

# **An Assessment of Sea Scallop Abundance and Distribution in the Mid-Atlantic Bight, Nantucket Lightship Closed Area and Closed Area II**

**David B. Rudders**

**Sally Roman**

**Hunter Tipton**

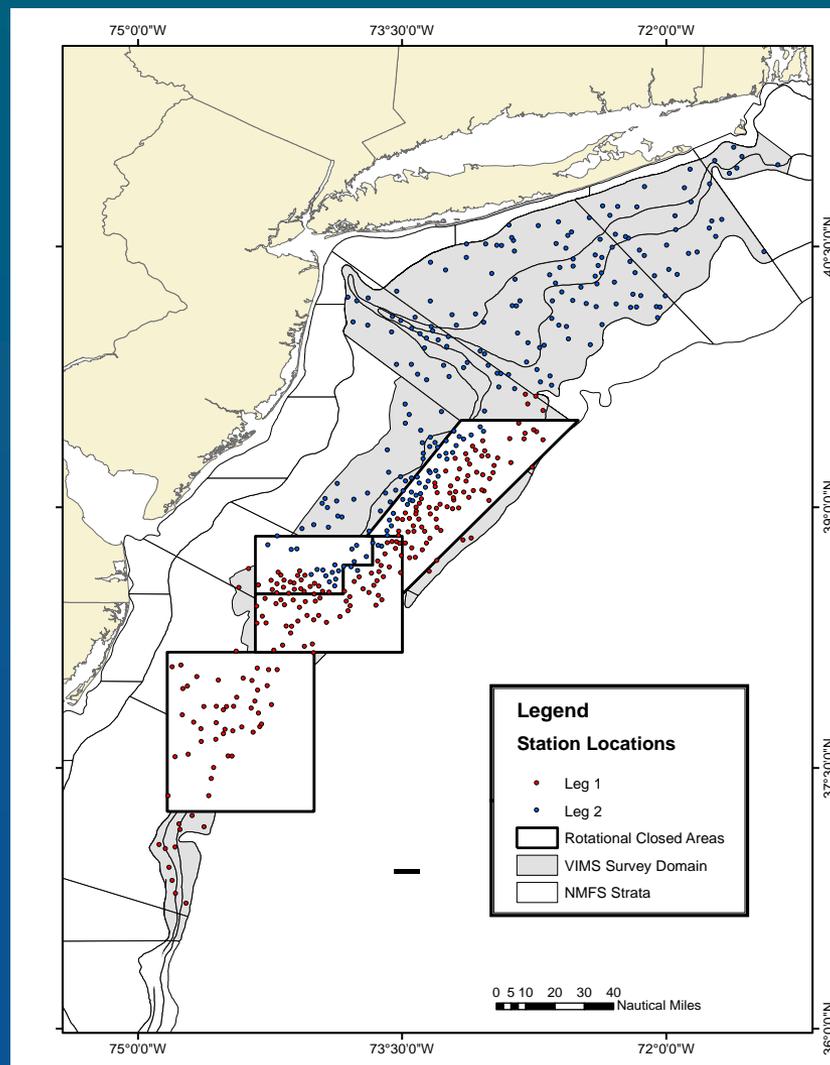
**Virginia Institute of Marine Science**

**Sea Scallop Plan Development Team**

**Falmouth, MA**

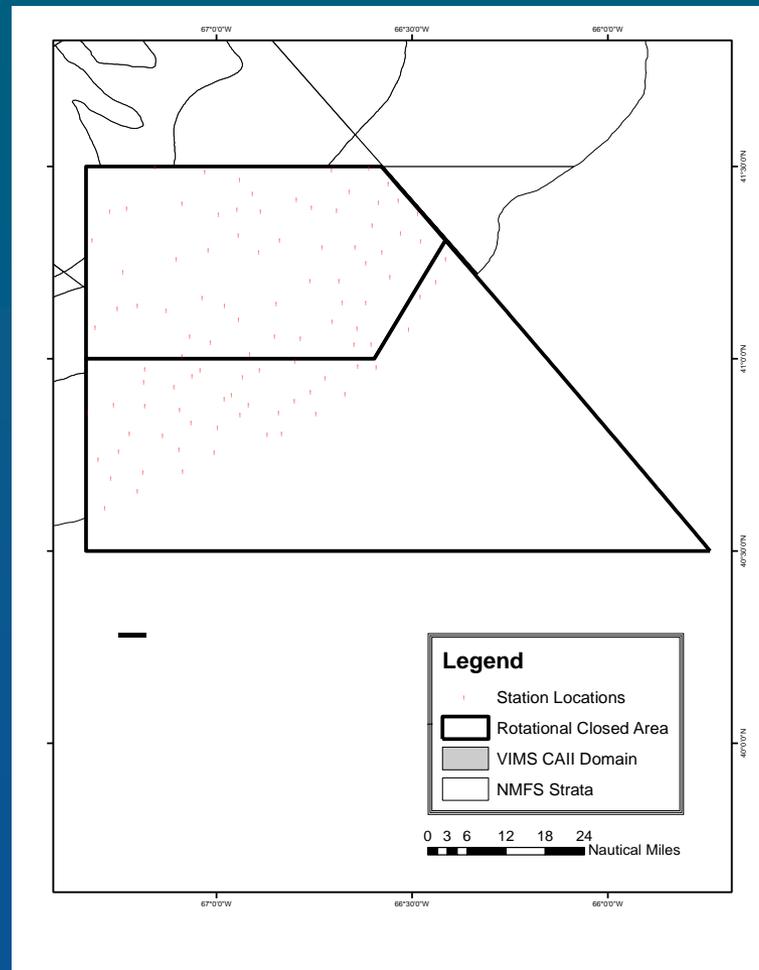
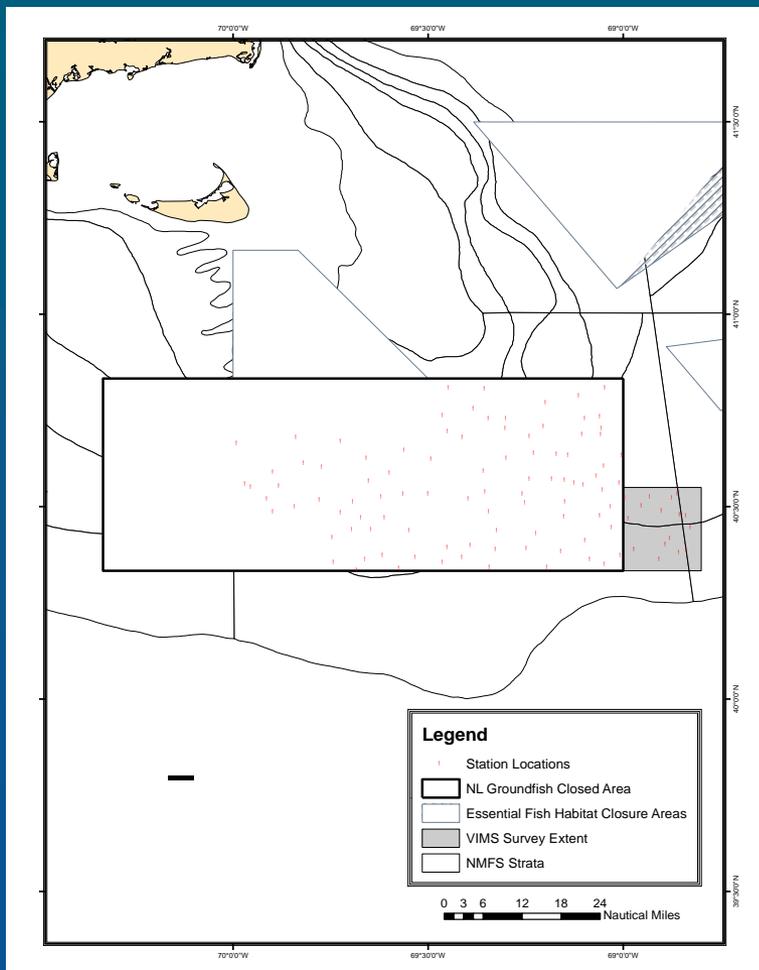
**August 30-31, 2016**

# 2016 VIMS-Industry Cooperative Surveys Mid-Atlantic Bight



# 2016 VIMS-Industry Cooperative Surveys

## NLCA and CA II



# 2016 VIMS-Industry Cooperative Surveys

## Primary Project Objectives

- **Assess the abundance and distribution of scallops in the Mid-Atlantic Bight, NLCA and CAII.**
  - **Mid-Atlantic Bight (Block Island to VA/NC)**
    - 2015 SAMS Area
    - 2015 SAMS Extended Area
  - **NLCA and surrounds**
    - 2015 SAMS Area
    - 2015 SAMS Extended Area
  - **CA II and surrounds**
    - 2015 SAMS Area
    - 2015 SAMS Extended Area
- **Estimate exploitable biomass.**
  - **Biomass of scallops available for capture with 4 inch ring commercial dredge.**

