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Comparison of USA Spring Bottom Trawl Survey Abundance Indices
for Mackerel Based on Day, Night, and Total Catches

by

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Abstract

Differences between day and night mackerel catches during USA spring bottom trawl surveys were examined. Day catches over all years averaged about four times greater than night catches. The stratified mean catch per tow indices based on day tows exhibited a close relationship to the indices based on total tows, whereas the indices based on night tows showed a weaker correspondence.

Introduction

Mackerel appear to exhibit a pattern of diel vertical periodicity in the water column. They are generally found near bottom during the day but move upward in the water column at night apparently as the result of feeding (Isakov 1976; Olla et al. 1976). Their movement off bottom at night would presumably render them less susceptible to capture by bottom trawls. Isakov (1976) reported that bottom trawling during daylight hours resulted in significantly larger catches of mackerel than that done at night.

Since the USA bottom trawl surveys are conducted 24 hours per day, data exist to compare day/night differences in mackerel catches. The purpose of this paper is to examine these differences and determine the difference between abundance indices based on (1) day tows, (2) night tows, and (3) total tows.

Methods

Data used were from the USA spring bottom trawl surveys conducted in 1968-1976 from Cape Hatteras through Georges Bank (strata 1-25, 61-76) (Figure 1). These were the same data used to calculate the mean catch per tow indices reported by Anderson et al. (1976). Since the 1968-1972 surveys were conducted using a No. 36 Yankee trawl and the 1973-1976 surveys used a No. 41 trawl, the 1968-1972 individual catches (both in weight and number) were adjusted upwards by a 3.25:1 ratio (Anderson 1976) to be equivalent to No. 41 trawl catches.

USA survey catches are grouped into six 4-hour daily time periods for analysis. These periods include midnight-4 a.m., 4 a.m.-8 a.m., 8 a.m.-12 noon, 12 noon-4 p.m., 4 p.m.-8 p.m., and 8 p.m.-midnight. Although these periods cannot be grouped into precisely day and night periods (e.g. the 4 a.m.-8 a.m. and 4 p.m.-8 p.m. periods include both daylight and darkness), it was felt that the time periods from 4 a.m.-8 p.m. (16 hours) and 8 p.m.-4 a.m. (8 hours) could adequately define day and night, respectively, for the purpose of this paper.

Stratified mean catch (kg) per tow (\log_e scale) indices were calculated for strata 1-25, 61-76, using (1) all tows, (2) only day tows, and (3) only night tows. During the surveys it sometimes happens that all tows in a particular stratum are made either during the day or during the night. In the analyses involving

only day tows and only night tows, it was necessary to maintain the same number of strata as in the analysis involving all tows so that all three stratified mean catch per tow indices would be based on the same overall area (43,155 mi² or 111,771 km² for strata 1-25, 61-76). Therefore, for the day and night analyses, any stratum without tows was still weighted into the final stratified mean.

Results and Discussion

During 1968-1976, about 67% of the tows were made during the day and 33% at night (Table 1). This corresponds to the fact that 16 hours (67%) were assigned to the day period and 8 hours (33%) were assigned to the night period. Approximately 190 tows per year were made in the strata set used. The percentage of tows that caught at least one mackerel averaged 25% in the day and 23% at night. The yearly mean number of mackerel caught per tow ranged from 1.1 to 121.2 during the day and from 0.5 to 121.4 at night. Ratios between the yearly day and night mean numbers per tow ranged from 0.16 to 30.60 and averaged 6.68 for the 9-year period. Excluding a single extraordinarily large catch from the analysis in 1973 reduced the 9-year mean day/night ratio to 3.55.

Stratified mean catch per tow (log_e scale) indices are given in Table 2 and plotted in Figure 2. The indices calculated from day tows exhibited a close relationship to the indices based on total tows. A strong correlation ($r = 0.88$, $p = 0.01$) was found between these two sets of indices (Figure 3A). The indices calculated from night tows showed a weaker correspondence to the indices calculated from both day and total tows, although the 1972-1976 night indices demonstrated the same downward trend in abundance as the other two indices. The correlation coefficient between night and total indices (Figure 3B) was 0.74 ($p = 0.05$).

The day indices were larger than the night and total indices in all years except 1968. In that year, the night catches of mackerel were much larger than the day catches (Table 1). The ratios between the day and night indices in 1969-1976 averaged 2.4, reflecting the larger day catches.

Mean lengths of mackerel in day and night catches were compared to see if there was any apparent size difference. In five of the nine years, mackerel in the day catches were larger than those caught at night; and in the remaining four years, the mackerel caught at night were larger. These results are insufficient to suggest any overall differences.

