Chapter 8: Monitoring aquatic biomass via hydroacoustics: echo sounding data processing and summary

Final Report to the Maryland Department of Natural Resources and the Maryland Energy Administration, 2015

Sarah M. Johnson, Kathryn A. Williams, Andrew T. Gilbert

Biodiversity Research Institute, Portland, ME

Project webpage: *www.briloon.org/mabs*

Suggested citation: Johnson SM, Williams KA, and Gilbert, AT. 2015. Echo sounding data management and summary. In: Baseline Wildlife Studies in Atlantic Waters Offshore of Maryland: Final Report to the Maryland Department of Natural Resources and the Maryland Energy Administration, 2015. Williams KA, Connelly EE, Johnson SM, Stenhouse IJ (eds.) Report BRI 2015-17, Biodiversity Research Institute, Portland, Maine. 12 pp.

Acknowledgments: This material is based upon work supported by the Maryland Department of Natural Resources and the Maryland Energy Administration under Contract Number 14-13-1653 MEA, and by the Department of Energy under Award Number DE-EE0005362. Donald Degan (Aquacoustics Inc.), Dr. Richard Veit (College of Staten Island), and Capt. Brian Patteson made significant contributions towards the completion of this study.

bri

Chapter 8 Highlights

Outlines data collection and data processing protocols for echo sounding data collected during boat-based surveys, and provides a brief summary of results

Context[1]

Part III of this report focuses on boat-based surveys for wildlife in the offshore environment, including methodological reviews and data analyses. Most chapters within this section deal directly with the survey data itself (i.e., observations of marine birds, mammals, and sea turtles). While collecting survey data, however, various environmental covariate data were simultaneously collected, including sea state, sea surface water temperature and salinity, and hydroacoustic data.

This chapter focuses exclusively on the collection and data processing of hydroacoustic data collected on boat survey transects, and provides a simple summary of results. These data provide us with the relative abundance of underwater biomass, and can be used to approximate prey (i.e., fish and plankton) biomass availability to seabirds and other marine predators.

Study goal/objectives

Estimate the relative abundance of hydroacoustically detected biomass along boat survey transects, using a scientific echo sounder.

Highlights

- Data were collected along boat survey transects during 16 surveys conducted between 2012-2014, using a Simrad EK60 echo sounder unit (Kongsberg Maritime AS, Horten, Norway).
- Raw data were processed using Echoview 5.3 (Myriax Software Pty. Ltd., Hobart, Australia)
- Data were integrated by 1 x 500 m cells across the depth and length of each survey, calculating a biomass index value per cell.
- Total biomass varied widely both within and between surveys, indicating a high level of spatial and temporal variation of prey biomass abundance across the Mid-Atlantic Outer Continental Shelf, and throughout the year.
- The mean depth of biomass did not vary significantly between seasons.
- Total biomass was higher in nearshore areas in the summer and fall, and in the southern end of the Mid-Atlantic Baseline Studies (MABS) study area during winter surveys.

Implications

Hydroacoustic echo sounding data can be used to investigate relative abundances of prey biomass and look for relationships with seabird distributions and abundances (Veit, 2015). There was a high level of spatial and temporal variation of prey biomass with high total biomass nearshore in summer and fall, and in the southern end of the regional study area in winter.

[1] For more detailed context for this chapter, please see the introduction to Part III of this report.

Abstract

This chapter outlines the methods used in the collection and processing of hydroacoustic echo sounding data collected as part of the Mid-Atlantic Baseline Studies Project, and provides a basic summary of results. Hydroacoustic data were collected during 16 boat-based surveys offshore of Delaware, Maryland, and Virginia, USA between 2012 and2014, using a Simrad EK60 echo sounder unit. Raw data were processed by trained personnel using Echoview 5.3 software. Data were filtered to remove small particles, surface noise, bottom substrates, and anomalous data. Data were integrated into 500 m cells across the length of each survey and 1 m depth strata, calculating a biomass index value (Nautical Area Scattering Coefficient; NASC) per 1 x 500 m cell. Due to removal of surface noise and bottom substrates, data are limited to the water column between 2m depth and the bottom substrate, and do not include surface and benthic biomass. Total biomass varied widely both within and between surveys, indicating a high level of spatial and temporal variation of prey biomass (i.e., fish and large plankton) abundance across Mid-Atlantic Outer Continental Shelf throughout the year. Total biomass was higher in nearshore areas in the summer and fall, and in the southern end of the Mid-Atlantic Baseline Studies (MABS) study area during winter surveys.

