Developing an index of Atlantic mackerel abundance using commercial catch and effort data in the U.S. waters of the north Atlantic

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Introduction

During the Atlantic mackerel (mackerel from here on) *Scomber scombrus* Transboundary Resource Assessment Committee (TRAC) data review meeting, held October 22-23, 2009, the suggestion was made to explore the use of commercial catch and effort data as an index of abundance. Fishery stock assessments often assume that such fishery dependent catch per effort (CPE) data are proportional to average abundance. However, this assumption can be violated for several reasons (e.g., non-random search effort, gear changes; Quinn and Deriso 1999), and in some cases this has been a contributing factor to fishery collapse (Rose and Kulka 1999; Harley et al. 2001). Consequently, some have suggested that fishery-dependent data not be used when fishery independent surveys are available (NRC 1998). In contrast, Wilberg and Bence (2006) found that ignoring fishery dependent indices of abundance only worked well when the fishery independent indices of abundance were fairly precise, and that including the fishery dependent data can produce more accurate abundance estimates in some cases. So, the utility of fishery dependent data may be case specific.

To account for some of the variation in commercial CPE data not attributable to abundance, CPE data are often standardized by using statistical models and then using year effect estimates as the index of abundance (Maunder and Punt 2004; Venables and Dichmont 2004). Commonly, some form of general or generalized linear model is used to standardize the CPE data (Maunder and Punt 2004).

The objective of this research was to standardize commercial mackerel CPE data to better evaluate its usefulness as a potential indicator of changes in abundance. I addressed this objective by developing a general linear model to account for some factors that may cause changes in mackerel CPE that are unrelated to abundance.

Methods

The mackerel CPE data used here were collected either through interviews conducted by NMFS port agents, or through the NMFS vessel trip report system (VTR). The exact range of years from which data were available depended on fishing gear (see below). All data prior to 1994 were from the interviews, while all other data were collected as part of the VTR system. I assumed that these two methods of data collection had similar potential for misreporting and so the two data sources were combined to form a single time series. Data consistently collected included: state where fish were landed, year, month, hull number of the vessel, gear used, Northwest Atlantic Fisheries Organization (NAFO) statistical area, ton class of the vessel, effort (days absent from port), and mackerel landed (pounds). Effort was defined as days absent from port so that search time was included in the unit of effort. Sometimes fishing occurred in multiple NAFO statistical areas or with multiple gears within the same fishing trip. In these cases, data from each area or from each gear were treated as separate observations, and effort in days absent from the entire fishing trip was divided among each observation based on the proportion of time spent towing in each area or by the proportion of the total number of tows conducted using each gear. No such reapportionment of the landings data was required because those data were recorded by area and gear type. Ton class was defined categorically as 1-4 tons, 5-50 tons, 51-150 tons, 151-500 tons, 501-1000 tons, or greater than 1000 tons. Data were also restricted to only those fishing trips where landings consisted of at least 25% mackerel. Several other alternatives were considered, but requiring that 25% of the landings consist of mackerel seemed to provide a good compromise between maintaining a reasonable sample size while not including too many 'non-representative' trips (Table 1).

Mackerel in the United States’ waters of the north Atlantic were mainly caught using paired trawls, mid-water otter trawls, or bottom fished otter trawls. These three gears accounted for over 99% of all mackerel caught during 1994-2008, and so all analyses were restricted to these three gears. Because each of these gears also likely has a catchability and selectivity that differs from the others, and so would be included in an assessment as separate indices, all analyses described below were conducted for each gear separately. The dataset contained 1043 observations from paired trawls, 758 from mid-water otter trawls, and 4004 from bottom fished otter trawls.

To provide a baseline with which to evaluate the effect of the standardization model, “raw” CPE was estimated for each gear as the ratio of the sum of landings to the sum of effort in each year. Data were available from paired trawls during 1998-2000, 2002-2004, and 2006-2008, from mid-water otter trawls during 1994-2008, and from bottom fished otter trawls during 1978-2008. Due to the relatively short and sporadic time series available for paired trawls, CPE data from that gear were not considered any further (Figure 1). As a preliminary evaluation of the consistency of the commercial mackerel CPE data with a standardized survey that has previously been used in assessments, the trends among years in raw CPE for mid-water and bottom fished otter trawls were qualitatively compared to the trend among years from the NMFS spring bottom trawl survey (see Deroba “Notes on mackerel abundance indices from NMFS bottom trawl surveys” prepared for the October 2009 data meeting for details). If the trends were generally similar, then the commercial CPE data were considered consistent with the spring survey, and the opposite conclusion was made if the trends were generally dissimilar.

General linear models with $\log_e$(CPE) as the dependent variable were fitted separately for mid-water and bottom fished otter trawls. The data were $\log_e$ transformed to meet the assumption of normality for general linear models. The full (i.e., saturated) model for mid-water otter trawls included fixed, categorical effects for year (α_y), month (β_m), NAFO statistical area (γ_a), ton class (ϑ_t), state where fish were landed (ρ_s), hull number (τ_h), and all two-way interactions except those with year:

$$log_e(CPE) = \mu + \alpha_y + \beta_m + \gamma_a + \vartheta_t + \rho_s + \tau_h + c_{ma} + d_{mt} + g_{ms} + h_{mh} + j_{at} + k_{as} + l_{ah} + m_{ts} + o_{sh} + p_{th} + \varepsilon_i$$

where μ was the overall mean, c_{ma} was the interaction of month and NAFO statistical area, d_{mt} was the interaction of month and ton class, g_{ms} was the interaction of month and state where fish were landed, h_{mh} was the interaction of month and hull number, j_{at} was the interaction of NAFO statistical area and ton class, k_{as} was the interaction of NAFO statistical area and state where fish were landed, l_{ah} was the interaction of NAFO statistical area and hull number, m_{ts} was the interaction of ton class and state where fish were landed, o_{sh} was the interaction of state where fish were landed and hull number, p_{th} was the interaction of ton class and hull number, and ε_i was residual error for each observation *i*. For the bottom fished otter trawl gear type, many hull numbers (i.e., boats) had few observations in the dataset (e.g., 63% of boats had less than five observations and 38% of boats had only one observation), and so factors for hull number were not estimable. So, hull number and interactions with hull number were excluded from the full model for bottom fished otter trawls:

$$\log_e(CPE) = \mu + \alpha_y + \beta_m + \gamma_a + \vartheta_t + \rho_s + c_{ma} + d_{mt} + g_{ms} + f_{at} + k_{as} + m_{ts} + \varepsilon_t \, ;$$

where all terms were defined as for mid-water otter trawls. These models assume that the residual errors are independent and identically distributed as normal with a mean of zero. Interactions with year were excluded a priori because retaining these factors in the models would preclude the use of the year effect estimates as indices of abundance, and this was the objective of the research.

Final models for both gear types were determined by evaluating which effects could be removed using the percentage of deviance explained by each factor relative to that of the full models. During this process, a 'minimal' model was fit that only estimates the overall mean (i.e., μ in the equations above). The impact of each explanatory factor was summarized by the percentage of the deviance explained, i.e. the reduction in deviance due to the additional factor divided by the difference between the residual deviances of the minimal and full models (e.g., Ortiz and Arocha 2004). Factors and interactions with a percentage of deviance explained of 5% or more were retained in the final models. Percentage deviance was chosen as the model selection methodology over parametric tests (e.g., p-values based on F-statistics) because parametric tests can be sensitive to a large number of degrees of freedom (see above for sample sizes for each gear type), which would tend to over-parameterize the models. Percentage deviance explained is more robust to this problem (e.g., Ortiz and Arocha 2004).

Once the final models for each gear type were determined, the least squares means (LSMs) for each year were calculated as the sum of μ , α_y, and the average of the coefficient estimates over all levels of fixed effects other than year in the final models. The bias-corrected, back transformed LSMs were used as the standardized indices of abundance (I_y) for each gear type:

$$I_y = e^{\mathrm{LSM}_y + \left(\frac{\sigma_\varepsilon^2}{2}\right)}$$

where LSM_y was the least squares mean for each year y, and σ_ε^2 was the residual error variance.

To evaluate the effect of the standardization process, the trends among years between the "raw" CPE values and standardized indices (I_y) were qualitatively compared by plotting the proportional difference (PD) between raw CPE and the I_y values in each year. Proportional difference was calculated as:

$$\mathrm{PD} = \mathrm{CPE}_y / I_y ;$$

where CPE_y was the raw CPE for each year. The PD measures the magnitude of the difference between raw CPE and the standardized index. For example, if PD equals 2, then the raw CPE was two times greater than the standardized index. Since both the raw CPE and standardized values are relative indices, temporal trends among years in PD are of interest, and not deviations of average PD from 1.0. So, if PD varied without trend, I concluded that raw CPE and standardized indices suggested similar trends in abundance through time. Conversely, if PD trended through time, I concluded that the two indices suggested different temporal trends. A plot of the raw CPE and I_y time series for each gear type are also provided for the sake of completeness and as an alternative to examining plots of PD.

