

Appendix III

An analysis of catch rates of groundfish species from a bait selectivity experiment in Closed Area I

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June 10, 2008

This paper was produced at the request of the Cape Cod Commercial Hook Fishermen's Association by the Massachusetts Division of Marine Fisheries. Although the author is a member of the Multi-species Plan Development Team (PDT), the opinions and conclusions of this paper are independent of the PDT.

Introduction

The Cape Cod Commercial Hook Fishermen's Association has requested that the Closed Area I Hook Gear Haddock Special Access Program (SAP) area be expanded and the SAP open from May 1 to January 31. Data from a bait selectivity study (Leach and Golhor, 2005) can be used to compare expected hook fishery catch rates of groundfish in the proposed expansion with the current SAP.

However, this study was not designed to address impacts of expanding the Closed Area SAP and as such, are limiting with respect to comparing catch rates in the two areas. For example, the distribution of sets within the proposed area was based on fishermen's knowledge of sites with commercially viable catch rates of groundfish and selection did not involve random component. However, the area selected does not cover the entire proposed area (Figure 1). Similarly, the distribution of hauls by month within the proposed area is inconsistent: no data exist for January, one sample for August, and very low number of samples in May (5) and July (6) in the proposed area. Data were not collected in the proposed area in 2003, but 176 hauls were collected in the current SAP area in 2003. Bait type by area is heterogeneous especially with respect to squid (109 in current area, 2 hauls in proposed area). Finally, the data are given at the haul level rather than the trip level. I ignored the cluster sampling design of the original study and conducted the analysis at haul level. This will result in underestimating the variance, but should have no impact on the mean.

Methods

Datasets were provided by the Cape Cod Commercial Hook Association and represents data taken by trained, independent data collectors¹ during the experiment. The dataset consists of catches of species by weight and categorized as kept or discarded, as well as location of haul and number of hooks per haul. I trimmed the datasets so that characteristics (Year, Month, bait type) for both the current SAP area (Inside) and the proposed SAP area (Proposed) were similar. I selected 2004 and 2005 for years, clams, fish with binders/ casings and herring for bait, and May, June, July, August, September, November, and December for months. The trimmed dataset consists of 193 hauls within the current SAP (Inside) and 106 hauls in the proposed area. Catch weight in each haul was standardized to lb per 1000 hooks. Comparisons of the number of hauls by categories in the full dataset and trimmed dataset are shown in Tables 1-3.

I calculated 5 order statistics (minimum, 1st quartile, median, 3rd quartile, maximum) and the mean for the distribution of catch weight in a haul for each species by area. These provide useful summaries for comparing the central location and shape of the catch rate distribution among groundfish species in the current and proposed area.

I used a randomization test (1,000 replications) using t-statistic with pooled standard error to test for equality of means for catch in weight of total cod and total white hake in the proposed and inside areas.

¹ Most observers were independent contractors that were former observers in the Alaskan fisheries. A few trips were observed by NEFSC at sea observer program.

I calculated the ratio estimator statistics for each area using catch weight in pounds on each haul:

$$R_{\text{species A}} = \frac{\sum \text{lb. species A}}{\sum \text{lb. haddock kept}}$$

I calculated ratio estimators for total cod: haddock-kept and total white hake: haddock-kept for both the Inside and Proposed area (all months and baits aggregated). I estimated approximate 95% confidence limits using the percentile method with nonparametric bootstrap (1000 replications) and the Efron's bias corrected and accelerated method (BC_a) using 25,000 replications (Efron, 1987).

Table 1. Distribution of the number of hauls conducted in the Closed Area 1 SAP (Inside) and the proposed expanded SAP area (Proposed) by year for the full and trimmed dataset.

Year	Full dataset		Trimmed dataset	
	Inside	Proposed	Inside	Proposed
2003	176	0	0	0
2004	295	118	186	95
2005	17	11	7	11
Total	488	129	193	106

Table 2. Distribution of the number of hauls conducted in the Closed Area 1 SAP (Inside) and the proposed expanded SAP area (Proposed) by month for the full dataset and trimmed dataset.

Month	Full dataset		Trimmed dataset	
	Inside	Proposed	Inside	Proposed
Jan	10	0	0	0
Feb	71	5	0	0
May	6	5	6	4
June	7	11	7	11
July	80	6	44	5
Aug	67	1	66	1
Sept	57	33	56	32
Oct	82	15	0	0
Nov	71	23	8	23
Dec	37	30	6	30
Total	488	129	193	106

Table 3. Distribution of the number of hauls conducted in the Closed Area 1 SAP (Inside) and the proposed expanded SAP (Proposed) by bait.