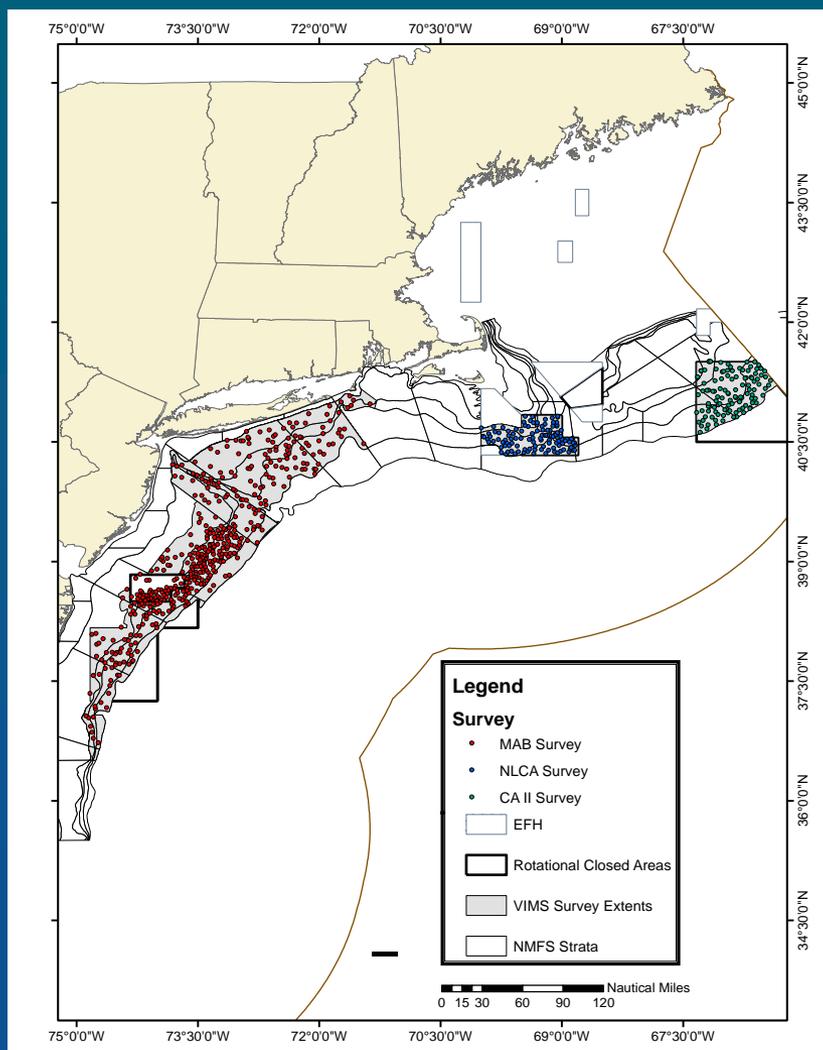


## 2016 VIMS-Industry Cooperative Surveys Secondary Project Objectives

- **Gear performance**
  - Estimate size selectivity and relative performance of 4.0 ring dredge (NBD & CFTDD).
- **Scallop Biology & Product Quality**
  - Spatially and temporally explicit shell height:meat weight relationships.
  - Assess metrics associated with product quality.
  - Examine the incidence and pathology of the shell disease observed in survey areas.
  - Investigate the spatial distribution including incidence and intensity of the parasitic nematode observed in scallop meats.
- **Finfish Bycatch**
  - Obtain a snapshot of finfish bycatch rates and species assemblages in the surveyed areas from the commercial dredge.
- **Scallop Predators**
  - Quantify the species composition, spatial extent and abundance of scallop predators (crabs and starfish).
- **Additional Sample Requests**
  - Jonah crabs, scallops for gray meat analysis, hake sp., and *Astarte*



# 2016 VIMS-Industry Cooperative Surveys



- **Sampling design**
  - Stratified random design
    - NMFS shellfish strata plus
    - Allocation
      - Area, prior year catch data (biomass, number) or modified proportional allocation (CA II and NLCA)
  
- **Vessels**
  - MAB Survey: 2 vessels with 1 new to the survey
    - Carolina Capes II (veteran), Sea Hawk (new)
  - NLCA Survey: Celtic (veteran)
  - NLCA Survey: K.A.T.E. (veteran)
  
- **Data acquisition system**
  - Electronic boards (1mm res.)
  - Custom front end to Access DB
  - Integrated with Marel scale
  - Automated recording of wheel house data
  
- **All other protocols remained the same (see scallop survey peer review materials for details)**

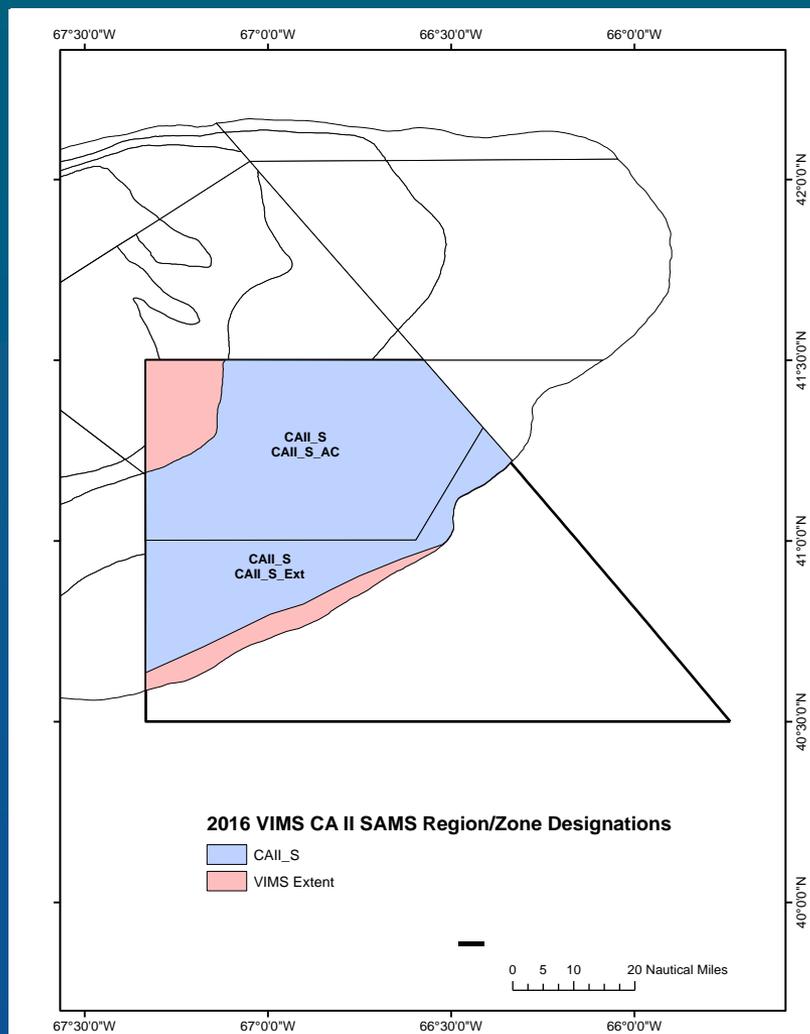
# 2016 VIMS-Industry Cooperative Surveys Analytical Framework

- **Area swept per tow**
  - Navigational info
  - Tilt sensor
- **Catch weight per tow (stratified means and variances)**
  - Length frequencies
  - Length-weight relationship (for this analysis regional SARC 59).
  - Selectivity (Yochum and DuPaul, 2008)
- **Efficiency (constant)**
  - Values from SARC 2014
    - 65% Commercial Dredge
    - 40% NMFS Survey Dredge
- **Exploitable Biomass**
  - Selectivity curve applied to catch for both the survey and commercial dredges (Yochum and DuPaul, 2008)
- **Sub-Area (constant)**
  - Dependent upon the spatial extent of the survey domain
    - 2015 NMFS SAMS regions and zones
    - 2016 SAMS VIMS extended

$$TotalBiomass = \sum_j \left( \frac{\left( \frac{CatchWtperTowinSubarea_j}{AreaSweptperTow} \right)}{Efficiency} \right) SubArea_j$$

# 2016 VIMS-Industry Cooperative Surveys

## SAMS Regions/Zones



- The projection model (SAMS) examines the resource on a variety of spatial scales.
  - region, zone
- The VIMS surveys included some areas outside of the NMFS area specification.
- Biomass estimates will be presented in the context of the VIMS expanded areas.

# 2016 VIMS-Industry Cooperative Surveys

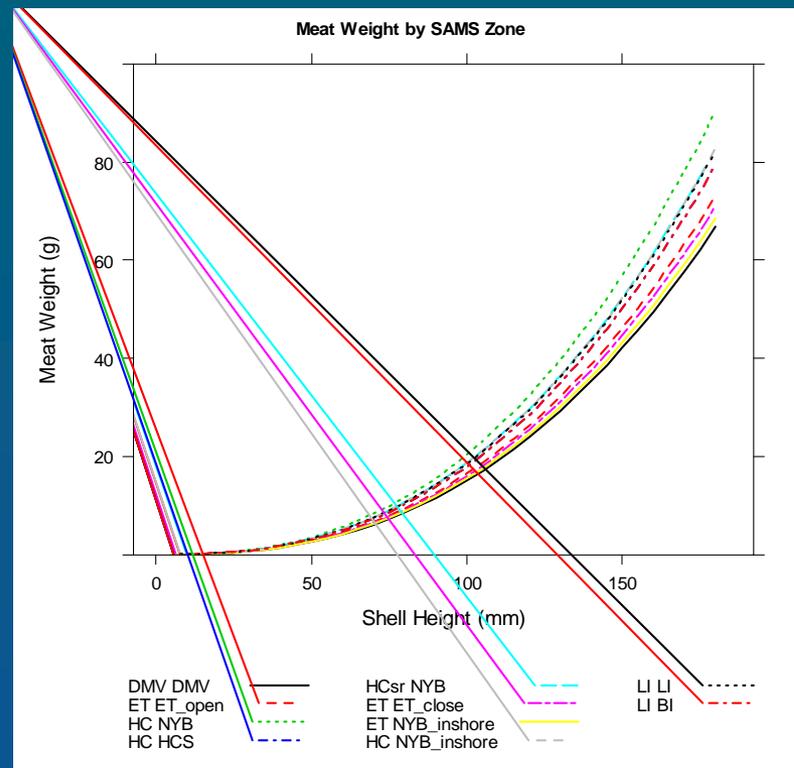
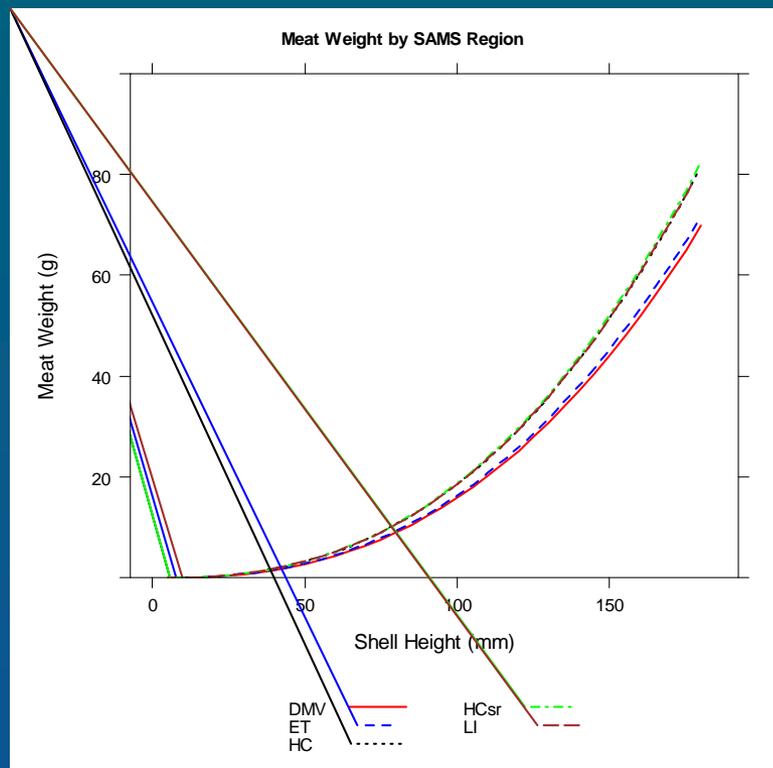
## SH:MW Relationship