Results of the analyses presented in this paper support Isakov's (1976) conclusion that day trawling achieves much higher catches of mackerel than night trawling. It is evident, though, that mackerel were caught by survey tows made at night, and in some cases (1968) the night catches were greater than the day catches. Since the use of day-only tows resulted in a time-series of abundance indices differing only slightly from and showing the same trend in mackerel abundance as indices using all data, it is concluded that the survey indices used in the assessment of the mackerel stock (Anderson et al. 1976) are not unduly biased downwards by the inclusion of night tows.

Literature Cited

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Table 1. Comparison of day and night tows for mackerel in USA spring bottom trawl surveys in SA 5-6 (strata 1-25, 61-76) in 1968-76.

Year	Day				Night				Day/Night			
	Number of tows	Percentage of total	Percentage of tows catching mackerel	Number of mackerel caught	Number per tow	Number of tows	Percentage of total	Percentage of tows catching mackerel	Number of mackerel caught	Number per tow	Number per tow	
1968	120	67	19	2,403	20.03	60	33	25	7,288	121.43	.16	
1969	122	66	10	130	1.07	62	34	6	31	.50	2.14	
1970	124	64	35	1,884	15.19	70	36	23	414	5.91	2.57	
1971	126	66	29	2,070	16.43	64	34	13	62	.97	16.94	
1972	134	68	26	1,398	10.43	62	32	26	200	3.23	3.23	
1973	140	65	27	16,963	121.16	76	35	38	301	3.96	30.60	
1974	105	66	37	817	7.78	54	34	35	189	3.50	2.22	
1975	134	67	19	1,362	10.16	65	33	25	507	7.80	1.30	
1976	133	70	23	1,036	7.79	58	30	14	455	8.02	.97	
Mean		67	25			33	33	23			6.68	3.551

¹A single day tow in 1973 contained 15,619 fish and excluding that catch from the calculations gives a number/tow of 9.67 instead of 121.16, a day/night catch/tow of 2.44 instead of 30.60 and an overall day/night mean ratio of 3.55 instead of 6.68.

Table 2. Stratified mean catch (kg) per tow (\log_e scale) indices of mackerel from USA spring bottom trawl surveys (strata 1-25, 61-76) based on (1) all catches, (2) day catches, and (3) night catches.

Year	All catches		Day catches		Night catches	
	Index	Mean length (cm)	Index	Mean length (cm)	Index	Mean length (cm)
1968	.058	20.0	.40	18.5	.81	20.4
1969	.03	24.2	.04	23.7	.02	24.1
1970	.47	29.6	.62	30.2	.18	21.4
1971	.43	28.9	.49	29.5	.13	26.1
1972	.35	26.6	.40	26.2	.24	20.9
1973	.23	26.5	.24	32.0	.16	18.6
1974	.28	27.3	.31	27.3	.16	31.5
1975	.12	21.4	.14	19.1	.12	17.3
1976	.14	25.1	.20	25.1	.05	26.3

