NECOFS Oceanographic information by SASI cell
Northeast United States
February 2016

Prepared by:
School of Marine Science and Technology (SMAST)
University of Massachusetts Dartmouth
Contact: Dr. Kevin Stokesbury. kstokesbury@umassd.edu

1. INTRODUCTION

This group of data products contains oceanographic data from the Northeast Coastal Ocean Forecast System (NECOFS) joined to the New England Fishery Management Council Swept Area Seabed Impact (SASI) model grid. This oceanographic information includes monthly average and maximum bottom stress, bottom and surface temperature, and bottom and surface salinity from 2003 to 2012.

The purpose of this data product was to characterize these environmental variables over the domain of the University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST) video survey. The SASI model is a new quantitative tool for evaluating fisheries management alternatives by examining the tradeoffs between habitat impacts and fishery yields (NEFMC 2011). With the aid of the commercial scallop fishing industry, the SMAST video survey covered the Continental Shelf from the southern Mid-Atlantic to the USA-Canadian border on eastern Georges Bank from 2003 to 2012. The survey followed a centric systematic sampling design with stations on 1.6 km to 5.6 km grids. At each station a video pyramid was lowered for times to obtain four quadrat samples. Within each quadrat, macroinvertebrates and fish were counted and the substrate was identified. When possible fish and macroinvertebrates were identified to species, otherwise animals were grouped into categories based on taxonomic orders. Several references to papers about the video survey method and the data derived from it are listed as supplemental information. Stokesbury 2002, Stokesbury et al. 2004, Adams et al. 2008 and Stokesbury 2012 provide information on the sampling design of the survey and scallop abundance. Adams et al. 2010 and Carey et al. 2013 investigate the scale of scallop beds. O'Keefe et al. 2008 and Carey and Stokesbury 2011 examine the calibration and use of different camera areas and types. Harris and Stokesbury 2010 and Harris et al. 2012 use sediment information collected during the video survey to characterize benthic habitat on Georges Bank. Marino et al. 2007 and MacDonald et al. 2010 used survey information to document the distribution of sea starts and skates, respectively.

NECOFS is an integrated atmosphere/surface wave/ocean forecast model system designed for the northeast U.S. coastal region covering a computational domain from central New Jersey to the eastern end of the Scotian Shelf. The oceanic components of the system were developed based on the Finite-Volume Coastal Ocean Model (FVCOM) developed by Chen et al. (2003) and upgraded by a team effort (Chen et al., 2006a-b, Chen et al., 2011). The NECOFS product used for this project is the GoM-FVCOM results. The GoM-FVCOM grid features unstructured triangular meshes with horizontal resolution of ~ 0.3-25 km and a hybrid terrain-following vertical coordinate with a total of 45 layers, 10 and 5 uniform layers near the surface and bottom, respectively, in regions deeper than 225 m with a transfer to a sigma-coordinate in the shallow continental and coastal regions. The thickness of the uniform layers is 5 m, so the hybrid coordinate transition occurs at locations where all layers have uniform thickness of 5 m. NECOFS hindcast fields have been validated by comparing the results with observations of tidal elevation and currents (Chen et al. 2011), water stratification (Li et al. 2014), surface currents, and Nor'easter and hurricane-induced storm elevation and currents (Beardsley et al. 2013, Chen et al. 2013, and Sun et al. 2013).

2. PURPOSE

The main goal of this project (the "Offshore Video Survey and Oceanographic Analysis: Georges Bank to the Chesapeake") was to provide a better picture of the marine environment on the highly productive U.S. Northeast Shelf, from the Hague Line to the Chesapeake. This project, which was managed by The Nature Conservancy (TNC) and funded by The Gordon and Betty Moore Foundation, introduced spatial data products that will significantly advance the understanding of marine habitats and ecological function in the Northwest Atlantic. This study provided new information about several species groups observed in a video survey. Additionally, the project has provided a comprehensive baseline of information on the benthic habitat and associated oceanographic conditions on the U.S. Northeast Shelf at a scale that is useful to fisheries managers, spatial planners, and the wider community of stakeholders.