Results

The trends among years in raw CPE for mid-water and bottom fished otter trawls were generally similar to the mean number of mackerel per tow from the NMFS spring bottom trawl survey (Figure 1).

Beginning in 1994 for the mid-water otter trawl and 1978 for the bottom fished otter trawls, the CPE values from all three sources generally increased until the late 1990s and varied without trend for the remainder of the time series (Figure 1). The raw CPE from each gear also peaked in some of the same years as the NMFS survey (e.g., 2006). Generally, the raw CPE from each gear type was less variable among years than the NMFS survey (Figure 1). These results suggested that the commercial mackerel CPE data were generally consistent with the NMFS spring bottom trawl survey.

The final model for mid-water otter trawls included fixed effects for year, NAFO statistical area, state where fish were landed, hull number, month by NAFO statistical area interaction, month by hull number interaction, and a NAFO statistical area by hull number interaction (Table 2):

$$log_e(CPE) = \mu + \alpha_y + \gamma_a + \rho_s + \tau_h + c_{ma} + h_{mh} + l_{ah} + \varepsilon_i \, .$$

The final model for bottom fished otter trawls included fixed effects for year, month, NAFO statistical area, ton class, state where fish were landed, and month by NAFO statistical area interaction (Table 2):

$$log_e(CPE) = \mu + \alpha_y + \beta_m + \gamma_a + \vartheta_t + \rho_s + c_{ma} + \varepsilon_i \, .$$

For each gear type, the raw CPE values suggested different temporal trends from the standardized indices over some or all of the time series. For mid-water otter trawls, PD generally increased from 1994-1999, decreased from 1999-2002, varied without trend from 2002-2007, and increased in 2008 (Figure 2; Figure 3). For bottom fished otter trawls, PD was variable but generally showed an increasing trend over the time series (Figure 2; Figure 3). PD generally increased from 1978-1986, decreased from 1986-1988, increased from 1988-1991, decreased from 1991-1995, increased from 1995-1998, and varied without trend for the remainder of the time series, albeit with some short-term (i.e., 2-3 year) trends (Figure 2; Figure 3).

Discussion

Some have warned against the use of commercial catch and effort data as an index of abundance when standardized surveys are available as an alternative. However, the cautious use of commercial CPE data can be beneficial in some situations (Wilberg and Bence 2006). In this study, trends in raw CPE from two commercial fishing gears were generally similar to those from a standardized survey dataset, which suggested that commercial catch and effort data may warrant consideration when standardized for various factors not believed to be related to abundance, as was done here.

Using an index of abundance estimated from commercial catch and effort data in a stock assessment may also require additional inputs. For example, a selectivity curve for each gear would have to be estimated based on age composition data or input as a constant. Such additional requirements should not be overlooked when considering the use of supplementary indices of abundance based on fishery dependent data.

The final models for mid-water and bottom fished otter trawls contained several of the same factors, and these factors were also similar to factors retained in models from other studies. For example, month, NAFO statistical area, or interactions with those terms were retained in the final models for both gear types. Ton class was retained in the final model for bottom fished otter trawls and not in the final model for mid-water otter trawls, but this result may have been due to the consideration of hull number in the models for mid-water otter trawls, which was confounded with ton class. Factors for individual vessels, such as hull number in this study, are commonly included in models for CPE standardization, and often explain a large proportion of variation by acting as a catch-all for boat characteristics that are not included in models (Battaile and Quinn 2004; Bishop et al. 2004; Cooper et al. 2004; Helser et al. 2004; Deroba and Bence 2009). Other factors that are common in models developed for other fisheries and similar to those in the final models in this study include factors for month (or some other temporal measure on a finer scale than year) and vessel power, such as ton class or horsepower (Maynou et al. 2003; Battaile and Quinn 2004; Bishop et al. 2004; Helser et al. 2004).

A factor for the state where fish were landed was retained in the final models for both gear types, and such a factor was relatively unique to this study. This factor was considered because a large proportion of the mackerel fishing trips come from 2-3 states (Table A1). So, boats operating out of those states may have greater expertise or access to better mackerel fishing grounds than boats operating in other states, which may cause artificially high CPE values (e.g., hyperstability). The coefficient estimates from states with the largest proportion of observations for each gear type were relatively higher than other states, which lends some support to this hypothesis (Table A2).

Temporal trends exhibited by standardized CPE data have differed from “raw” CPE in other studies (Maynou et al. 2003; Battaile and Quinn 2004), as well as in this evaluation of mackerel CPE data. Thus, a standardization approach should be used when commercial CPE data are being considered as an index of abundance. Furthermore, standardization models can provide more accurate measures of uncertainty around the indices (Figure A1; Table A3), which can be especially important when estimates of uncertainty are used to weight the importance of the yearly CPE indices in stock assessment models (Maunder and Starr 2003; Helser et al. 2004).

References

Battaile, B.C. and T.J. Quinn II. 2004. Catch per unit effort standardization of the eastern Bering Sea walleye Pollock fleet. Fisheries Research 70(2004): 161-177.

Bishop, J., W.N. Venables, and Y-G. Wang. 2004. Analyzing commercial catch and effort data from a Penaeid trawl fishery: A comparison of linear models, mixed models, and generalized estimating equations approaches. Fisheries Research 70(2004): 179-193.

Cooper, A.B., A.A. Rosenberg, G. Stefansson, and M. Mangel. 2004. Examining the importance of consistency in multi-vessel trawl survey design based on the U.S. west coast groundfish bottom trawl survey. Fisheries Research 70(2004): 239-250.

Deroba, J.J. and J.R. Bence. 2009. Developing model based indices of lake whitefish abundance using commercial fishery catch and effort data in Lakes Huron, Michigan, and Superior. North American Journal of Fisheries Management 29:50-63.

Harley, S.J., R.A. Myers, and A. Dunn. 2001. Is catch-per-unit-effort proportional to abundance? Canadian Journal of Fisheries and Aquatic Sciences 58: 1760-1772.

Helser, T.E., A.E. Punt, and R.D. Methot. 2004. A generalized linear mixed model analysis of a multi-vessel fishery resource survey. Fisheries Research 70(2004): 251-264.

Maunder, M.N. and A.E. Punt. 2004. Standardizing catch and effort data: a review of recent approaches. Fisheries Research 70(2004): 141-159.

Maunder, M.N. and P.J. Starr. 2003. Fitting fisheries models to standardized CPUE abundance indices. Fisheries Research 63(2003): 43-50.

Maynou, F., M. Demestre, and P. Sanchez. 2003. Analysis of catch per unit effort by multivariate analysis and generalised linear models for deep-water crustacean fisheries off Barcelona. Fisheries Research 65(2003): 257-269.

National Research Council (NRC). 1998. Improving Fish Stock Assessments. Washington, D.C.: National Academy Press.

Ortiz, M. and F. Arocha. 2004. Alternative error distribution models for standardization of catch rates of non-target species from a pelagic longline fishery: billfish species in the Venezuelan tuna longline fishery. Fisheries Research 70:275-297.

Quinn, T.J., II, and R.B. Deriso. 1999. Quantitative Fish Dynamics. Oxford University Press Inc. New York, New York.

Rose, G.A. and D.W. Kulka. 1999. Hyperaggregation of fish and fisheries: how catch-per-unit-effort increased as the northern cod declined. Canadian Journal of Fisheries and Aquatic Sciences 56(supplement 1): 118-127.

Venables, W.N., and C.M. Dichmont. 2004. GLMs, GAMs, and GLMMs: an overview of theory for applications in fisheries research. Fisheries Research 70(2004): 319-337.

Wilberg, M.J. and J.R. Bence. 2006. Performance of time-varying catchability estimators in statistical catch-at-age analysis. Canadian Journal of Fisheries and Aquatic Sciences 63:2275-2285.

Figure 1. Mackerel raw catch per effort (sum of catch over sum of effort for each year) for paired trawls (PTM), mid-water otter trawls (OTM), and bottom fished otter trawls (OTF) in the U.S. waters of the north Atlantic, and the back-transformed geometric mean number of mackerel per tow from the NMFS spring bottom trawl survey.

