

Investigating alternative measures of fishing effort in the bycatch rate calculation

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Summary

This paper investigates two issues related to the measure of fishing effort used to calculate the bycatch of harbor porpoises in the New England and mid-Atlantic gill net fisheries. In the past, the amount of landings was used as a proxy for the measure of fishing effort. This was mainly a practical decision because other possible measures of total fishing effort in these two gill net fisheries were not reliably recorded in the Vessel Trip Report (VTR) database (Orphanides and Palka 2007). However, because this is not an intuitive choice and there were outreach efforts to improve the VTR reporting, we wanted to explore other possible choices for the measure of total fishing effort. In this paper we explored the quality of recent VTR data fields that relate to measures of fishing effort. We also explored the effect of using different measures of fishing effort in the bycatch rate by calculating the bycatch rate using six different measures of fishing effort, then comparing the actual bycatch rates with these different measures of fishing effort for the two Consequence Closure Associated Areas (CCAAs) to corresponding trigger bycatch rates (Palka and Orphanides 2008) that were also calculated with the different measures of fishing effort. This exploration also addresses concerns raised in Wiersma (2012).

The quality of recent VTR data was explored by comparing the value of four variables (number of hauls, soak duration, gear quantity and gear size) as recorded on a VTR log for trips taken during 2007 – 2011 to the value as recorded by the observer on the same trip. Over 3,000 matched trips were compared. On average, VTR values for gear quantity (average number of nets per string on each haul) were about three times higher than those recorded by observers. These types of discrepancies are similar to what was found in previous years (1999 – 2005), as reported to the 2007 harbor porpoise take reduction team meeting (Orphanides and Palka 2007). In conclusion, at this time, the only available and reliable measure of total fishing effort is metric tons (mtons) landed, because fishing effort fields as recorded in the VTR database do not reflect the same data when recorded by observers.

To explore the effect of different measures of fishing effort, observed bycatch rates were calculated using the Northeast Fisheries observer program (NEFOP) data, where fishing effort was measured as: mtons landed (used in 2010 harbor porpoise take reduction plan - HPTRP); number of hauls; soak duration (days); string length (km); soak duration * string length (days*km); and soak duration * string length * net height (days*km²). As an example of the effect of the different measures of fishing effort and to address concerns raised in Wiersma (2012), trigger bycatch rates with different measures of fishing effort were calculated in the same way as the trigger bycatch rates in the 2010 harbor porpoise take reduction plan (HPTRP; Palka and Orphanides 2008). Actual bycatch rates with the different measures of fishing effort were also calculated using the 2010 and 2011 fishing years in a manner similar to Orphanides and Palka (2012) and Orphanides (2012). Then the actual bycatch rates with the measures of fishing effort were compared to the corresponding trigger bycatch rate.

For the Coastal Gulf of Maine CCAA, actual bycatch rates in both fishing years exceeded the corresponding trigger bycatch rate, no matter which measure of fishing effort was used. For the Southern New England CCAA, actual bycatch rates from the 2011 fishing year exceeded the corresponding trigger bycatch rates for all measures of fishing effort. While for the 2010 fishing year, most of the actual bycatch rates were below the corresponding trigger bycatch rate. In conclusion, using different measures of fish effort in the calculation of the bycatch rate resulted in the same conclusion when using mtons landed as the measure of fishing effort; that is, for the Coastal Gulf of Maine CCAA, the actual bycatch rates during the 2010 and 2011 fishing seasons exceeded the trigger bycatch rate.