Bait	Full dataset		Trimmed dataset	
	Inside	Proposed	Inside	Proposed
Clams	4	8	4	8
Fish with binders/casings	113	55	113	45
Herring	249	63	76	53
Mackerel	4	0	0	0
Other	6	0	0	0
Squid	109	2	0	0
Unknown	3	1	0	0

Results

Summary statistics for catch per haul by species and area are given in Table 4. Haddock, cod and white hake are listed by kept, discarded and total. All other species are listed as total. Species are listed if they had a positive observation in the full dataset. Catch in weight was dominated by haddock kept (mean catch rate of 875.1 lb. in the inside area and 858 lb. in the proposed area). Catch rates for other species were nearly an order of magnitude lower (mean catch rate for total cod was 18.6 lb in the inside area and 9.8 lb in the proposed area, mean catch rate for total white hake was 11.3 lb in the inside area and 9.9 lb in the proposed area. I focused on comparing haddock, cod and white hake as catches of other species were negligible (as they were in the full dataset).

Summaries of the catch distribution by haul for kept haddock, total cod and total white hake by area for all months and bait combined are shown in Figure 2. Both the linear scale and arithmetic scale are provided to help facilitate seeing the shape of the distributions. Figure 2 suggests little difference in either central location or in distribution of catch rates between the two areas for these three species. Similarly, catch distributions by haul for haddock, total cod and total white hake by months and area and bait combined are shown in Figures 3, 4 and 5. The distributions of catches for haddock between areas appear similar for each month with the exception of May and June, where catch rates may be higher in the proposed area (Figure 3). The distribution of catch rates for total cod and white hake also appear to be similar across area for each month (Figures 4, 5). This analysis indicates that catch rates for cod and white hake are not higher in the proposed area than the current SAP (inside area).

The randomization tests indicates that total cod catch per 1000 hooks in the proposed area (10.2 lbs per 1000 hooks) are not significantly greater than in catch rates in the current SAP (18.6 lb per 1000 hooks). The observed t-statistic (-2.78) had an achieved significance level = 0.99 indicating that the total cod catch is significantly less in the proposed area than in the current SAP. The bootstrap distribution of the t-statistic along with observed t-statistic is shown in Figure 6.

Total white hake catch per 1000 hooks in the proposed area (9.9 lbs per 1000 hooks) are not significantly greater than in catch rates in the current SAP (11.3 lb per 1000 hooks). The observed t-statistic (-.60) had an achieved significance level = 0.69. The bootstrap distribution of the t-statistic along with observed t-statistic is shown in Figure 6.

Ratio estimator

Bootstrap results are summarized in (Table 6). Ratio estimators were moderately well estimated with CV ranging from 12% to 18% and with negligible bias (< 0.016 SE units or 0.6%). The distribution of bootstrap replications of the ratio estimator for total cod: haddock kept and total white hake: haddock kept are shown in Figure 7.

The ratio estimator for total cod: haddock kept inside the current SAP was 0.021 with approximate 95% BC_a confidence limits of 0.016-0.027 compared with 0.014 (0.009-0.019). The ratio estimator is well below 5% and the cod: haddock ratio estimator is not statistically higher in the proposed area than in the current SAP area.

The ratio estimator for total white hake: haddock kept inside the current SAP was 0.013 with approximate 95% BC_a confidence limits of 0.01-0.016 compared with 0.013 (0.010-0.019). The ratio estimator is well below 5% and the white hake: haddock ratio in the proposed area is not statistically higher than in the current SAP area.

Conclusions

These analyses are on a trimmed dataset from a bait selectivity study. Data limitations include incomplete spatial coverage of the proposed area, imbalance in number of hauls within months between the current SAP and proposed area, and low or no sampling in some of the months proposed for the expanded SAP. In addition, most samples are from 2004. With these caveats in mind, these analyses indicate catch rates of species in the proposed area are not higher than in the current SAP. Similarly, the ratio estimators for total cod: haddock kept and total white hake to haddock kept are below 5% and do not appear to be higher in the proposed area than in the current SAP for either cod or white hake.

Literature Cited

Efron, B. 1987. Better Bootstrap Confidence Intervals. *Journal of the American Statistical Association*. 82 (397) pp 171-185.

Leach, M and S. Golhor (2005) Production and Testing of an Alternative Bait Selecting for Haddock, Final Report to NEC- award #P4UZE113.

Table 4. Summary order statistics and mean for catch in weight (lb per 1000 hooks) for various species in the trimmed dataset.

