attached to the VTR data and we were only interested in removals from the area the fishery takes place and to which management measures apply. All observer and VTR data used were from statistical areas 562, 525, 526, 537, 616, 622, 623 and 626, offshore areas from the Hague line south to Chesapeake Bay.

The targeted fisheries investigated were the ones which the observer data indicated had red crab bycatch over the years: Lobster, monkfish and silver hake. These were generally the fisheries that went deep enough to overlap with red crab habitat. There is some red crab bycatch associated with trips targeting "unclassified groundfish", which could be added to the estimate of total bycatch, but is somewhat complicated to calculate. Trips targeting mixed groundfish do not often fish deep enough to bycatch many red crabs, however.

Lobster and monkfish are both fished using two main types of gear, trawls and pots for lobster and trawls and gillnets for monkfish. Silver hake are almost all caught in trawls. The discard estimates are based on separated data for the lobster and monkfish fisheries by gear. The fisheries referred to here are only lobster trawl, lobster pot, monkfish trawl, monkfish gillnet and silver hake trawl.

To determine the probability that a trip from any fishery catches red crabs, we looked at all the observer data from trips with that combination of target species and gear to see if there were any patterns in which trips caught red crab and which did not. It should be noted that observed trips do not necessarily represent a random sample from the fishery of interest. The data for lobster are not as good as monkfish and silver hake, with only 40 and 43 trips observed for the trawl and pot fisheries respectively (Table 1). For 4 out of five of the fisheries there is a relationship between depth and red crab bycatch (Figures 1-5); trips that fished beyond a certain depth were catching red crab. For estimating red crab discard by these fisheries (all but monkfish gillnet), the probability a trip would catch red crab was the same as the probability that they would fish at a depth at which the fishery caught red crab.

To use the lobster pot fishery as an example, red crabs were only caught during trips where the average haul depth was more than 130 fathoms. Out of all the observed trips, 19% fished at a mean haul depth greater than 130 fathoms, so a lobster pot trip has an estimated 0.19 probability of catching red crab. For the monkfish gillnet fishery, (which hardly caught any red crab at all during 1017 observed trips), the percentage of observed trips that caught red crab was used as the probability of catching red crab.

The percentage of observed trips that fished at depths where they would encounter red crab is very similar to the percentage of trips that fished in depths where they would encounter red crab in the VTR database. Not all trips report an average haul depth on the VTR so the observed percentages were used.

To estimate the weight of red crab discarded by a fishery during any given year, mean ratios of the weight of red crabs caught to the weight of target species kept on observed trips were calculated (Table 2). To estimate the amount of red crab bycatch for a fishery, we multiplied the landings by the probability that a trip will catch red crab, then by the ratio of red crab discarded to target species landed. To determine the biomass of dead discards, we multiplied the bycatch estimate by the assumed mortality rate.

Probabilities and ratios were also calculated by area and year, but the variation was high and sample sizes low. The mean of all years and areas seems to be the most accurate and make best use of the smaller sample sizes.

Using this method, dead red crab discards from the lobster, monkfish, and silver hake fisheries were calculated from 2001-2009 using VTR landings data (Table 3).

Caveats:

Observed trips do not necessarily represent a random sample of trips from the fishery of interest.

For this straightforward method, the assumption that each trip catches the same amount is made, as the percentage of trips that catch red crab is supposedly responsible for that same percentage of landings.

The discard mortality rate applied was 50%, as the survival of crabs discarded from pots is probably low, but their survival rate after being trawled up is unknown. There may be good reason to lower the mortality rate but at the present we acknowledge it is probably an overestimate.

Trips with less than 500 pounds of landed lobster or 1,000 pounds of landed monkfish or silver hake were also removed from the total landings since these may not have been targeted trips for the species in question. This cutoff point is arbitrary and needs to be refined.

It is assumed all red crab caught by these fisheries is discarded, but that may not be true for the lobster pot fishery. On the observed lobster pot trips, red crab was never landed, but it should be determined if lobster trips are also landing red crab.

This method assumes fishing patterns don not change too much over the years, the same percentage of trips will enter the area where crabs were caught, and the same fisheries are responsible for red crab

bycatch. Of course this will vary from year to year, but long-term trends need to be checked and numbers updated.

