

APPENDIX A. MODEL-BASED ESTIMATION OF ATLANTIC STURGEON BYCATCH

Here we have provided a portion of the report by Miller and Shepherd (2011) that pertains to estimation of the total discards by trawl and gillnet gear for 2006 – 2009.

Miller and Shepherd (2011) fit a set of quasi-Poisson generalized linear models to observer trip data with number of sturgeon takes as the response and where an FMP was retained, year and quarter were potential explanatory factors. Separate sets of models were fit to trips using gillnet and otter trawl gear. The general model for the log-mean take on trip i is

$$\ln(\hat{T}_i) = \hat{\beta}_0 + \hat{\beta}_1 X_{1i} + \dots + \hat{\beta}_p X_{pi}$$

where $\hat{\beta}$ are the estimated coefficients and X_{1i}, \dots, X_{pi} are the covariates that represent FMP, year, quarter and any interactions. For gillnet gear, the best performing model of those fitted to the trip specific data based on QAIC_c was a model that allowed yearly effects of the FMPs on sturgeon take. For other trawl gear, the best performing model of those fitted to the trip specific data based on QAIC_c was a model that allowed quarterly effects of the FMPs on sturgeon take.

To predict sturgeon take for all landings, the same covariates on VTR trips were used to make predictions for all VTR trips in a given subset of effort (e.g., year, quarter, gear type). The predictions are made using the anti-log of the same equation above, but where the covariates are for VTR trip i . The total discard estimates are the sum of all the model predictions in year y

$$\hat{T}_y = \sum_{i=1}^{N_y} \hat{T}_{y,i}$$

Variance estimation for total discards

Let $\hat{\beta}$ be the $p \times 1$ vector of coefficients estimated from the best fitted model (trawl or gillnet) and $\hat{\mathbf{V}}$ ($p \times p$) be the estimated covariance matrix of the estimated coefficients (p is the number of estimated coefficients). Also, let \mathbf{X}_y be the $n_y \times p$ matrix of covariates for the VTR trips in year y where n_y is the number of trips. Then the log estimated predictions for the n_y VTR trips is $\log(\hat{\mathbf{T}}_y) = \mathbf{X}_y \hat{\beta}$ and the estimated takes are $\hat{\mathbf{T}}_y = e^{\mathbf{X}_y \hat{\beta}}$. The $n_y \times n_y$ covariance matrix for the log predictions is

$$\hat{\mathbf{V}}_{\log(\hat{\mathbf{T}}_y)} = \mathbf{X}_y \hat{\mathbf{V}} \mathbf{X}_y'$$

and the approximate (delta method) covariance matrix for the estimated takes is

$$\hat{\mathbf{V}}_{\hat{\mathbf{T}}_y} = \hat{\mathbf{T}}_y \hat{\mathbf{T}}_y' \circ \hat{\mathbf{V}}_{\log(\hat{\mathbf{T}}_y)}$$

where $\mathbf{X} \circ \mathbf{Y}$ is the Hadamard (element-wise) product of matrices \mathbf{X} and \mathbf{Y} . The variance of the total take estimate for year y is just the sum of all n_y^2 elements of $\hat{\mathbf{V}}_{\hat{\mathbf{T}}_y}$:

$$\hat{V}(\hat{T}_y) = \mathbf{1}_y' \hat{\mathbf{V}}_{\hat{\mathbf{T}}_y} \mathbf{1}_y$$

where $\mathbf{1}_y$ is a $n_y \times 1$ vector of ones. Confidence intervals are based on standard errors (square root of variance) and approximate normality of the point estimates.

APPENDIX B. SWEEPED AREA CALCULATION METHOD

(Information provided by Dr. Chris Bonzek, Virginia Institute of Marine Science).

The NEAMAP survey uses tow-by-tow net measurements to calculate catch per square meter as the base metric in the calculation. That is, the (tow distance) x(wingspread) measurement on tow X is the denominator for number per unit area on tow X. Tow distance is calculated as a sum from moment-by-moment recordings of location (i.e. not straight-line distance from beginning and ending coordinates). For those tows where either a sensor malfunction or GPS malfunction results in missing data, average figures for the particular cruise are substituted. Swept area abundance is calculated as the sum of abundances in each stratum. Tow and net measurement stats are in the table below. These figures are summarized from 1,520 tows to date. Net height does not (currently) enter into swept-area calculations but is included here to help demonstrate the consistent way in which the net fishes. The total survey area is 12,135.27 square km.

	Tow		
	Distance (m)	Wingspread (m)	Net Height (m)
Mean	1856.1	13.52	5.4
Min	1098.2	11.2	3.2
Max	2585.3	15.24	6.75
Std. Dev.	139.3	0.46	0.26