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

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Preliminary – PDT use only.

2019 VIMS-Industry Cooperative Surveys
Project Objectives

Primary Objectives

- Assess the abundance and distribution of scallops in the Mid-Atlantic Bight, NL, CAI & CAII by SAMS Area
- Estimate total & exploitable biomass

Secondary Objectives

- Gear performance
  - Selectivity of commercial gear
- Scallop Biology & Product Quality
  - Assess marketability, growth, disease & SHMW
- Finfish Bycatch
- Scallop Predators

2019 VIMS-Industry Cooperative Surveys

- Sampling design
  - Stratified random design
    - NMFS shellfish strata plus SAMS areas included in survey domains
  - Allocation
    - Area, prior year catch data (biomass, number)
- Automated Data acquisition system
- Survey dredge performance monitored
- All other protocols remained the same
  - Tow a survey dredge & commercial dredge simultaneously
    - Survey dredge – 8 ft in width, 2 in rings & 1.5 in diamond mesh liner
    - Commercial dredge – varies by vessel and area

Biomass Estimation

- **Swept area method is used to calculate biomass estimates (Cochran, 1997)**
- **Area swept per tow (a_s)**
  - **Navigational info**
  - **Tilt sensor**
- **Catch weight per tow (C_h)**
  - **Expanded length frequencies**
  - **Length-weight relationship (SARC 65 or determined by PDT)**
  - **Selectivity (Yochum and DuPaul, 2008)**
- **Efficiency (E_s)**
  - **Values from SARC 59 (2014)**
    - **65%Commercial Dredge**
    - **40% NMFS Survey Dredge**

L = # of strata
n = # of stations in stratum h
h = stratum
i = station i in stratum h
s = subarea s in survey of interest
A_s = area of survey of interest in subarea s
E_s = gear efficiency estimate for subarea s
$\bar{a}_s$ = mean area swept per tow in subarea s
$\hat{B}_s$ = total biomass in subarea s
$\bar{C}_s$ = stratified mean biomass caught per tow for subarea s
$\bar{C}_{h,s}$ = mean biomass caught per tow in stratum h for subarea s
W_h = proportion of survey/subarea in stratum h

Stratified mean biomass per tow in stratum and subarea of interest

$$\bar{C}_{h,s} = \frac{1}{n_h}\sum_{i=1}^{h} C_{i,h,s}$$

$$Var(\bar{C}_{h,s}) = \frac{1}{n_h(n_h-1)}\sum_{i=1}^{n_h}\left(C_{i,h,s} - \bar{C}_{h,s}\right)^2$$

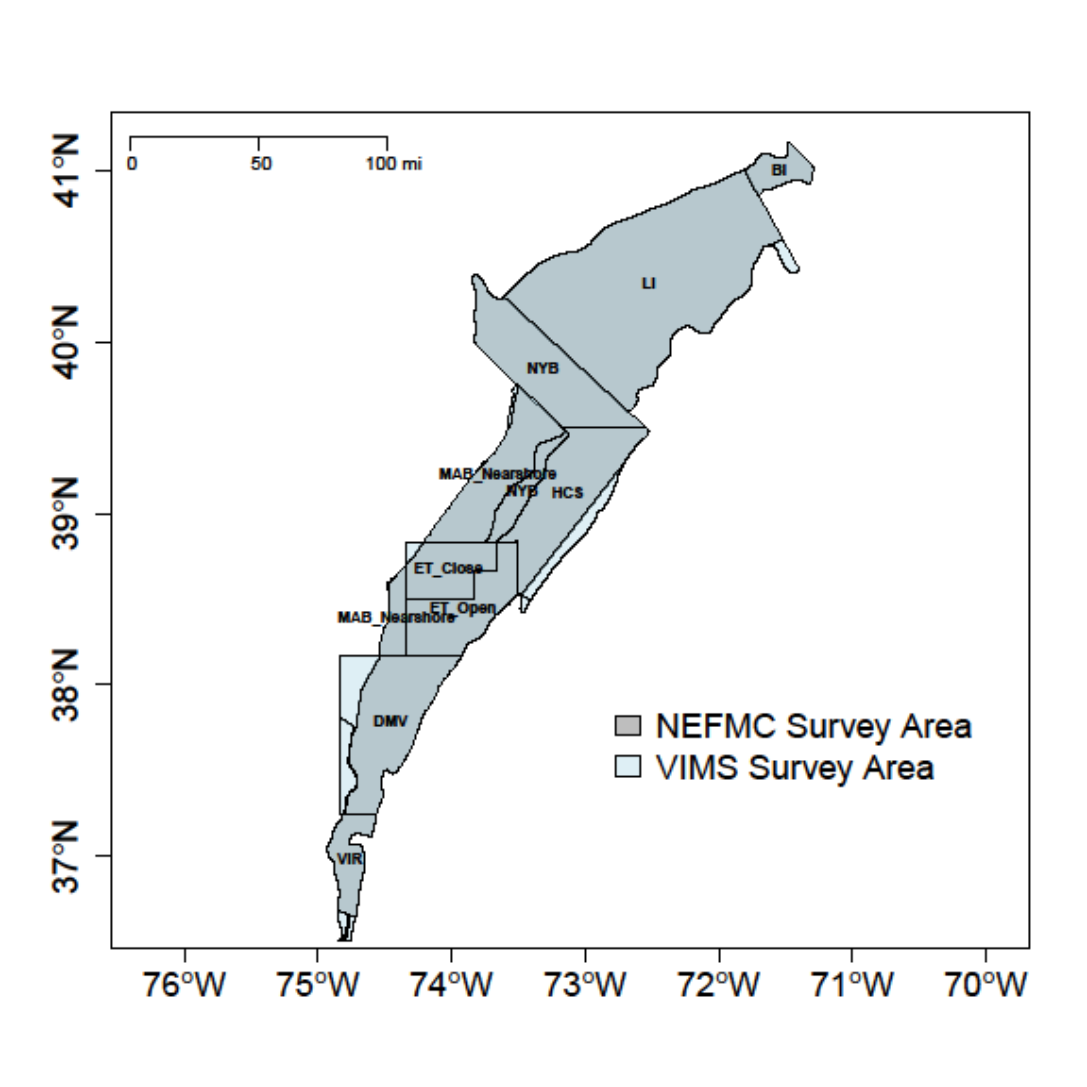
Stratified mean biomass per tow in subarea of interest

$$\bar{C}_s = \sum_{h=1}^{L} W_h \cdot \bar{C}_{h,s} \quad Var(\bar{C}_s) = \sum_{h=1}^{L} W_h^2 \cdot Var(\bar{C}_h)$$

Total biomass in subarea of interest

$$\widehat{B_s} = \left(\frac{\left(\frac{\bar{C}_s}{\bar{a}_s}\right)}{E_s}\right) A_s \quad Var(\widehat{B_s}) = Var(\bar{C}_s) \cdot \left(\frac{A_s}{\bar{a}_s}\right)^2$$

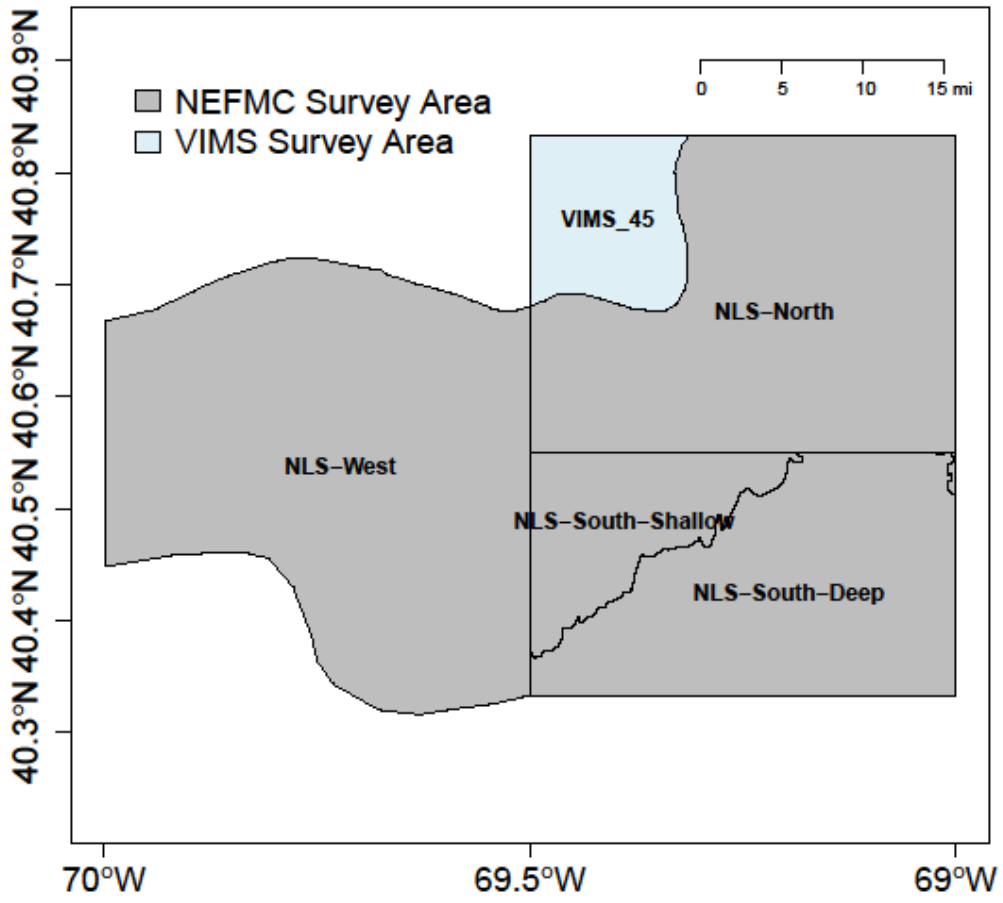
2019 SAMS Areas



MAB Survey

- 9 SAMS Areas
- Only minor changes to some area names
- VIMS surveys outside of areas & biomass in VIMS areas is included in the closest SAMS Area