Introduction

When using ratio estimators to estimate total bycatch, the total bycatch is calculated as the product of a bycatch rate (derived from a sample of the fishery), and total fishing effort in the fishery. The generic definition of a harbor porpoise bycatch rate is the sum of observed harbor porpoises taken divided by the sum of observed fishing effort. The ideal definition of a bycatch rate involves a definition of fishing effort such that, as fishing effort increases, so does the number of harbor porpoise takes. In this regard, the measure of fishing effort should reflect the amount of gear and fishing time that could interact with a harbor porpoise. For example, an ideal unit of effort would consider the total length and soak time of the gill net. Currently, for the New England and mid-Atlantic gill net fisheries, the measure of fishing effort used in the bycatch estimates is the amount of landings (recorded in metric tons – mtons). As has been discussed at previous harbor porpoise take reduction team meetings, this decision was arrived at mainly for the practical reason that there was no other reliable measure of total fishing effort in the Vessel Trip Reports (VTR) that were available for these gillnet fisheries (Orphanides and Palka 2007). Metric tons landed is an appropriate measure of fishing effort for harbor porpoise bycatch in these gillnet fisheries because, on average, the observed number of harbor porpoise takes increases as the observed amount of landings increases.

However, despite the fact that mtons landed is a statistically appropriate measure of fishing effort to estimate harbor porpoise bycatch, it does not reflect the amount of gear or fishing time in the water. So, we wanted to explore whether other appropriate measures are available and could be used to improve the bycatch estimate. In this paper, we explored the quality of recent VTR data fields that relate to measures of fishing effort, beyond the amount of metric tons landed. We also explored the effect of using different measures of fishing effort to calculate the trigger bycatch rates for the two Consequence Closure Associated Areas (CCAAs), which were originally calculated with mtons landed in Palka and Orphanides (2008). Then for the two CCAAs, we compared the actual bycatch rates which were calculated with the different measures of fishing effort to the corresponding trigger bycatch rates. This exploration also addresses concerns raised in Wiersma (2012).

Data

The Northeast Fisheries Observer Program (NEFOP) record several data fields that could be used to calculate fishing effort. For example, the observer program records values for the amount of time a string of gill nets is in the water (soak duration), the total length of a gillnet string, the height of the net, and the number of hauls fished in a trip. Using these data fields, it is possible to calculate the following measures of observed fishing effort:

- (1) mtons landed (used in 2010 HPTRP)
- (2) number of hauls
- (3) soak duration (days)
- (4) string length (km)
- (5) soak duration * string length (days*km), and
- (6) soak duration * string length * net height (days*km²).

The VTR database, used to calculate the total fishing effort for the entire fishery, has similar data fields (with different names) that allow deriving different measures of fishing effort. The VTR data fields include:

- (1) mtons landed
- (2) number of hauls
- (3) soak duration
- (4) gear size (average length of the individual nets used in a string), and
- (5) gear quantity (average number of nets per string on each haul).

Methods

VTR exploration

To explore the quality of recently collected VTR data fields that are related to measures of fishing effort, the 2007 – 2011 VTR data were matched to the observer data by using the VTR serial number. Using only the VTR trips that were matched to an observed trip, the values of the following VTR data fields were compared to the observer values: gear quantity, gear size, soak duration, and number of hauls.

Effects of different measures

To explore the effect of using different measures of fishing effort, the observer data used to calculate the trigger bycatch rate published in the 2010 HPTRP (Palka and Orphanides 2008) were used to calculate trigger bycatch rates with different measures of fishing effort. These different trigger bycatch rates were then compared to the 2010 and 2011 actual bycatch rates, when calculated using the different measures of fishing effort. The six measures of fishing effort discussed above were investigated.

Data used to estimate the trigger bycatch rates were from the NEFOP data collected from January 1999 – May 2007 that were from hauls with all of the required number of pingers (though functionality of pingers was unknown). That is, the exact same data used to calculate the trigger

bycatch rates published in the 2010 HPTRP. Coastal Gulf of Maine CCAA trigger bycatch rates were derived from observed hauls in the Massachusetts Bay, Midcoast and Stellwagen management areas. Southern New England CCAA trigger bycatch rates were derived from observed hauls in the Southern New England management area.

The actual bycatch rates were derived using methods similar to that done for the actual bycatch rates (Orphanides 2012; Orphanides & Palka 2012). Data were from hauls observed only in the NEFOP observer program during the 2010 fishing year (June 1, 2010 – May 31, 2011) and the 2011 fishing year (June 1, 2011 – May 31, 2012). Data from the Coastal Gulf of Maine CCAA included hauls from the Massachusetts Bay, Midcoast and Stellwagen Bank management areas. Data from the Southern New England CCAA included the Southern New England management area.