Some low-sample-size issues are present, for instance only one lobster trawl trip caught red crab so probabilities and ratios are based on one data point, and one silver hake trip caught 56,625 pounds of red crab, which was almost one hundred times the mean crab bycatch of a silver hake trip beyond a certain depth.

Table 1- Number of trips observed per fishery of interest from 1991-2009.

Target species and gear	Number of observed trips
Lobster trawl	40
Lobster pot	43
Monkfish trawl	253
Monkfish gillnet	1017
Silver hake trawl	148

Table 2- From observed trips, the probability a trip will catch red crabs and the ratio of red crabs caught to target species kept.

Target species and gear	Percent of trips with mean haul depth falling within the zone where red crabs are caught	Ratio of red crab discarded to target species landed
Lobster trawl	2.5	0.00006
Lobster pot	18.6	0.0045
Monkfish trawl	29.3	0.16522
Monkfish gillnet	0.19*	0.0000011
Silver hake trawl	11.5	0.0304

***There was no relationship between depth and observed red crab bycatch, so percent of trips that caught red crab was used.**

Table 3- Estimates of discards of dead red crab from the combined lobster trawl, lobster pot, monkfish trawl, monkfish gillnet and silver hake trawl fisheries.

Year	Estimated dead discards of red crab in metric tons
2001	27
2002	16.8
2003	17.6
2004	16.7
2005	25.5
2006	16.6
2007	11.7
2008	13.7
2009	11.5

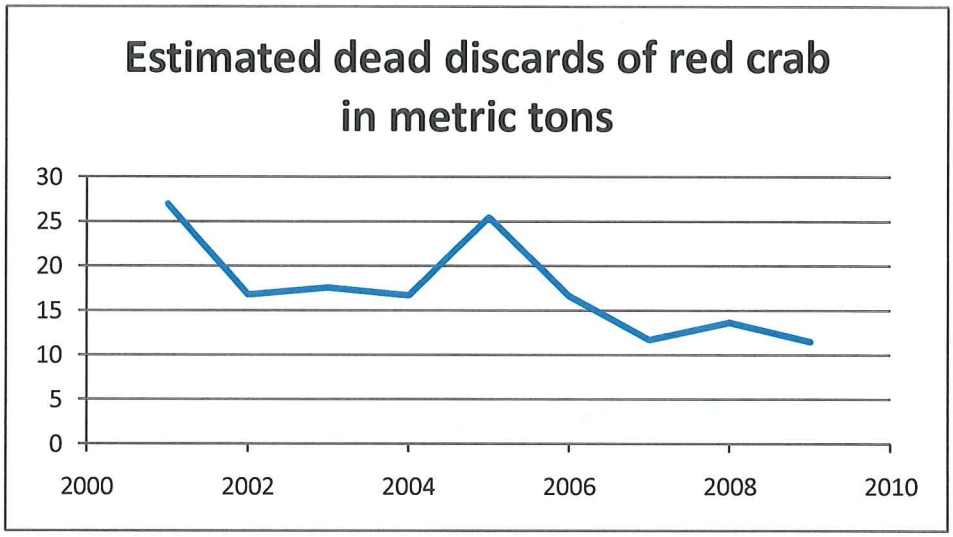

Figure 1- Estimated dead discards of red crab from five fisheries that are known to have red crab bycatch.