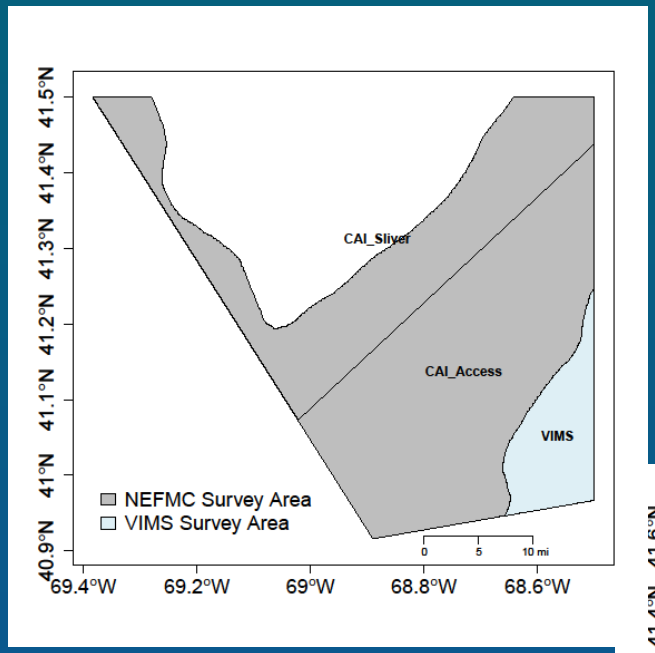
2019 SAMS Areas

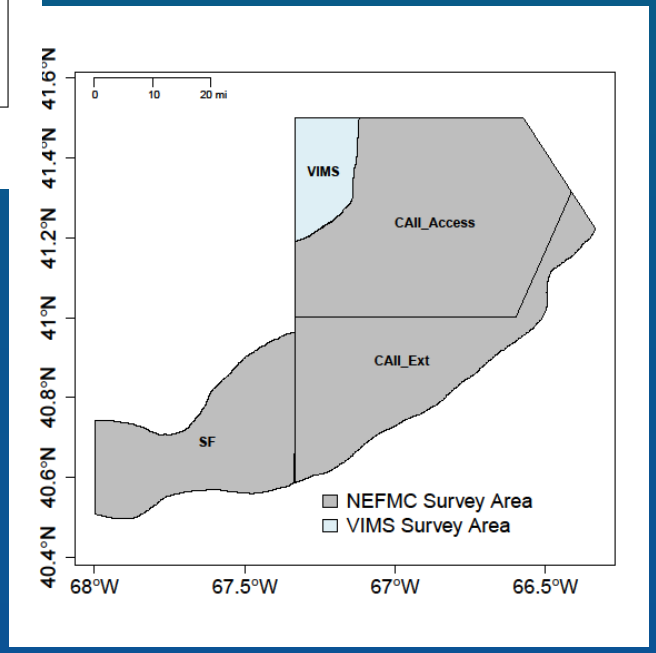


NL Survey

- 4 SAMS Areas
- 2018 Ext SAMS Area included in GSC
- VIMS surveys outside of areas & biomass in VIMS areas is calculated as a separate area

2019 SAMS Areas





CAI II Survey

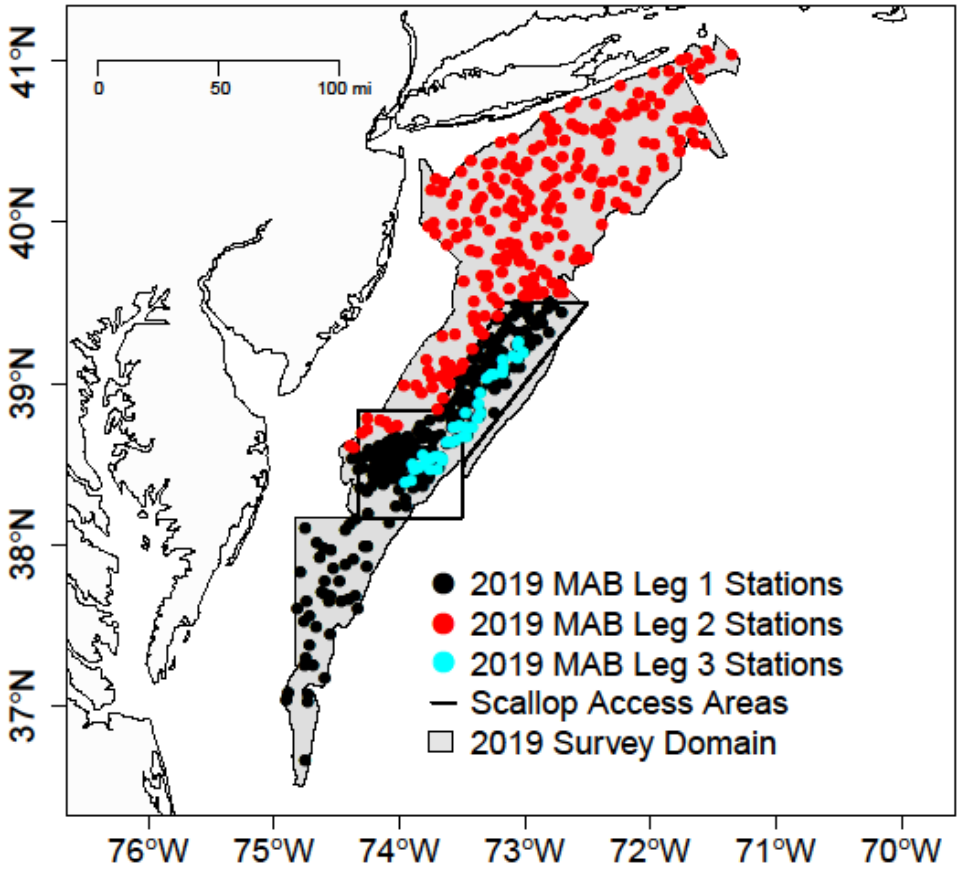
- CAI - 2 SAMS Areas
- CAII - 3 SAMS Areas

- Only changes to names

- VIMS surveys outside of areas & biomass in VIMS areas is calculated as separate areas

2019 VIMS-Industry Cooperative Surveys

MAB



First Leg
- F/V Italian Princess
- 5/10/19 – 5/19/19
- 225 Stations

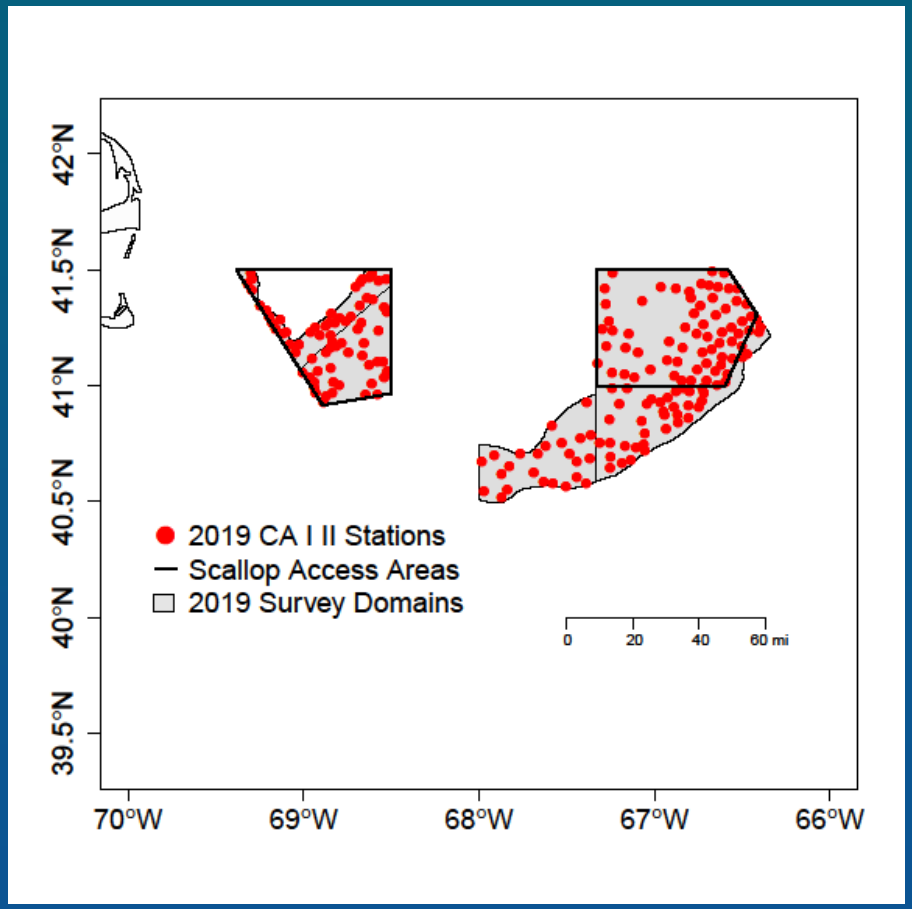
Second Leg
- F/V Carolina Capes II
- 5/22/19 – 6/2/19
- 225 Stations

Third Leg
- F/V Anticipation
- 8/12/19 – 8/15/19
- 39 Stations reoccupied from Leg 1