Introduction

Non-invasive, quantitative estimates of fish abundance and aquatic biomass have been made possible in recent years with the development and subsequent improvement of acoustic echo sounding hardware, including split- and multi-beam transducers employing echo-counting and interpretation software. During the past decade, the development of stable, scientific echo sounders, multi-frequency applications, new transducer deployment techniques, standardized calibration procedures, and more realistic models of the sound-scattering properties of biological targets have improved accuracy of biomass estimations (Rudstam et al., 2013; Simrad, 2012).

While conducting boat-based surveys for higher trophic level wildlife (birds, marine mammals, sea turtles, and other taxa) in the Mid-Atlantic region, we employed echo sounding technology in order to estimate the biomass and size classes of aquatic prey species (fish and zooplankton) present beneath the survey vessel. The echo sounder sends acoustic signals into the water column and detects resulting backscattered energy reflected from fish and other objects. Data from the Simrad EK60 scientific echo sounder were automatically processed using appropriate software, manually vetted, and integrated and summed by distance and depth intervals in order to estimate the contribution of backscattered energy from all targets within each sampling volume. These data were subsequently used to calculate estimates of fish size class and biomass by area and by volume along the survey transects.

Data collection

Hydroacoustic data were collected during all 16 boat-based surveys, totaling 66 of 68 survey days. Data were not collected during the boat-based surveys conducted on February 3 and June 18, 2013 due to errors with equipment and surveyor oversight. Data were collected using a Simrad EK60 scientific echo sounder unit with a hull mounted 120 kHz split-beam transducer, transceiver, and a laptop computer with Simrad-EK60 echo sounder software, run off an external marine battery. A Garmin Map60CSX GPS (Garmin International, Inc., Olathe, KS) was attached to the data collection computer for georeferencing the echo sounder data. Transducer settings can be found in Table 8A-1. The unit was calibrated using a tungsten carbide calibration sphere in a monofilament harness, following calibration guidelines given in the Simrad EK60 reference manual (Simrad, 2012).

Data processing

Raw data files were processed by trained personnel at BRI or Aquacoustics, Inc. (Sterling, AK). Data files were post-processed using Echoview 5.3, and the results summarized in Microsoft Excel. GPS data were reviewed to ensure spatial referencing was complete and accurate, and hydroacoustic data were calibrated for the speed of sound and absorption coefficients using mean sea surface temperature and salinity values collected every 30 minutes during boat-based surveys (Chapter 6).

Several steps were taken to filter and exclude data within the Sv fileset echogram that were generated from sources other than fish or zooplankton biomass. The Sv echogram is a visual representation of the volumetric backscattering of hydroacoustic signals sent and received by the echo sounder (Echoview, 2015). Data were initially filtered at -60 dB to exclude very small targets (< 2 cm) and low-intensity surface noise. A surface line was drawn at a depth of 2 m below the water surface (roughly 0.8 m below the surface of the transducer), and a bottom line was generated at roughly 20 cm above the ocean floor. Within the Sv echogram window, the bottom line was manually edited to exclude the bottom substrate and targets indistinguishable from the bottom substrate, as well as to ensure that the line was continuous from the beginning to the end of the survey. All backscattering signals occurring above the surface line or below the bottom line were excluded from analysis. Additionally, the Sv echogram was reviewed in order to exclude anomalous data from analysis, such as surface disturbances, non-fish objects, or other anomalies. After manual review, and per the recommendation of fishery acoustics specialists at Aquacoustics, Inc., data from surveys conducted in August, September, and October of 2013, and data for depths ranging from 25-40 m in April and June of 2012 were filtered at -54 dB rather than at -60 dB, to compensate for high densities of abnormal low-frequency signals (possibly caused by small invertebrates or suspended particulate matter; D. Degan pers. comm.).