Species	area	Mean	Min.	1st Quartile	Median	3rd Quartile	Max.
Haddock kept (dressed)	Inside current SAP	875.1	0.0	535.4	834.2	1179.0	2199.0
	Proposed area	858.3	9.3	360.6	721.8	1335.0	2551.0
haddock discard	Inside current SAP	4.7	0.0	0.0	2.2	6.4	70.1
	Proposed area	4.8	0.0	1.0	3.3	7.9	34.2
cod kept	Inside current SAP	18.2	0.0	0.0	0.0	23.8	198.8
	Proposed area	9.8	0.0	0.0	0.0	10.7	95.2
cod discard	Inside current SAP	0.4	0.0	0.0	0.0	0.0	23.1
	Proposed area	0.4	0.0	0.0	0.0	0.0	5.8
cod total	Inside current SAP	18.6	0.0	0.0	0.0	24.0	198.8
	Proposed area	10.2	0.0	0.0	0.0	13.1	97.8
white hake kept	Inside current SAP	11.1	0.0	0.0	0.0	15.6	135.0
	Proposed area	6.5	0.0	0.0	0.0	4.2	76.8
white hake discards	Inside current SAP	0.2	0.0	0.0	0.0	0.0	5.3
	Proposed area	3.4	0.0	0.0	0.0	2.9	106.7
white hake total	Inside current SAP	11.3	0.0	0.0	0.0	17.0	135.0
	Proposed area	9.9	0.0	0.0	0.0	11.8	106.7
yellowtail flounder total	Inside current SAP	0.0	0.0	0.0	0.0	0.0	0.0
	Proposed area	0.0	0.0	0.0	0.0	0.0	2.2
winter flounder total	Inside current SAP	0.0	0.0	0.0	0.0	0.0	0.0
	Proposed area	0.0	0.0	0.0	0.0	0.0	0.0
witch flounder total	Inside current SAP	0.0	0.0	0.0	0.0	0.0	0.0
	Proposed area	0.0	0.0	0.0	0.0	0.0	0.0
American plaice total	Inside current SAP	0.0	0.0	0.0	0.0	0.0	1.5
	Proposed area	0.6	0.0	0.0	0.0	0.0	21.1
halibut total	Inside current SAP	0.1	0.0	0.0	0.0	0.0	13.3
	Proposed area	0.0	0.0	0.0	0.0	0.0	0.0
barndoor skate total	Inside current SAP	0.7	0.0	0.0	0.0	0.0	44.4
	Proposed area	0.9	0.0	0.0	0.0	0.0	72.2
pollock total	Inside current SAP	0.2	0.0	0.0	0.0	0.0	15.7
	Proposed area	0.0	0.0	0.0	0.0	0.0	0.0
dogfish total	Inside current SAP	2.8	0.0	0.0	0.0	0.0	514.3
	Proposed area	6.5	0.0	0.0	0.0	0.0	608.8

Table 6. Ratio estimators of total white hake: haddock kept and total cod: haddock kept., Jackknife standard error (SE) and bias (in standard error units), and 95% confidence limits using the Percentile method (1000 bootstrap replications) and the Bias Corrected and Accelerated method (BCa) using 10,000 replications.

species	Area	Ratio estimator (CV)	Jackknife SE	Jackknife bias (SE units)	95% CL percentile method		95% CL BCa method	
Total white hake	Inside	0.013 (12.3%)	0.0016	0.013	0.010	0.016	0.010	0.016
	Proposed	0.013 (18.2%)	0.0024	0.004	0.009	0.018	0.009	0.019
Total cod	Inside	0.021 (13.2%)	0.0027	0.012	0.016	0.026	0.016	0.027
	Proposed	0.014 (18.7%)	0.0026	0.016	0.009	0.019	0.010	0.020