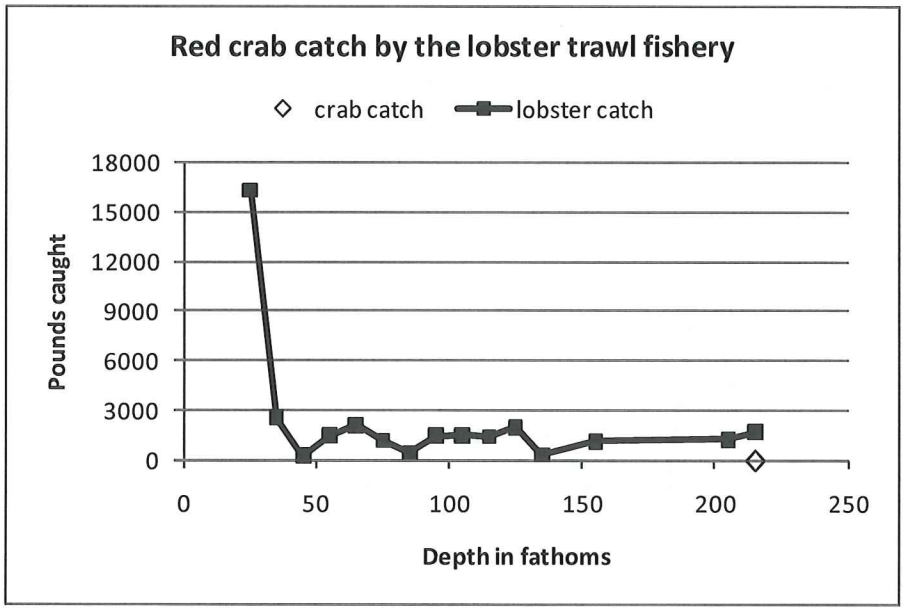

Figure 2- Depth vs. pounds caught by the lobster trawl fishery.

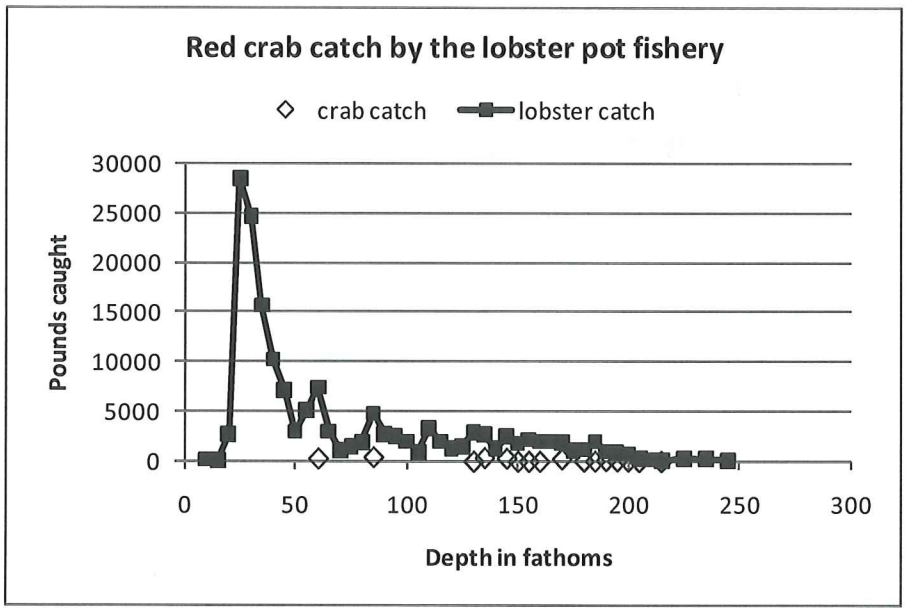

Figure 3- Depth vs. pounds caught by the lobster pot fishery.

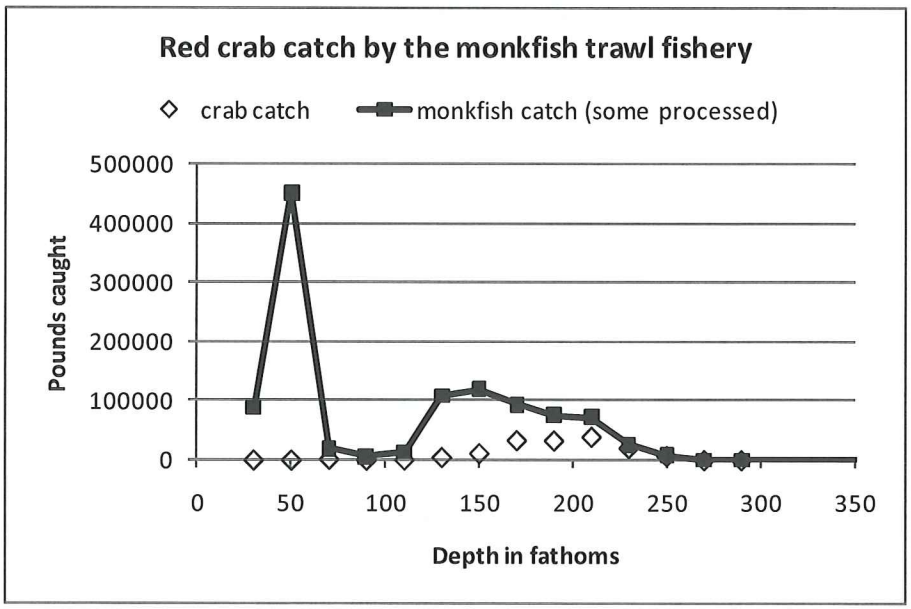

Figure 4- Depth vs. pounds caught by the monkfish trawl fishery.