- SH:MW samples were taken from all stations that had scallops (15/station):
  - MAB Survey: ~5000
  - NLCA and CA II Surveys: ~ 1,000/survey
- The objective is to construct a model to predict meat weight based on a suite of potential covariates (i.e. shell height, depth, SAMS area, sex, disease...).
- Average depth was calculated for each tow from tilt sensor
- A GLMM was used to fit model (Gamma distribution, log link, random effect at the station level) with R v 3.3.1 Package lme4.



# 2016 VIMS-Industry Cooperative MAB Survey

## SH:MW Results



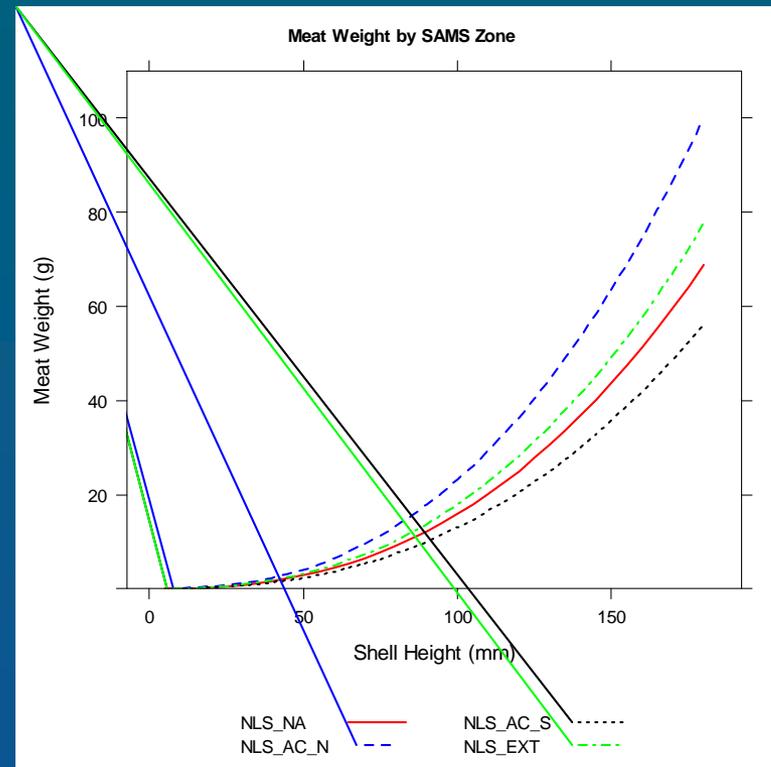
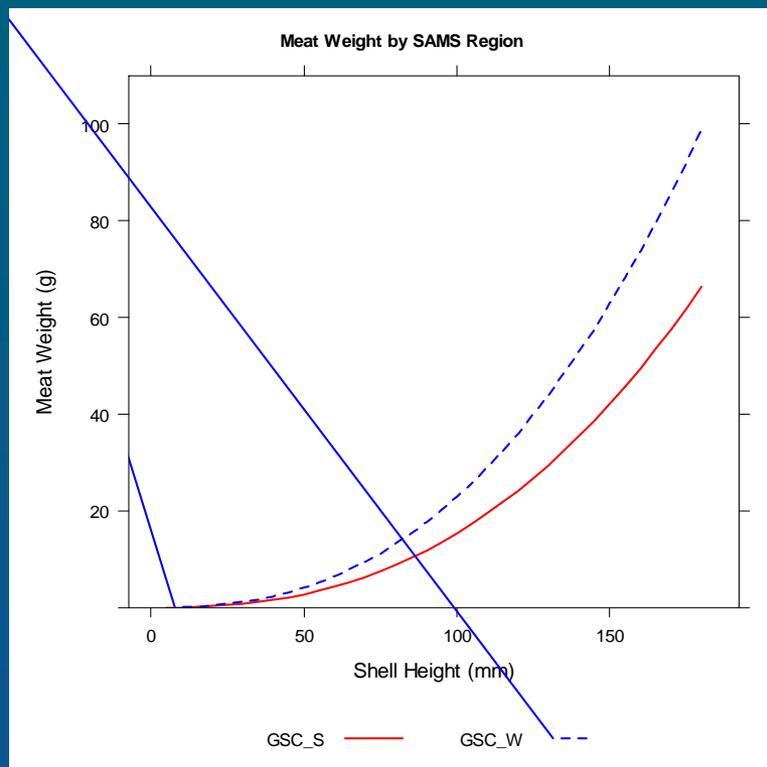
### •MAB SAMS Areas

•Significantly different relationships between SAMS Regions and Zone.

•Likely a function of average depths for each of subarea, as well as the temporal spread of the sampling

# 2016 VIMS-Industry Cooperative NLCA Survey

## SH:MW Results

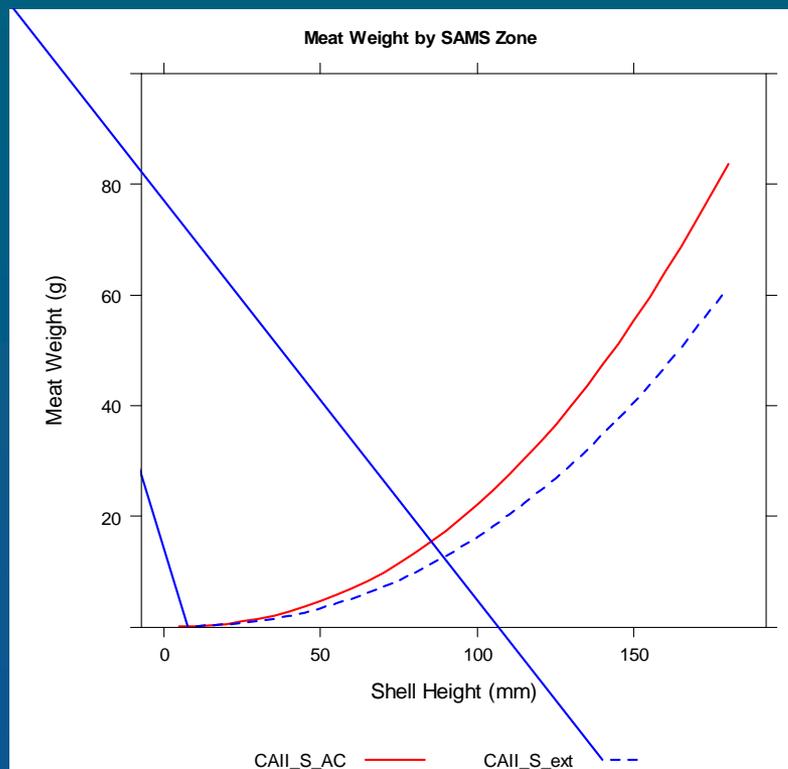


### •NLCA SAMS Areas

•Significantly different relationships between SAMS Regions and Zones.

