Appendix A11: Striped Bass Catch Curve Analysis

The coastwide 1982 – 2006 striped bass catch-at-age data was used to conduct a series of cohort catch curves (i.e. following the fate of a single cohort through time). For any given cohort, all age specific data available were analyzed to determine the age at full recruitment. The catch data from the age of full recruitment, plus one age group, through age-12 were used to conduct the cohort catch curves (i.e. the 13+ group was not used in the analysis). Ages-6 or 7 were usually the starting ages for the catch curve; however age-5 was typically the starting point for older cohorts, most likely due to smaller size limits during that time period resulting in earlier recruitment to the fishery.

Two different regression techniques were employed. The first analysis was a standard parametric linear regression analysis using the Proc Reg procedure in SAS software (SAS Institute Inc., v. 8e, 2001). The analysis determined the regression coefficient (estimate of total mortality, Z) for each cohort, the associated standard error and 95% confidence intervals and p-value to determine if the regression coefficient was significantly different from zero (Table 1, Figure 1). In an effort to develop more robust estimates of total mortality, a nonparametric regression analysis was also conducted in R 2.4 software. This analysis used a distribution-free test for the slope estimator using the Theil Statistic (Hollander and Wolfe, 1999). This analysis produced regression coefficients for each cohort, the associated 95% confidence intervals and p-vales (Table 2).

The two methods produced similar results in terms of total mortality estimates (on a per cohort basis), confidence intervals for those estimates, and determining significance for those estimates (Figures 1 and 2). The relationship between the two methods total mortality estimates is quite strong – i.e. similar regression coefficient estimates ($R^2 = 0.960$). The 1988 cohort was the only substantial difference between the two methods, in terms of total mortality estimates, with the nonparametric method producing lower estimates than the parametric method, 0.196 and 0.296 respectively. Also, there was one difference between the two methods when calculation significance for the regression coefficient. The nonparametric method determined the regression coefficient for the 1987 cohort was not significantly different from zero (p-value = 0.054), where the parametric test showed that is was (p-value = 0.025).

An alternate analysis was also conducted in order to create a timeseries of total mortality estimates that are more in line with the 1982 – 2006 catch information and other modeling techniques. A year specific total mortality estimate was derived using the cohort specific catch curve data, described above, in which the total mortality estimates of a cohort were aligned by years in which that cohort would have been harvested. For example, the 1980 cohort catch curve was estimated with catch data that began in 1985 (5 year olds) through 1992 (12 year olds); the 1981 cohort catch curve was estimated with data that began in 1986 through 1993. Those cohorts were then used, along with other cohorts with estimates in the same year, to calculate an average total mortality in 1986 for example. A minimum of three cohorts within a given year were used to calculate the average total mortality for that year. The average total mortality estimates were the highest in the early 1980's, followed by a decline to the mid 1990's and a subsequent rise through 2000; since 2000 there has been a steady decline in total mortality (Figure 3).

References

Hollander M, Wolfe D. 1999. Nonparametric Statistical Methods. John Wiley and Sons, Inc. p 416 – 420.

Appendix A11 Tables

Table 1.

Cohort (Year Class)	Regression Coefficient - Z	S.E.	Upper 95% C.I.	Lower 95% C.I.	P - value
1978	0.566	0.058	0.707	0.426	**0.0001**
1979	0.434	0.068	0.600	0.268	**0.0007**
1980	0.301	0.069	0.471	0.132	**0.0048**
1981	0.218	0.047	0.334	0.102	**0.0037**
1982	0.166	0.035	0.249	0.082	**0.0022**
1983	0.267	0.066	0.436	0.098	**0.0098**
1984	0.125	0.043	0.243	0.006	**0.0430**
1985	0.136	0.064	0.301	-0.029	0.0883
1986	0.135	0.045	0.245	0.025	**0.0239**
1987	0.156	0.048	0.273	0.039	**0.0250**
1988	0.296	0.081	0.504	0.088	**0.0145**
1989	0.489	0.050	0.628	0.350	**0.0006**
1990	0.410	0.034	0.504	0.316	**0.0003**
1991	0.272	0.015	0.313	0.230	**0.0001**
1992	0.265	0.043	0.375	0.155	**0.0016**
1993	0.281	0.039	0.380	0.182	**0.0008**
1994	0.200	0.036	0.301	0.099	**0.0053**
1995	0.167	0.015	0.208	0.125	**0.0004**
1996	0.136	0.013	0.173	0.099	**0.0005**
1997	0.145	0.030	0.242	0.049	**0.0174**

Ages 4 - 12 used for analysis (if all available and depending upon age of full recruitment)
Used standard parametric linerar regression techniques in SAS
Bold P-values indicate significance - reg. coeff. sig. diff. from zero
Took the absolute value of the regression coefficient for Z estimate

Table 2.