3. SOURCES AND AUTHORITIES

- Adams C.F., B.P. Harris, K.D.E. Stokesbury. 2008. Geostatistical comparison of two independent video surveys of sea scallop abundance in the Elephant Trunk Closed Area, USA. ICES Journal of Marine Science 65:995-1003.
- Adams C.F., B.P. Harris, M.C. Marino II and K.D.E. Stokesbury. 2010. Quantifying sea scallop bed diameter on Georges Bank with geostatistics. Fish Res. 106:460-467.
- Beardsley R. C., C. Chen, Q. Xu. 2013. Coastal flooding in Scituate (MA): A FVCOM study of the 27 December 2010 nor'easter. Journal of Geophysical Research: Oceans. Vol. 118, 6030–6045, doi:10.1002/2013JC008862,

- Carey, J.D. and K.D.E. Stokesbury. 2011. An assessment of juvenile and adult sea scallop, Placopecten magellanicus, distribution in the northwest Atlantic using high-resolution still imagery. J. Shellfish. Res. 30:1-14.
- Carey, J.D. R. A. Wahle, and K.D.E. Stokesbury. 2013. Spatial scaling of juvenile-adult associations in Northwest Atlantic sea scallop *Placopecten magellanicus* populations. Mar. Ecol. Prog. Ser. 493: 185-194.
- Chen, C. S., Liu, L., & Beardsley, R. C., 2003. An unstructured grid, finite-volume, three-dimensional, primitive equation ocean model: Application to coastal ocean and estuaries. *Journal of Atmospheric and Oceanic Technology*, 20, 159-186.
- Chen, C., Beardsley, R. C., & Cowles, G. 2006a. An unstructured grid, finite-volume coastal ocean model (FVCOM) system. Special Issue entitled “Advance in Computational Oceanography”. *Oceanography*, 19, 78-89.
- Chen, C., Beardsley, R. C., & Cowles, G. 2006b. An unstructured grid, finite-volume coastal ocean model-FVCOM user manual, School for Marine Science and Technology, University of Massachusetts Dartmouth, New Bedford, Second Edition. SMAST/UMASSD Technical Report-06-0602, 318 pp.
- Chen**,** C., H. Haung, R. C. Beardsley, Q. Xu, R. Limeburner, G. W Gowles, Y. Sun, J. Qi and H. Lin, 2011. Tidal dynamics in the Gulf of Maine and New England Shelf: An application of FVCOM. J. Geophys. Res., 116, C12010, doi: 10.1029/2011JC007054
- Chen, C., Z. Lai, R. Beardsley, Q. Xu, H. Lin, N. T. Viet, and D. Yang. 2013. Reply to comment on “Current separation and upwelling over the southeast shelf of Vietnam in the South China Sea”. *J. Geophys. Res. Oceans*, *118*. 1624, doi:10.1002/jgrc.20114.
- Harris, B.P. and K.D.E. Stokesbury. 2010. The spatial structure of local surficial sediment characteristics on Georges Bank, USA. Cont. Shelf Res. 30:1840-1853.
- Harris, B.P., G.W. Cowles and K.D.E. Stokesbury. 2012. Surficials sediment stability on Georges Bank in the Great South Channel and on eastern Nantucket Shoals. Cont. Shelf Res. 49:65-72.
- Li, Y., P. S. Fratantoni, R. Ji, C. Chen, J. A. Hare, Y. Sun and R. C. Beardsley, 2014. Spatial-temporal patterns of stratification on the northwest Atlantic shelf. Progress in Oceanography, in revision.
- MacDonald, A.M., C.F. Adams, and K.D.E. Stokesbury. 2010. Abundance estimates of skates (Rajidae) on the continental shelf of the northeastern USA using a video survey. Trans. Am. Fish. Soc. 139:1415-1420.
- Marino II M.C., F. Juanes, K.D.E. Stokesbury. 2007. Effect of closed areas on populations of sea star, *Asterias* spp., on Georges Bank. Mar. Ecol. Prog. Ser. 347:39-49.
- NEFMC (New England Fisheries Management Council). Essential Fish Habitat (EFH) Omnibus Amendment “The Swept Area Seabed Impact (SASI) Model: A Tool for Analyzing the Effects of Fishing on Essential Habitat”, Newburyport, MA. Available: nefmc.org/habitat/sasi_info/110121_SASI_Document.pdf (2011).
- O'Keefe, C.E., J.D. Carey, L.D. Jacobson, D.R. Hart and K.D.E. Stokesbury. 2010. Comparison of scallop density estimates using the SMAST scallop video survey data with a reduced view field and reduced counts of individuals per image. Appendix 3 to NEFSC SAW 50. July, 2010. 5.