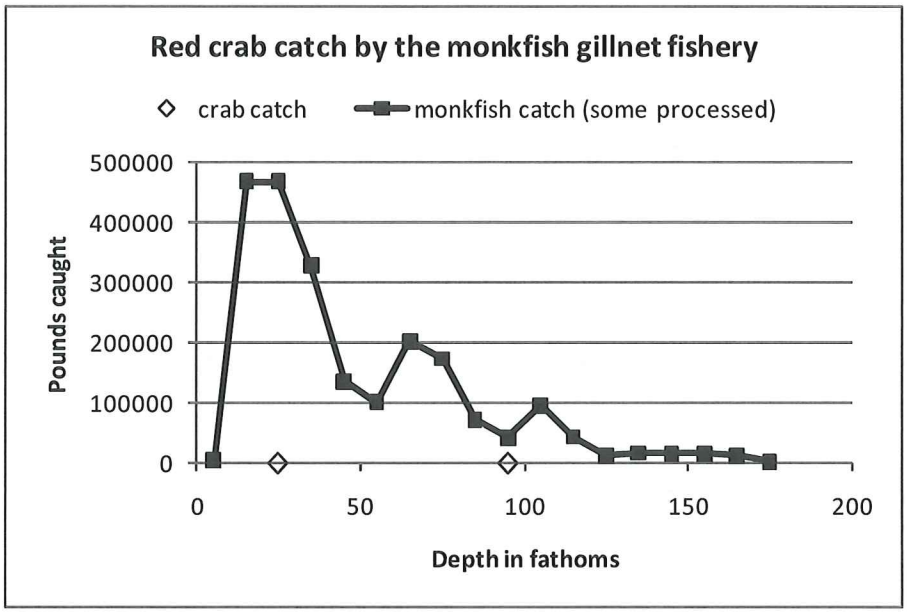

Figure 5- Depth vs. pounds caught by the monkfish gillnet fishery.

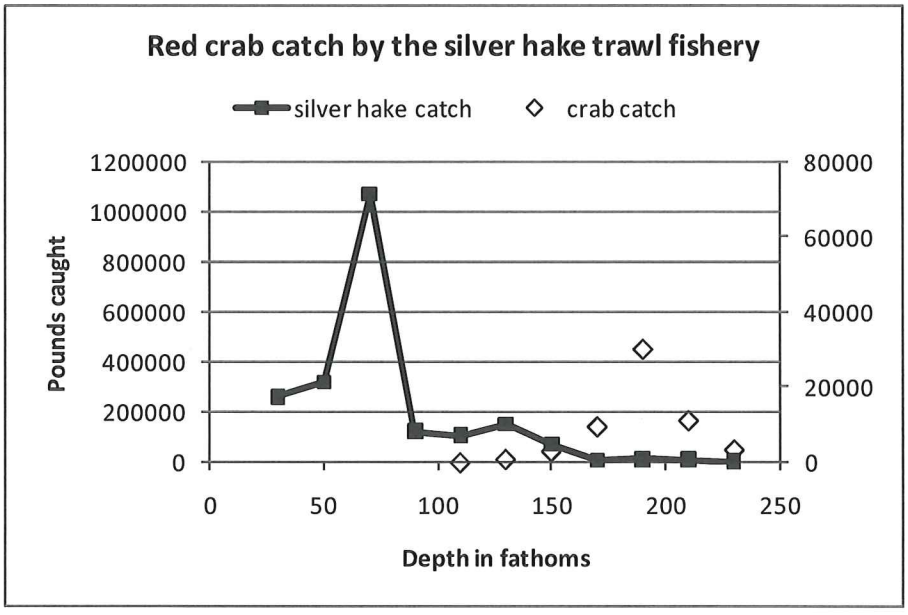

Figure 6- Depth vs. pounds caught in the silver hake trawl fishery (note different scales on the 2 axes).

Table 4- Landings from statistical areas 562, 525, 526, 537, 616, 622, 623, and 626 by fishery and year with estimates of dead red crab discards by fishery and year.