Cohort (Year Class)	Regression Coefficient - Z	Upper 95% C.I.	Lower 95% C.I.	P - value
1978	0.595	0.696	0.384	**0.0000**
1979	0.433	0.607	0.268	**0.0010**
1980	0.326	0.603	0.162	**0.0070**
1981	0.212	0.368	0.063	**0.0045**
1982	0.169	0.247	0.082	**0.0010**
1983	0.265	0.421	0.056	**0.0130**
1984	0.139	0.298	0.020	**0.0340**
1985	0.157	0.433	-0.117	0.0700
1986	0.135	0.313	0.053	**0.0160**
1987	0.134	0.314	0.004	0.0540
1988	0.196	0.675	0.013	**0.0250**
1989	0.497	0.657	0.353	**0.0100**
1990	0.391	0.548	0.313	**0.0100**
1991	0.283	0.318	0.215	**0.0100**
1992	0.251	0.417	0.071	**0.0130**
1993	0.284	0.430	0.062	**0.0060**
1994	0.187	0.466	0.089	**0.0180**
1995	0.163	0.269	0.103	**0.0100**
1996	0.131	0.189	0.095	**0.0100**
1997	0.141	0.306	0.058	**0.0420**

Ages 4 - 12 used for analysis (if all available and depending upon age of full recruitment)
Used nonparametric regression techniques in R - Distribution-Free Test for the Slope, the Theil Statistic method described in Hollander, M. and Wolfe, D. (1999) - Nonparametrci Statistical Methods

Bold P-values indicate significance - reg. coeff. sig. diff. from zero

Took the absolute value of the regression coefficient for Z estimate
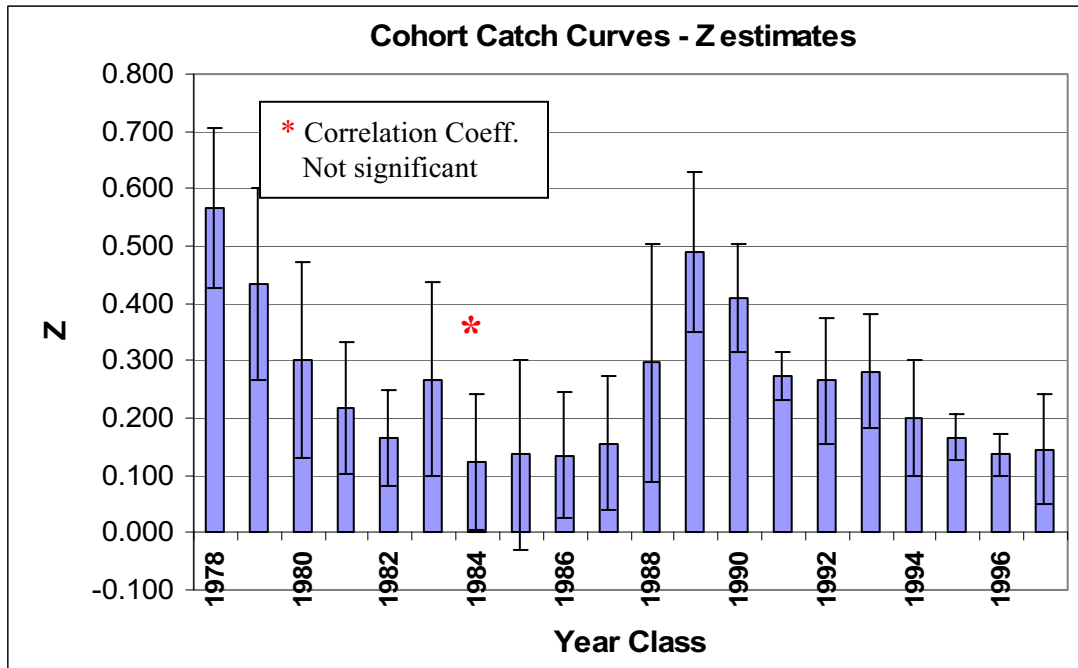
Appendix A11 Figures