The Sv echogram was integrated by 1 m depth intervals (or “layers”) and 500 m distance intervals (or “intervals”), calculating the mean volume backscattering strength (Sv Mean), the area backscattering coefficient (ABC), and nautical area-scattering coefficient (NASC) value for each 1 x 500 m cell within the survey, among other variables and coefficients (Appendix 8B). Frequency distributions of ABC values were plotted and outliers were reviewed to ensure that the resulting ABC values were representative of biomass rather than an error in data filtering.

While the Sv echogram represents volumetric backscattering, the Single Target echogram represents individual targets (i.e., fish or large plankton) derived from single points. The Single Target echogram was also reviewed and integrated using the same exclusion criteria (surface line, bottom line, and anomalous data regions) established while vetting the Sv echogram. Single target detection variable properties defined prior to integration are listed in Table 8A-2.

The resulting integrated data gives the estimated number of individual targets per cell, as well as each target's compensated target strength (TS Comp) value. The length of each target (cm) was calculated using a simplification for Love's dorsal aspect equation for 120 kHz frequency (Love, 1971):

$$\text{Length} = (10^{(TS\_Comp + 26.1)/19.1})\bullet 100$$

Additionally, the backscattering cross-section (σ_{bs}) value for each target was calculated using the following equation (Echoview, 2015; Simmonds and MacLennan, 2005):

$$\sigma_{bs} = 10^{(TS\_Comp/10)}$$

The ABC value, Sv Mean, and mean backscattering cross-section value by layer ($\overline{\sigma}_{bs}$) were then used to calculate aerial density (number of targets/m^2) and volumetric density (number of targets/m^3) for each cell within the survey, using the following equations (Echoview, 2015; Simmonds and MacLennan, 2005):

$$\text{Aerial density} = ABC/(\overline{\sigma}_{bs})$$

$$\text{Volumetric density} = 10^{(Sv\_Mean/10)} /(\overline{\sigma}_{bs})$$

Data for each survey-day were processed separately and combined in a unified Microsoft Access database after undergoing QA/QC procedures outlined below.

Quality assurance and quality control (QA/QC)

For each survey day, the following post-processing steps were implemented to ensure that data within and between each survey were processed consistently and accurately:

1) GPS data were reviewed to ensure that correct spatial data were assigned to each dataset;
2) Calibration files were reviewed to ensure that correct temperature and salinity data were used in determining speed of sound and absorption coefficients;
3) Sv echogram cells with the highest ABC values were reviewed to ensure that values were representative of biomass; and
4) Integrated data were examined by interval and layer to look for instances where biomass was identified in Layer 3 (from 2-3 m in depth), and no biomass was identified in Layer 4, as this pattern may indicate the presence of surface noise that was not completely excluded from analysis. In these instances, the corresponding cell within the Sv echogram was reviewed to see if the values were representative of actual biomass.

If corrections were made during any of these four steps, cell integration of Sv and Single Target data as well as subsequent calculations were performed again, and corrected data were incorporated into the final dataset.

Surveys conducted on January 1-3, 2013 were independently analyzed by both a BRI analyst and a fishery acoustics specialist from Aquacoustics, Inc., to determine the repeatability and comparability of analyses. This comparison was conducted by an expert at Aquacoustics, who concluded that analyses were highly comparable, and differences were within the expected margin of error.