	Landings from red crab management area (mt)					Estimated dead red crab discards (mt)					
	Lob trawl	Lob pot	Monk trawl	Monk gill	Hake trawl	Lob trawl	Lob pot	Monk trawl	Monk gill	Hake trawl	total
1973	168	892	1		512	0.00012	0.37	0.03		0.89	**1.3**
1974	125	1109	0		732	0.00009	0.46			1.28	**1.7**
1975	37	1494	7		668	0.00003	0.63	0.17		1.17	**2.0**
1976	39	1478	32		518	0.00003	0.62	0.77		0.91	**2.3**
1977	19	1431	47		581	0.00001	0.60	1.14		1.01	**2.7**
1978	16	1763	26		1215	0.00001	0.74	0.62		2.12	**3.5**
1979	17	1483	26		1311	0.00001	0.62	0.63		2.29	**3.5**
1980	13	1165	15		1243	0.00001	0.49	0.36		2.17	**3.0**
1981	10	1222	26		2659	0.00001	0.51	0.63		4.64	**5.8**
1982	14	1486	132	2	5526	0.00001	0.62	3.19	0.00000000	9.65	**13.5**
1983	12	1930	74	1	4255	0.00001	0.81	1.78	0.00000000	7.43	**10.0**
1984	22	2223	112	3	4332	0.00002	0.93	2.71	0.00000000	7.57	**11.2**
1985	64	2136	83	3	4488	0.00005	0.89	2.00	0.00000000	7.84	**10.7**
1986	102	2210	144	1	5057	0.00007	0.92	3.49	0.00000000	8.83	**13.2**
1987	164	2132	146	1	6849	0.00012	0.89	3.53	0.00000000	11.96	**16.4**
1988	203	2004	221		7030	0.00015	0.84	5.33		12.28	**18.4**
1989	214	2123	602		6689	0.00016	0.89	14.55		11.68	**27.1**
1990	229	3224	380		6637	0.00017	1.35	9.18		11.59	**22.1**
1991	288	2707	1516	57	6509	0.00021	1.13	36.64	0.00000006	11.37	**49.1**
1992	333	1209	1715	201	9045	0.00024	0.51	41.44	0.00000021	15.80	**57.7**
1993	166	1037	1200	235	9136	0.00012	0.43	29.00	0.00000025	15.96	**45.4**
1994	45	1016	1149	283	3353	0.00003	0.43	27.76	0.00000030	5.86	**34.0**
1995	25	1480	1849	897	7333	0.00002	0.62	44.69	0.00000094	12.81	**58.1**
1996	69	1672	2035	869	9261	0.00005	0.70	49.18	0.00000091	16.17	**66.1**
1997	34	2261	2052	1064	8368	0.00002	0.95	49.59	0.00000111	14.61	**65.2**

Red Crab Dead Discards in Bycatch Fisheries – June 7, 2010

	Lob trawl	Lob pot	Monk trawl	Monk gill	Hake trawl	Lob trawl	Lob pot	Monk trawl	Monk gill	Hake trawl	total
1998	33	2026	1811	965	8471	0.00002	0.85	43.75	0.00000101	14.79	**59.4**
1999	20	2423	1799	1450	7198	0.00001	1.01	43.47	0.00000152	12.57	**57.1**
2000	17	1917	984	838	7067	0.00001	0.80	23.77	0.00000088	12.34	**36.9**
2001	65	2006	579	1145	6945	0.00005	0.84	14.00	0.00000120	12.13	**27.0**
2002	32	1718	164	1395	6945	0.00002	0.72	3.96	0.00000146	12.13	**16.8**
2003	87	1642	302	2376	5522	0.00006	0.69	7.31	0.00000248	9.64	**17.6**
2004	125	1619	223	2059	6086	0.00009	0.68	5.38	0.00000215	10.63	**16.7**
2005	95	1599	574	1763	6282	0.00007	0.67	13.88	0.00000184	10.97	**25.5**
2006	81	1636	365	1560	4049	0.00006	0.68	8.81	0.00000163	7.07	**16.6**
2007	72	1421	139	1014	4431	0.00005	0.59	3.36	0.00000106	7.74	**11.7**
2008	33	1698	228	1245	4308	0.00002	0.71	5.51	0.00000130	7.52	**13.7**
2009	44	1812	117	1075	4537	0.00003	0.76	2.83	0.00000112	7.92	**11.5**