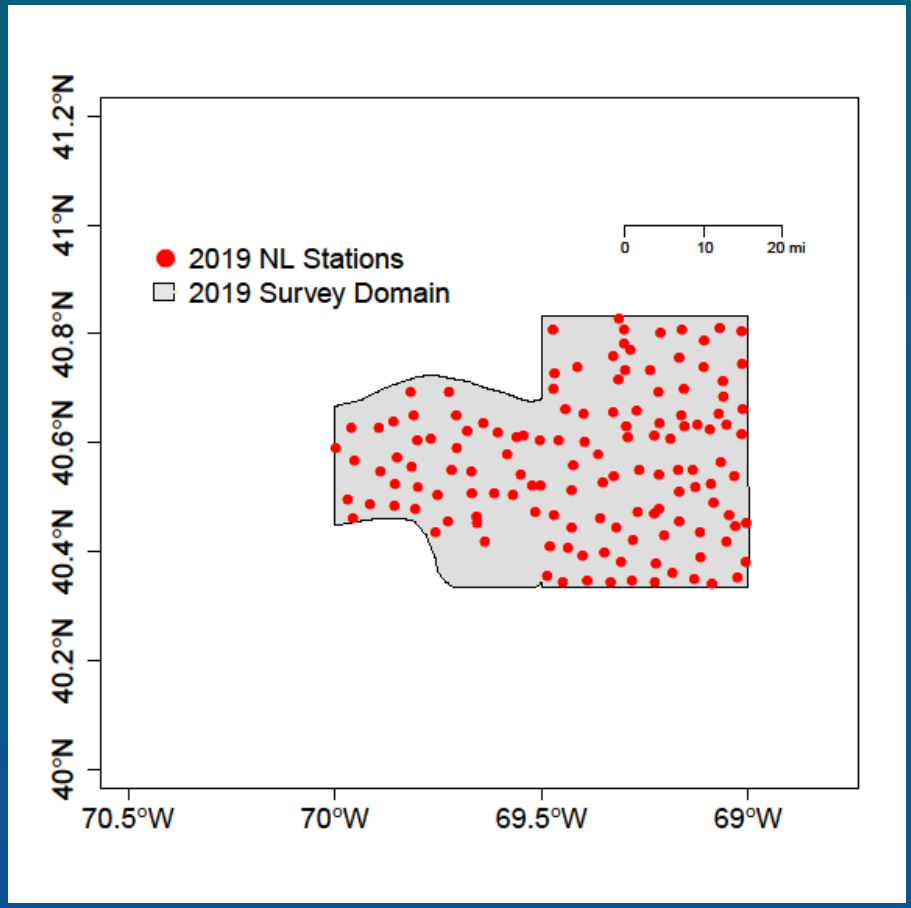
Total
- 450 Stations

2019 VIMS-Industry Cooperative Surveys

CA I II and NL

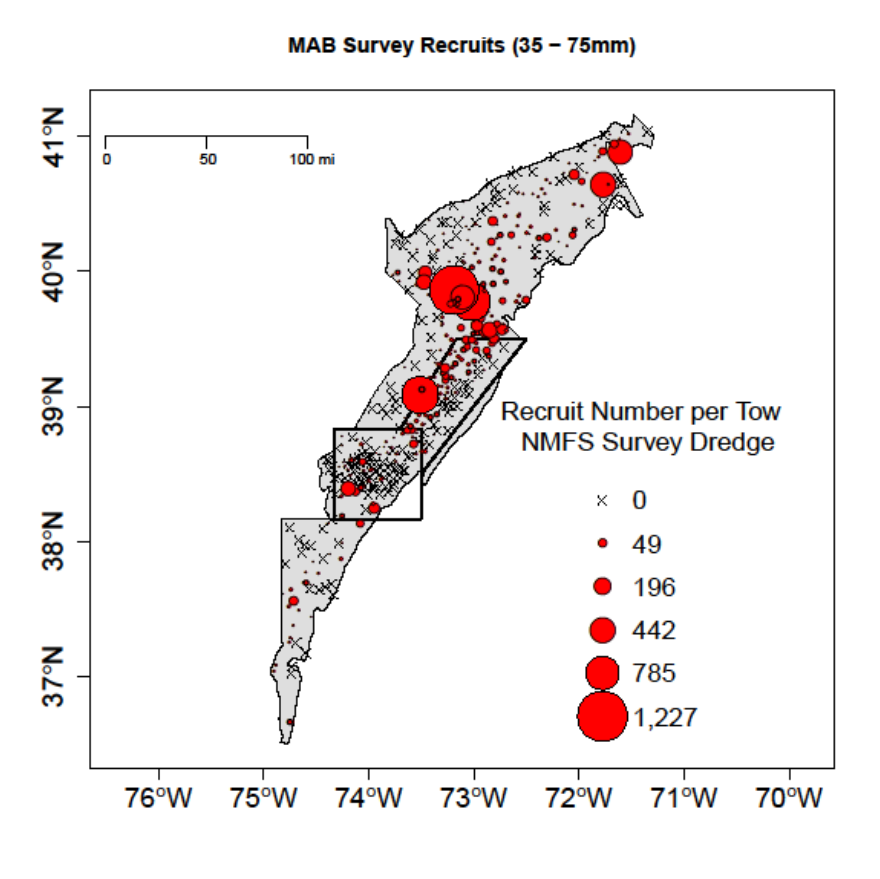


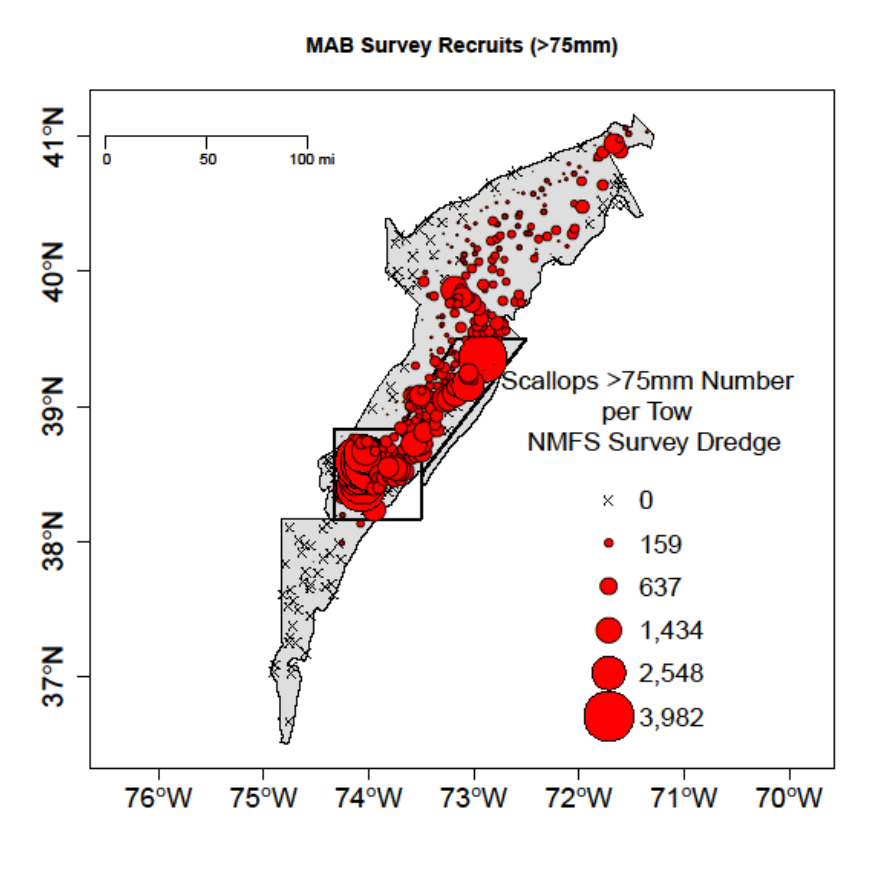
- F/V Polaris
- 6/7/19 - 6/14/19
- 200 Stations



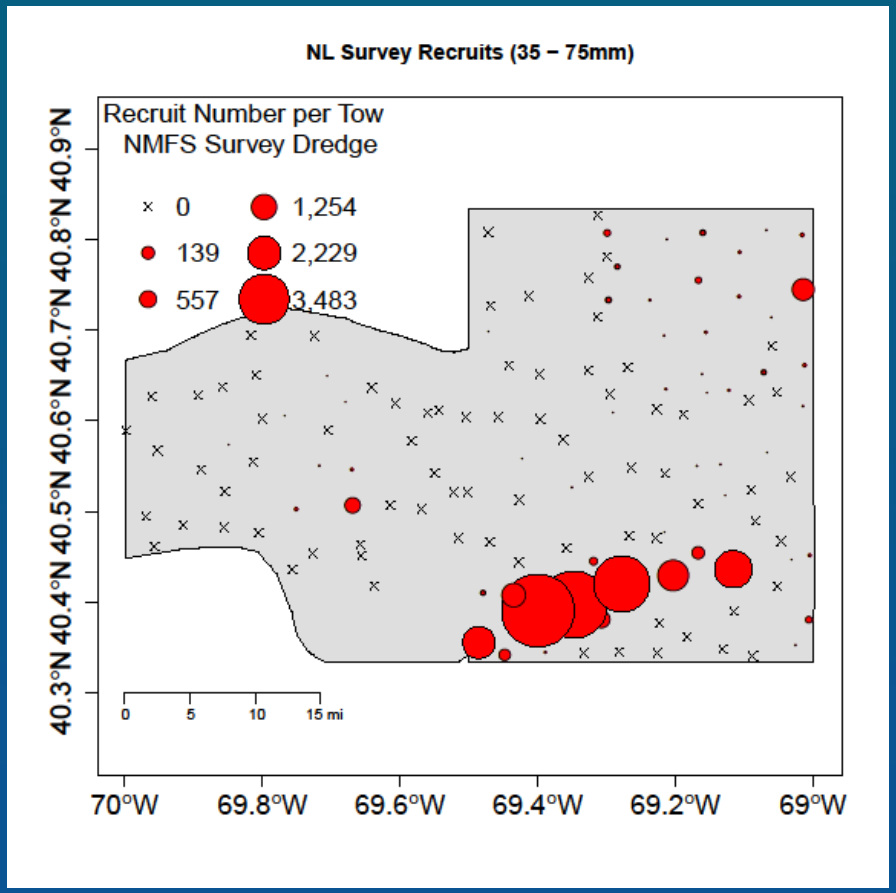
- F/V Socetean
- 7/24/19 - 7/31/19
- 135 Stations