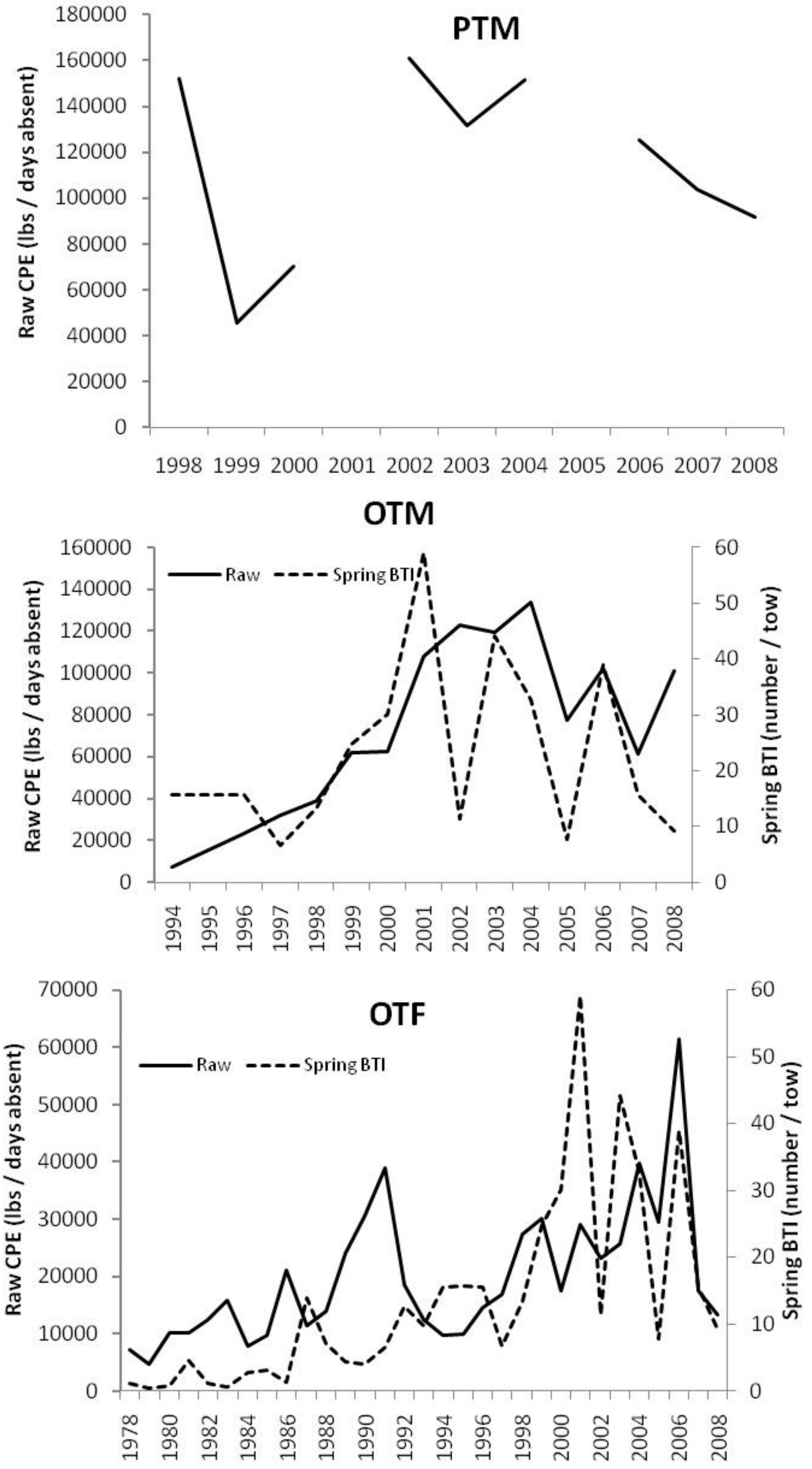


Figure 2. The proportional difference between the raw catch per effort and standardized catch per effort (see text for details) from mid-water and bottom fished otter trawls (OTM and OTF, respectively) for mackerel in the U.S. waters of the north Atlantic.

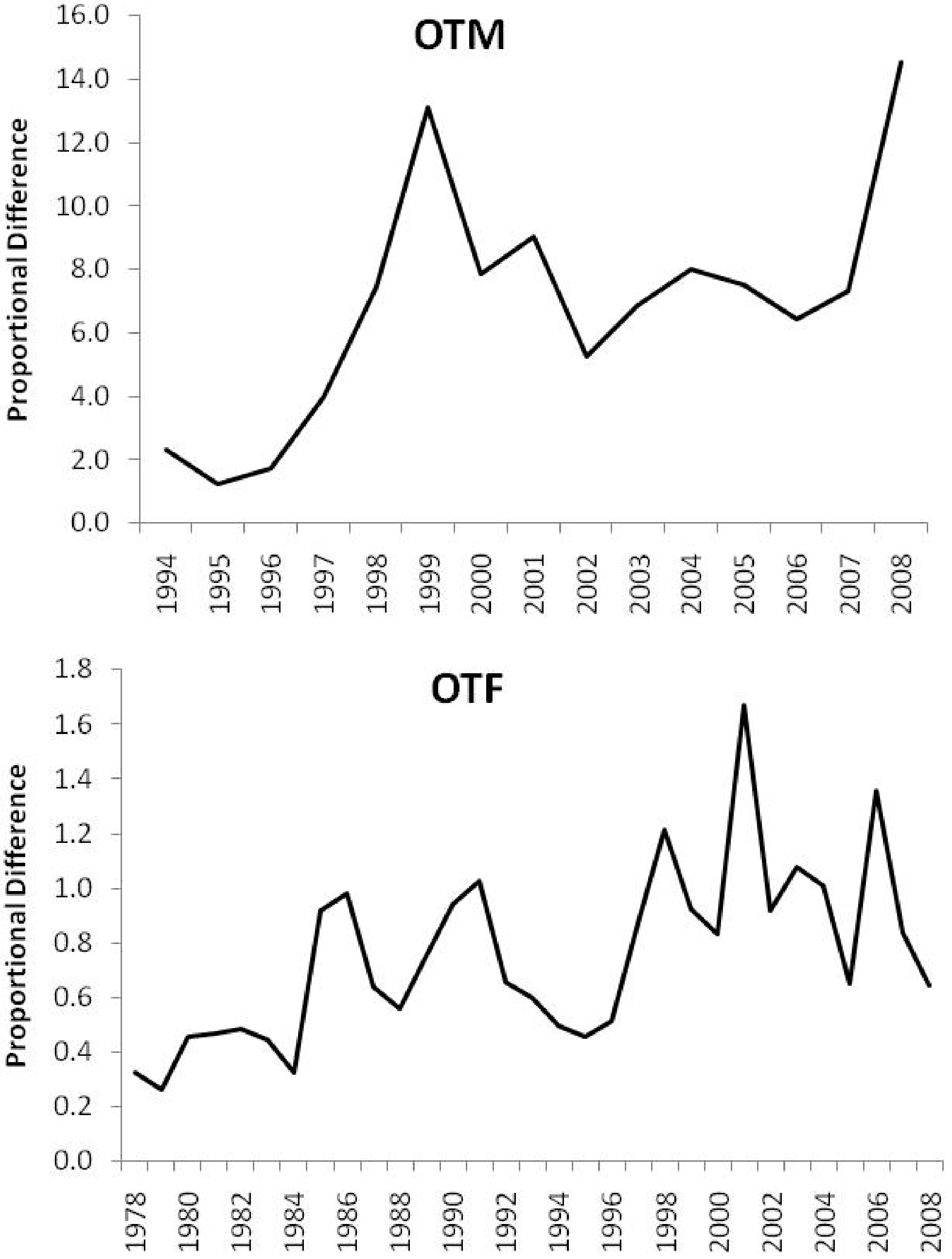
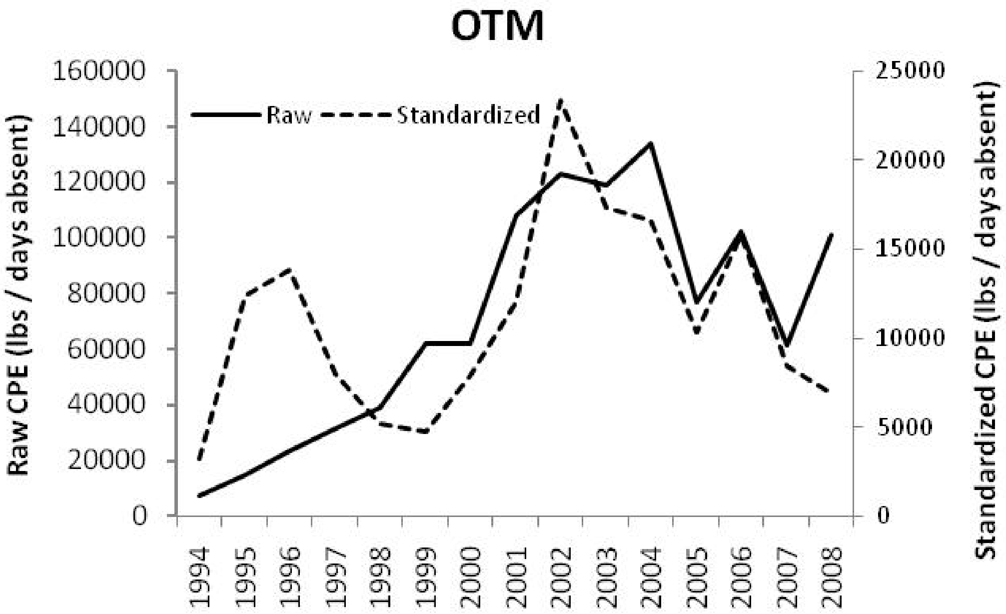