Results and Conclusions

VTR exploration

When comparing the data field values from matched VTR and observer trips, the average and median values of the soak duration and gear size were similar, in contrast to the average and median values of the gear quantity and number of hauls (Table 1). On average, the VTR values for gear quantity were about three times higher than those recorded by observers. In addition, even though the comparison was only from matched VTR and observer trips, the upper ranges of values of all four data fields were quite different, where the VTR recorded more gear, longer gear sizes, more hauls and shorter soak durations (Table 1). Though not shown here, these patterns were consistent when compared for each year separately.

These types of discrepancies were similar to what was found in previous years (1999 – 2005), as reported to the 2007 harbor porpoise take reduction team meeting (Orphanides and Palka 2007). In conclusion, at this time, the only possible available and reliable measure of total fishing effort is mtons landed, because fishing effort as recorded in the VTR database do not reflect the same data when recorded by observers.

Effects of different measures

The observed number of hauls in a management area during January 1999 – May 2007 ranged from 118 in the Stellwagen Bank management area to 1057 in the MidCoast management area (Tables 2A and 2C). The trigger bycatch rates were calculated using six different measures of fishing effort for the two CCAAs (Tables 2D and 2E).

Table 3 provides the comparison of the different trigger bycatch rates to the actual bycatch rates observed in the 2010 and 2011 fishing years, when using six different measures of fishing effort in the bycatch rate calculation. For the Coastal Gulf of Maine CCAA, the actual bycatch rate in both fishing years exceeded the corresponding trigger bycatch rate, no matter which measure of fishing effort was used to define the bycatch rate. For the Southern New England CCAA, the actual bycatch rates from the 2011 fishing year exceeded the corresponding trigger bycatch rates for all measures of fishing effort. While for the 2010 fishing year in the Southern New England CCAA, most of the actual bycatch rates were below the corresponding trigger bycatch rates, where the actual bycatch

rate exceeded the trigger bycatch rate when using the number of hauls and days*km² as the measure of fishing effort. In conclusion, using different measures of fishing effort in the calculation of the bycatch rate resulted in the same conclusion when using mtons landed as the measure of fishing effort; that is, for the Coastal Gulf of Maine CCA, the actual bycatch rates during the 2010 and 2011 fishing seasons exceeded the trigger bycatch rate.

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Table 1. Comparison of the mean, median and range of values recorded in the VTR and NEFOP observer databases for four data fields that could be used to derive measures of fishing effort. Data were from matched trips from January 2007 – December 2011 that were recorded in both databases.

Data field	VTR			Observer		
	Mean	Median	Range	Mean	Median	Range
Gear quantity ¹	29.3	18	1-700	10.4	10	1-50
Gear size (ft) ²	330.4	300	30-4000	303.8	300	50-1400
Soak duration (hrs)	48.3	24	1-450	48.2	24	0-672
Number of hauls	3.1	3	1-54	4.3	4	1-35

¹ Average number of nets per string on each haul

² Average length of the nets used in a string (not length of entire string)

Table 2. By management area and over all three Gulf of Maine management areas, the number of observed hauls, takes, and several potential measures of fishing effort: landings (obs landings), soak duration (days), gear length, soak duration * gear length (days*km), and soak duration * gear length * net height (days*km²), along with the resulting six bycatch rates (sum of harbor porpoise takes/sum of the measure of fishing effort). Hauls that had all of the required number of pingers and were observed from 1 January 1999–31 May 2007 were used. Yellow highlighted values are the trigger bycatch rates for the two Consequence Closure Associated Areas (CCAAs). The Massachusetts Bay (A), Stellwagen Bank (B), and Midcoast (C) management areas together comprise the Coastal Gulf of Maine CCAA (D). The Southern New England CCAA (E) is the Southern New England management area.