•Likely a function of average depths for each of subarea, as well as the density of scallops and temporal spread of the sampling

# 2016 VIMS-Industry Cooperative CA II Survey SH:MW Results

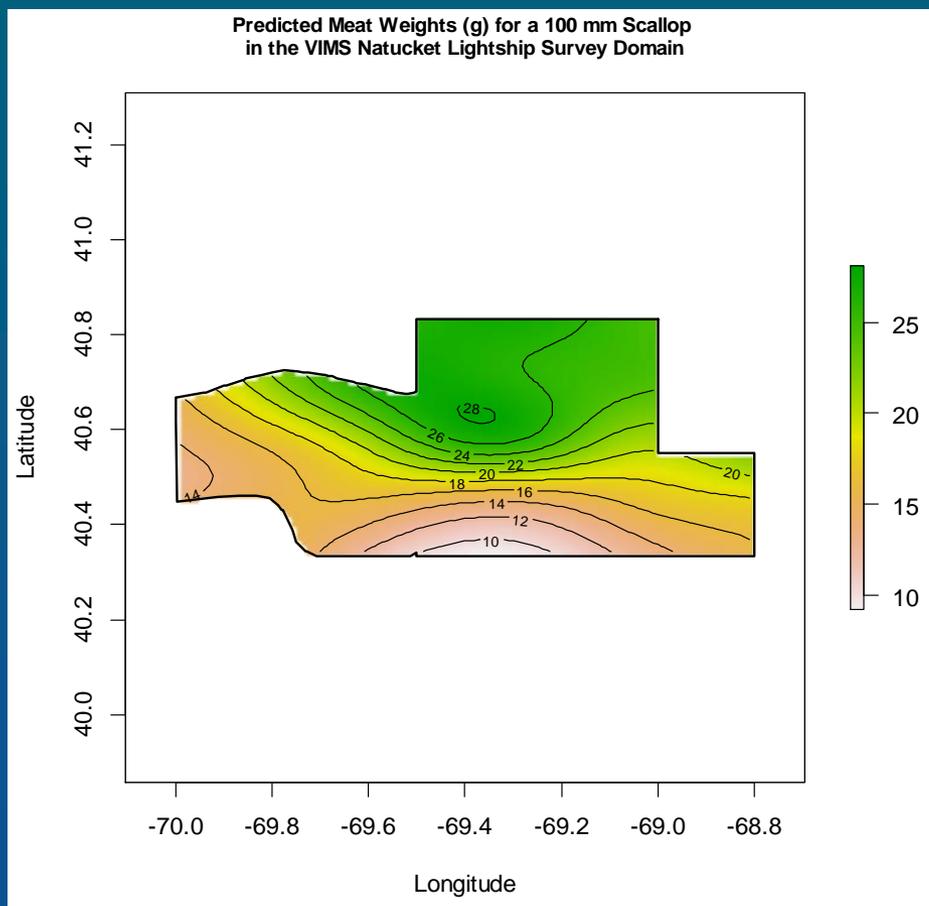


## •CA II SAMS Areas

- Significantly different relationships between SAMS Zones.
- Likely a function of average depths for each of subarea, as well as the temporal spread of the sampling

# 2015 VIMS-Industry Cooperative Surveys

## SH:MW Results – NLCA Survey



- Contour plot of meat weights predicted from a GAMM for a 100 mm scallop in the NLCA survey area.

- Gradient of meat weights was observed in the survey area.

- Small meats observed in the south in deeper water with high densities of scallops .

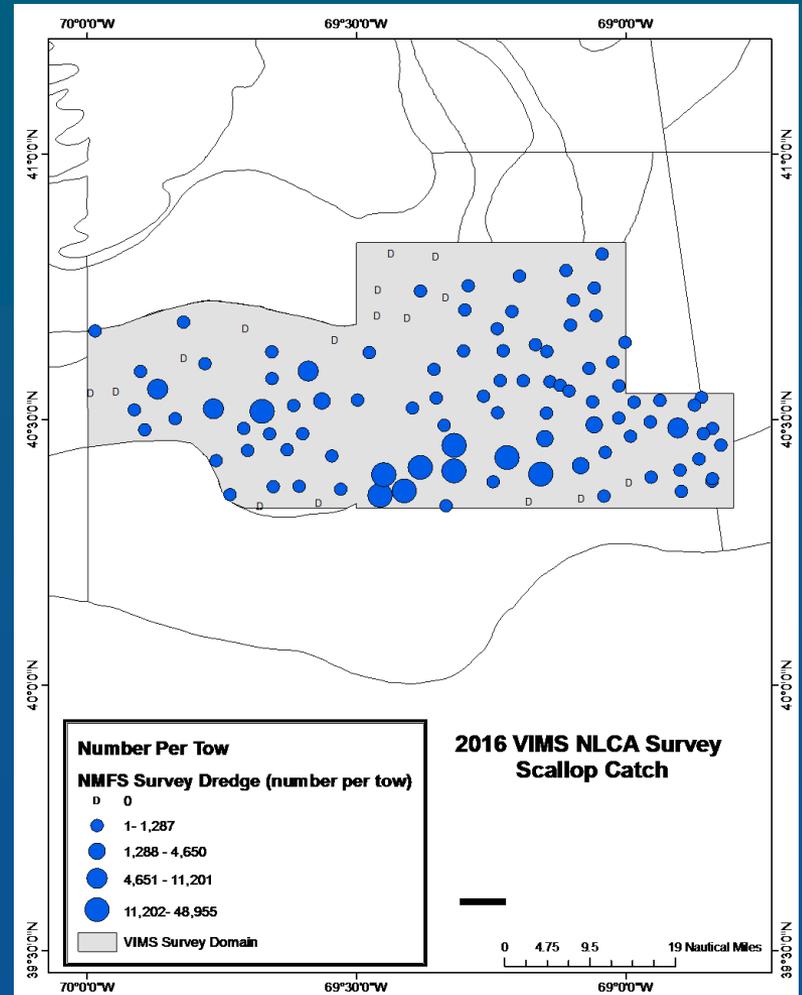
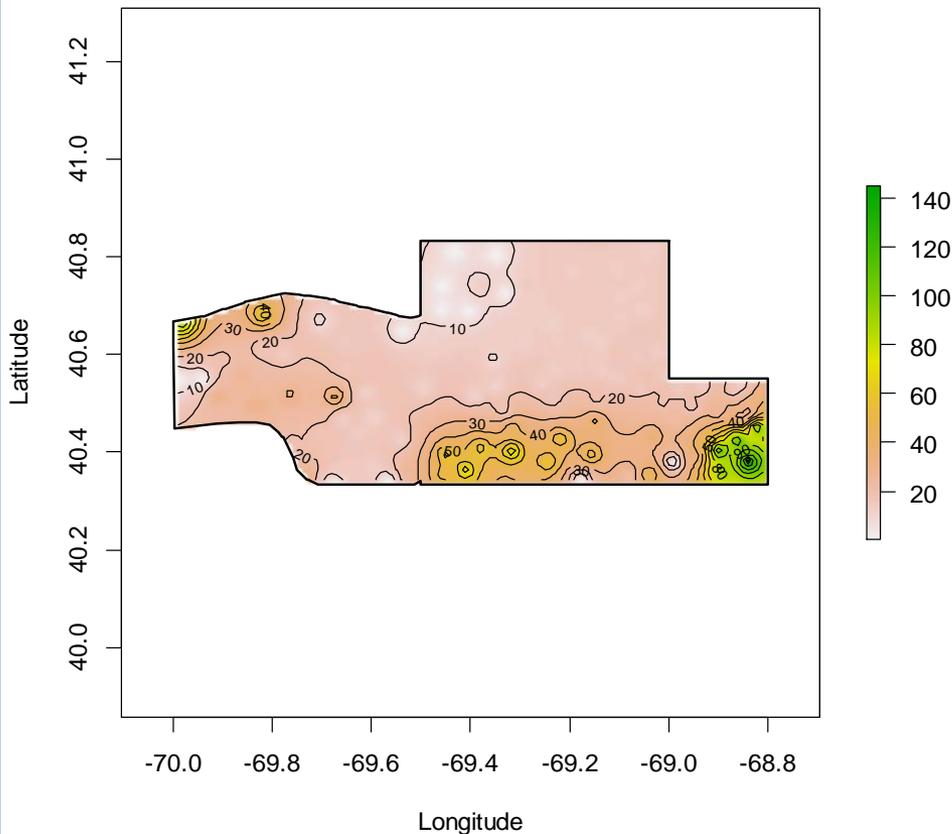
- Biomass of an area is a dynamic process that has significant spatial and temporal components that warrant consideration in the specification process.

- SARC 59 estimates one subarea coefficient for the NLCA.

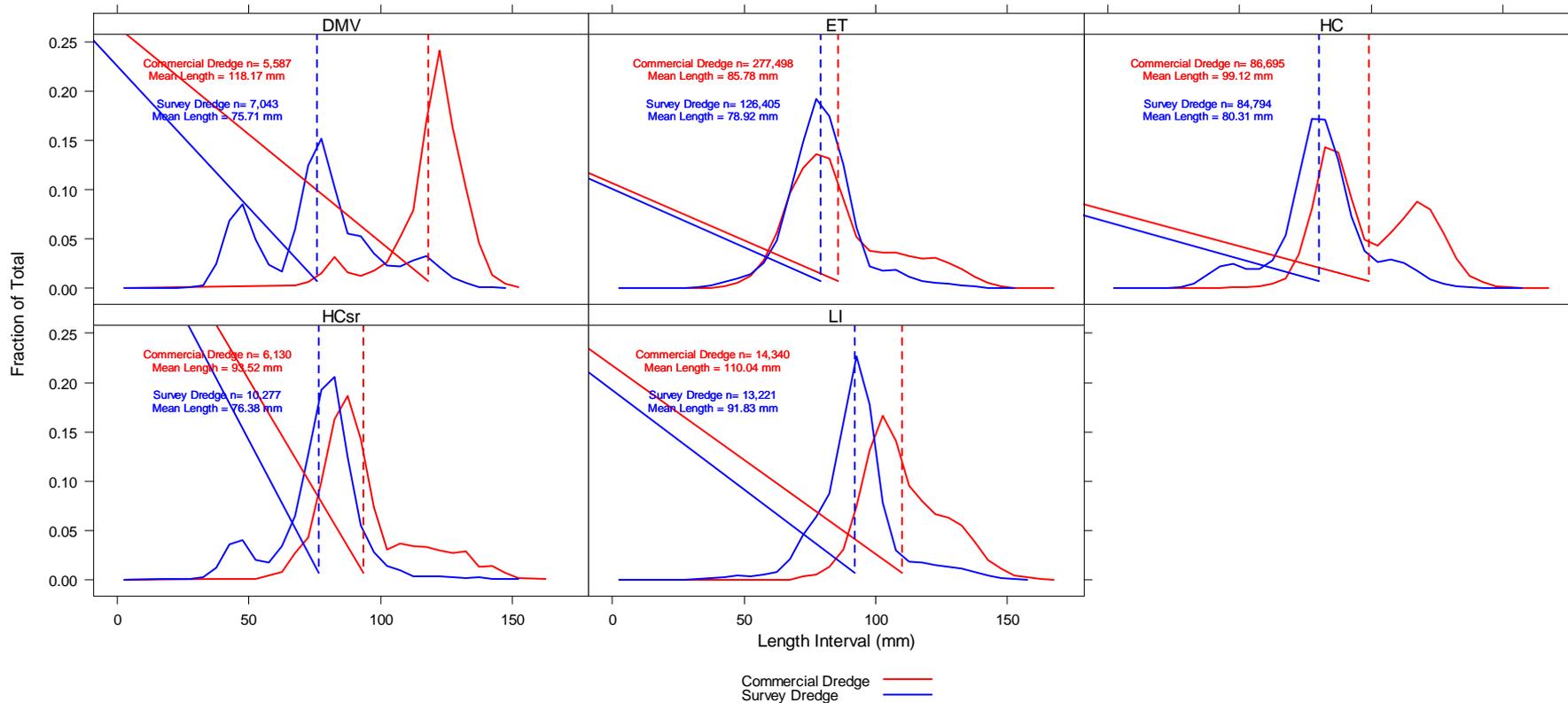
# 2015 VIMS-Industry Cooperative Surveys