Data summary

Data below are summarized by total NASC (m^2/nmi^2), or the NASC values summed across all depths within an interval or survey. This metric represents an index of total prey biomass in the water column. We chose to use this metric rather than fish density estimates as we are interested in representing total prey availability rather than estimated densities or numbers of individual fish. Total NASC was highly variable between individual surveys within the Maryland study area (Table 8-1) as well as within the MABS study area (Johnson et al., 2015). In the Maryland study area, total NASC values per survey ranged from 899 in January 2014, to 1,038,328 in October 2013, with a mean (± SD) of 132,387 (± 248,946). Total NASC was also highly variable within each survey, indicating variable geographic distributions of prey biomass within the MABS and Maryland study areas. For example, within the Maryland study area, the mean total NASC per 500 m interval in October 2013 was 2,941, with a standard deviation nearly an order of magnitude higher (14,288). This spatial variability within surveys was typical across all surveys (Table 8-1).

Total prey biomass within the water column also varied geographically by season. Within the Maryland study area, higher nearshore distributions were observed in the summer and fall, with more ubiquitous distributions in the winter and spring. Similar patterns were observed across the MABS study area, except with notably higher distributions observed off the coast of Virginia and the mouth of the Chesapeake Bay during winter surveys (Figure 8-1). Within the Maryland study area, the mean depth of biomass (± SD) did not vary significantly between seasons, ranging from 12.0 (± 5.7) m in fall surveys to 19.0 (± 8.5) m in spring surveys (Figure 8-2); these values were similar to the seasonal mean depths of biomass across the MABS study area, which ranged from 13.3 (± 6.8) m in fall surveys to 18.5 (± 8.3) m in spring surveys (Johnson et al., 2015).

Further analysis and caveats

These data paint a picture of the distribution and relative abundance of prey biomass within the MABS and Maryland study areas throughout the year. They can also be used in combination with the boat-based survey observations to examine the relationship between acoustically detected prey and observed predators such as gannets, gulls, and terns (Sollmann et al., 2015; Veit, 2015). However, several limitations of these data should be noted prior to further explorations and interpretation of predator and prey correlations. First, it is important to keep in mind that the top several meters of the water column were excluded from integration due to surface noise backscatter. Surface noise typically extended to 2 m in depth during calm conditions, so a minimum of the top 2 m of the water column were excluded across all surveys. The depth to which the surface noise extended varied with sea state, however, and there were many instances where surface noise penetrated to greater depths, commonly requiring exclusion of the top 4-6 m of the water column for several kilometers within a survey, and on occasion requiring exclusion of the top 10-12 m. Similarly, this technique does not measure the biomass of benthic biota, such as shellfish, as they cannot be distinguished from the bottom substrate within the echogram. Thus, species that forage exclusively within the top few meters of water (such as storm-petrels, Hydrobatidae) and species that forage on benthos (such as scoters, *Melanitta* spp.) are unlikely to show direct correlations with distributions of biomass as detected by the echo sounder. Even for species which forage within our surveyed water depths, the relevance of aquatic biomass distributions will vary depending upon the species composition and size classes present in the water column. We did not directly measure the sizes or abundance of fish and plankton that would be consumed by our target species (e.g., seabirds, marine mammals, and sea turtles), as “ground truthing” the hydroacoustic data would have required substantial additional resources (and was not the focus of this study). However, measured aquatic biomass can be used as an index of prey availability (Santora et al., 2011, 2009; Simmonds and MacLennan, 2005). The relationship between acoustically detected biomass and observed seabird predators, along with these limitations, are further discussed in Sollmann et al. (2015) and Veit (2015).

Literature cited

Echoview, 2015. Echoview Help File 6.1.11.

Johnson, S., Williams, K., Gilbert, A., 2015. Monitoring aquatic biomass via hydroacoustics: echo sounding data processing and sumary of results, Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf: Final Report to the Department of Energy EERE Wind & Water Power Technologies Office., Award Number: DE-EE0005362. BRI ID# 2015-11. Biodiversity Research Institute, Portland, ME.

Love, R.H., 1971. Dorsal-aspect target strength of an individual fish. J. Acoust. Soc. Am. 49, 816–823.

Rudstam, L.G., Jech, J.M., Parker-Stetter, S.L., Horne, J.K., Sullivan, P.J., Mason, D.M., 2013. Fisheries Acoustics, in: Zale, A. V., Parrish, D.L., Sutton, T.M. (Eds.), Fisheries Techniques. American Fisheries Society, Bethesda, MD, pp. 1–40.