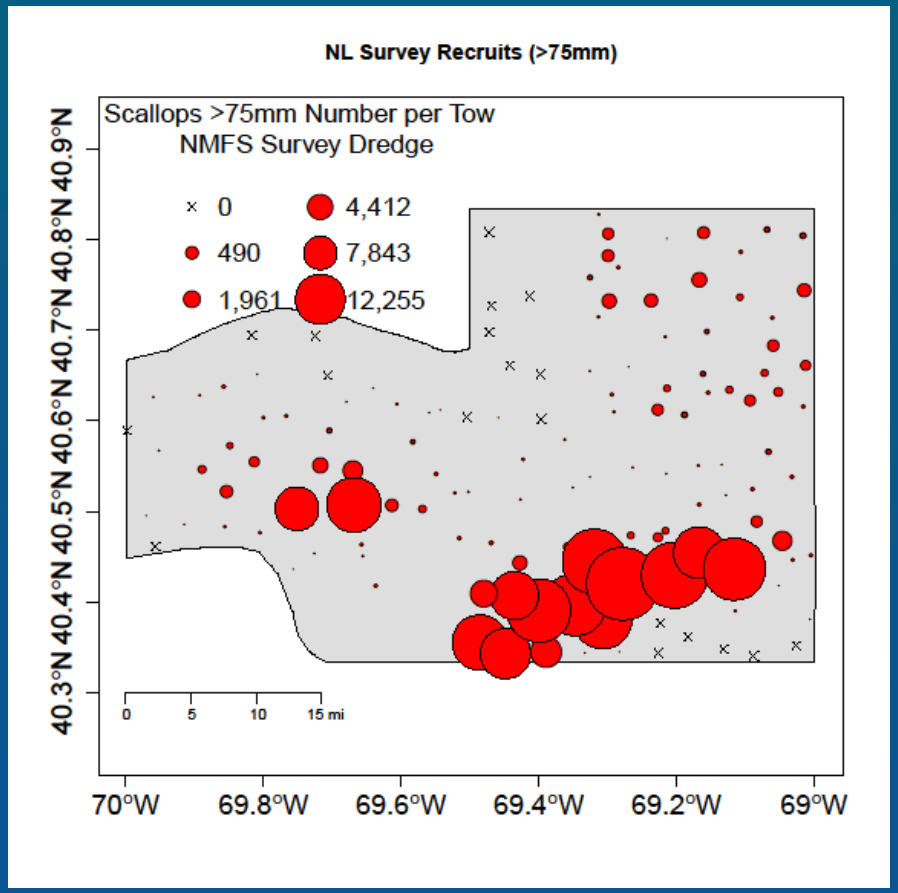
2019 MAB Survey
Scallop Distribution



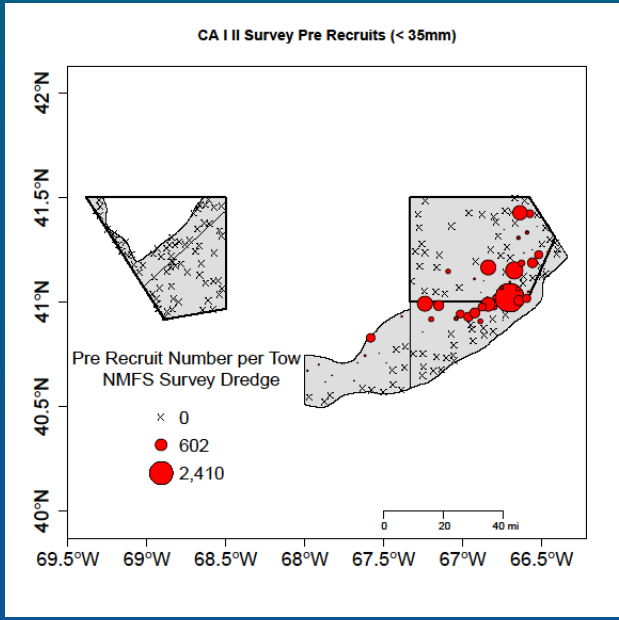


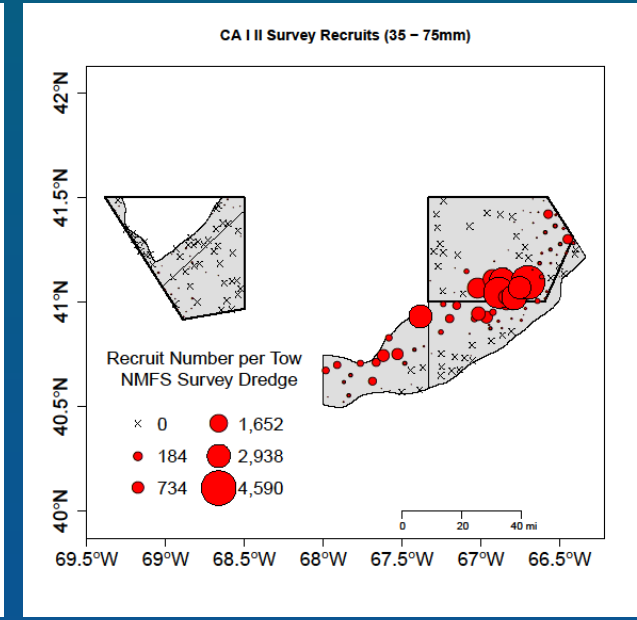
2019 NL Survey
Scallop Distribution

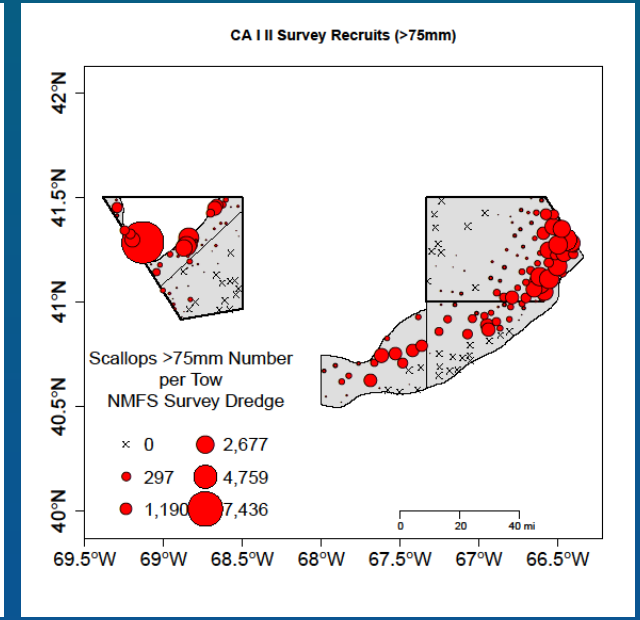




2019 CA I II Survey
Scallop Distribution



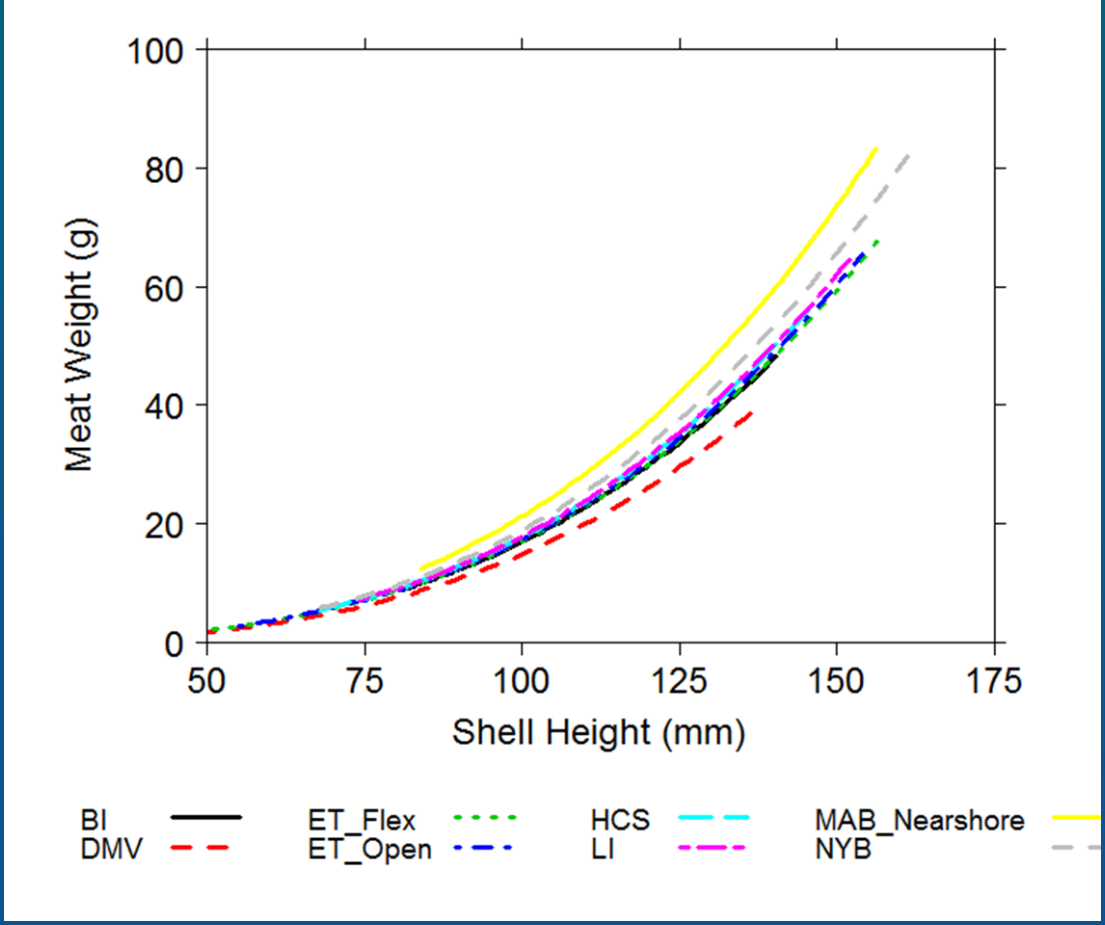




SHMW Relationship

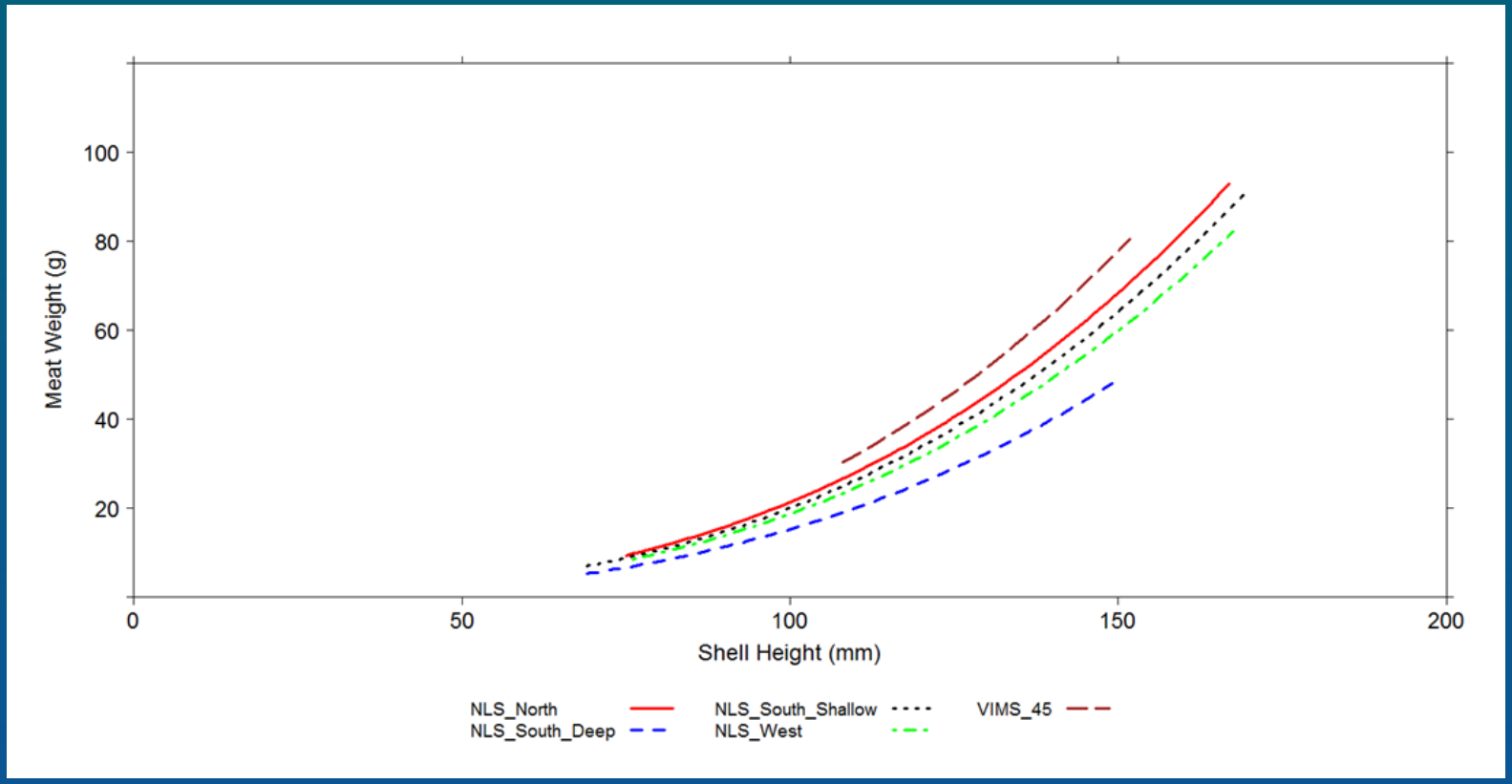
- SHMW samples (meat & gonad weight) were taken from all stations that had scallops (15/station):