## NLCA Survey

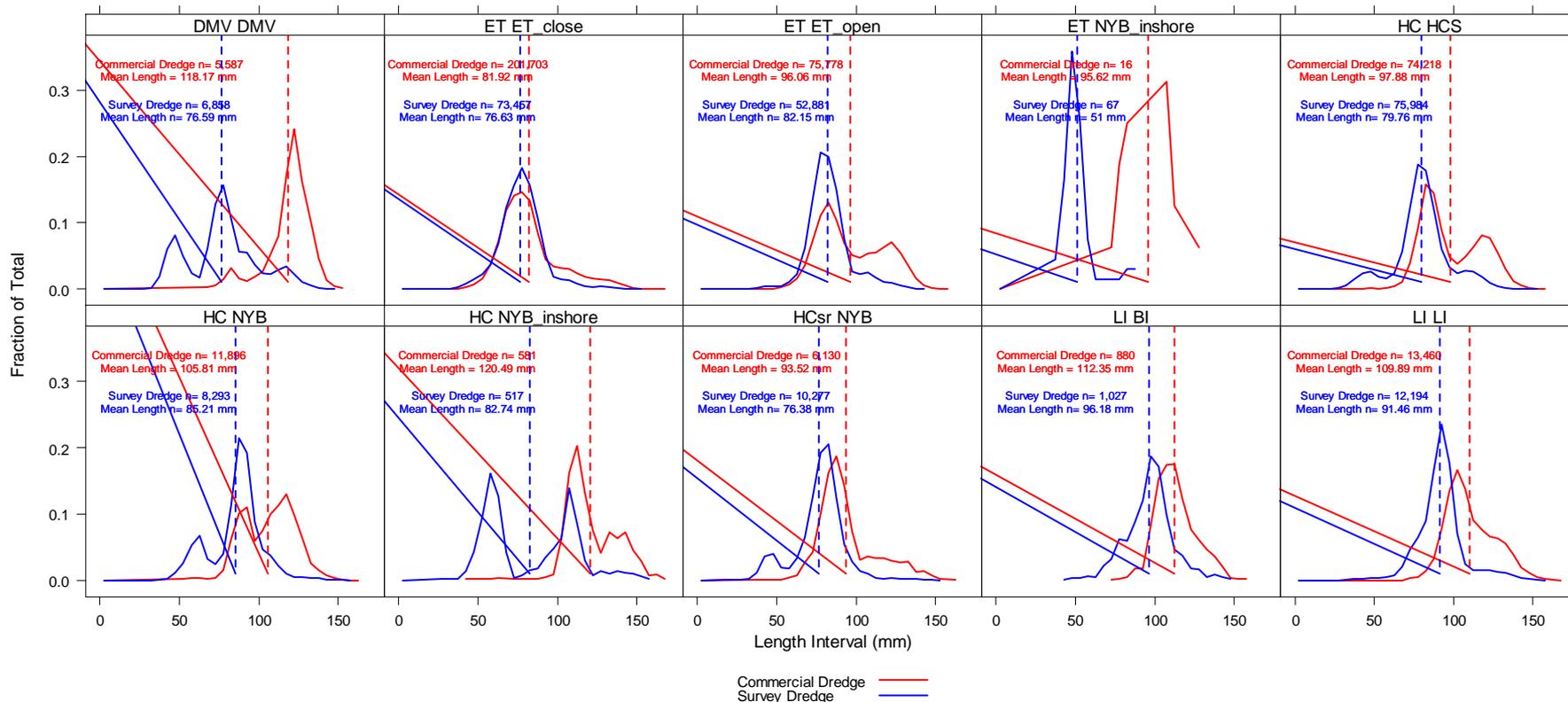
Interpolated Map of Scallop Meat Counts Per Pound in the VIMS Nantucket Lightship Survey Domain



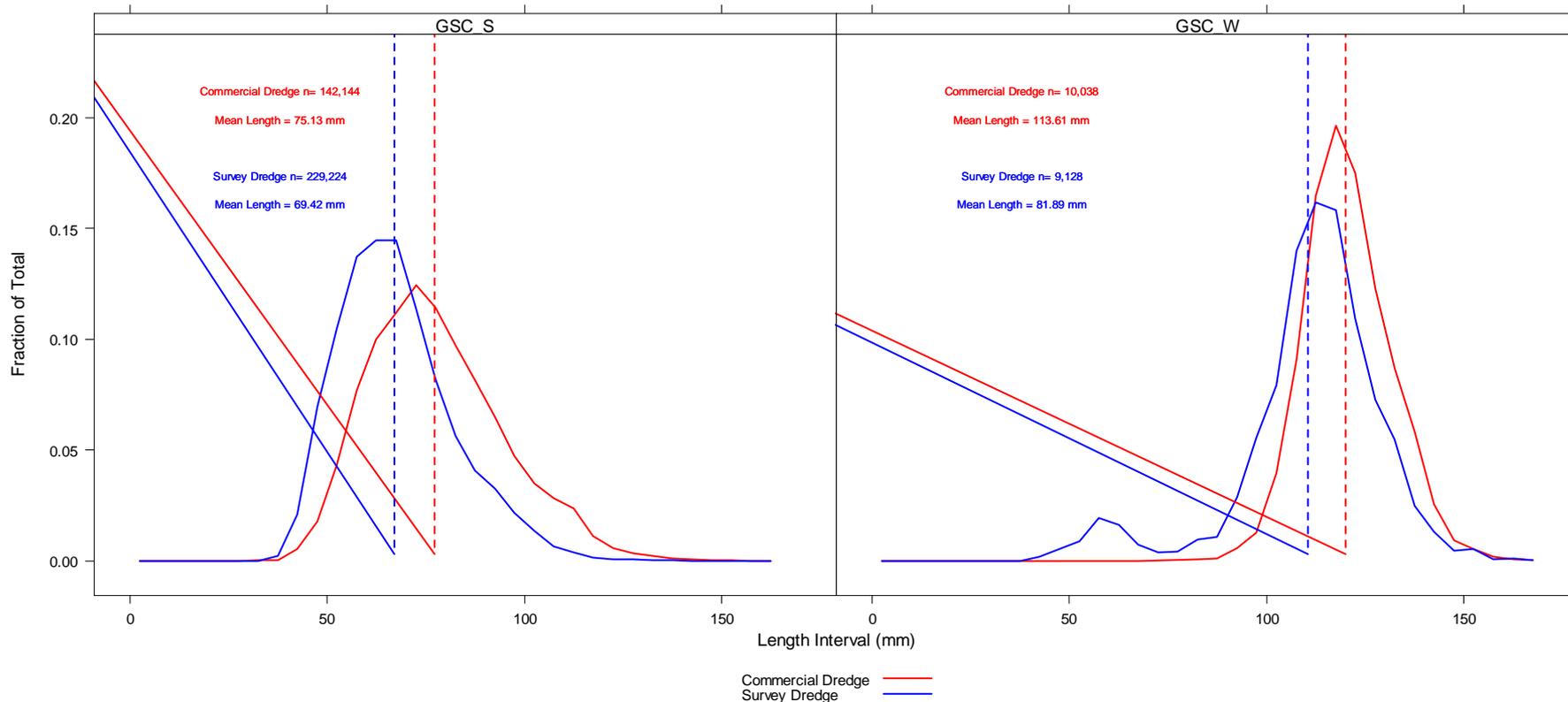
# 2016 VIMS-Industry Cooperative MAB Survey Length Frequency- SAMS Region