- Stokesbury, K. D. E. 2002. Estimation of sea scallop abundance in closed areas of Georges Bank, USA. Transactions of the American Fisheries Society 131: 1081-1092.
- Stokesbury, K.D.E., B.P. Harris, M.C. Marino II and J.I. Nogueira. 2004. Estimation of sea scallop abundance using a video survey in off-shore USA waters. Journal of Shellfish Research 23: 33-44. 9.
- Stokesbury, K.D.E. 2012. Stock definition and recruitment: Implications for the US sea scallop (*Placopecten magellanicus*) fishery from 2003 to 2011. Rev. Fish. Sci. 20:154-164.
- Sun, Y., C. Chen, R. C. Beardsley, Q. Xu, J. Qi, and H. Lin. 2013. Impact of current-wave interaction on storm surge simulation: A case study for Hurricane Bob. *J. Geophys. Res. Oceans, 118*. 2685-2701, doi:10.1002/jgrc.20207.

4. DATABASE DESIGN AND CONTENT

Native storage format: ArcGIS File Geodatabase – simple feature class

Feature Types: Cell polygons

Data Dictionary:

** Some lines include multiple fields

Line**	Name	Definition	Type	Size
1	OBJECTID	Uniquely identifies a feature	OBJECTID	*
2	Shape	Geometric representation of the feature	geometry	*
3	100km_Id	SASI 100 km unique identifier	Short	*
4	1000Km_Id	SASI 1000 km unique identifier	Double	*
5	AreaKm	The area of the SASI grid cell in kilometers	Double	*
6	TS_Nodes	The number of NECOFS output locations used to create the temperate and salinity data within the SASI grid cell	Double	*
7	TS_Join	The method in which temperature and salinity values were calculated for the SASI grid cell. “Average” – Values from NECOFS output locations within the SASI model grid cell were used to calculate average and standard deviation. “Closest” – No NEFCOS output location was within the SASI model grid cell, so temperature and salinity values from the closest NECOFS output location were	Text	254

		used.		
8	Avg[MONTH]BT	The average monthly bottom temperature (°C) for each month	Double	*
9	SD[MONTH]BT	The standard deviation between node values for the average monthly bottom temperature for each month.	Double	*
10	Avg[MONTH]ST	The average monthly surface temperature (°C) for each month	Double	*
11	SD[MONTH]ST	The standard deviation between node values for the average monthly surface temperature for each month	Double	*
12	Avg[MONTH]BS	The average monthly bottom salinity for each month	Double	*
13	SD[MONTH]BS	The standard deviation between node values for the average monthly bottom salinity for each month	Double	*
14	Avg[MONTH]SS	The average monthly surface salinity for each month.	Double	*
15	SD[MONTH]SS	The standard deviation between node values for the average monthly surface salinity for each month	Double	*
16	Avg_0312BT	The average bottom temperature for all months from 2003 through 2012	Double	*
17	SD_0312BT	The standard deviation within all monthly bottom temperature values from 2003 through 2012	Double	*
18	Avg_0312ST	The average surface temperature for all months from 2003 through 2012	Double	*
19	SD_0312ST	The standard deviation within all monthly surface temperature values from 2003 through 2012	Double	*
20	Avg_0312BS	The average bottom salinity for all months from 2003 through 2012	Double	*
21	SD_0312BS	The standard deviation within all monthly bottom salinity values from 2003 through 2012	Double	*
22	Avg_0312SS	The average surface salinity for all months from 2003 through 2012	Double	*
23	SD_0312SS	The standard deviation within all monthly surface salinity values from 2003 through 2012	Double	*
24	Str_Nodes	The number of NECOFS output	Double	*