  - MAB Survey: 5,510 (377 stations)
  - CA I II Survey: 2,350 (174 stations)
  - NL Survey: 1,989 (124 stations)
- The objective is to construct a model to predict meat weight based on a suite of potential 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

2019 MAB Survey
SHMW Results



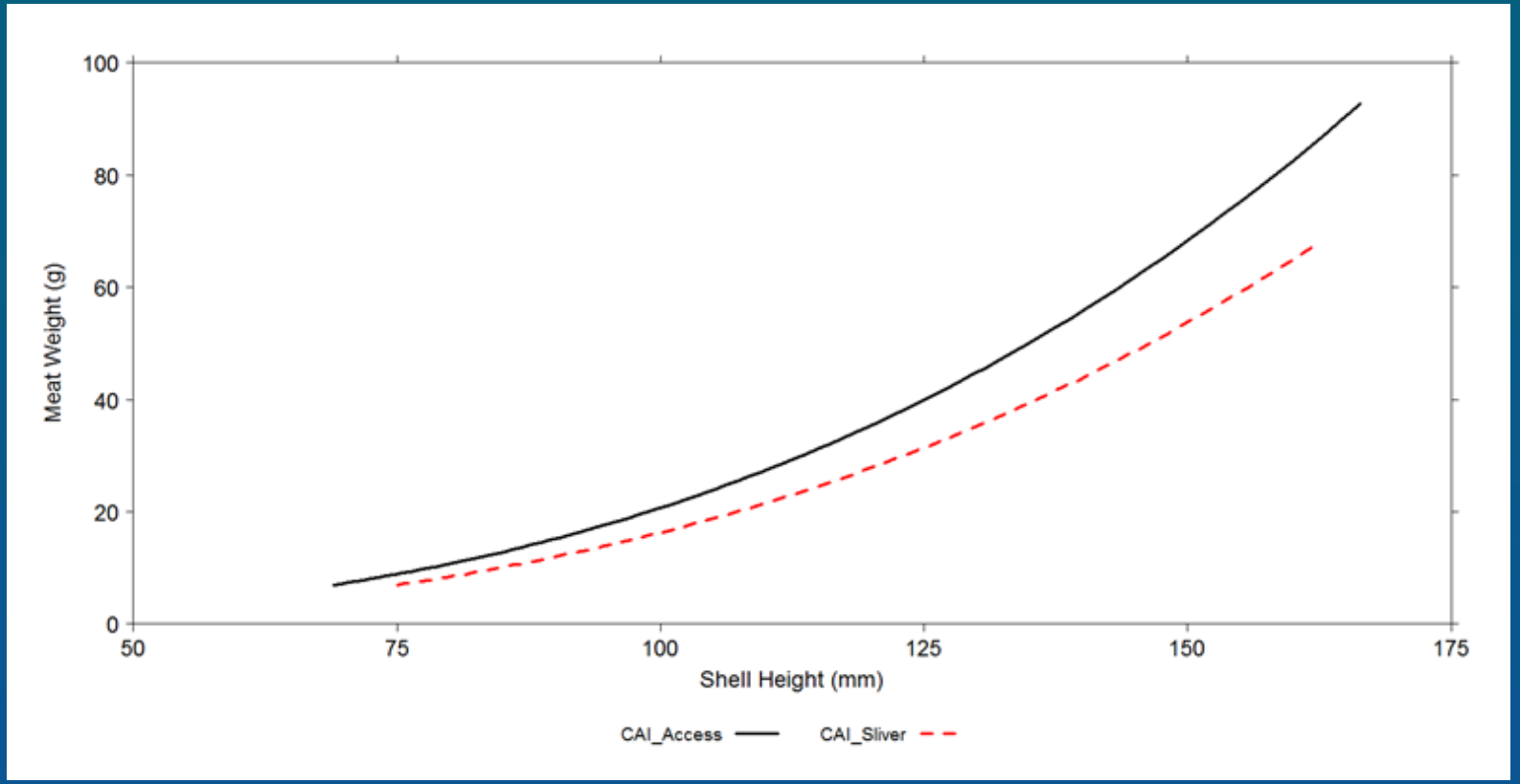
- Majority of SAMS Areas have similar SHMW relationship
- DMV has the smallest meat weight at a given shell height