Figure 3. Raw catch per effort and standardized catch per effort (see text for details) for mid-water and bottom fished otter trawls (OTM and OTF, respectively) for mackerel in the U.S. waters of the north Atlantic.



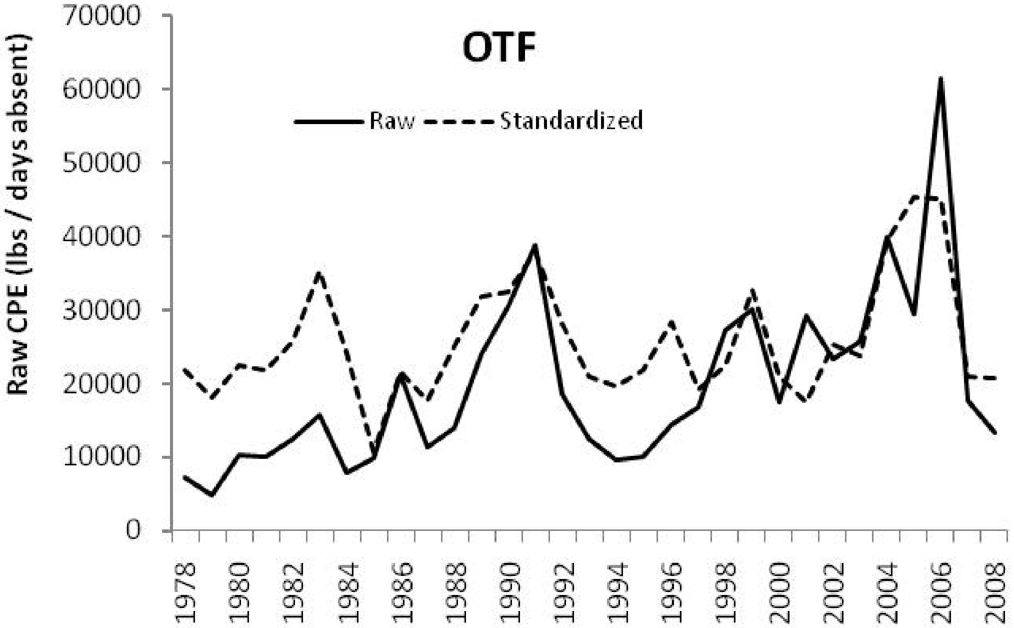


Table 1. The options considered for use as a cut-off for inclusion in a dataset of commercial mackerel catch and effort data (see text for details). The data summarized in this table include trips from paired trawls, mid-water otter trawls, and bottom fished otter trawls fished in U.S. waters of the north Atlantic during 1994-2008.

Cut-off Option	**NumTrips**	**%Trips**
Landings>5000lbs Mackerel	3610	0.20
≥ 10% of Landings are Mackerel	6655	0.37
≥ 25% of Landings are Mackerel	4812	0.27
≥ 25% of Landings are Mackerel and Landings >1000lbs	4150	0.23
≥ 50% of Landings are Mackerel	3523	0.20

Table 2. Deviance analysis table of explanatory factors for standardization models of mackerel catch per effort (pounds landed / days absent) for mid-water and bottom fished otter trawls in the U.S. waters of the north Atlantic. Df=degrees of freedom used by addition of given parameter, Resid.=Residual, Dev=Deviance, Delta Dev=change in deviance, %of tot deve exp= percent of total deviance explained. If %of tot deve exp was ≥5%, then the additional factor was retained in the final model.

Model Structure	**Df**	**Resid. Df**	**Resid. Dev**	**Delta Dev**	**% of tot deve exp**
Mid-water Otter Trawl					
Minimal model (overall mean only)	1	757	1365.2		
Year	14	743	1110.4	254.8	29.2
Year Month	6	737	1099.1	11.3	1.3
Year Month Area	26	711	1018.5	80.6	9.2
Year Month Area TonClass	2	709	1004.1	14.5	1.7
Year Month Area TonClass State	7	702	932.0	72.1	8.3
Year Month Area TonClass State HullNum	31	671	748.1	183.9	21.1
Year Month Area TonClass State HullNum MonthxArea	40	631	692.1	56.0	6.4
Year Month Area TonClass State HullNum MonthxArea MonthxTonclass	8	623	679.0	13.0	1.5
Year Month Area TonClass State HullNum MonthxArea MonthxTonclass MonthxState	15	608	648.1	31.0	3.5
Year Month Area TonClass State HullNum MonthxArea MonthxTonclass MonthxState MonthxHullNum	55	553	584.3	63.8	7.3
Year Month Area TonClass State HullNum MonthxArea MonthxTonclass MonthxState MonthxHullNum AreaxTonClass	16	537	573.7	10.5	1.2
Year Month Area TonClass State HullNum MonthxArea MonthxTonclass MonthxState MonthxHullNum AreaxTonClass AreaxState	25	512	554.7	19.1	2.2
Year Month Area TonClass State HullNum MonthxArea MonthxTonclass MonthxState MonthxHullNum AreaxTonClass AreaxState AreaxHullNum	70	442	492.6	62.1	7.1
Year Month Area TonClass State HullNum MonthxArea MonthxTonclass MonthxState MonthxHullNum AreaxTonClass AreaxState AreaxHullNum TonClassxState StatexHullNum	2	440	492.6	0.0	0.0
Bottom Fished Otter Trawls					
Minimal model (overall mean only)		3986	11390.5		
Year	30	3956	10437.2	953.3	17.9
Year Month	11	3945	9775.5	661.7	12.4
Year Month Area	51	3894	8627.2	1148.3	21.6
Year Month Area TonClass	4	3890	7635.9	991.3	18.6
Year Month Area TonClass State	9	3881	7167.1	468.8	8.8
Year Month Area TonClass State MonthxArea	131	3750	6785.3	381.8	7.2
Year Month Area TonClass State MonthxArea MonthxTonClass	17	3733	6710	75.3	1.4
Year Month Area TonClass State MonthxArea MonthxTonClass MonthxState	39	3694	6615.1	94.9	1.8
Year Month Area TonClass State MonthxArea MonthxTonClass MonthxState AreaxTonClass	40	3654	6373	242.1	4.6
Year Month Area TonClass State MonthxArea MonthxTonClass MonthxState AreaxTonClass AreaxState	49	3605	6160.1	212.9	4.0
Year Month Area TonClass State MonthxArea MonthxTonClass MonthxState AreaxTonClass AreaxState TonClassxState	11	3594	6070.2	89.9	1.7

Appendix.

Figure A1. Standardized catch per effort indices of abundance (see text for details) for mid-water and bottom fished otter trawls (OTM and OTF, respectively) for mackerel in the U.S. waters of the north Atlantic. The error bars were calculated similar to that of the indices of abundance, except the coefficient estimates for each year were replaced with the coefficient estimates for each year plus or minus two standard errors.