		locations used to create the bottom stress data within the SASI grid cell.		
25	Str_Join	The method in which bottom stress values were calculated for the SASI grid cell. “Average” – Values from NECOFS output locations within the SASI model grid cell were then used to calculate an average and standard deviation. “Closest” - No NEFCOS output location was within the SASI model grid cell, so the bottom stress values from the closest NECOFS output location were used.	Text	254
26	Avg_[MONTH]MSt	The average maximum monthly bottom stress (N m^2) for each month	Double	*
27	SD_[MONTH]MSt	The standard deviation between node values for the average maximum monthly bottom stress for each month	Double	*
28	Avg_[MONTH]Str	The average monthly bottom stress (N m^2) for each month	Double	*
29	SD_[MONTH]Str	The standard deviation between node values for the average monthly bottom stress for each month	Double	*
30	Avg0312MSt	The average maximum monthly bottom stress from 2003 through 2012	Double	*
31	SD0312MSt	The standard deviation between node values for maximum bottom stress from 2003 through 2012	Double	*
32	Avg0312Str	The average monthly bottom stress from 2003 through 2012	Double	*
33	SD0312Str	The standard deviation between node values for monthly bottom stress from 2003 through 2012	Double	*

Feature Class Name: SASI_GridYEARMonthlyBotStressBotSurfTempSal

Total Number of Unique Features: 920

Dataset Status: Complete

5. SPATIAL REPRESENTATION

Geometry Type: vector polygon
Reference system: NAD 1983 UTM Zone 19N
Projection: Transverse Mercator
Geographic Coordinate System: GCS North American 1983
Horizontal Datum: North American Datum 1983
Ellipsoid: Geodetic Reference System 1980

XY Resolution: XY Scale is 0.0001 Meters
Tolerance: 0.001 Meters

Geographic extent: -75.679 to -66.275, 36.391 to 42.496

IS0 19115 Topic Category: biology, environment, oceans

Place Names:
Atlantic Ocean, Chesapeake Bay, Delaware Bay, Georges Bank, Gulf of Maine, Long Island Sound, Massachusetts Bay, Nantucket Shoals, Wilkinson Basin.

Recommended Cartographic Properties:
(Using ArcGIS ArcMap nomenclature)
Classified, Manual classification, 4 classes (percentile ranges), color model: R-G-B
min – 84^{th} Percentile: 162 – 180 – 189
84^{th} – 97.7^{th} Percentile: 255 – 255 – 191
97.7^{th} – 99.9^{th} Percentile: 250 – 185 – 132
> 99.9^{th} Percentile: 214 – 47 – 39

Scale range for optimal visualization: 5,000,000

6. DATA PROCESSING

NECOFS data was joined to the SASI model grid by first reducing the SASI domain to only grid cells with SMAST video survey stations within 5.6 km of all boundaries. Surface and bottom temperature (^{o}C) and salinity values from NECOFS output locations within a SASI model grid cell were then used to create an average and standard deviation value for each SASI grid cell. Twenty four SASI grid cells did not have a NEFCOS output location within them and were assigned the temperature and salinity value of the closest NECOFS output location. Bottom stress values (N m^2) were joined in the same manner, except with different

NECOFS output locations. Nine SASI grid cells did not have a NEFCOS output location within them and were assigned the bottom stress value of the closest NECOFS output location. The layer file for each environmental variable displays values divided by percentiles that approximately reflect standard deviations from the mean.

7. QUALITY PROCESS

Attribute Accuracy: Original attribution was retained from source material and are considered authoritative.

Logical Consistency: These data are believed to be logically consistent.

Completeness: Data are complete based on input source data from SMAST and the SASI model (6200 unique cells).

Positional Accuracy: Sample locations based on SMAST video scallop survey. Accuracy based on GPS in video pyramid used for this survey. Results are aggregated by SASI cell, which each have a resolution of 10 kilometers.

Timeliness: Source data are up to date, as of April 2016.

Use restrictions: Not for Navigation

Distribution Liability: Data provided as is. Neither SMAST nor any of the participants on this project makes any warranty, expressed or implied as to the use or appropriateness of use of the enclosed data, nor are there warranties of merchantability or fitness for a particular purpose or use. No representation is made as to the currency, accuracy or completeness of the information in this dataset or of the data sources on which it is based. Neither SMAST nor any of the participants in this project shall be liable for any lost profits or consequential damages, or claims against the user by third parties.