A. Massachusetts Bay								
Year	Number of hauls	Number of takes	Obs landings	soak dur (days)	gear length (km)	soak*len (days*km)	soak*area (days*km ²)	Bycatch rate
1999	59	0	5.35	105.81	49.97	93.66	0.3242	0
2000	115	0	16.77	294.17	96.95	249.05	0.8003	0
2001	74	0	7.00	115.59	52.76	87.47	0.2231	0
2002	8	0	0.62	11.00	3.69	5.07	0.0170	0
2003	8	0	0.94	16.00	5.23	11.19	0.0242	0
2004	3	0	0.23	2.73	1.84	1.59	0.0040	0
2005	4	0	4.59	8.00	3.72	7.45	0.0204	0
2006	29	0	5.70	31.58	22.79	26.20	0.0929	0
2007*	53	0	5.70	81.19	41.88	71.19	0.2529	0
TOTAL	353	0	46.90	666.07	278.83	552.87	1.7590	0
B. Stellwagen Bank								
Year	Number of hauls	Number of takes	Obs landings	soak dur (days)	gear length (km)	soak*len (days*km)	soak*area (days*km ²)	Bycatch rate
1999	10	0	0.56	23.00	8.67	19.00	0.0646	0
2000	1	0	0.04	2.00	0.91	1.83	0.0075	0
2001	1	0	0.02	1.00	0.46	0.46	0.0011	0
2002	1	0	0.38	2.00	0.74	1.48	0.0049	0
2003	1	0	0.10	3.00	0.91	2.74	0.0033	0
2004	6	0	0.95	6.00	3.96	3.96	0.0113	0
2005	10	0	2.83	23.00	8.45	20.37	0.0544	0
2006	9	0	2.16	20.00	7.38	16.61	0.0534	0
2007*	79	0	7.38	134.77	60.30	100.68	0.3542	0
TOTAL	118	0	14.42	214.77	91.78	167.13	0.5547	0

* Includes January – May 2007.

Table 2 continued.

C. MidCoast													
Year	Number of hauls	Number of takes	Obs landings (mtons)	soak dur (days)	gear length (km)	soak*len (days*km)	soak*area (days*km ²)	Bycatch rate (mtons)	Bycatch rate (hauls)	Bycatch rate (days)	Bycatch rate (km)	Bycatch rate (days*km)	Bycatch rate (days*km ²)
1999	232	3	65.50	403.40	242.40	420.01	1.4148	0.046	0.0129	0.0074	0.0124	0.0071	2.1204
2000	198	0	15.88	410.88	148.07	319.65	1.0237	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	109	2	21.29	230.70	85.58	193.37	0.5234	0.094	0.0183	0.0087	0.0234	0.0103	3.8212
2002	199	2	30.15	304.82	174.01	289.29	0.9732	0.066	0.0101	0.0066	0.0115	0.0069	2.0551
2003	40	0	4.46	58.75	30.19	46.64	0.1315	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	49	0	11.33	113.08	47.92	127.75	0.4005	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	134	1	29.30	271.00	133.92	277.66	0.9538	0.034	0.0075	0.0037	0.0075	0.0036	1.0484
2006	87	0	17.77	138.46	80.85	135.87	0.4555	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2007*	9	0	0.29	27.00	8.07	24.20	0.0476	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	1057	8	195.97	1958.09	951.01	1834.44	5.9240	0.041	0.0076	0.0041	0.0084	0.0044	1.3504
D. All three Gulf of Maine management areas = Coastal Gulf of Maine CCCA													
Year	Number of hauls	Number of takes	Obs landings	soak dur (days)	gear length (km)	soak*len (days*km)	soak*area (days*km ²)	Bycatch rate (mtons)	Bycatch rate (hauls)	Bycatch rate (days)	Bycatch rate (km)	Bycatch rate (days*km)	Bycatch rate (days*km ²)
1999	301	3	71.41	532.21	301.04	532.67	1.8036	0.042	0.0100	0.0056	0.0100	0.0056	1.6633
2000	314	0	32.69	707.05	245.93	570.53	1.8315	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	184	2	28.31	347.29	138.80	281.30	0.7476	0.071	0.0109	0.0058	0.0144	0.0071	2.6752
2002	208	2	31.15	317.82	178.44	295.84	0.9951	0.064	0.0096	0.0063	0.0112	0.0068	2.0098
2003	49	0	5.50	77.75	36.33	60.57	0.1590	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	58	0	12.51	121.81	53.72	133.30	0.4158	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	148	1	36.72	302.00	146.09	305.48	1.0286	0.027	0.0068	0.0033	0.0068	0.0033	0.9722
2006	125	0	25.63	190.04	111.02	178.68	0.6018	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2007*	141	0	13.37	242.96	110.25	196.07	0.6547	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	1528	8	257.29	2838.93	1321.62	2554.44	8.2377	0.031	0.0052	0.0028	0.0061	0.0031	0.9711