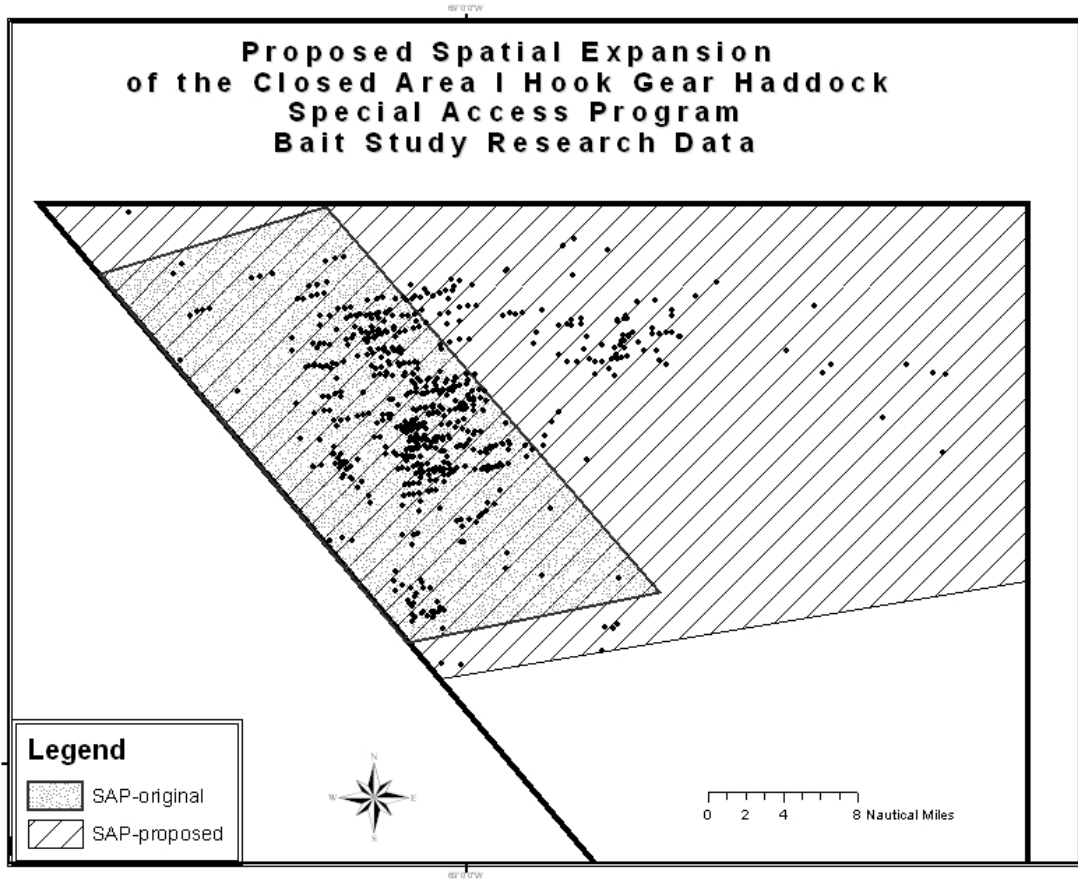


Figure 1. Location of hauls used in the bait selectivity study (Figure provided by Cape Cod Commercial Hook Fisherman’s Association). This represents haul locations in the full dataset.

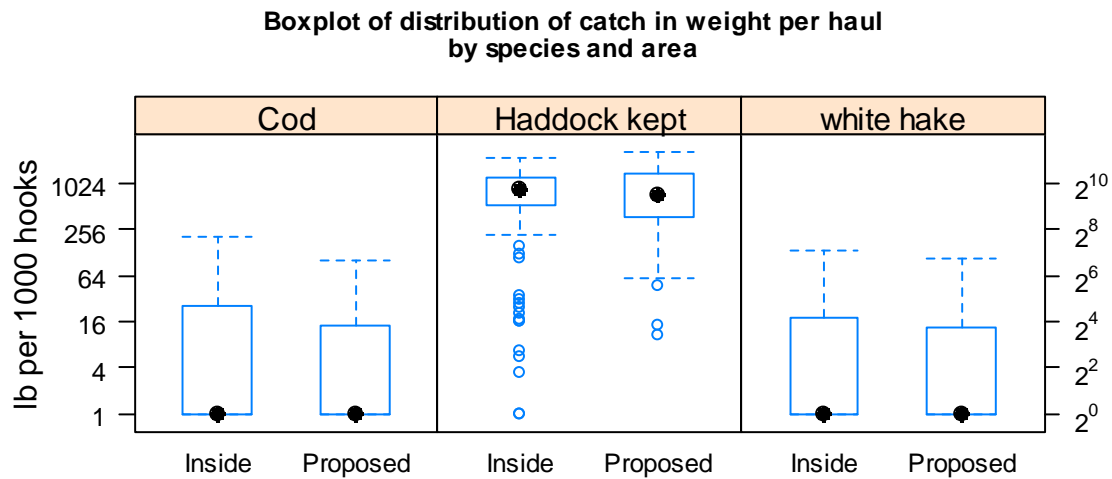
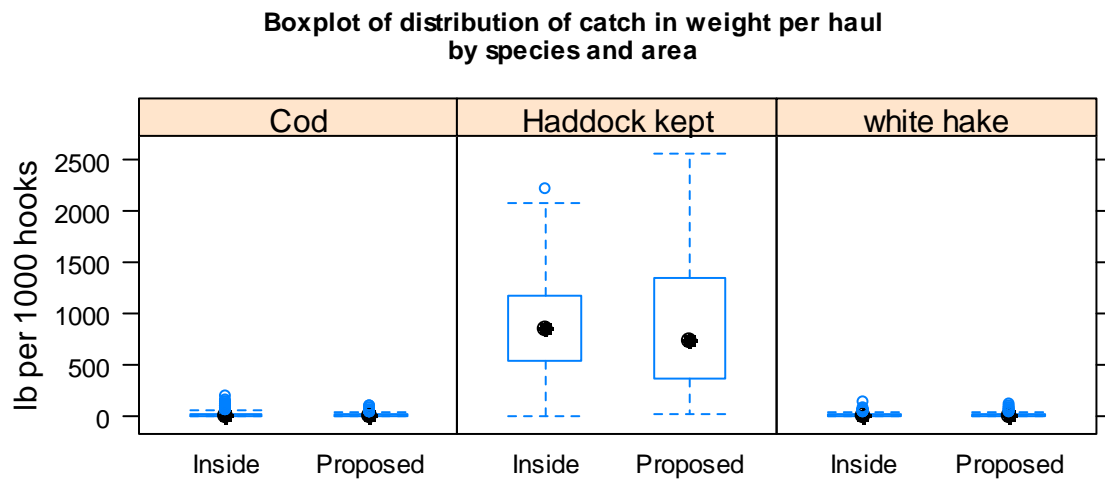


Figure 2. Boxplot of the distribution of catch in weight per haul by species and area. Top panel: linear scale. Bottom Panel: semi-log scale. Black dot is the median, box is the interquartile range.