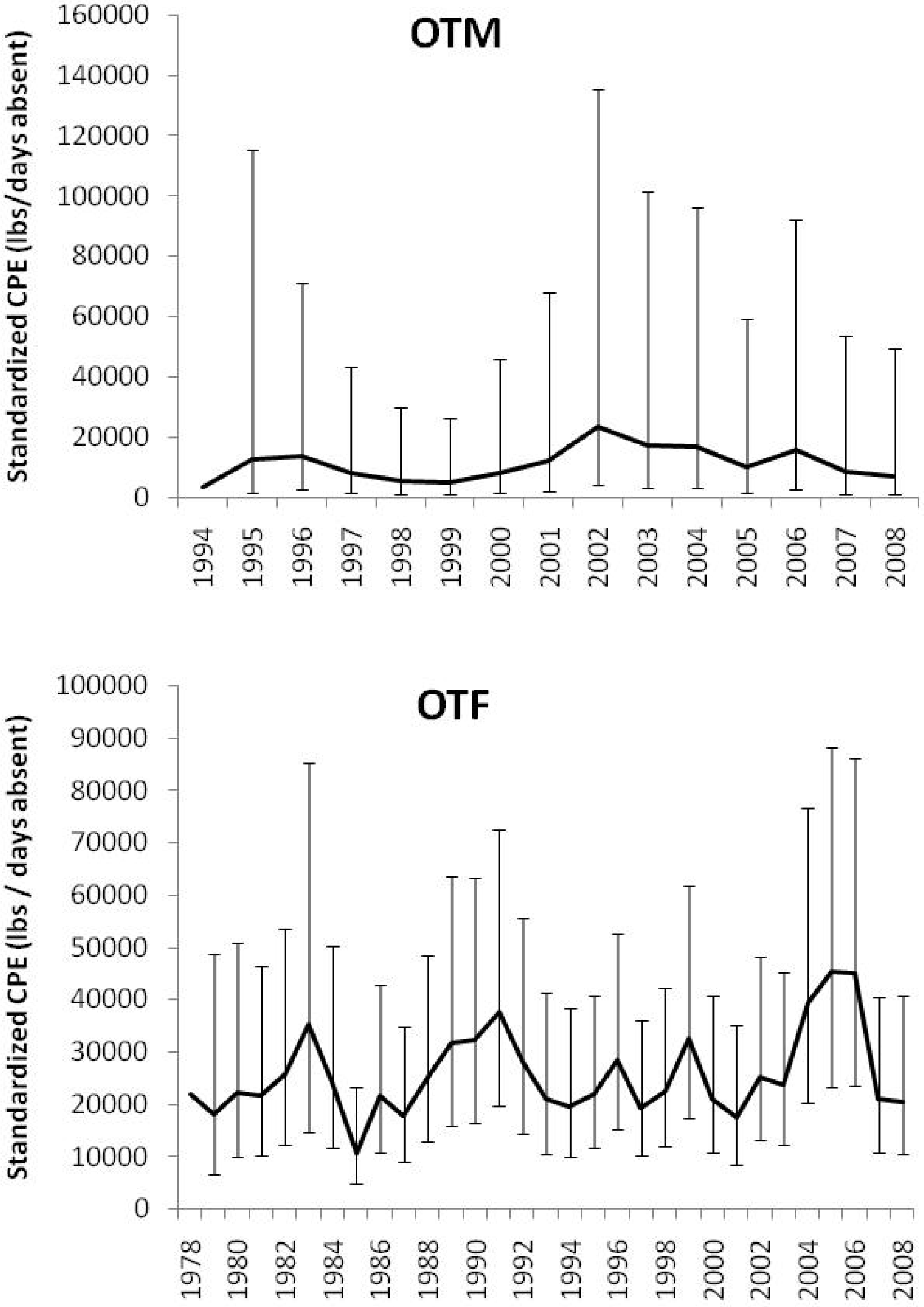


Table A1. The number and percentage of trips by state where mackerel were landed for mid-water otter trawls during 1978-2008 and for bottom fished otter trawls during 1994-2008 in the U.S. waters of the north Atlantic.

State	Number of Trips	% of Trips
Mid-water Otter Trawls		
CT	3	0.00
MA	223	0.29
ME	2	0.00
NC	5	0.01
NH	4	0.01
NJ	354	0.47
NY	14	0.02
RI	153	0.20
Bottom Fished Otter Trawls		
CT	246	0.06
MA	149	0.04
MD	47	0.01
ME	28	0.01
NC	14	0.00
NH	7	0.00
NJ	1456	0.36
NY	525	0.13
RI	1471	0.37
VA	61	0.02

Table A2. Coefficient estimates from general linear models used to standardize mackerel catch per effort (pounds landed/days absent) data from mid-water and bottom fished otter trawls in the U.S. waters of the north Atlantic (see text for details). Coefficents for the hull number factor and interactions with hull number have been deleted due to confidentiality issues.

FactorLevels	**Estimate**	**Std. Error**	**t value**	**Pr(>|t|)**
Mid-water Otter Trawls				
(Intercept)	10.99	2.22	4.96	0.00
factor(YEAR)1995	1.36	1.11	1.22	0.22
factor(YEAR)1996	1.47	0.82	1.80	0.07
factor(YEAR)1997	0.92	0.84	1.09	0.27
factor(YEAR)1998	0.50	0.87	0.57	0.57
factor(YEAR)1999	0.40	0.86	0.46	0.65
factor(YEAR)2000	0.91	0.88	1.04	0.30
factor(YEAR)2001	1.33	0.87	1.53	0.13
factor(YEAR)2002	2.00	0.88	2.27	0.02
factor(YEAR)2003	1.70	0.88	1.92	0.06
factor(YEAR)2004	1.66	0.88	1.89	0.06
factor(YEAR)2005	1.17	0.88	1.34	0.18
factor(YEAR)2006	1.61	0.88	1.82	0.07
factor(YEAR)2007	0.97	0.92	1.05	0.29
factor(YEAR)2008	0.78	0.98	0.80	0.43
factor(STATELND)MA	0.91	0.69	1.33	0.19
factor(STATELND)ME	0.23	2.97	0.08	0.94
factor(STATELND)NC	-3.57	2.31	-1.55	0.12
factor(STATELND)NH	1.11	1.11	1.00	0.32
factor(STATELND)NJ	0.79	0.84	0.94	0.35
factor(STATELND)NY	1.00	1.71	0.59	0.56
factor(STATELND)RI	0.59	0.81	0.73	0.47
factor(NEMAREA)513	0.64	3.24	0.20	0.84
factor(NEMAREA)514	-3.63	2.27	-1.60	0.11
factor(NEMAREA)515	-4.27	2.72	-1.57	0.12
factor(NEMAREA)521	-0.87	2.25	-0.39	0.70
factor(NEMAREA)522	-1.37	2.25	-0.61	0.54
factor(NEMAREA)525	-3.20	2.26	-1.41	0.16
factor(NEMAREA)526	-5.43	3.11	-1.75	0.08
factor(NEMAREA)537	-1.20	2.09	-0.57	0.57
factor(NEMAREA)539	-0.45	2.30	-0.19	0.85
factor(NEMAREA)561	-0.48	3.61	-0.13	0.89
factor(NEMAREA)562	-2.02	2.25	-0.90	0.37
factor(NEMAREA)610	-5.02	3.49	-1.44	0.15
factor(NEMAREA)611	-0.84	2.24	-0.38	0.71
factor(NEMAREA)612	-1.32	1.98	-0.67	0.51
factor(NEMAREA)613	-1.14	1.95	-0.59	0.56