2019 NL Survey
SHMW Results



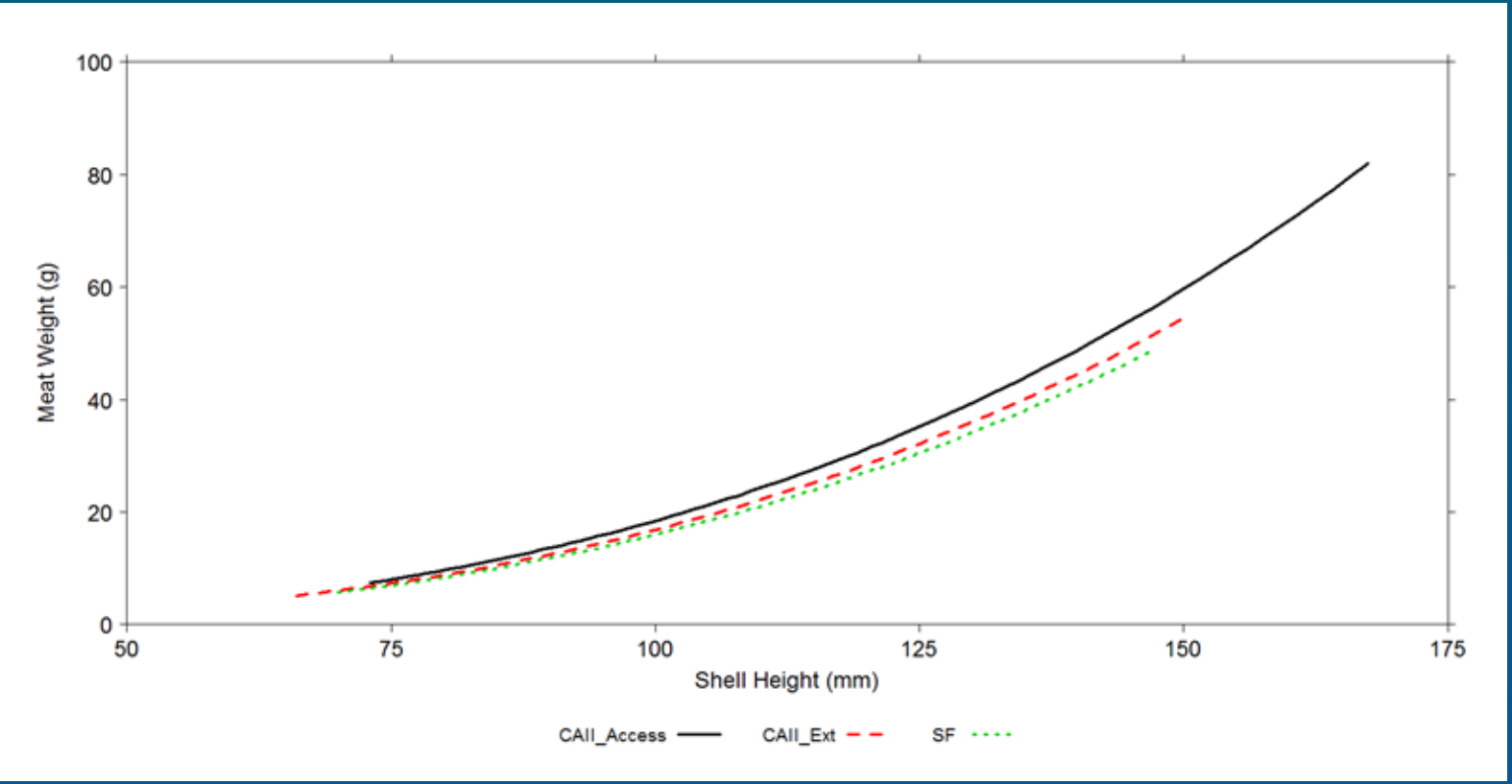
- Similar trend to previous years for the South Deep SAMS Area having the lowest meat weight at shell height
- South Deep SAMS only area significantly different than reference area: NLS-North

2019 CA I Survey
SHMW Results



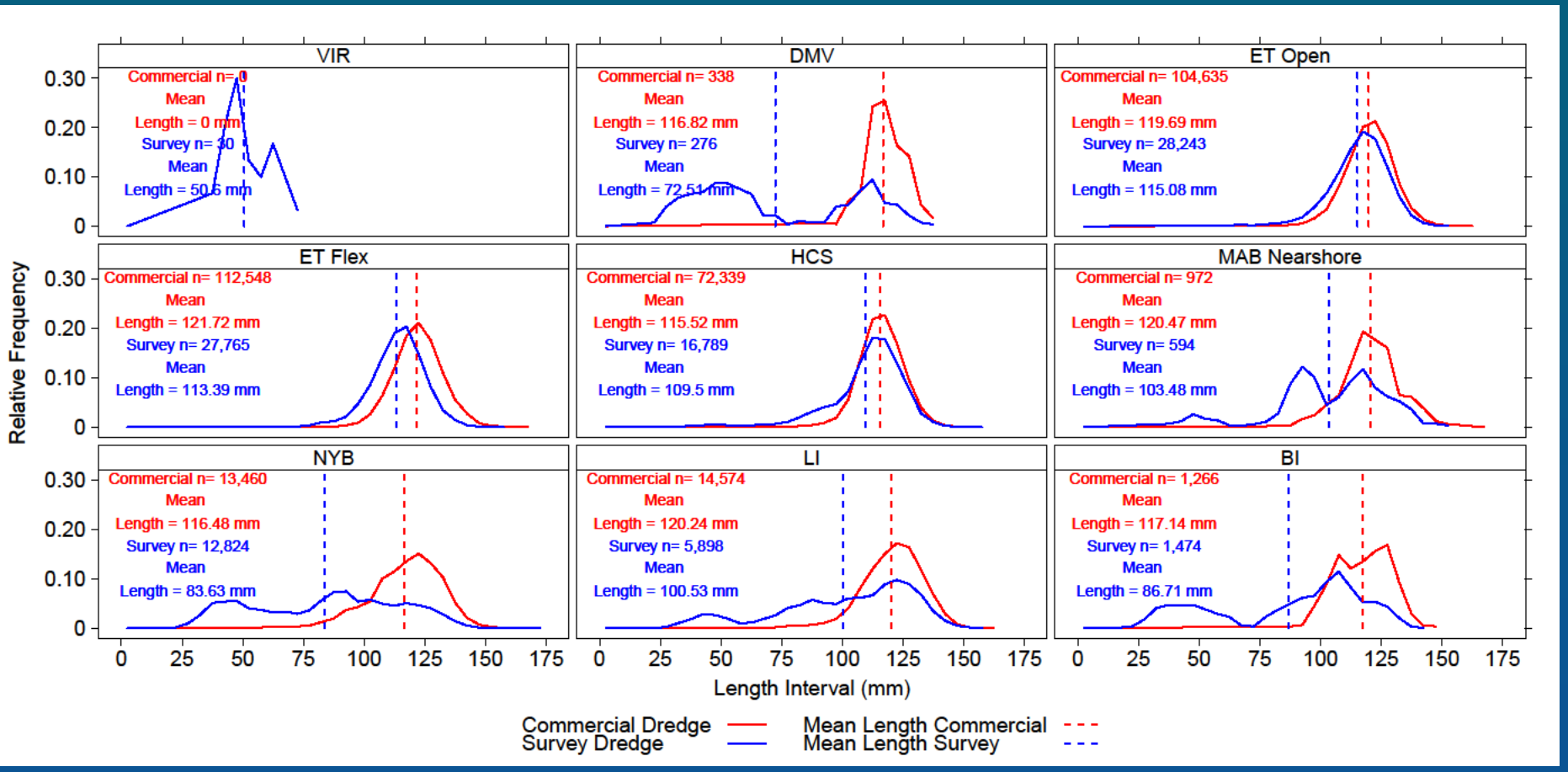
- CAI Access SAMS Areas significantly different from Sliver SAMS Area
- Likely a function of average depths for each subarea, as well as the temporal spread of the sampling

2019 CAII Survey
SHMW Results

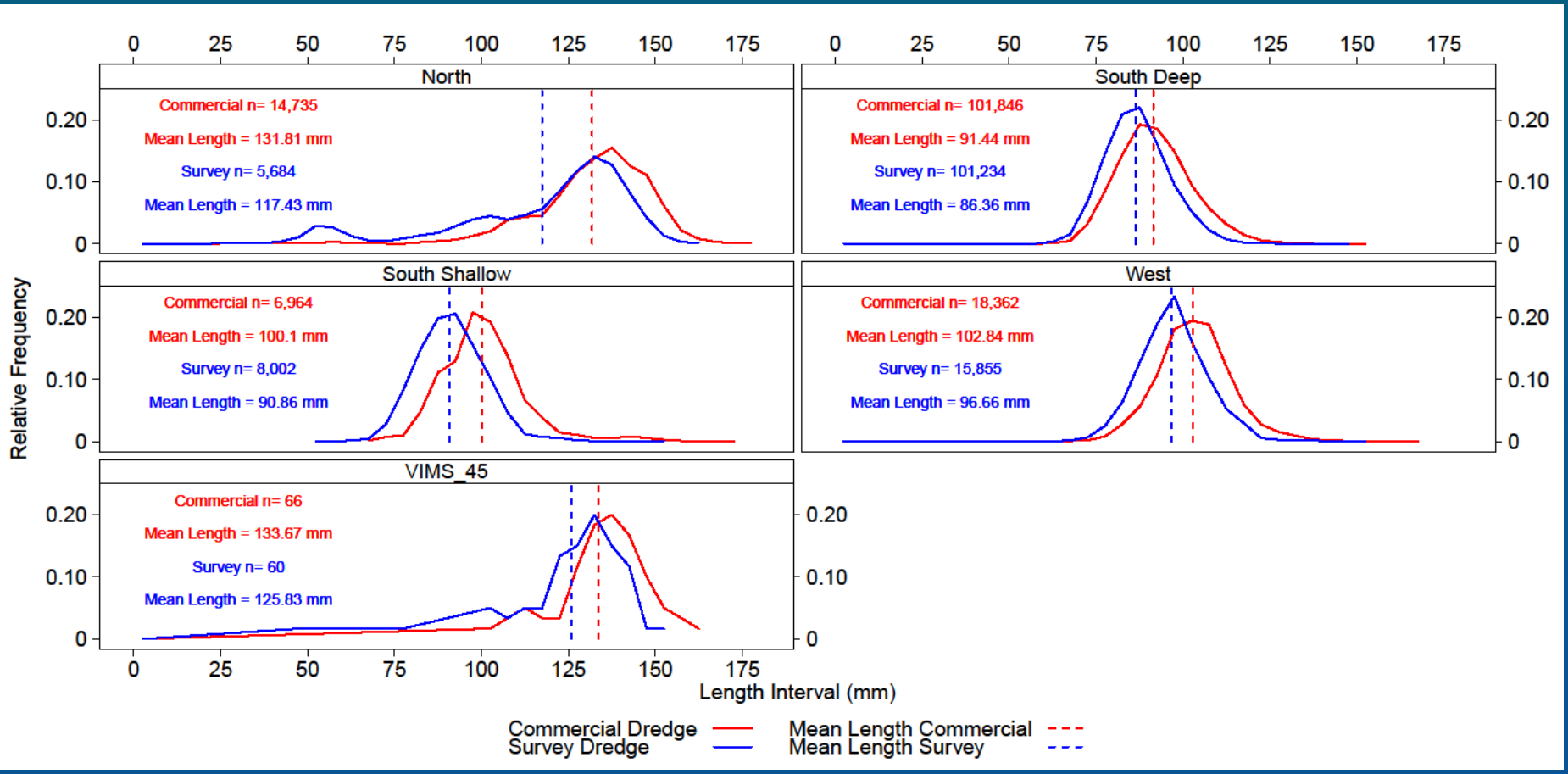


- **Extension and Open Area SF SHMW curves are lower than the Northern Access Area**