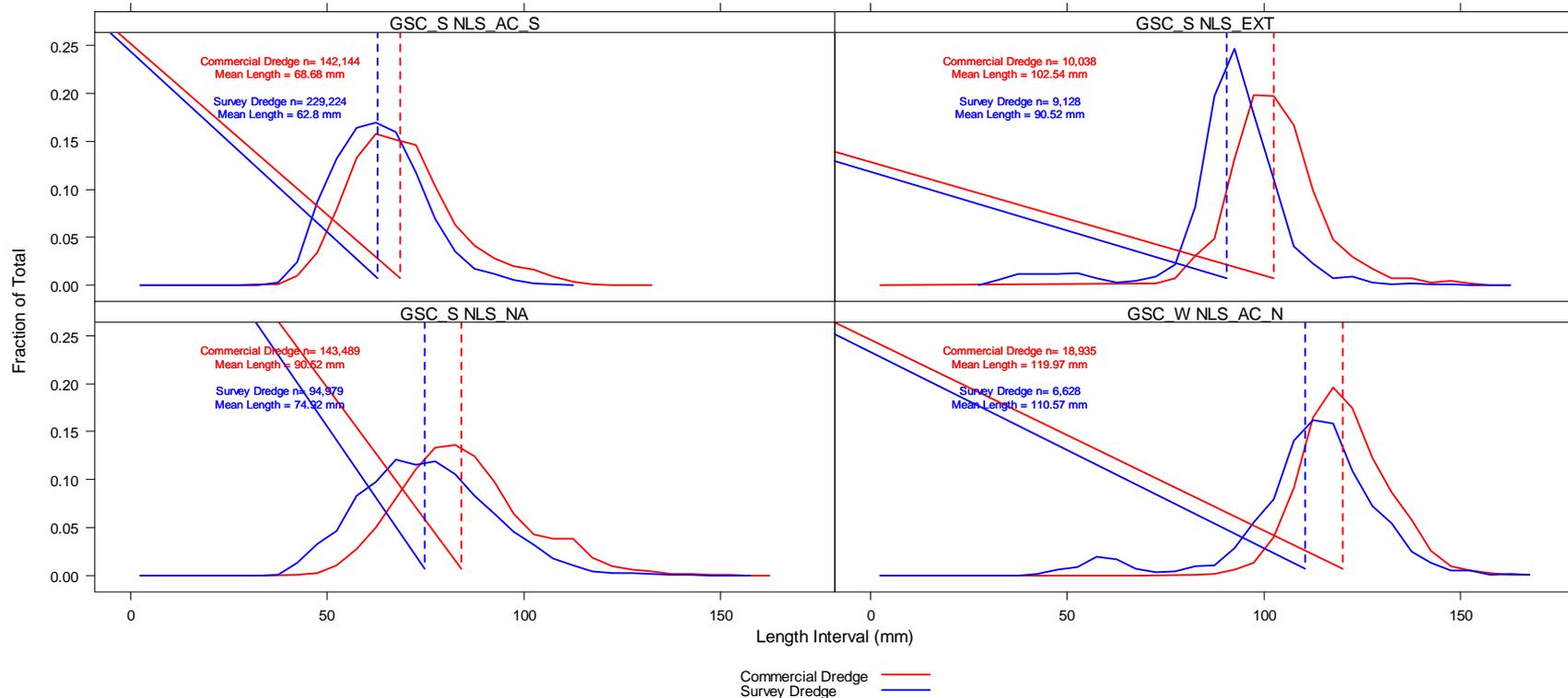
# 2016 VIMS-Industry Cooperative MAB Survey Length Frequency- SAMS Zone



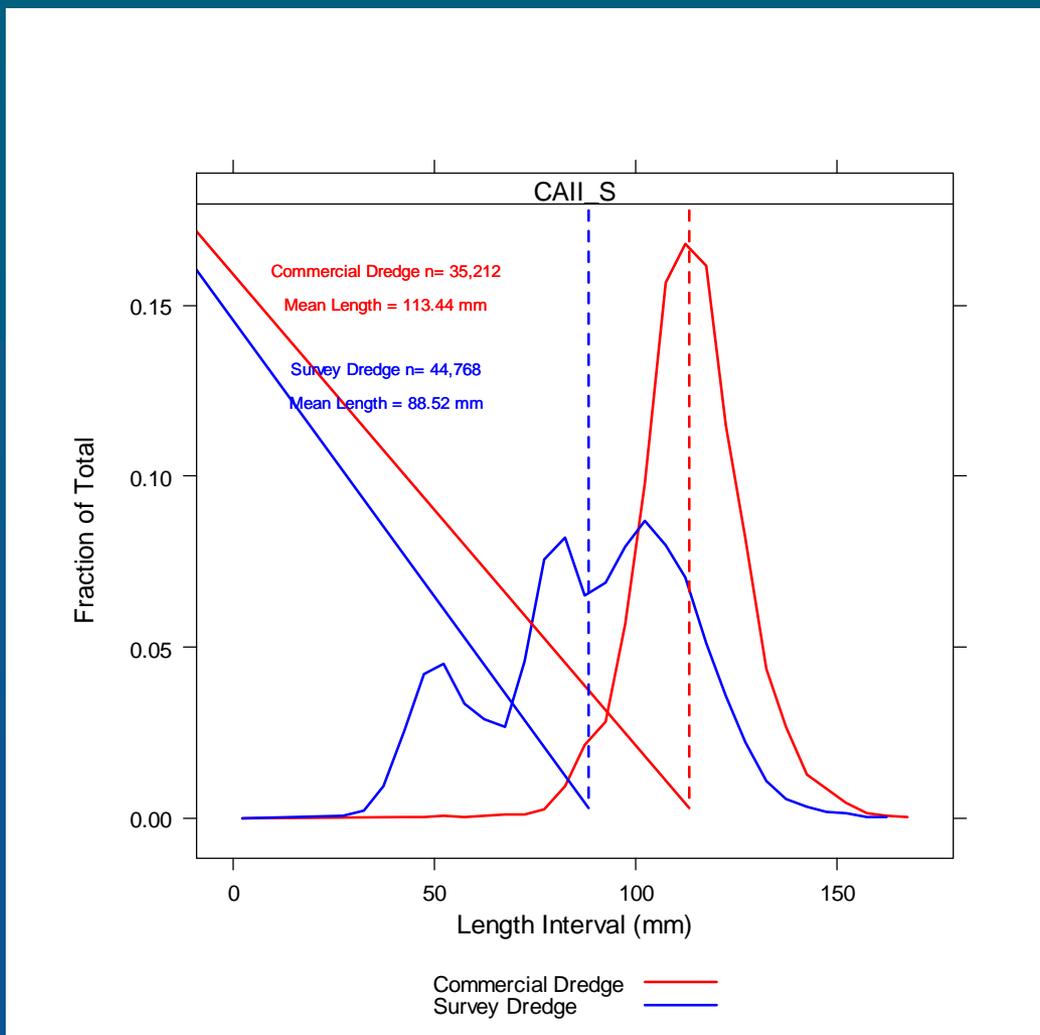
# 2016 VIMS-Industry Cooperative NLCA Survey Length Frequency- SAMS Region



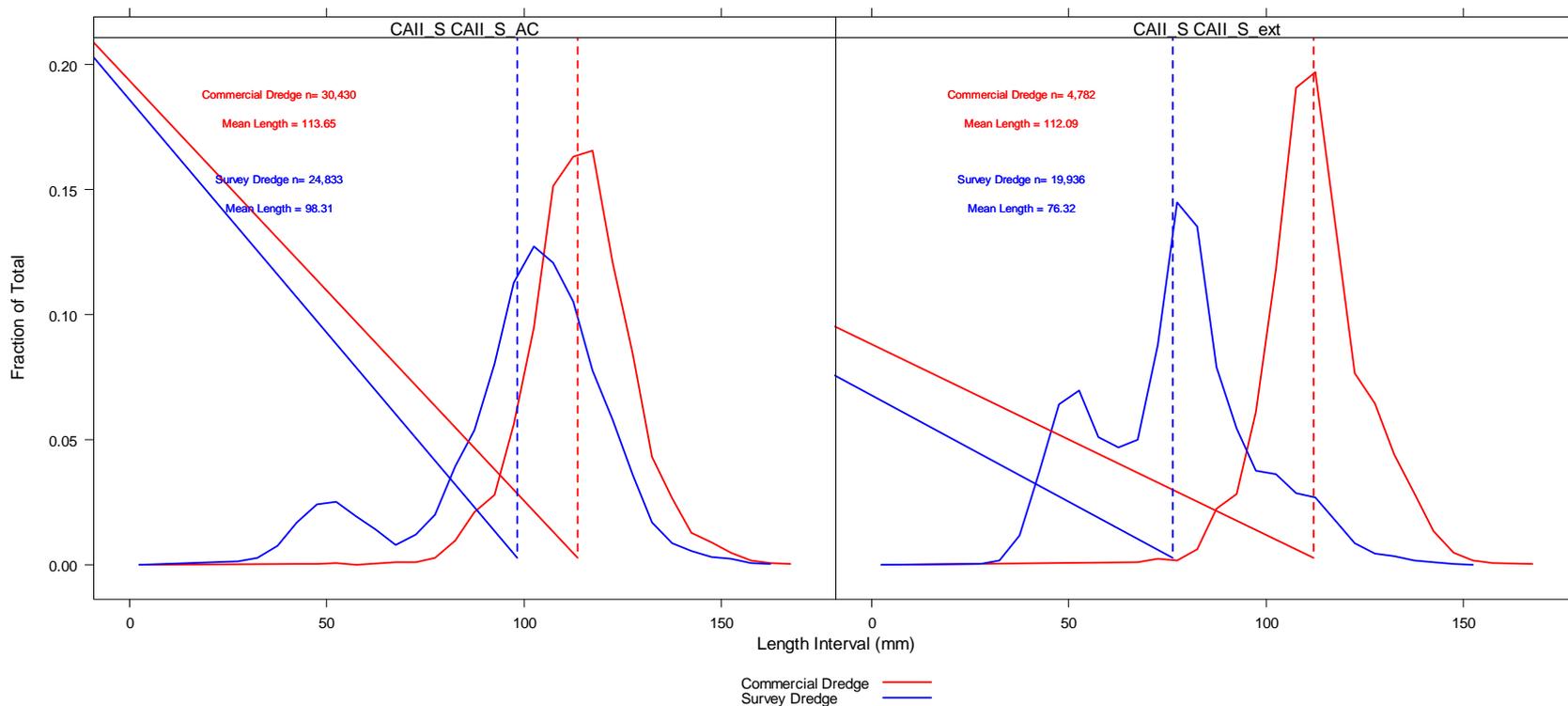
# 2016 VIMS-Industry Cooperative NLCA Survey Length Frequency- SAMS Zone