factor(NEMAREA)614	-2.66	2.62	-1.01	0.31
factor(NEMAREA)615	-1.13	1.93	-0.59	0.56
factor(NEMAREA)616	-0.45	2.24	-0.20	0.84
factor(NEMAREA)621	-1.45	2.04	-0.71	0.48
factor(NEMAREA)622	-0.81	2.09	-0.39	0.70
factor(NEMAREA)623	-2.76	2.24	-1.23	0.22
factor(NEMAREA)625	-3.41	2.18	-1.56	0.12
factor(NEMAREA)626	-2.90	2.40	-1.21	0.23
factor(NEMAREA)631	-3.15	2.29	-1.37	0.17
factor(NEMAREA)632	-2.86	2.42	-1.18	0.24
factor(NEMAREA)635	-0.89	3.11	-0.29	0.78
factor(NEMAREA)700	0.83	3.11	0.27	0.79
factor(MONTH)4:factor(NEMAREA)521	-4.32	2.26	-1.91	0.06
factor(MONTH)5:factor(NEMAREA)521	-0.06	2.65	-0.02	0.98
factor(MONTH)4:factor(NEMAREA)525	1.71	1.95	0.88	0.38
factor(MONTH)3:factor(NEMAREA)526	5.14	2.62	1.96	0.05
factor(MONTH)4:factor(NEMAREA)526	4.34	2.45	1.77	0.08
factor(MONTH)2:factor(NEMAREA)537	0.76	1.61	0.47	0.64
factor(MONTH)3:factor(NEMAREA)537	0.52	1.19	0.44	0.66
factor(MONTH)4:factor(NEMAREA)537	0.49	1.20	0.41	0.68
factor(MONTH)5:factor(NEMAREA)537	-0.98	1.47	-0.67	0.50
factor(MONTH)12:factor(NEMAREA)537	1.77	1.21	1.47	0.14
factor(MONTH)2:factor(NEMAREA)539	-0.74	1.85	-0.40	0.69
factor(MONTH)3:factor(NEMAREA)539	-1.36	1.54	-0.88	0.38
factor(MONTH)12:factor(NEMAREA)539	0.81	2.45	0.33	0.74
factor(MONTH)2:factor(NEMAREA)612	0.12	0.51	0.24	0.81
factor(MONTH)3:factor(NEMAREA)612	0.21	0.62	0.34	0.73
factor(MONTH)4:factor(NEMAREA)612	-1.60	1.28	-1.25	0.21
factor(MONTH)12:factor(NEMAREA)612	-2.07	1.78	-1.17	0.24
factor(MONTH)2:factor(NEMAREA)613	-0.49	0.47	-1.05	0.29
factor(MONTH)3:factor(NEMAREA)613	-0.19	0.52	-0.37	0.71
factor(MONTH)4:factor(NEMAREA)613	1.04	0.91	1.15	0.25
factor(MONTH)12:factor(NEMAREA)613	-0.60	1.77	-0.34	0.73
factor(MONTH)2:factor(NEMAREA)614	0.75	1.79	0.42	0.67
factor(MONTH)3:factor(NEMAREA)614	0.33	2.02	0.16	0.87
factor(MONTH)4:factor(NEMAREA)614	0.94	1.49	0.63	0.53
factor(MONTH)12:factor(NEMAREA)614	-0.02	2.00	-0.01	0.99
factor(MONTH)2:factor(NEMAREA)615	-0.32	0.50	-0.64	0.52
factor(MONTH)3:factor(NEMAREA)615	-0.39	0.56	-0.70	0.48
factor(MONTH)4:factor(NEMAREA)615	0.12	0.70	0.17	0.87
factor(MONTH)12:factor(NEMAREA)615	-1.07	1.25	-0.85	0.39
factor(MONTH)2:factor(NEMAREA)616	-1.03	1.17	-0.89	0.38
factor(MONTH)3:factor(NEMAREA)616	-0.94	1.13	-0.83	0.41

factor(MONTH)4:factor(NEMAREA)616	-0.87	1.16	-0.75	0.46
factor(MONTH)2:factor(NEMAREA)621	0.90	0.71	1.28	0.20
factor(MONTH)3:factor(NEMAREA)621	-0.21	0.75	-0.28	0.78
factor(MONTH)4:factor(NEMAREA)621	0.73	0.82	0.89	0.37
factor(MONTH)12:factor(NEMAREA)621	-0.35	1.78	-0.20	0.84
factor(MONTH)2:factor(NEMAREA)622	-0.22	0.89	-0.24	0.81
factor(MONTH)3:factor(NEMAREA)622	-0.63	0.92	-0.68	0.50
factor(MONTH)4:factor(NEMAREA)622	-1.16	0.94	-1.24	0.22
factor(MONTH)4:factor(NEMAREA)623	-3.13	3.71	-0.84	0.40
factor(MONTH)2:factor(NEMAREA)625	-1.03	0.82	-1.26	0.21
factor(MONTH)3:factor(NEMAREA)625	0.16	0.90	0.18	0.86
factor(MONTH)4:factor(NEMAREA)625	-0.75	1.47	-0.51	0.61
factor(MONTH)3:factor(NEMAREA)626	1.58	1.87	0.85	0.40
factor(MONTH)2:factor(NEMAREA)631	0.33	1.61	0.20	0.84
Bottom Fished Otter Trawls				
(Intercept)	10.15	1.58	6.41	0.00
factor(YEAR)1979	-0.19	0.50	-0.38	0.71
factor(YEAR)1980	0.02	0.41	0.06	0.96
factor(YEAR)1981	-0.01	0.38	-0.02	0.98
factor(YEAR)1982	0.16	0.37	0.45	0.65
factor(YEAR)1983	0.48	0.44	1.09	0.28
factor(YEAR)1984	0.10	0.36	0.28	0.78
factor(YEAR)1985	-0.72	0.39	-1.85	0.06
factor(YEAR)1986	-0.01	0.34	-0.04	0.97
factor(YEAR)1987	-0.21	0.34	-0.62	0.53
factor(YEAR)1988	0.14	0.33	0.42	0.68
factor(YEAR)1989	0.38	0.35	1.09	0.28
factor(YEAR)1990	0.39	0.33	1.18	0.24
factor(YEAR)1991	0.55	0.33	1.68	0.09
factor(YEAR)1992	0.25	0.34	0.74	0.46
factor(YEAR)1993	-0.04	0.34	-0.13	0.90
factor(YEAR)1994	-0.11	0.34	-0.33	0.74
factor(YEAR)1995	0.00	0.31	0.00	1.00
factor(YEAR)1996	0.26	0.31	0.84	0.40
factor(YEAR)1997	-0.13	0.31	-0.40	0.69
factor(YEAR)1998	0.03	0.32	0.09	0.93
factor(YEAR)1999	0.40	0.32	1.25	0.21
factor(YEAR)2000	-0.04	0.33	-0.13	0.90
factor(YEAR)2001	-0.23	0.35	-0.65	0.52
factor(YEAR)2002	0.14	0.32	0.45	0.66
factor(YEAR)2003	0.08	0.32	0.26	0.80
factor(YEAR)2004	0.59	0.33	1.79	0.07
factor(YEAR)2005	0.73	0.33	2.19	0.03

factor(YEAR)2006	0.72	0.32	2.24	0.03
factor(YEAR)2007	-0.04	0.33	-0.13	0.90
factor(YEAR)2008	-0.06	0.34	-0.17	0.86
factor(STATELND)MA	0.49	0.27	1.80	0.07
factor(STATELND)MD	-0.35	0.28	-1.25	0.21
factor(STATELND)ME	1.50	0.34	4.34	0.00
factor(STATELND)NC	-1.44	0.76	-1.88	0.06
factor(STATELND)NH	-0.18	0.94	-0.20	0.85
factor(STATELND)NJ	0.86	0.17	5.08	0.00
factor(STATELND)NY	-0.01	0.17	-0.03	0.97
factor(STATELND)RI	1.12	0.16	7.24	0.00
factor(STATELND)VA	-0.15	0.27	-0.56	0.58
factor(TONCL1)2	-0.18	0.75	-0.23	0.81
factor(TONCL1)3	0.28	0.75	0.37	0.71
factor(TONCL1)4	1.19	0.75	1.58	0.12
factor(TONCL1)6	3.66	1.24	2.94	0.00
factor(MONTH)2	0.88	1.70	0.52	0.61
factor(MONTH)3	-3.18	1.91	-1.67	0.10
factor(MONTH)4	-2.73	1.91	-1.42	0.15
factor(MONTH)5	-2.68	1.18	-2.27	0.02
factor(MONTH)6	-0.32	0.82	-0.39	0.69
factor(MONTH)7	-1.22	1.38	-0.89	0.38
factor(MONTH)8	-3.07	1.38	-2.23	0.03
factor(MONTH)9	-0.84	1.37	-0.62	0.54
factor(MONTH)10	-0.82	0.80	-1.02	0.31
factor(MONTH)11	-0.04	1.36	-0.03	0.97
factor(MONTH)12	-3.84	2.42	-1.59	0.11
factor(NEMAREA)75	-2.09	2.04	-1.02	0.31
factor(NEMAREA)92	-3.65	2.25	-1.62	0.10
factor(NEMAREA)116	-4.71	2.56	-1.84	0.07
factor(NEMAREA)121	-1.34	1.51	-0.89	0.38
factor(NEMAREA)127	-0.25	2.03	-0.12	0.90
factor(NEMAREA)132	-2.65	1.91	-1.39	0.17
factor(NEMAREA)144	1.04	2.42	0.43	0.67
factor(NEMAREA)148	0.24	2.15	0.11	0.91
factor(NEMAREA)149	-1.85	1.52	-1.22	0.22
factor(NEMAREA)162	-3.82	2.35	-1.63	0.10
factor(NEMAREA)166	1.13	2.09	0.54	0.59
factor(NEMAREA)167	1.25	2.04	0.61	0.54
factor(NEMAREA)500	-1.17	2.03	-0.58	0.56
factor(NEMAREA)512	-5.35	2.56	-2.09	0.04
factor(NEMAREA)513	-5.29	1.73	-3.07	0.00
factor(NEMAREA)514	-4.01	1.50	-2.67	0.01