Haddock kept dressed weight lb per 1000 hooks by area and month for all baits combined

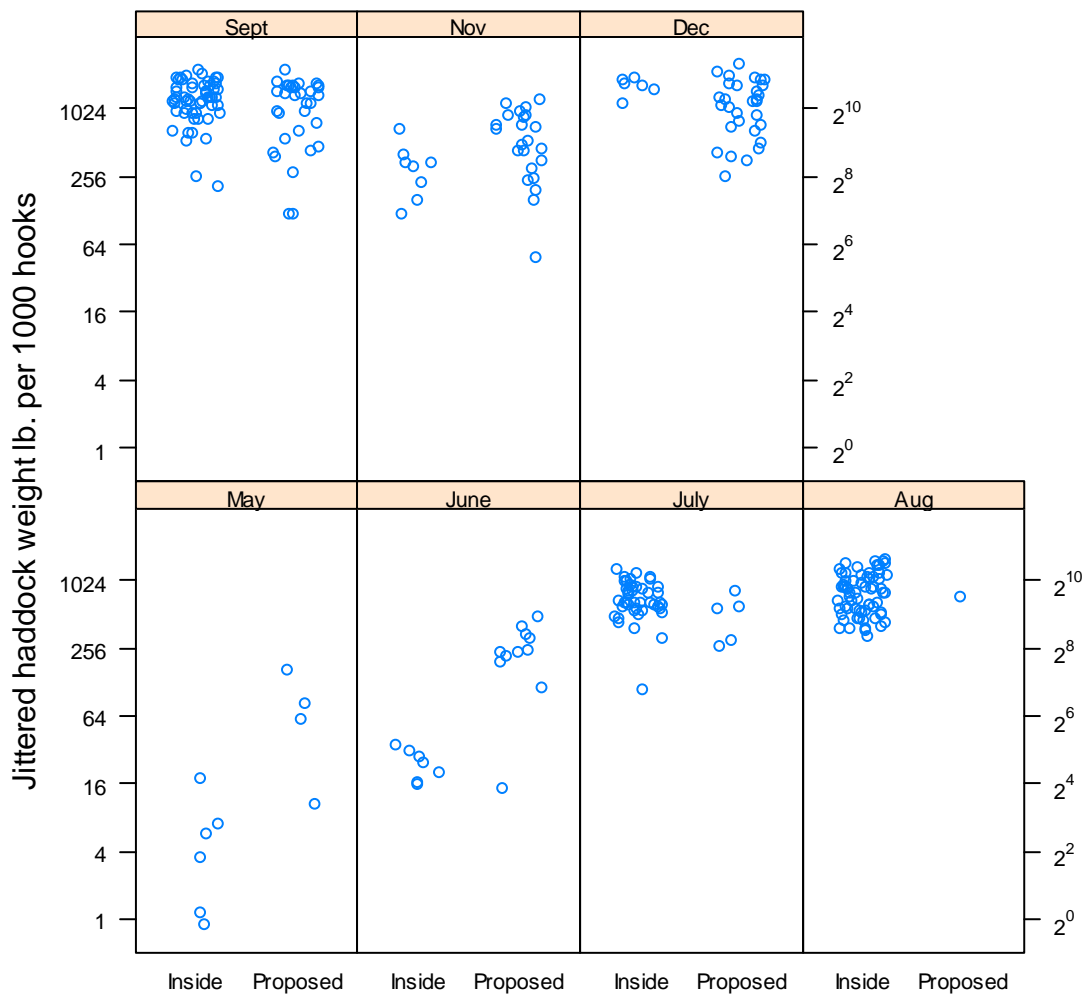


Figure 3. Distribution of catch in weight per 1000 hooks by haul for kept haddock. Note semi-log scale.

Total cod catch by haul (lb)per 1000 hooks by area and month for all baits combined