Santora, J.A., Ralston, S., Sydeman, W.J., 2011. Spatial organization of krill and seabirds in the central California Current. ICES J. Mar. Sci. 68, 1391–1402. doi:10.1093/icesjms/fsr046

Santora, J.A., Reiss, C.S., Cossio, A.M., Veit, R.R., 2009. Interannual spatial variability of krill (Euphausia superba) influences seabird foraging behavior near Elephant Island, Antarctica. Fish. Oceanogr. 18, 20–35. doi:10.1111/j.1365-2419.2008.00490.x

Simmonds, J., MacLennan, D.N., 2005. Fisheries Acoustics: Theory and Practice, 2nd ed. ed. Blackwell Publishing, Oxford.

Simrad, 2012. Simrad EK60 Reference Manual, Release 2.4.X. Kongsberg Maritime AS.

Sollmann, R., Gardner, B., Gilbert, A., Williams, K., Veit, R., 2015. A community distance sampling model to investigate the abundance and distribution of seabirds, Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf: Final Report to the Department of Energy EERE Wind & Water Power Technologies Office, Award Number: DE-EE0005362. BRI ID# 2015-11. Biodiversity Research Institute, Portland, ME.

Veit, R., 2015. Spatial association between seabirds and prey on the Mid-Atlantic Outer Continental Shelf, Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf: Final Report to the Department of Energy EERE Wind & Water Power Technologies Office, Award Number: DE-EE0005362. BRI ID# 2015-11. Biodiversity Research Institute, Portland, ME.