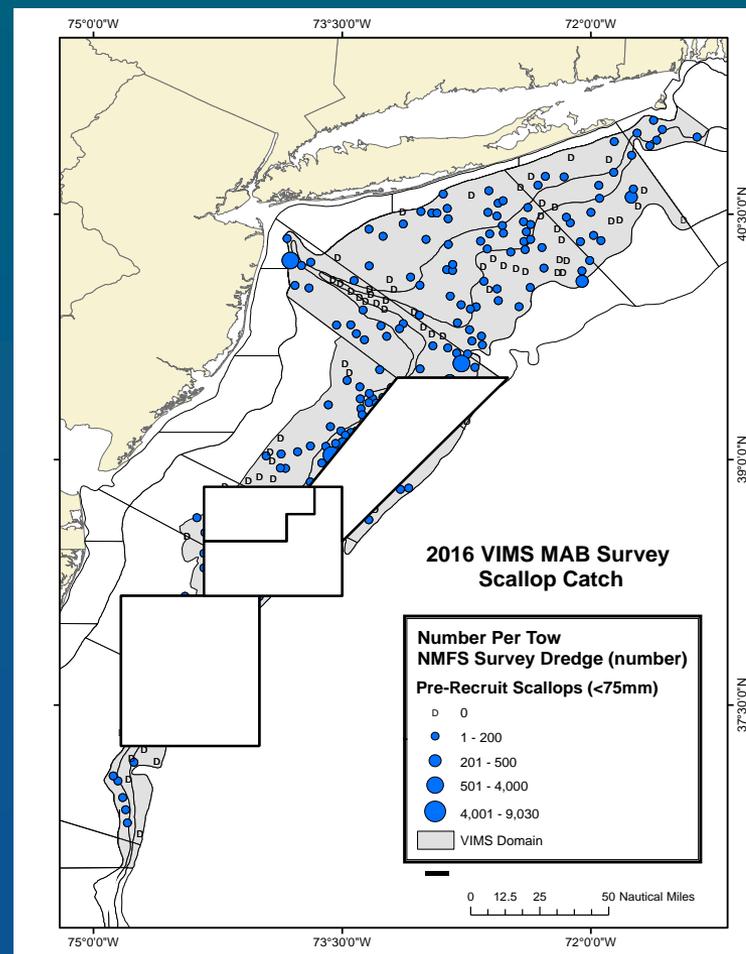
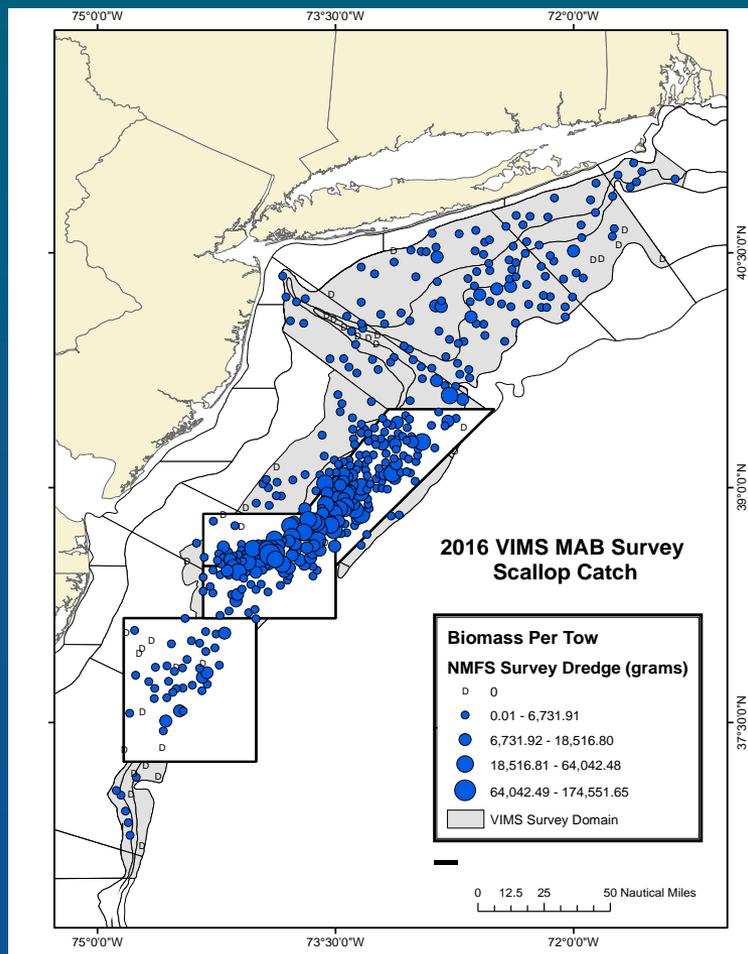
# 2016 VIMS-Industry Cooperative CA II Survey Length Frequency- SAMS Region



# 2016 VIMS-Industry Cooperative CA II Survey Length Frequency- SAMS Zone

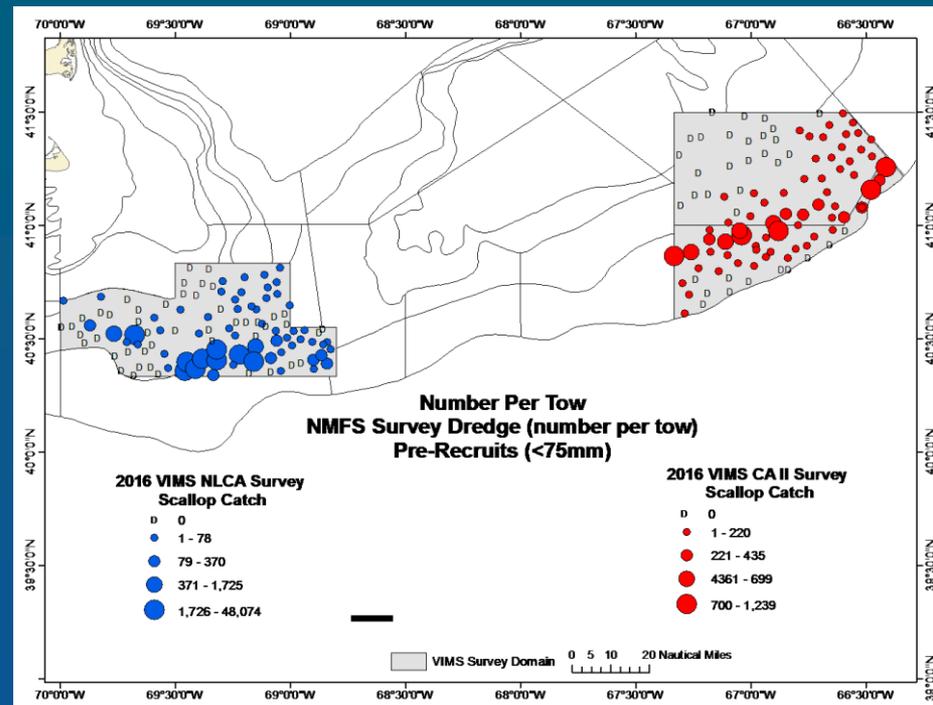
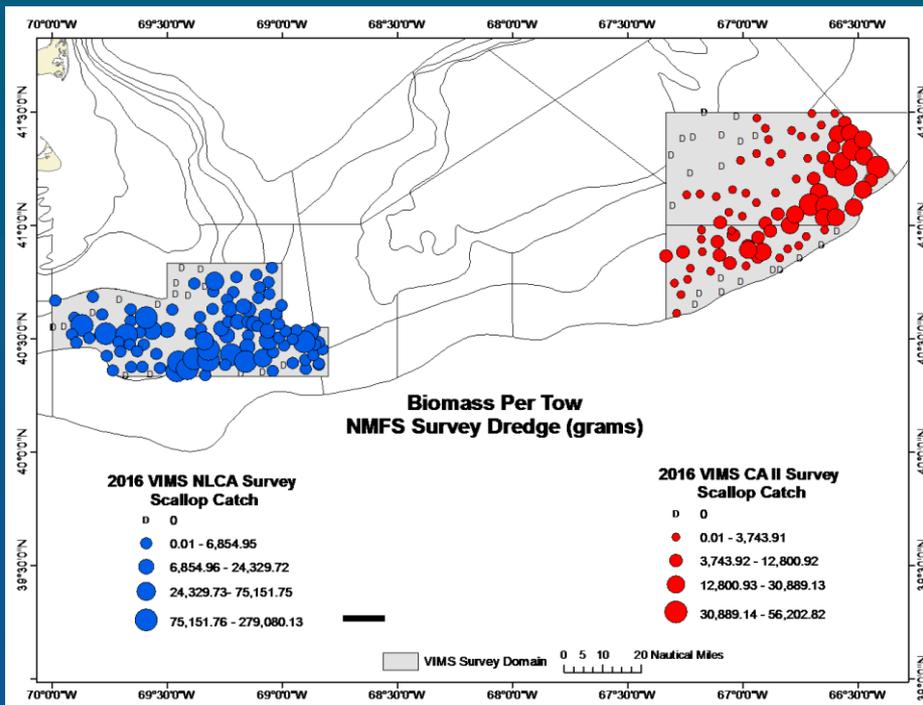