* Includes January – May 2007.

Table 2 continued.

Year	E. Southern New England CCA												
	Number of hauls	Number of takes	Obs landings	soak dur (days)	gear length (km)	soak*len (days*km)	soak*area (days*km ²)	Bycatch rate (mtons)	Bycatch rate (hauls)	Bycatch rate (days)	Bycatch rate (km)	Bycatch rate (days*km)	Bycatch rate (days*km ²)
1999	190	1	20.98	445.66	140.01	357.22	1.2282	0.0480	0.0053	0.0020	0.0071	0.0028	0.8142
2000	101	0	18.94	129.51	89.13	111.75	0.3759	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	52	0	9.78	131.64	45.91	124.28	0.3387	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	93	2	28.63	275.90	73.57	229.59	0.7709	0.0700	0.0215	0.0070	0.0272	0.0087	2.5944
2003	21	0	7.50	75.33	17.11	65.52	0.2197	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2004	78	0	17.49	262.58	71.68	230.24	0.7225	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	53	0	8.27	191.59	39.40	148.62	0.4589	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	49	0	3.38	67.81	12.93	32.92	0.1158	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007*	106	0	15.38	216.15	59.18	162.27	0.5322	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	743	3	130.35	1796.17	548.92	1462.41	4.7628	0.0230	0.0040	0.0020	0.0055	0.0021	0.6299

* Includes January – May 2007.

Table 3. Using different measures of fishing effort in the bycatch rate, a comparison of the trigger bycatch rate and actual observed bycatch rate in the Coastal Gulf of Maine Consequence Closure Associated Area (CCAA) and the Southern New England CCAA. All bycatch rates derived from the Northeast Fisheries Observer Program (NEFOP) data. Trigger bycatch rates (in bold) derived from data collected during January 1, 1999 - May 31, 2007. Actual bycatch rates derived from data collected during the fishing seasons of 2010 (June 1, 2010 - May 31, 2011) and 2011 (June 1, 2011 - May 31, 2012). Shaded actual bycatches are greater than its corresponding trigger bycatch rate.

Measures of fishing effort	Coastal Gulf of Maine CCAA ¹			Southern New England CCAA ²		
	Trigger bycatch rate	Actual bycatch rate		Trigger bycatch rate	Actual bycatch rate	
		2010	2011		2010	2011
landings (mtons)	0.0310	0.0780	0.0430	0.0230	0.0120	0.0290
number of hauls	0.0052	0.0181	0.0063	0.0040	0.0042	0.0146
soak duration (days)	0.0028	0.0110	0.0035	0.0020	0.0010	0.0030
string length (km)	0.0061	0.0210	0.0062	0.0055	0.0034	0.0115
soak duration * string length (days*km)	0.0031	0.0120	0.0035	0.0021	0.0007	0.0024
soak duration * string length * net height (days*km ²)	0.9711	5.7348	1.3913	0.6299	0.9091	1.5789

¹ includes the following management areas: Midcoast, Massachusetts Bay and Stellwagen Bank

² includes only the Southern New England management area