Figures and tables

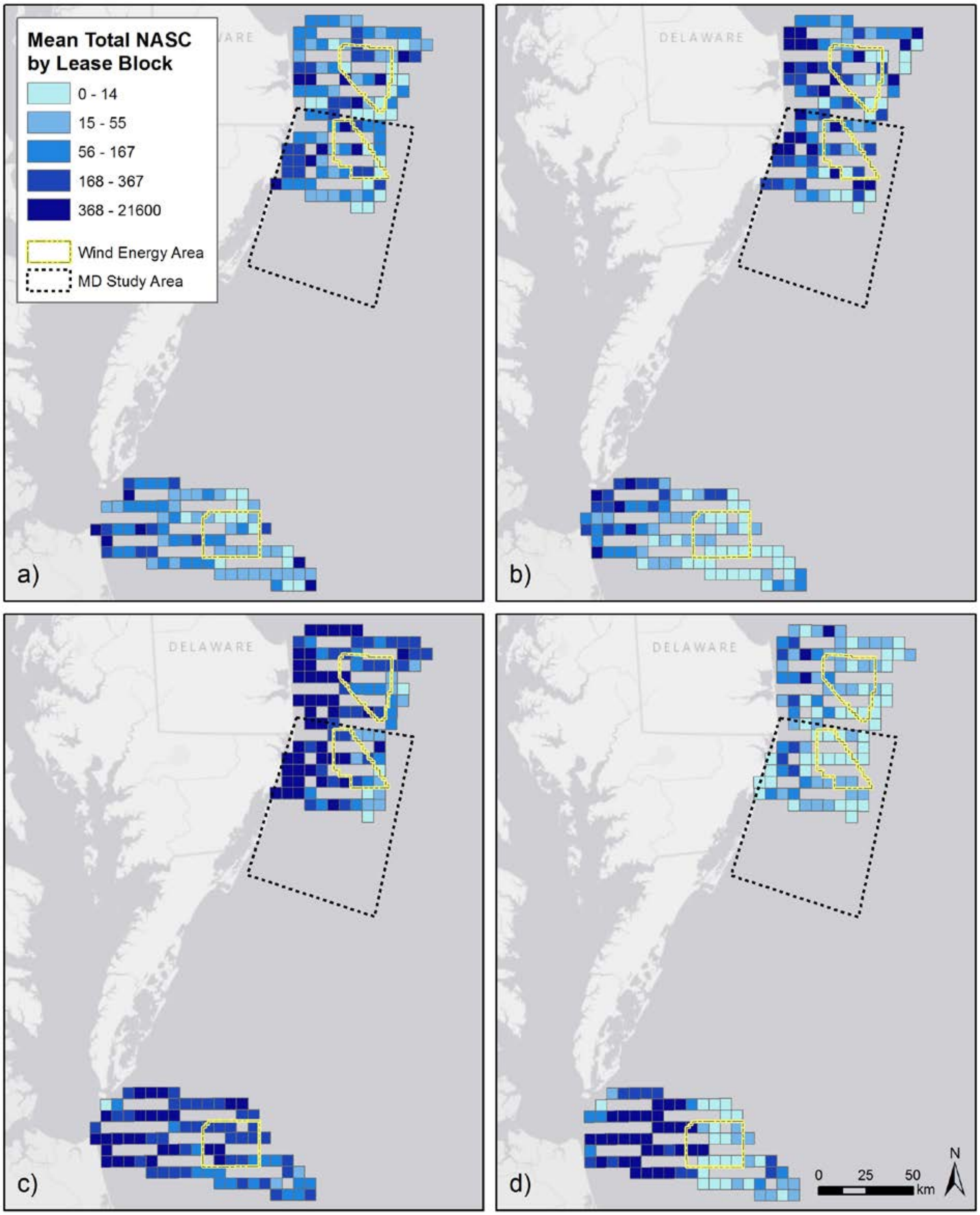

Figure 8-1. Seasonal mean total NASC per lease block. a) Spring, March 1 – May 31; b) Summer, June 1 – August 31; c) Fall, September 1 – November 30; d) Winter, December 1 – February 28. Total NASC was calculated by summing NASC across all depths for each 500 m interval within each survey. Total NASC values were binned and averaged by lease block. Mean total NASC is categorized by quintiles for mapping purposes.

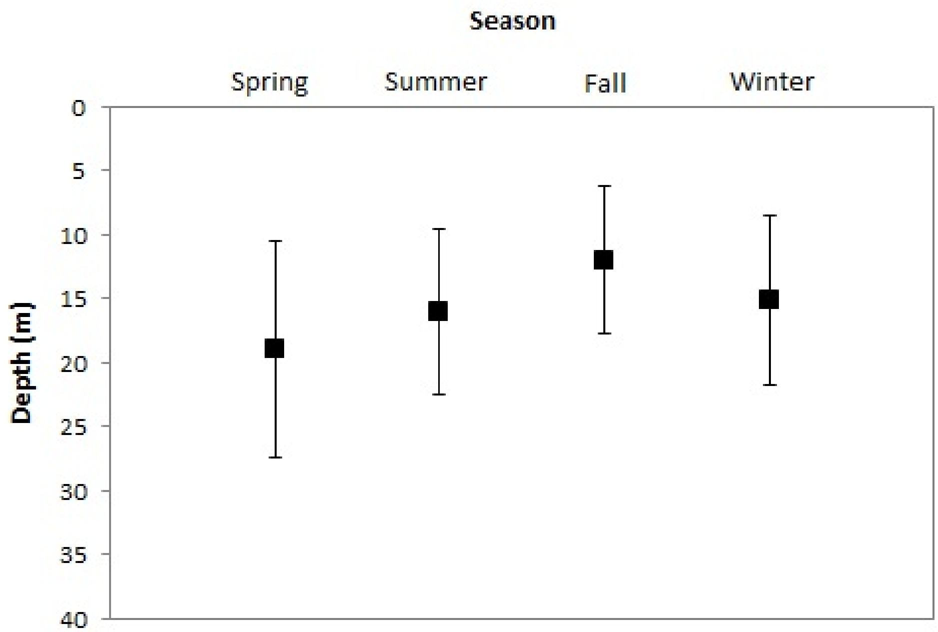

Figure 8-2. Seasonal mean depth ± SD of biomass within the water column in the Maryland study area. Total NASC by layer by season was calculated by summing NASC values within a layer across all survey intervals seasonally. Depth was weighted by the corresponding total NASC value in order to calculate the seasonal mean depth of biomass. Spring: March 1 – May 31; Summer: June 1 – August 31; Fall: September 1 – November 30; Winter: December 1 – February 28.