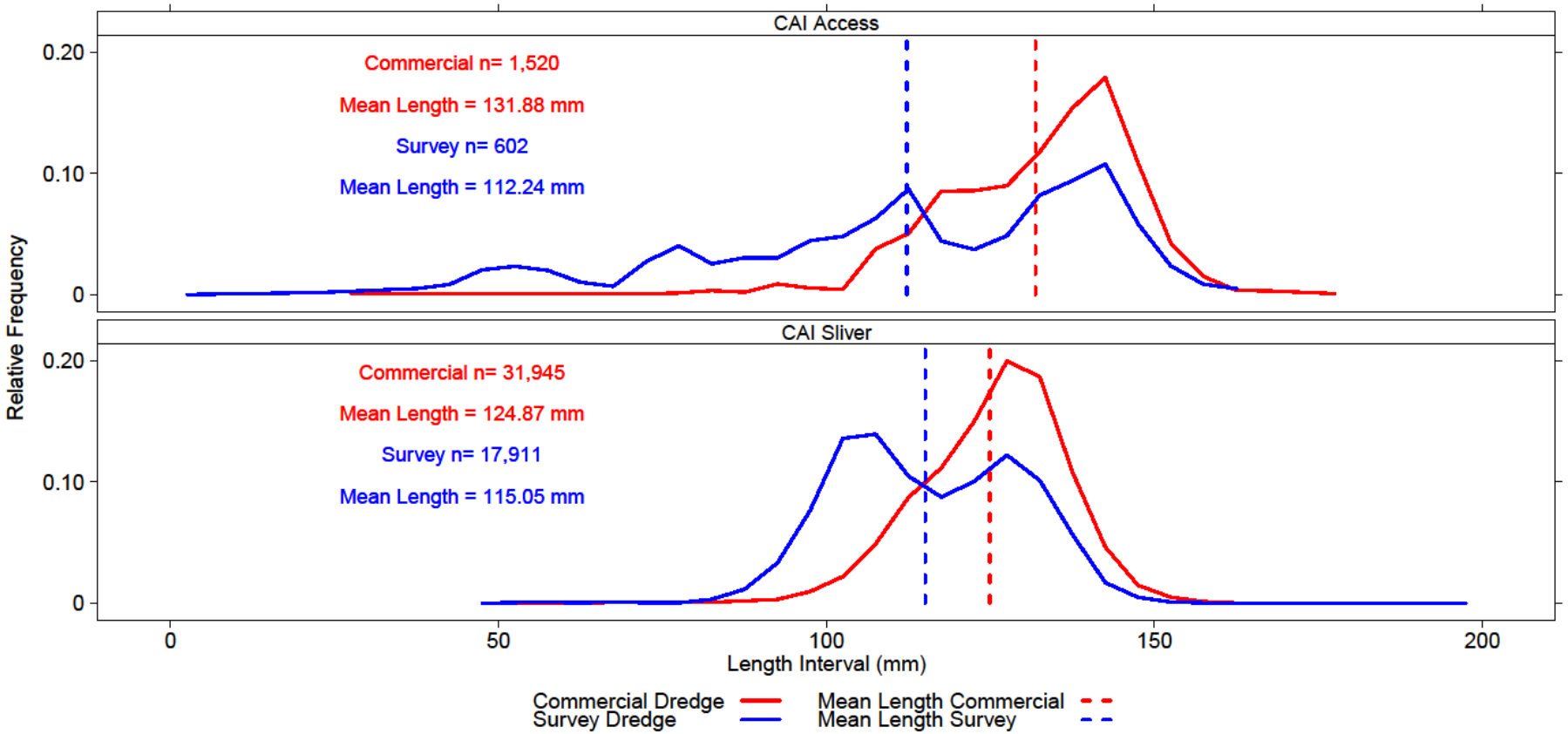
2019 MAB Survey
Length Frequency- SAMS Areas



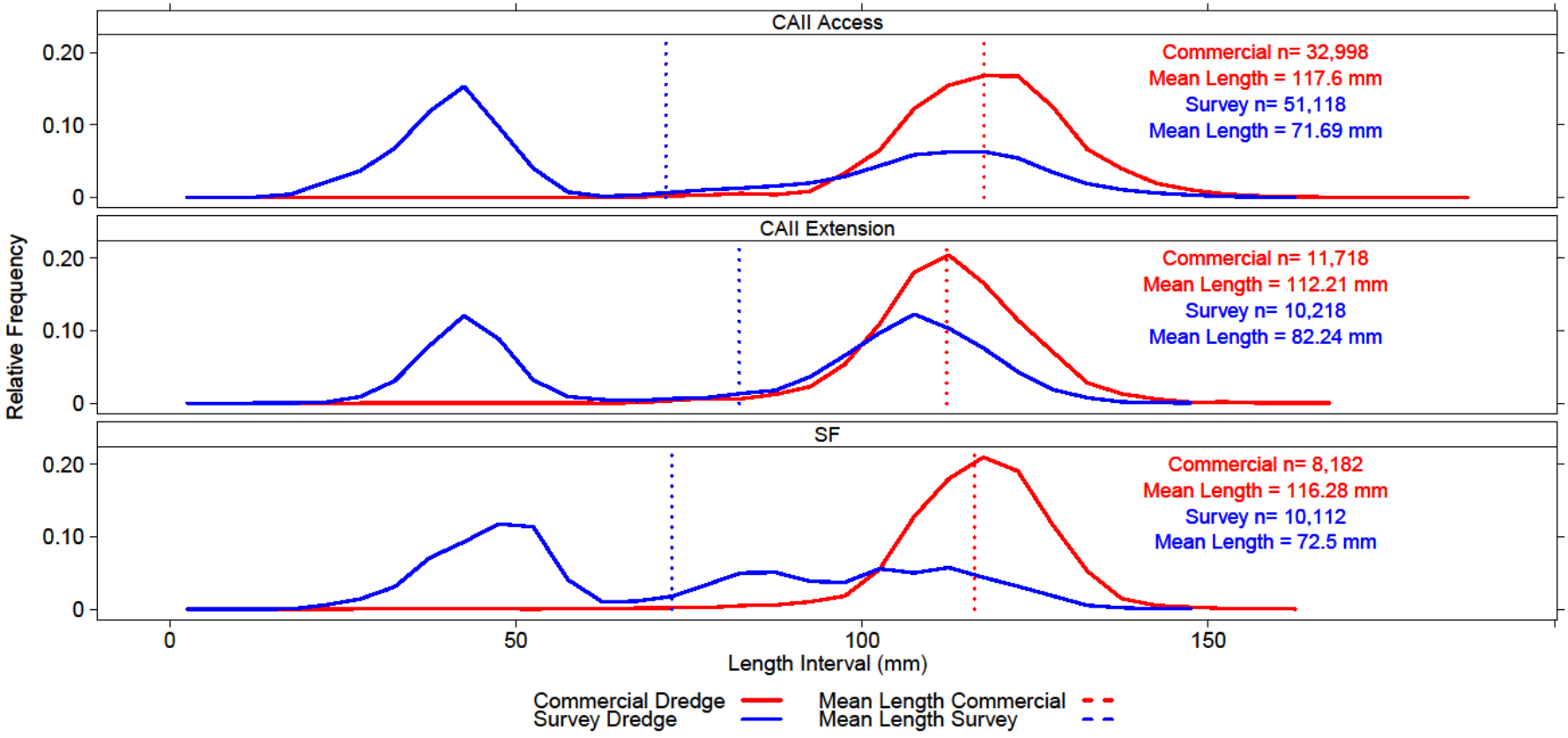
2019 NL Survey
Length Frequency- SAMS Areas



2019 CA I Survey
Length Frequency- SAMS Areas



2019 CA II Survey
Length Frequency- SAMS Areas



2019 CA II Survey
Recruitment

2019 VIMS-Industry Cooperative Surveys

Total Biomass Survey Gear – SAMS Areas

SAMS Area	Total Biomass (mt)	SE Biomass (mt)	CV Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Total Number
VIR	13.76	1.12	20.29	0.00	2.98	4,182,976
DMV	203.02	43.41	53.46	0.01	10.48	20,305,939
ET Open	15,104.89	896.65	14.84	0.30	25.84	592,011,891
ET Flex	13,528.87	1,174.25	21.70	0.44	25.46	523,603,853
HCS	8,544.00	774.62	22.67	0.13	22.63	380,404,883
MAB Nearshore	1,264.53	180.52	35.69	0.02	23.67	53,427,827
NYB	7,424.97	522.70	17.60	0.12	14.84	537,825,315
LI	9,079.02	349.85	9.63	0.03	22.44	407,307,126
BI	1,514.65	254.05	41.93	0.11	17.33	94,885,840
NLS North	3,368.23	209.81	15.57	0.08	41.26	81,516,050
NLS South Deep	11,897.84	1,181.65	24.83	1.62	10.11	1,176,063,622
NLS South Shallow	1,721.07	425.60	61.82	0.40	14.64	117,563,486
NLS West	3,276.12	663.54	50.63	0.20	16.68	195,268,579
VIMS 45	82.57	29.51	89.33	0.01	49.51	1,667,620
CAI Access	693.40	83.55	30.12	0.02	35.57	18,434,122
CAI Sliver	7,856.85	911.86	29.01	0.32	29.54	258,991,330
CAII Access	20,689.43	1,129.01	13.64	0.56	15.49	1,670,993,750
CAII Ext	5,567.79	565.55	25.39	0.17	17.49	312,054,690
SF	6,437.53	646.95	25.12	0.29	12.15	529,788,692