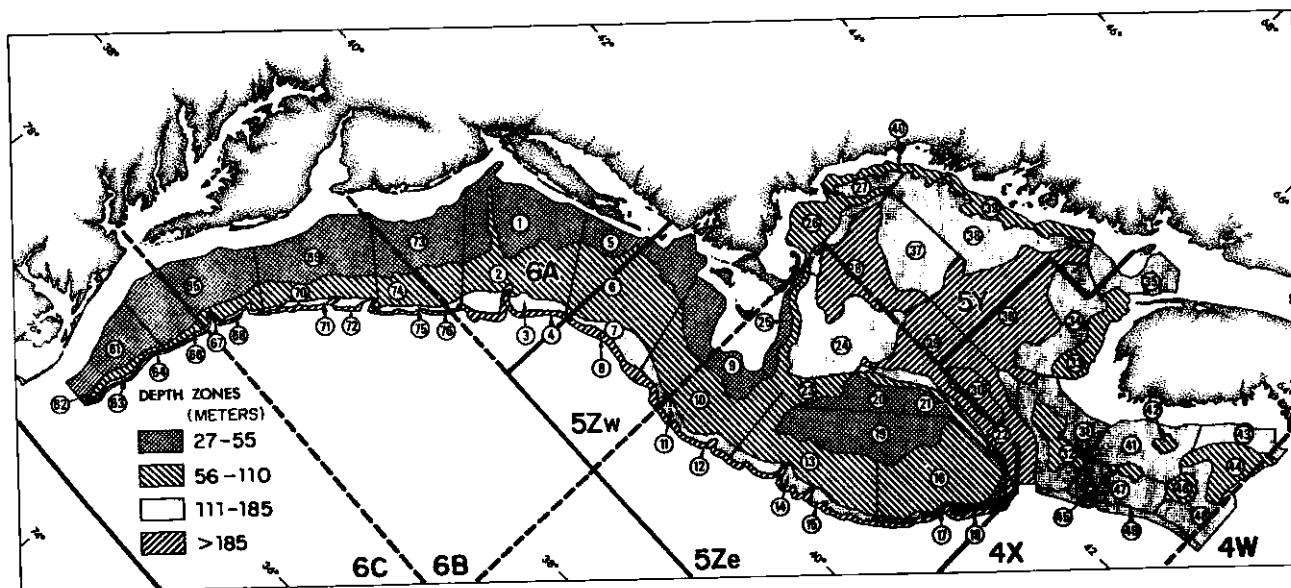


Fig. 1. US bottom trawl survey sampling strata in ICNAF SA 5-6.

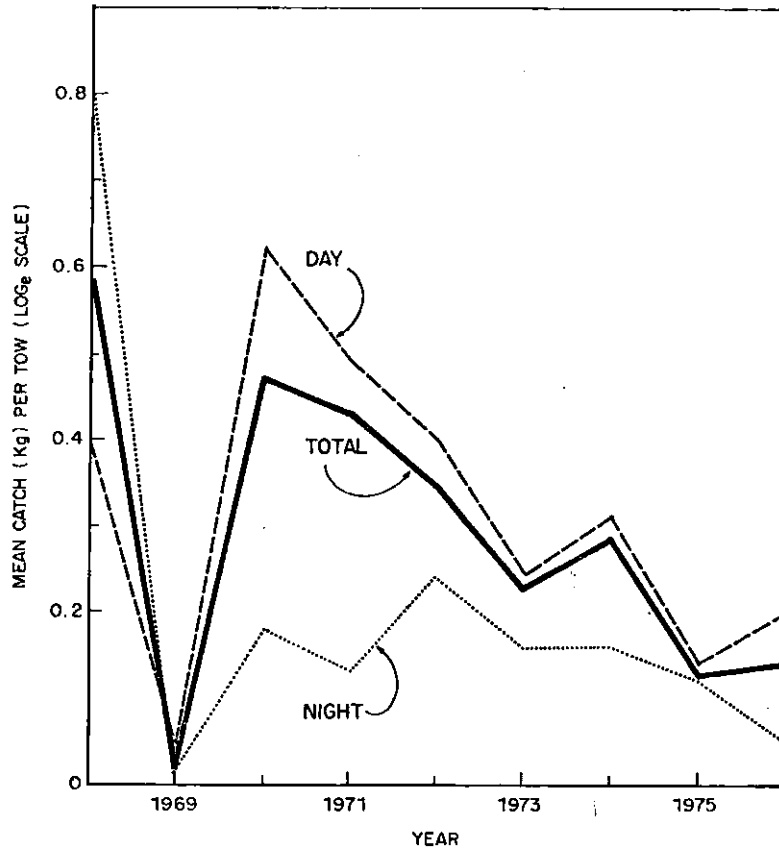


Fig. 2. Stratified mean catch (kg) per tow of mackerel (\log_e scale) from US spring bottom trawl surveys calculated using (1) the total number of tows, (2) only day tows, and (3) only night tows.

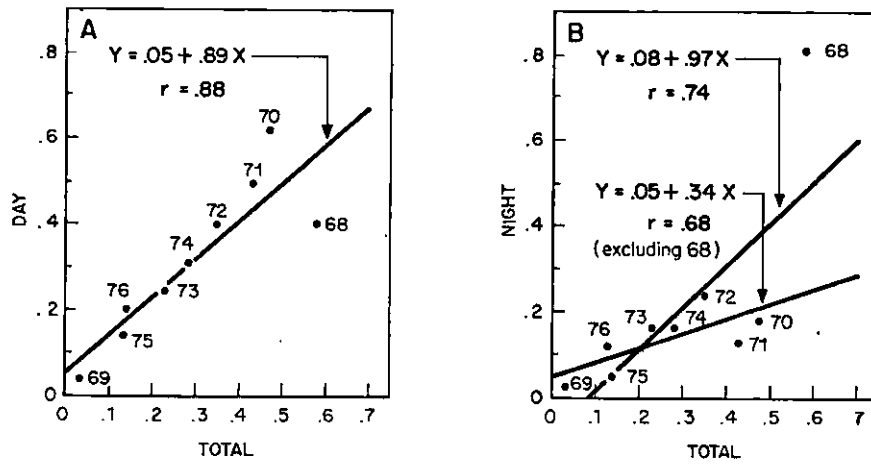


Fig. 3. Correlation between stratified mean catch (kg) per tow of mackerel (\log_e scale) from US spring bottom trawl surveys using day tows compared to total number of tows (A) and night tows compared to the total number of tows (B).