Table 8-1. Total NASC by survey and interval, representing an index of total prey biomass within the water column in the Maryland study area.

Survey	Total NASC by Survey	Total NASC by Interval			
		Mean	SD	Min.	Max.
Survey 1 April 2012	124,620	409	1,992	0	20,762
Survey 2 June 2012	139,460	483	2,890	0	44,376
Survey 3 August 2012	63,561	209	1,131	0	13,147
Survey 4 September 2012	219,800	714	2,311	0	31,218
Survey 5 November 2012	74,849	221	337	2	3,842
Survey 6 Dec. 2012/Jan. 2013	6,900	22	98	0	1,053
Survey 7 Jan./Feb. 2013	33,450	101	526	0	7,582
Survey 8 March 2013	53,220	163	803	0	10,735
Survey 9 May 2013	98,707	285	3,194	0	59,263
Survey 10 June 2013	40,861	119	381	0	5,253
Survey 11 July/Aug. 2013	70,881	203	815	0	11,239
Survey 12 September 2013	135,410	398	1,223	0	10,645
Survey 13 October 2013	1,038,328	2,941	14,288	0	123,833
Survey 14 December 2013	13,721	39	271	0	4,828
Survey 15 Jan./Feb 2014	899	3	10	0	170
Survey 16 April 2014	3,518	11	82	0	1,345

Supplementary material

Appendix 8A. Transducer settings and integration variable properties

Table 8A-1. Split-beam transducer settings used while collecting hydroacoustic data during boat surveys.

Field Name	Setting
Transducer draft (m)	0.000
Sample interval (s)	0.000064
Transmit power (W)	250.0
Pulse length (ms)	0.256
Transducer gain (dB)	27.000
Sa correction (dB)	0.000
Minor-axis beam width (degrees)	7.000
Major-axis beam width (degrees)	7.000
Frequency (kHz)	120.000
Two-way beam angle (dB re 1 Steradian)	-21.000

Table 8A-2. Single target detection variable properties parameters set prior to single target cell integration.

Field Name	Setting
TS Threshold (dB)	-60.0
Pulse length determination level (dB)	6.0
Minimum normalized pulse length	0.7
Maximum normalized pulse length	1.75
Beam compensation model	Simrad LOBE
Maximum beam compensation (dB)	6.0
Maximum standard deviation of minor-axis angles (degrees)	0.6
Maximum standard deviation of major-axis angles (degrees)	0.6

Appendix 8B. Exported data fields and definitions

Table 8B-1. Sv data set field names and definitions. Definitions are adapted from the Echoview glossary, through personal communications with specialists at Aquacoustics Inc. (Echoview, 2015; D. Degan, personal communication, 10 February 2014). Fields marked with an asterisk (*) were added to the dataset and calculated post cell-integration. All other fields were exported during the cell-integration process.