# 2016 VIMS-Industry Cooperative MAB Survey Scallop Distribution



# 2016 VIMS-Industry Cooperative NLCA & CA II Surveys

## Scallop Distribution



# 2016 VIMS-Industry Cooperative Surveys

## Total Biomass - Region

Survey	SAMS Region	Total Biomass (mt)	SE Biomass (mt)	Density (scal/m <sup>2</sup> )	Avg MW (g)	Total #
MAB	DMV	4,125.96	434.32	0.07	11.24	394,116,594.99
	ET	22,485.56	1,023.28	0.70	10.47	2,035,382,047.86
	HC	17,115.44	722.81	0.33	12.07	1,395,865,849.41
	HCsr	4,937.67	917.70	0.17	10.42	492,190,000.77
	LI	16,202.76	742.02	0.07	17.41	922,179,496.32
NLCA	GSC_S	58,706.81	5,353.98	2.56	8.62	6,723,574,032.92
	GSC_W	3,571.57	298.14	0.12	30.06	118,974,287.52
	VIMS_45	5.41	2.00	0.00	30.20	179,063.89
CA II	CAII_S	18,229.87	994.76	0.26	15.83	1,160,535,650.77

# 2016 VIMS-Industry Cooperative Surveys

## Total Biomass – Region/Zone

Survey	SAMS Region Zone	Total Biomass (mt)	SE Biomass (mt)	Density (scal/m <sup>2</sup> )	Avg MW (g)	Total #
MAB	DMV DMV	4,031.45	397.25	0.09	11.49	375,179,508.77
	DMV VIR	16.77	1.79	0.01	2.24	7,471,138.85
	ET ET_close	10,975.09	855.54	1.06	9.83	1,015,942,940.96
	ET ET_open	11,324.17	450.02	0.48	11.37	989,468,483.68
	ET NYB_inshore	61.55	0.41	0.01	3.39	19,618,868.30
	HC HCS	13,812.14	633.46	0.44	11.78	1,170,351,530.61
	HC NYB	2,603.36	339.48	0.18	14.46	180,727,689.59
	HC NYB_inshore	665.22	73.62	0.01	16.58	40,129,837.46
	HCsr NYB	4,937.66	917.75	0.17	10.42	492,176,971.18
	LI BI	1,508.47	83.34	0.10	20.41	73,974,647.90
	LI LI	14,713.37	736.31	0.07	17.16	848,918,181.20
NLCA	GSC_S NLS_AC_S	22,657.69	2,344.53	7.48	7.04	3,217,822,591.33
	GSC_S NLS_EXT	1,696.60	509.55	0.31	17.49	100,240,930.77
	GSC_S NLS_NA	25,801.89	3,970.65	1.38	11.58	2,230,524,250.16
	GSC_W NLS_AC_N	3,571.57	298.14	0.12	30.06	118,974,287.52
	VIMS_45	5.41	2.00	0.00	30.20	179,063.89
CA II	CAII_S CAII_S_AC	13,875.77	866.06	0.26	20.23	477,721,662.76
	CAII_S CAII_S_ext	4,963.42	427.42	0.25	10.34	688,469,033.23

# 2016 VIMS-Industry Cooperative Surveys

## Exploitable Biomass Survey - Region

Survey	SAMS Region	Total Biomass (mt)	SE Biomass (mt)	Density (scal/m <sup>2</sup> )	Avg MW (g)	Total #
MAB	DMV	1,469.98	157.07	0.07	21.79	70,117,637.93
	ET	6,587.21	241.11	0.70	15.95	390,650,676.93
	HC	5,785.78	253.78	0.07	18.60	300,577,220.62
	HCsr	1,363.84	144.69	0.03	15.98	74,358,084.86
	LI	7,301.62	312.27	0.07	22.34	321,313,419.67
NLCA	GSC_S	9,721.64	1,004.46	2.56	16.16	595,200,859.59
	GSC_W	2,782.11	212.06	0.09	33.72	81,548,737.32
	VIMS_45	3.62	1.34	0.001	32.55	111,077.97
CAII	CAII_S	10,186.87	592.36	0.26	23.80	420,696,521.70

# 2016 VIMS-Industry Cooperative Surveys

## Exploitable Biomass Survey – Region/Zone

Survey	SAMS Region Zone	Total Biomass (mt)	SE Biomass (mt)	Density (scal/m <sup>2</sup> )	Avg MW (g)	Total #
MAB	DMV DMV	1,440.98	145.99	0.09	21.81	68,868,929.86
	DMV VIR	0.18	0.03	0.00	3.71	47,855.93
	ET ET_close	3,159.04	197.06	1.06	15.59	183,249,825.64
	ET ET_open	3,415.01	131.55	0.10	16.32	203,522,665.83
	ET NYB_inshore	3.45	0.05	0.00	9.23	383,992.95
	HC HCS	4,422.69	229.24	0.09	18.28	239,014,768.09
	HC NYB	959.68	98.96	0.05	19.90	48,270,214.98
	HC NYB_inshore	405.64	39.40	0.00	30.80	13,169,425.83
	HCsr NYB	1,363.19	144.63	0.03	15.98	74,324,998.92
	LI BI	799.24	39.25	0.04	25.04	31,933,585.39
	LI LI	6,515.49	309.41	0.07	22.05	289,852,478.73
NLCA	GSC_S NLS_AC_S	1,741.46	185.82	7.48	11.03	157,851,406.44
	GSC_S NLS_EXT	681.89	180.23	0.11	20.79	32,824,672.28
	GSC_S NLS_NA	6,509.38	929.39	0.21	19.13	340,146,590.83
	GSC_W NLS_AC_N	2,782.11	212.06	0.09	33.72	81,548,737.32
	VIMS_45 VIMS_45	3.62	1.34	0.00	32.55	111,077.97
CA II	CAII_S CAII_S_AC	8,997.18	520.28	0.13	25.51	347,640,879.00
	CAII_S CAII_S_ext	1,720.24	152.22	0.25	18.13	92,805,506.65

# 2016 VIMS-Industry Cooperative Surveys

## Exploitable Biomass - Commercial by Region

Survey	SAMS Region	Total Biomass (mt)	SE Biomass (mt)	Density (scal/m <sup>2</sup> )	Avg MW (g)	Total #
MAB	DMV	2,520.01	500.68	0.02	32.78	78,783,082.93
	ET	12,431.27	927.26	0.55	23.75	502,606,892.42
	HC	10,885.20	1,868.13	0.06	26.82	403,258,055.37
	HCsr	1,219.18	149.83	0.01	26.16	40,744,069.92
	LI	7,183.71	531.89	0.03	31.31	224,762,172.76
NLCA	GSC_S	8,756.97	1,910.63	0.80	21.38	407,904,423.34
	GSC_W	3,463.90	323.75	0.13	36.61	93,837,894.39
	VIMS_45	1.36	0.82	0.00	46.91	29,038.49
CAII	CAII_S	6,574.37	668.20	0.07	28.92	221,450,176.26

# 2016 VIMS-Industry Cooperative Surveys

## Exploitable Biomass - Commercial by Region/Zone

Survey	SAMS Region_Zone	Total Biomass (mt)	SE Biomass (mt)	Density (scal/m <sup>2</sup> )	Avg MW (g)	Total #
MAB	DMV DMV	2,488.60	490.24	0.02	32.78	77,805,762.73
	DMV VIR	0.00	0.00	0.00	0.00	0.00
	ET ET_close	6,740.28	929.89	1.04	22.67	283,002,777.88
	ET ET_open	6,119.70	478.98	0.24	25.27	234,758,902.35
	ET NYB_inshore	3.11	1.09	0.00	26.20	118,684.81
	HC HCS	6,645.94	1,143.73	0.15	26.48	255,826,265.84
	HC NYB	3,700.39	1,433.83	0.09	27.47	134,610,305.82
	HC NYB_inshore	526.10	73.59	0.01	41.32	12,731,296.67
	HCsr NYB	1,219.10	149.82	0.04	26.16	40,742,725.13
	LI BI	522.31	31.63	0.03	32.86	15,906,955.82
	LI LI	6,665.26	530.08	0.03	31.20	208,962,219.62
NLCA	GSC_S NLS_AC_S	960.14	289.76	1.62	15.15	63,359,444.84
	GSC_S NLS_EXT	516.61	216.69	0.06	25.78	20,020,927.73
	GSC_S NLS_NA	6,774.37	1,819.28	0.18	22.94	295,157,372.01
	GSC_W NLS_AC_N	3,463.90	323.75	0.10	36.61	93,837,894.39
	VIMS_45 VIMS_45	1.36	0.82	0.00	46.91	29,038.49
CAII	CAII_S CAII_S_AC	6,149.25	609.17	0.10	29.29	138,811,858.69
	CAII_S CAII_S_ext	775.98	113.03	0.02	26.52	9,745,384.04

# 2016 VIMS-Industry Cooperative Surveys Summary

- The good
  - Biomass in the MAB closed area, as well as the NLCA and CA II access areas and surrounds appear to be strong.
- Causes of concern
  - General lack of strong recruiting year class across all surveyed areas.
  - How to handle the age 4 scallops in the NLS if expected growth is not realized. This may result in a reduced contribution in terms of yield to the fishery relative to projections.
  - Continued and expanded presence of a nematode parasite observed in the scallop meats which may limit effort in south portions of the resource (DMV and parts of ET).

# Acknowledgements

- The owners, captains and crews;
  - *F/V Carolina Capes II*
  - *F/V Sea Hawk*
  - *F/V K.A.T.E*
  - *F/V Celtic*
- Daniel Smith, Lee Rollins, Chase Long and Nick Cardoso
- Support from NMFS NEFSC: Dvora Hart, Vic Nordahl.
- Funding through Sea Scallop RSA program.