2019 VIMS-Industry Cooperative Surveys

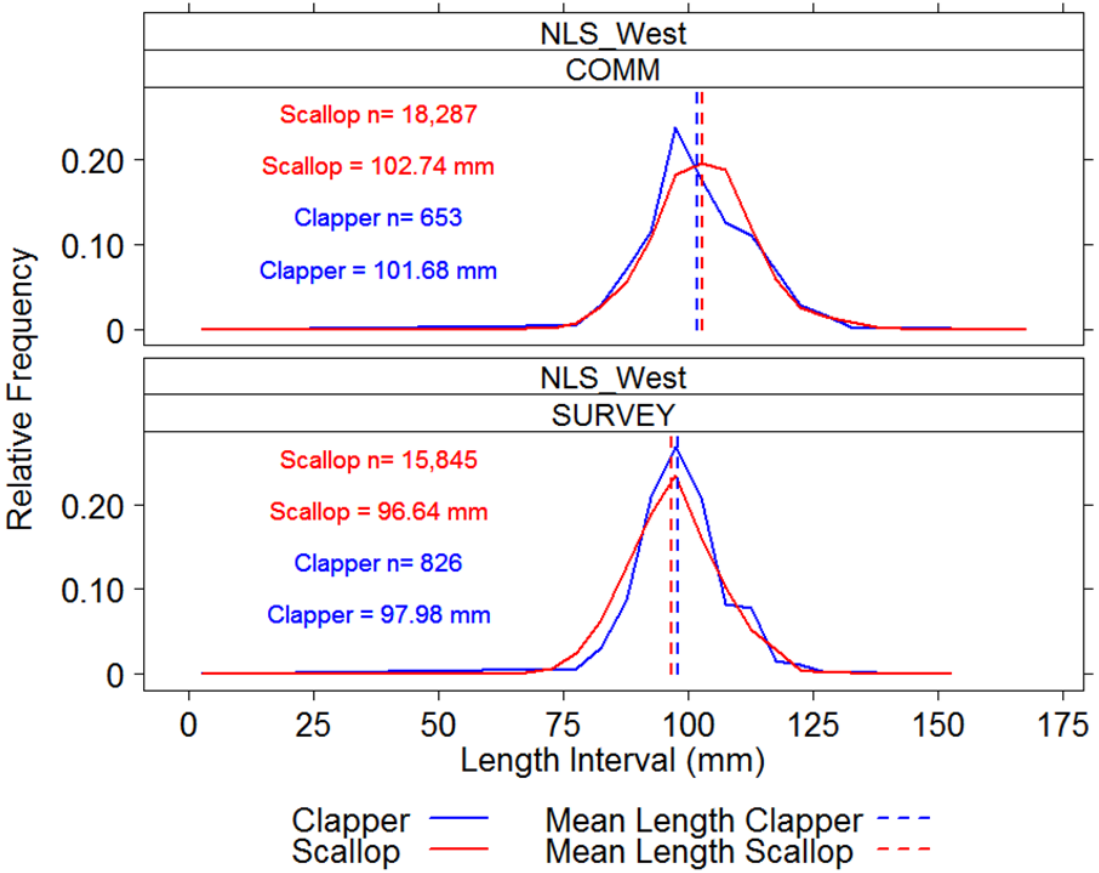
Exploitable Biomass Commercial Gear - SAMS Areas

SAMS Area	Exp Biomass (mt)	SE Biomass (mt)	CV Biomass (mt)	Density (scal/m^2)	Avg MW (g)	Exp Number
VIR	0.00	0.00	0.00	0.00	0.00	0.00
DMV	173.98	66.99	59.24	0.00	26.38	6,574,359.16
ET Open	18,883.50	1,437.89	11.71	0.37	29.10	639,647,357.29
ET Flex	18,691.29	2,682.01	22.08	0.54	31.25	601,828,611.86
HCS	10,986.92	1,122.82	15.72	0.16	25.79	428,387,241.60
MAB Nearshore	861.19	192.73	34.43	0.01	34.06	25,293,944.23
NYB	3,880.14	264.69	10.49	0.03	31.02	127,356,560.41
LI	9,437.00	546.96	8.92	0.02	33.50	282,714,230.41
BI	705.68	128.19	27.95	0.03	32.26	21,781,182.10
NLS North	4,118.83	339.75	12.69	0.07	54.68	75,192,779
NLS South Deep	2,200.75	396.60	27.73	0.21	14.63	150,332,552
NLS South Shallow	448.49	115.78	39.72	0.07	23.26	19,279,540
NLS West	1,080.04	308.25	43.91	0.05	22.19	47,986,968
VIMS_45	37.93	21.70	88.02	0.00	58.85	644,404
CAI Access	957.27	135.98	21.85	0.01	51.91	18,194,175
CAI Sliver	6,438.48	1,076.98	25.73	0.20	39.34	162,369,294
CAII Access	9,690.29	817.91	12.99	0.11	38.06	244,325,929
CAII Ext	3,258.13	486.51	22.97	0.05	32.06	100,845,369
SF	4,193.63	704.08	25.83	0.07	32.86	127,630,804

SARC 65 Total Biomass Estimates Compared to VIMS 2016-19 Estimates NL

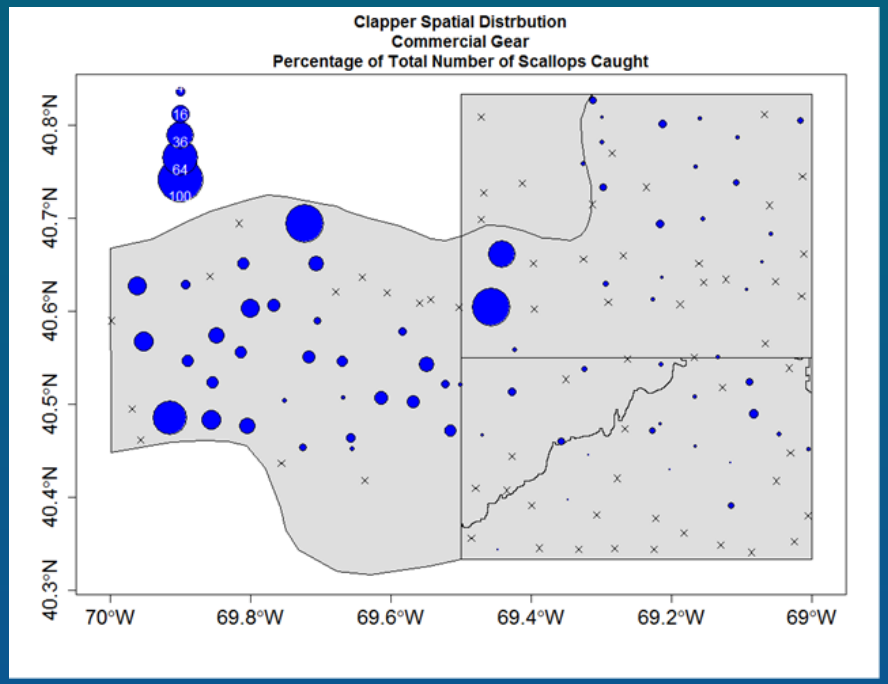
SAMS Area	Total Biomass (mt)- SARC 65	Total Biomass (mt) VIMS 2016-19
NLS North	3,613.91	3,368.23
NLS South Deep	11,955.05	11,987.84
NLS South Shallow	2,402.17	1,721.06
NLS West	4,732.83	3,276.12
VIMS 45	90.47	82.58

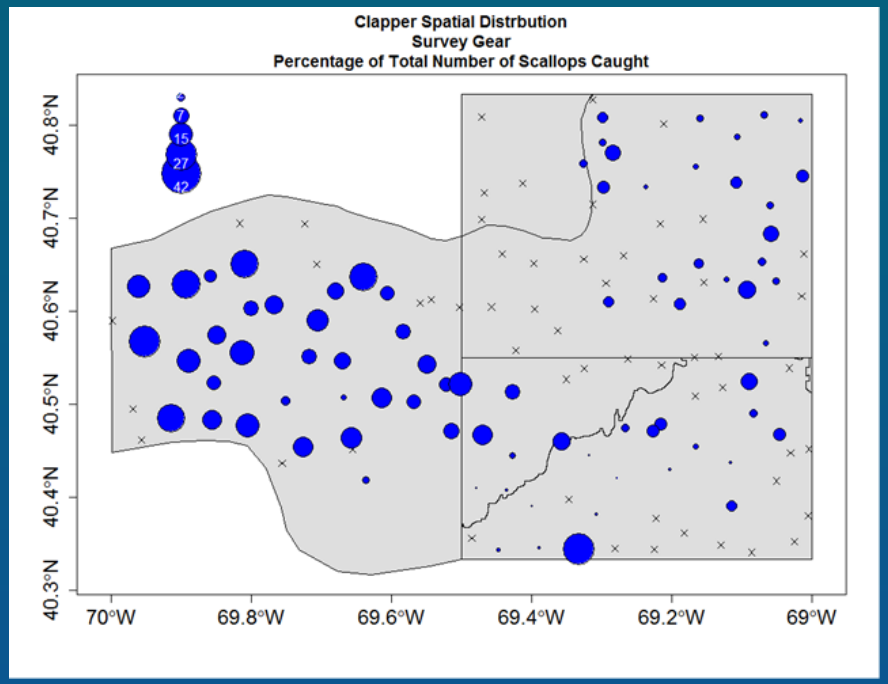
NLS West Clappers



- Observed large quantities of clappers in the NLS-West SAMS Area
- Maybe an indication of higher than expected discard and/or incidental mortality.
- This information may provide insight into potential fishery behavior in the South Deep SAMS Area in the future, due to the size range of scallops in this SAMS Area.

NLS West Clappers





- **The percentage of clappers in the catch was greatest in the NLS-West SAMS Area for both gears**
- **Percentage of clappers in both dredges ranged from 1 to 26%.**

Acknowledgements

- The owners, captains and crews:
  - *F/V Carolina Capes II*
  - *F/V Italian Princess*
  - *F/V Polaris*
  - *F/V Socetean*
- Scientific Staff:
  - Lee Rollins, Kelly Lewis, Victoria Thomas, and Sarah Borsetti
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