factor(NEMAREA)515	-5.98	1.93	-3.10	0.00
factor(NEMAREA)521	-2.38	2.07	-1.15	0.25
factor(NEMAREA)522	-3.26	2.09	-1.56	0.12
factor(NEMAREA)525	1.49	2.43	0.61	0.54
factor(NEMAREA)526	-4.54	1.66	-2.74	0.01
factor(NEMAREA)533	0.04	1.57	0.02	0.98
factor(NEMAREA)534	-2.88	2.35	-1.23	0.22
factor(NEMAREA)537	-3.95	1.39	-2.84	0.00
factor(NEMAREA)538	-1.62	2.42	-0.67	0.50
factor(NEMAREA)539	-2.92	1.37	-2.13	0.03
factor(NEMAREA)541	2.28	1.68	1.36	0.17
factor(NEMAREA)542	-1.77	2.24	-0.79	0.43
factor(NEMAREA)551	0.45	1.91	0.24	0.81
factor(NEMAREA)561	-10.01	2.57	-3.90	0.00
factor(NEMAREA)562	-0.73	2.25	-0.33	0.75
factor(NEMAREA)600	-0.14	2.42	-0.06	0.95
factor(NEMAREA)611	-2.21	1.37	-1.61	0.11
factor(NEMAREA)612	-2.82	1.35	-2.08	0.04
factor(NEMAREA)613	-2.34	1.37	-1.71	0.09
factor(NEMAREA)614	-1.93	1.40	-1.38	0.17
factor(NEMAREA)615	-1.41	1.38	-1.03	0.31
factor(NEMAREA)616	-3.46	1.40	-2.47	0.01
factor(NEMAREA)620	-3.15	1.91	-1.65	0.10
factor(NEMAREA)621	-1.62	1.36	-1.19	0.23
factor(NEMAREA)622	-2.67	1.41	-1.89	0.06
factor(NEMAREA)623	-0.85	1.48	-0.57	0.57
factor(NEMAREA)625	-1.66	1.39	-1.19	0.23
factor(NEMAREA)626	-1.53	1.51	-1.01	0.31
factor(NEMAREA)627	1.58	1.91	0.83	0.41
factor(NEMAREA)631	-2.65	1.92	-1.38	0.17
factor(NEMAREA)632	0.03	1.91	0.01	0.99
factor(NEMAREA)633	-3.77	1.91	-1.98	0.05
factor(NEMAREA)635	-3.17	1.93	-1.65	0.10
factor(NEMAREA)637	1.58	1.91	0.82	0.41
factor(NEMAREA)800	0.35	1.91	0.18	0.85
factor(MONTH)4:factor(NEMAREA)121	0.12	2.24	0.06	0.96
factor(MONTH)5:factor(NEMAREA)121	-0.28	1.66	-0.17	0.87
factor(MONTH)11:factor(NEMAREA)121	-0.17	2.03	-0.08	0.93
factor(MONTH)12:factor(NEMAREA)121	2.58	2.56	1.01	0.31
factor(MONTH)2:factor(NEMAREA)132	1.43	2.56	0.56	0.58
factor(MONTH)12:factor(NEMAREA)132	3.28	2.83	1.16	0.25
factor(MONTH)11:factor(NEMAREA)148	-3.64	3.04	-1.20	0.23
factor(MONTH)11:factor(NEMAREA)149	-0.31	1.56	-0.20	0.84

factor(MONTH)12:factor(NEMAREA)149	3.76	2.52	1.49	0.14
factor(MONTH)5:factor(NEMAREA)166	-2.55	3.07	-0.83	0.40
factor(MONTH)3:factor(NEMAREA)167	-0.33	2.80	-0.12	0.91
factor(MONTH)4:factor(NEMAREA)167	-1.08	1.67	-0.65	0.52
factor(MONTH)5:factor(NEMAREA)167	-2.20	2.80	-0.79	0.43
factor(MONTH)11:factor(NEMAREA)167	-3.79	2.91	-1.30	0.19
factor(MONTH)4:factor(NEMAREA)500	-0.15	2.79	-0.05	0.96
factor(MONTH)2:factor(NEMAREA)513	-0.94	2.43	-0.39	0.70
factor(MONTH)3:factor(NEMAREA)513	3.13	2.58	1.21	0.23
factor(MONTH)5:factor(NEMAREA)513	3.22	2.08	1.55	0.12
factor(MONTH)6:factor(NEMAREA)513	0.18	1.91	0.10	0.92
factor(MONTH)7:factor(NEMAREA)513	2.51	2.19	1.15	0.25
factor(MONTH)10:factor(NEMAREA)513	3.55	1.40	2.53	0.01
factor(MONTH)12:factor(NEMAREA)513	3.90	2.74	1.43	0.15
factor(MONTH)4:factor(NEMAREA)514	2.23	2.43	0.92	0.36
factor(MONTH)8:factor(NEMAREA)514	4.67	1.79	2.61	0.01
factor(MONTH)9:factor(NEMAREA)514	-0.03	1.78	-0.02	0.99
factor(MONTH)10:factor(NEMAREA)514	1.15	1.11	1.03	0.30
factor(MONTH)11:factor(NEMAREA)514	-0.34	1.53	-0.22	0.82
factor(MONTH)12:factor(NEMAREA)514	3.97	2.50	1.59	0.11
factor(MONTH)2:factor(NEMAREA)515	-0.79	2.55	-0.31	0.76
factor(MONTH)12:factor(NEMAREA)515	3.77	3.08	1.22	0.22
factor(MONTH)3:factor(NEMAREA)521	2.10	2.80	0.75	0.45
factor(MONTH)5:factor(NEMAREA)521	-3.43	2.37	-1.45	0.15
factor(MONTH)11:factor(NEMAREA)521	-0.44	2.47	-0.18	0.86
factor(MONTH)12:factor(NEMAREA)521	2.57	2.91	0.88	0.38
factor(MONTH)2:factor(NEMAREA)522	-3.28	2.68	-1.22	0.22
factor(MONTH)4:factor(NEMAREA)522	2.38	2.67	0.89	0.37
factor(MONTH)8:factor(NEMAREA)522	3.71	2.50	1.48	0.14
factor(MONTH)9:factor(NEMAREA)522	-0.56	2.47	-0.23	0.82
factor(MONTH)2:factor(NEMAREA)525	-5.91	3.35	-1.77	0.08
factor(MONTH)3:factor(NEMAREA)525	-0.83	2.88	-0.29	0.77
factor(MONTH)4:factor(NEMAREA)525	-2.08	2.09	-0.99	0.32
factor(MONTH)5:factor(NEMAREA)525	-1.96	3.04	-0.64	0.52
factor(MONTH)7:factor(NEMAREA)525	-3.53	3.39	-1.04	0.30
factor(MONTH)8:factor(NEMAREA)525	-0.85	3.38	-0.25	0.80
factor(MONTH)11:factor(NEMAREA)525	-3.80	3.38	-1.13	0.26
factor(MONTH)3:factor(NEMAREA)526	3.83	2.28	1.68	0.09
factor(MONTH)4:factor(NEMAREA)526	4.39	2.18	2.02	0.04
factor(MONTH)5:factor(NEMAREA)526	3.81	1.57	2.42	0.02
factor(MONTH)7:factor(NEMAREA)526	2.24	2.15	1.04	0.30
factor(MONTH)3:factor(NEMAREA)533	-1.69	2.47	-0.68	0.49
factor(MONTH)2:factor(NEMAREA)534	-1.79	2.90	-0.62	0.54