Figure 1. Catch Curve Z estimates (95% confidence intervals) - Parametric analysis
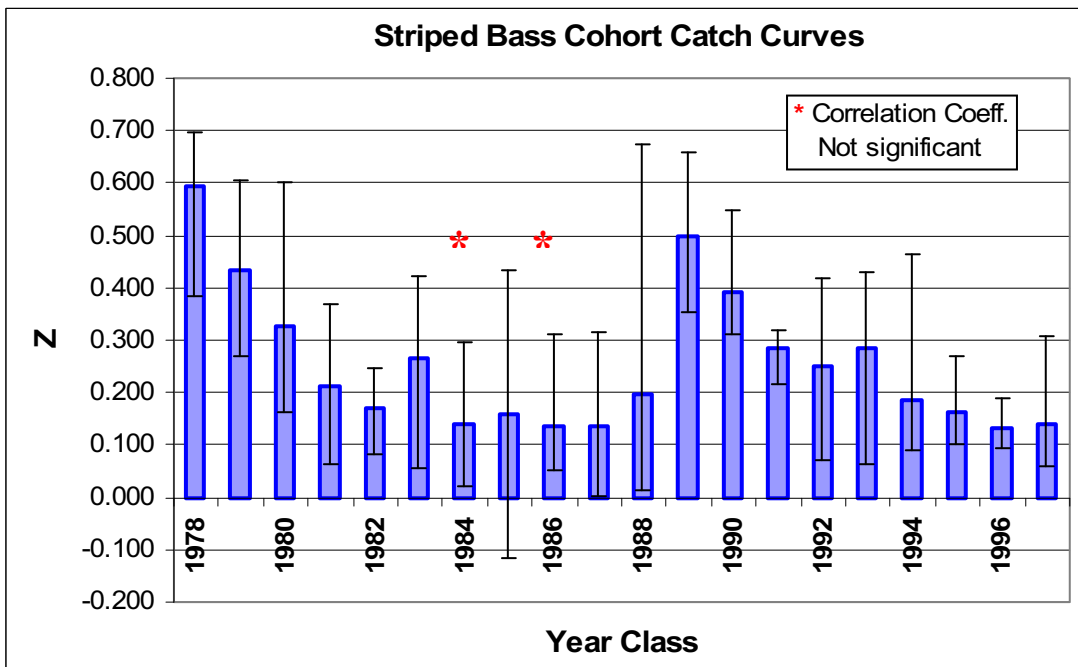

Figure 2. Catch Curve Z estimates (95% confidence intervals) – Nonparametric estimates
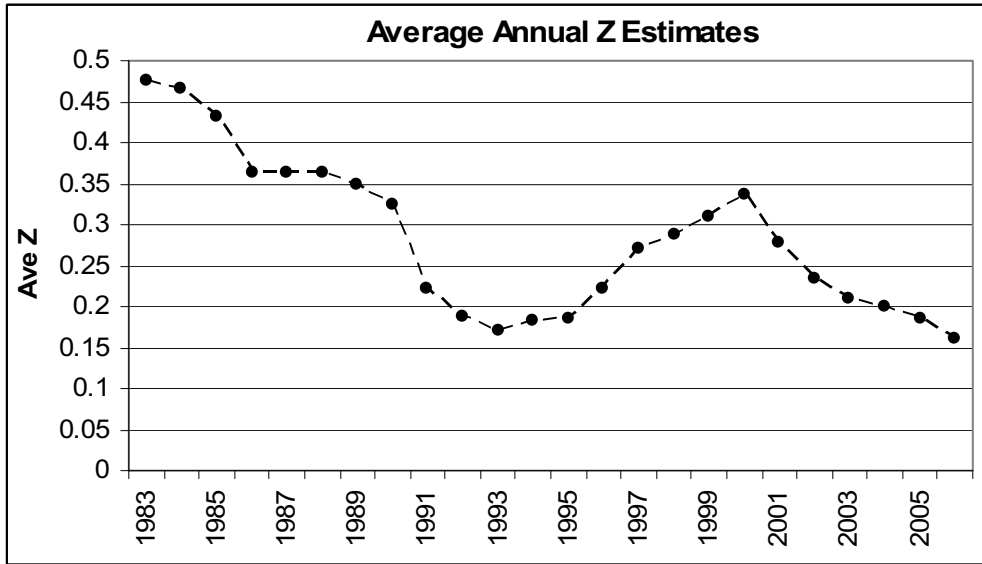
Figure 3. Average total mortality of striped bass by year using cohort specific catch curve estimates.