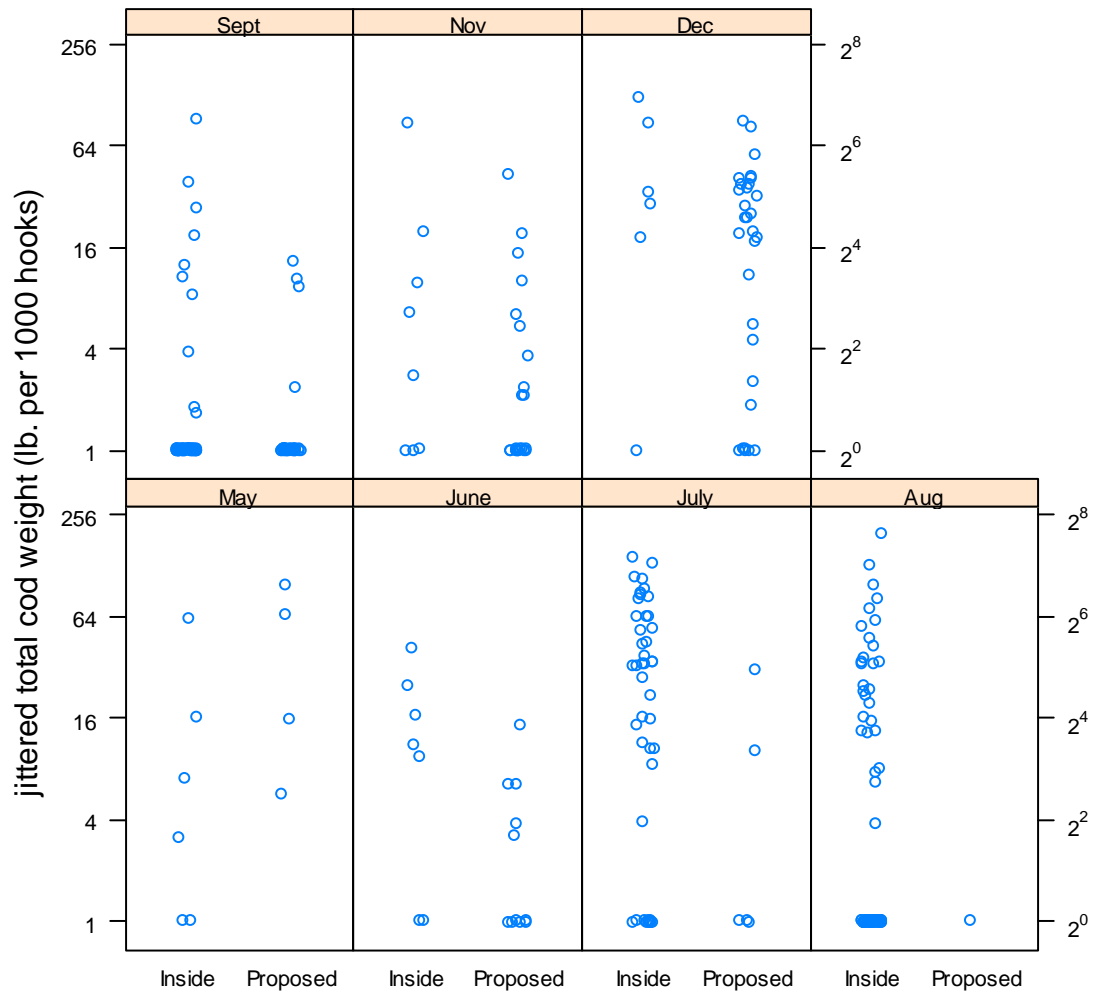


Figure 4. Jittered catch rate of total cod (weight per 1000 hooks) by month. Note semi-logarithmic scale on Y axis.

Total white hake catch (lb)per 1000 hooks by area and month for all baits combined