Field	Example	Definition
Surv_Date*	11/4/2012	Date of survey.
ABC	1.04E-07	Area backscattering coefficient (m^2/m^2). Measure of area scattering rather than volume scattering.
NASC	4.46	Nautical area-scattering coefficient (m^2/nmi^2). Scaled version of ABC, equal to $4\pi(1852)^2(ABC)$.
Sigma*	5.75E-06	The back-scattering cross-section, or a measure of the backscatter strength from the target (m^2), calculated using data from the single target dataset. The mean sigma value per layer per day ($\overline{\sigma}_{bs}$) is presented here, and is used as a scalar when converting area and volume backscattering measurements to absolute numbers.
Aerial Density*	0.0137	Aerial fish density in the region (number of fish per square meter for a given thickness layer). Calculated as ABC/($\overline{\sigma}_{bs}$).
Volumetric Density*	0.0412	Volumetric fish density in the region (number of fish per cubic meter). Calculated as $10^{(Sv\_Mean/10)}/(\overline{\sigma}_{bs})$.
Thickness_mean	1.008047	The mean thickness (m) of an analysis domain (i.e., the average thickness of each layer within the 500 m bin).
Interval	1	The sequentially numbered 500 m survey segment by which data is binned.
Layer	3	The layer or stratum number of the cell being analyzed (e.g., the number of the domain layer, counting from the water surface downwards).
Sv_mean	-55.74	The linear mean Sv value for all samples in the 500 m bin, or domain, in (m^2/m^3). Another definition: the mean volume backscattering strength of the domain being integrated.
Height_mean	1.008047	The mean height (m) of the domain layer across the 500 m interval, or the projection of thickness mean onto the vertical axis taking transducer geometry into account. Height mean and thickness mean are equal for this project, due to the orientation of the transducer.
Depth_mean	2.494063	The mean depth (m) of the domain layer across the 500 m interval.
Layer_depth_min	2	The minimum depth (m) of the domain layer across the 500 m interval.
Layer_depth_max	3	The maximum depth (m) of the domain layer across the 500 m interval.
Ping_S, Ping_M, Ping_E	15126	A ping is the representation of the return signal (echo trace) measured after the transmission of a single acoustic pulse. Ping_S reports the sequential number of the first ping in the analysis domain (500 m interval) (S for start); Ping_M reports the number of the middle ping (M for middle); and Ping_E reports the number of the last ping (E for end).
Dist_S, Dist_E	499.867146	The distance (measured by GPS, in meters) from the first ping in the survey to the first ping (S for start) of the 500 m interval, or from the first ping in the survey to the last ping (E for end) in the 500 m interval.
Date_S, Date_M, Date_E	20121104	The date of the first ping (S for start), middle ping (M for middle), and last ping (E for end) in the 500 m interval.
Time_S, Time_M, Time_E	10:49:40.70	The time of day at which the first ping (S for start), middle ping (M for

Field	Example	Definition
		middle), and last ping (E for end) in the 500 m interval occurred. Time was recorded in GMT.
Lat_M	36.93391333	The latitude in decimal degrees of the middle ping in the analysis domain (i.e., the center latitude of the 500 m interval).
Lon_M	-76.04724667	The longitude in decimal degrees of the middle ping in the analysis domain (i.e., the center longitude of the 500 m interval).
Exclude_below_line_depth_mean	15.421739	The mean depth of the bottom line, or exclude-below line, for the 500 m interval.
Minimum_Sv_threshold_applied	1	A value of 1 indicates that a minimum Sv threshold has been applied (see Minimum_integration_threshold), 0 indicates otherwise.
Minimum_integration_threshold	-60	The value of the minimum threshold entered on the Data page of the Variable Properties dialog box for the variable which was analyzed (dB re $1m^2/m^3$). For this project the threshold was set to -60 or -54 dB.
Maximum_Sv_threshold_applied	0	A value of 1 indicates that a maximum Sv threshold has been applied; 0 indicates otherwise. A maximum threshold was never applied for this project.
Exclude_above_line_applied	1	A value of 1 indicates that the exclude above line has been applied; 0 indicates otherwise. For this project the exclude above line was always applied.
Exclude_above_line_depth_mean	2	The mean depth (m) of exclude-above line across the 500 m interval.
Exclude_below_line_applied	1	A value of 1 indicates that the exclude-below line has been applied; 0 indicates otherwise. For this project the exclude below line was always applied.
Standard_deviation	9.20E-09	The standard deviation of all sample values in the analysis domain (1 x 500 m cell). This is calculated in the linear domain (not the dB domain).
Range_mean	1.344063	The distance (m) between the mean depth of the layer, and the depth of the center of the transducer face, within the 500 m interval.
Exclude_below_line_depth_min	14.165446	The minimum depth of the exclude-below line (or essentially the minimum bottom depth) within the 500 m interval.
Exclude_below_line_depth_max	16.602294	The maximum depth of the exclude below line (or essentially the maximum bottom depth) within the 500 m interval.