factor(MONTH)3:factor(NEMAREA)534	3.60	3.02	1.19	0.23
factor(MONTH)2:factor(NEMAREA)537	-0.75	1.75	-0.43	0.67
factor(MONTH)3:factor(NEMAREA)537	3.58	1.94	1.84	0.07
factor(MONTH)4:factor(NEMAREA)537	3.40	1.94	1.75	0.08
factor(MONTH)5:factor(NEMAREA)537	2.66	1.22	2.17	0.03
factor(MONTH)7:factor(NEMAREA)537	1.39	1.73	0.80	0.42
factor(MONTH)8:factor(NEMAREA)537	2.60	1.62	1.61	0.11
factor(MONTH)10:factor(NEMAREA)537	0.22	1.29	0.17	0.87
factor(MONTH)11:factor(NEMAREA)537	0.15	1.53	0.10	0.92
factor(MONTH)12:factor(NEMAREA)537	4.28	2.45	1.75	0.08
factor(MONTH)4:factor(NEMAREA)538	-2.05	2.42	-0.85	0.40
factor(MONTH)5:factor(NEMAREA)538	-0.54	3.06	-0.18	0.86
factor(MONTH)2:factor(NEMAREA)539	-0.76	1.78	-0.43	0.67
factor(MONTH)3:factor(NEMAREA)539	2.75	1.96	1.40	0.16
factor(MONTH)4:factor(NEMAREA)539	2.49	1.98	1.26	0.21
factor(MONTH)5:factor(NEMAREA)539	2.07	1.23	1.69	0.09
factor(MONTH)6:factor(NEMAREA)539	-0.44	1.60	-0.28	0.78
factor(MONTH)9:factor(NEMAREA)539	-1.94	1.94	-1.00	0.32
factor(MONTH)11:factor(NEMAREA)539	-0.68	1.42	-0.48	0.63
factor(MONTH)12:factor(NEMAREA)539	3.93	2.43	1.62	0.11
factor(MONTH)3:factor(NEMAREA)562	0.99	2.95	0.34	0.74
factor(MONTH)4:factor(NEMAREA)562	0.10	2.74	0.04	0.97
factor(MONTH)3:factor(NEMAREA)600	1.48	3.07	0.48	0.63
factor(MONTH)4:factor(NEMAREA)600	0.80	2.21	0.36	0.72
factor(MONTH)2:factor(NEMAREA)611	-1.76	1.80	-0.98	0.33
factor(MONTH)4:factor(NEMAREA)611	1.04	1.99	0.52	0.60
factor(MONTH)5:factor(NEMAREA)611	1.99	1.23	1.62	0.11
factor(MONTH)8:factor(NEMAREA)611	0.11	1.96	0.06	0.95
factor(MONTH)9:factor(NEMAREA)611	1.03	1.70	0.61	0.55
factor(MONTH)11:factor(NEMAREA)611	-0.54	1.47	-0.37	0.72
factor(MONTH)12:factor(NEMAREA)611	3.52	2.43	1.45	0.15
factor(MONTH)2:factor(NEMAREA)612	-1.48	1.72	-0.86	0.39
factor(MONTH)3:factor(NEMAREA)612	2.91	1.93	1.51	0.13
factor(MONTH)4:factor(NEMAREA)612	1.85	1.93	0.96	0.34
factor(MONTH)5:factor(NEMAREA)612	1.02	1.30	0.79	0.43
factor(MONTH)9:factor(NEMAREA)612	-0.56	1.93	-0.29	0.77
factor(MONTH)11:factor(NEMAREA)612	2.56	1.92	1.33	0.18
factor(MONTH)12:factor(NEMAREA)612	3.00	2.43	1.24	0.22
factor(MONTH)2:factor(NEMAREA)613	-1.25	1.74	-0.72	0.47
factor(MONTH)3:factor(NEMAREA)613	2.89	1.93	1.50	0.13
factor(MONTH)4:factor(NEMAREA)613	1.96	1.93	1.02	0.31
factor(MONTH)5:factor(NEMAREA)613	1.15	1.21	0.95	0.34
factor(MONTH)8:factor(NEMAREA)613	0.52	1.94	0.27	0.79

factor(MONTH)12:factor(NEMAREA)613	3.57	2.43	1.47	0.14
factor(MONTH)2:factor(NEMAREA)614	-0.64	1.79	-0.36	0.72
factor(MONTH)3:factor(NEMAREA)614	3.00	2.00	1.50	0.13
factor(MONTH)4:factor(NEMAREA)614	1.96	2.01	0.97	0.33
factor(MONTH)5:factor(NEMAREA)614	2.09	1.85	1.13	0.26
factor(MONTH)12:factor(NEMAREA)614	0.80	2.57	0.31	0.76
factor(MONTH)2:factor(NEMAREA)615	-1.32	1.74	-0.76	0.45
factor(MONTH)3:factor(NEMAREA)615	2.50	1.95	1.29	0.20
factor(MONTH)4:factor(NEMAREA)615	2.37	1.96	1.21	0.23
factor(MONTH)5:factor(NEMAREA)615	1.73	1.55	1.11	0.27
factor(MONTH)12:factor(NEMAREA)615	2.35	2.50	0.94	0.35
factor(MONTH)2:factor(NEMAREA)616	-0.38	1.75	-0.22	0.83
factor(MONTH)3:factor(NEMAREA)616	3.61	1.95	1.85	0.06
factor(MONTH)4:factor(NEMAREA)616	2.99	1.95	1.53	0.13
factor(MONTH)5:factor(NEMAREA)616	2.48	1.25	1.98	0.05
factor(MONTH)12:factor(NEMAREA)616	0.64	2.57	0.25	0.80
factor(MONTH)2:factor(NEMAREA)621	-0.97	1.72	-0.56	0.57
factor(MONTH)3:factor(NEMAREA)621	3.00	1.92	1.56	0.12
factor(MONTH)4:factor(NEMAREA)621	2.53	1.93	1.31	0.19
factor(MONTH)5:factor(NEMAREA)621	0.24	1.32	0.19	0.85
factor(MONTH)2:factor(NEMAREA)622	-0.51	1.77	-0.29	0.77
factor(MONTH)3:factor(NEMAREA)622	3.16	1.96	1.61	0.11
factor(MONTH)4:factor(NEMAREA)622	2.75	1.96	1.40	0.16
factor(MONTH)5:factor(NEMAREA)622	2.17	1.30	1.67	0.10
factor(MONTH)12:factor(NEMAREA)622	3.39	2.80	1.21	0.23
factor(MONTH)2:factor(NEMAREA)623	-0.43	2.95	-0.15	0.88
factor(MONTH)3:factor(NEMAREA)623	0.86	2.07	0.42	0.68
factor(MONTH)2:factor(NEMAREA)625	-0.48	1.78	-0.27	0.79
factor(MONTH)3:factor(NEMAREA)625	3.66	1.97	1.86	0.06
factor(MONTH)4:factor(NEMAREA)625	2.64	2.10	1.26	0.21
factor(MONTH)2:factor(NEMAREA)626	-1.36	1.90	-0.71	0.48
factor(MONTH)3:factor(NEMAREA)626	3.42	2.05	1.67	0.10
factor(MONTH)4:factor(NEMAREA)626	1.94	2.05	0.95	0.34
factor(MONTH)2:factor(NEMAREA)631	0.75	2.23	0.34	0.74
factor(MONTH)3:factor(NEMAREA)631	5.16	2.40	2.15	0.03
factor(MONTH)3:factor(NEMAREA)635	6.08	2.51	2.42	0.02
factor(MONTH)4:factor(NEMAREA)635	5.68	2.64	2.15	0.03

Table A3. Bias-corrected, back transformed least squares means for each year (i.e., indices of abundance) from a general linear model used to standardize mackerel catch per effort (pounds landed/days absent) data for mid-water (OTM) and bottom fished (OTF) otter trawls in the U.S. waters of the north Atlantic (see text for details). The upper and lower confidence intervals (UpperCI and LowerCI, respectively) were calculated similar to that of the indices of abundance, except the coefficient estimates for each year were replaced with the coefficient estimates for each year plus or minus two standard errors.

YEAR	OTF	OTF UpperCI	OTF LowerCI	OTM	OTM UpperCI	OTM LowerCI
1978	21887					
1979	18171	30782	11426			
1980	22390	28535	12546			
1981	21708	24670	11547			
1982	25791	27859	13392			
1983	35344	50056	20716			
1984	24254	26022	12553			
1985	10664	12520	5759			
1986	21574	21227	10700			
1987	17701	17299	8749			
1988	25118	23322	12093			
1989	31891	31869	15940			
1990	32451	30888	15825			
1991	37822	34663	18087			
1992	28189	27497	13919			
1993	20963	20543	10375			
1994	19587	18916	9623	3177		
1995	21857	19077	10186	12400	102836	11066
1996	28364	24422	13123	13842	57349	11150
1997	19290	16818	8985	7992	35199	6513
1998	22510	19805	10535	5222	24439	4302
1999	32635	29131	15392	4720	21798	3880
2000	20997	19852	10204	7928	38033	6560
2001	17427	17840	8816	11989	55969	9874
2002	25277	22946	12028	23363	112206	19337
2003	23802	21588	11320	17330	84065	14368
2004	39551	37199	19170	16655	79619	13774
2005	45370	43033	22085	10287	48921	8500
2006	45161	41070	21509	15839	76463	13121
2007	20969	19411	10080	8410	44962	7085
2008	20628	20072	10173	6940	42498	5966