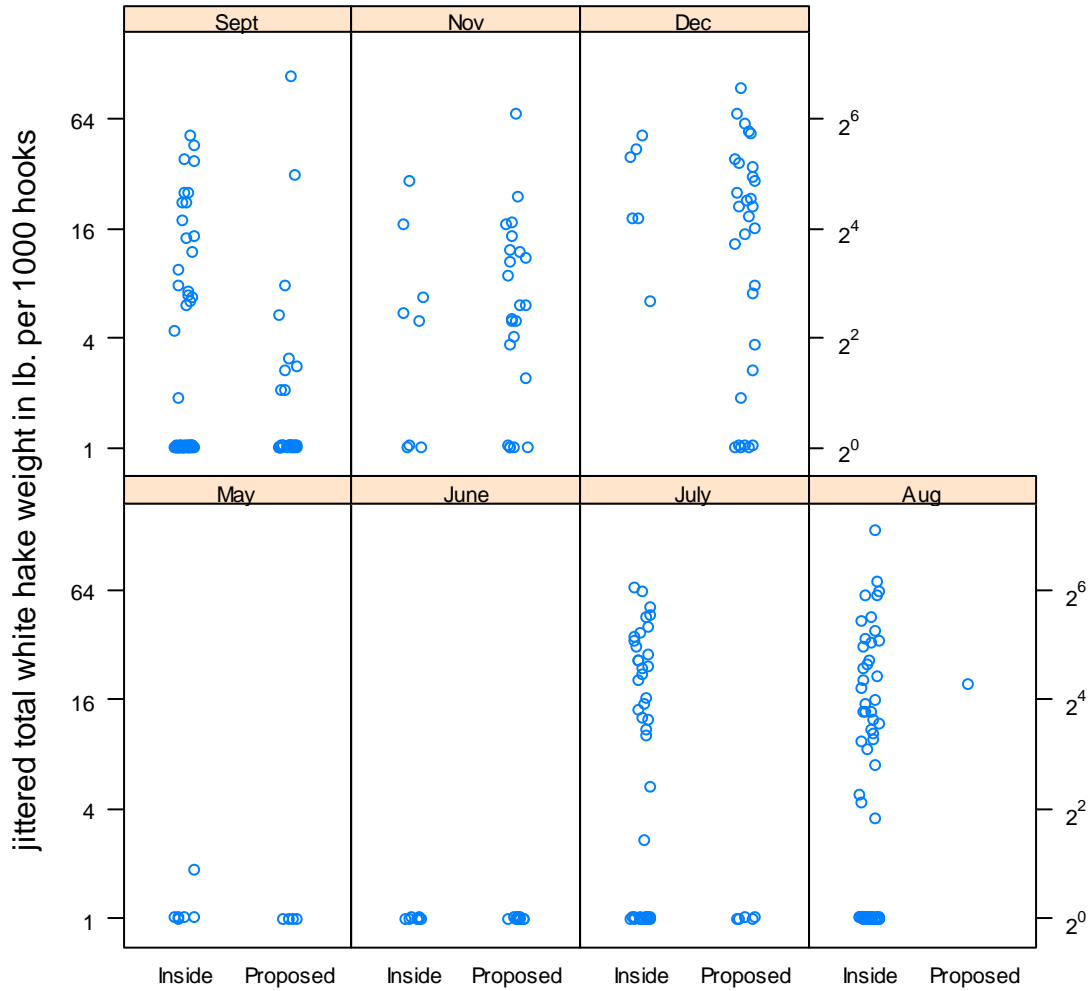


Figure 5. Catch rate of total white hake (weight per 1000 hooks) in an haul by month. Note semi-logarithmic scale on Y axis.

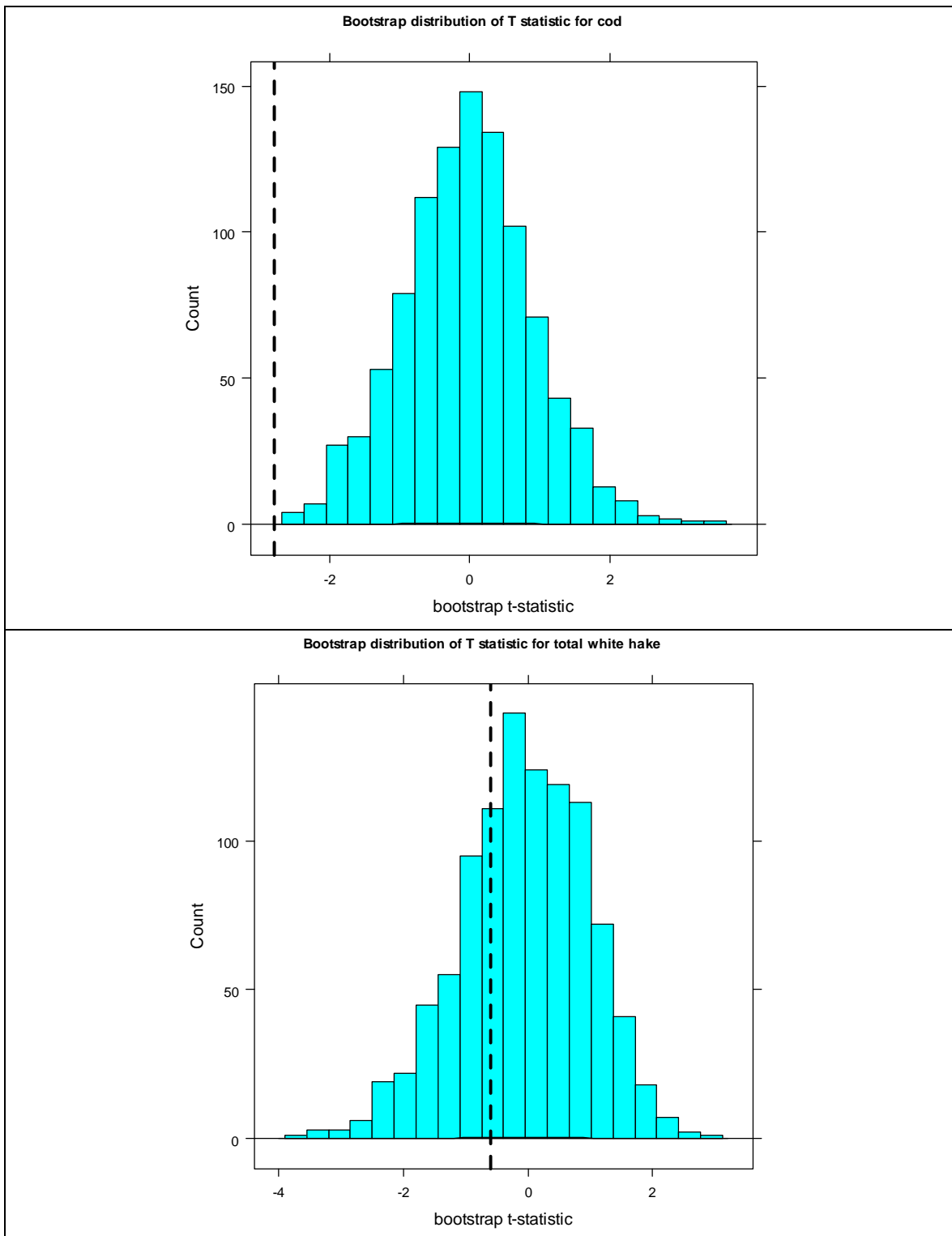


Figure 6. Distribution of bootstrapped t-statistic (1,000 replications). Top panel: Bootstrap distribution of T-statistic for mean cod catch proposed-mean cod catch inside area. Dashed line is the observed T.statistic -2.78. Bottom panel : Bootstrap distribution of T-statistic for mean white hake catch proposed-mean white hake catch inside area. Dashed line is the observed T.statistic - 0.60.

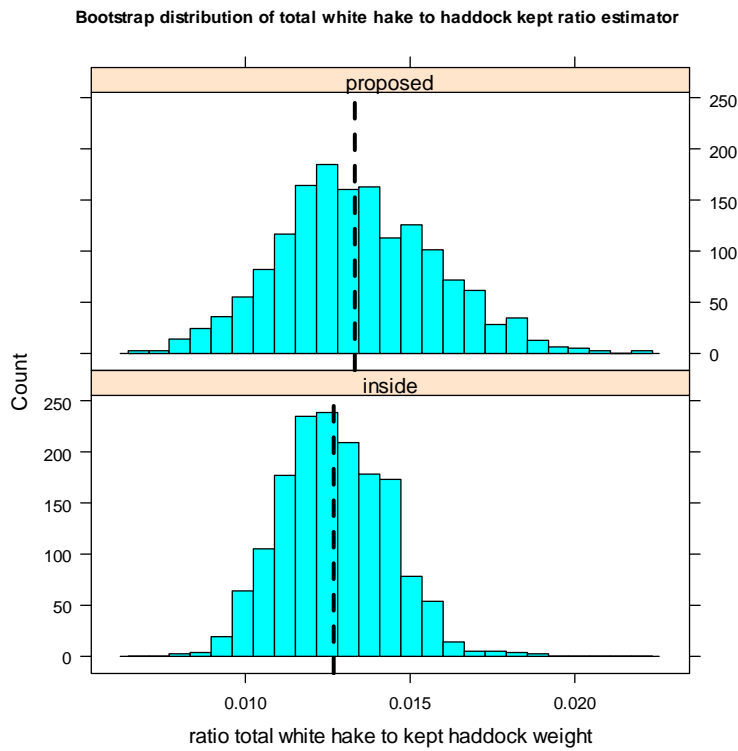
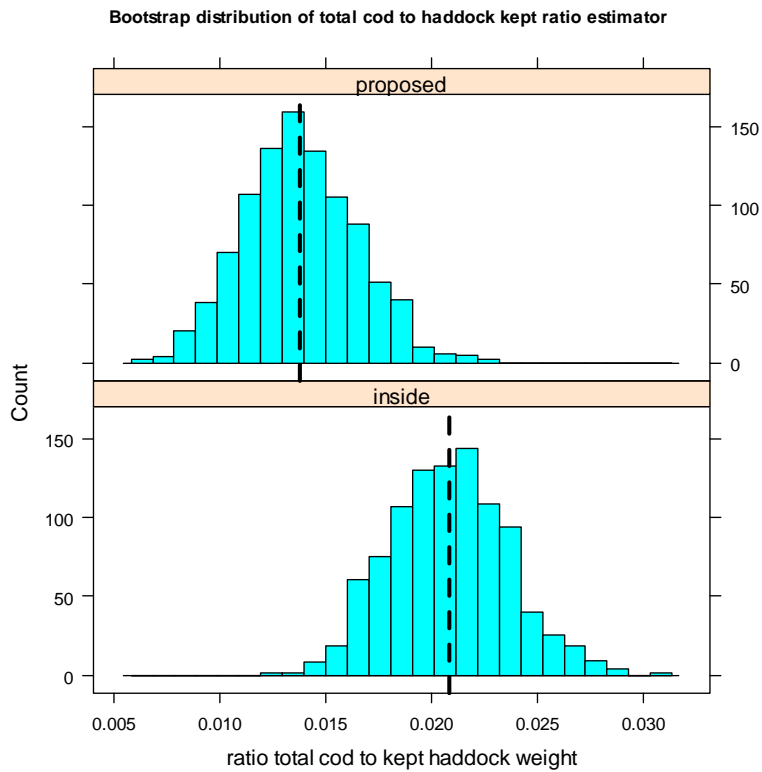


Figure 6. Distribution of bootstrapped ratio estimators (1,000 replications). Top two panels: Total cod to kept haddock in current SAP (inside) and proposed area. Bottom two panels: total white hake to kept haddock. Dashed black lines are the observed ratio estimator.

Literature cited