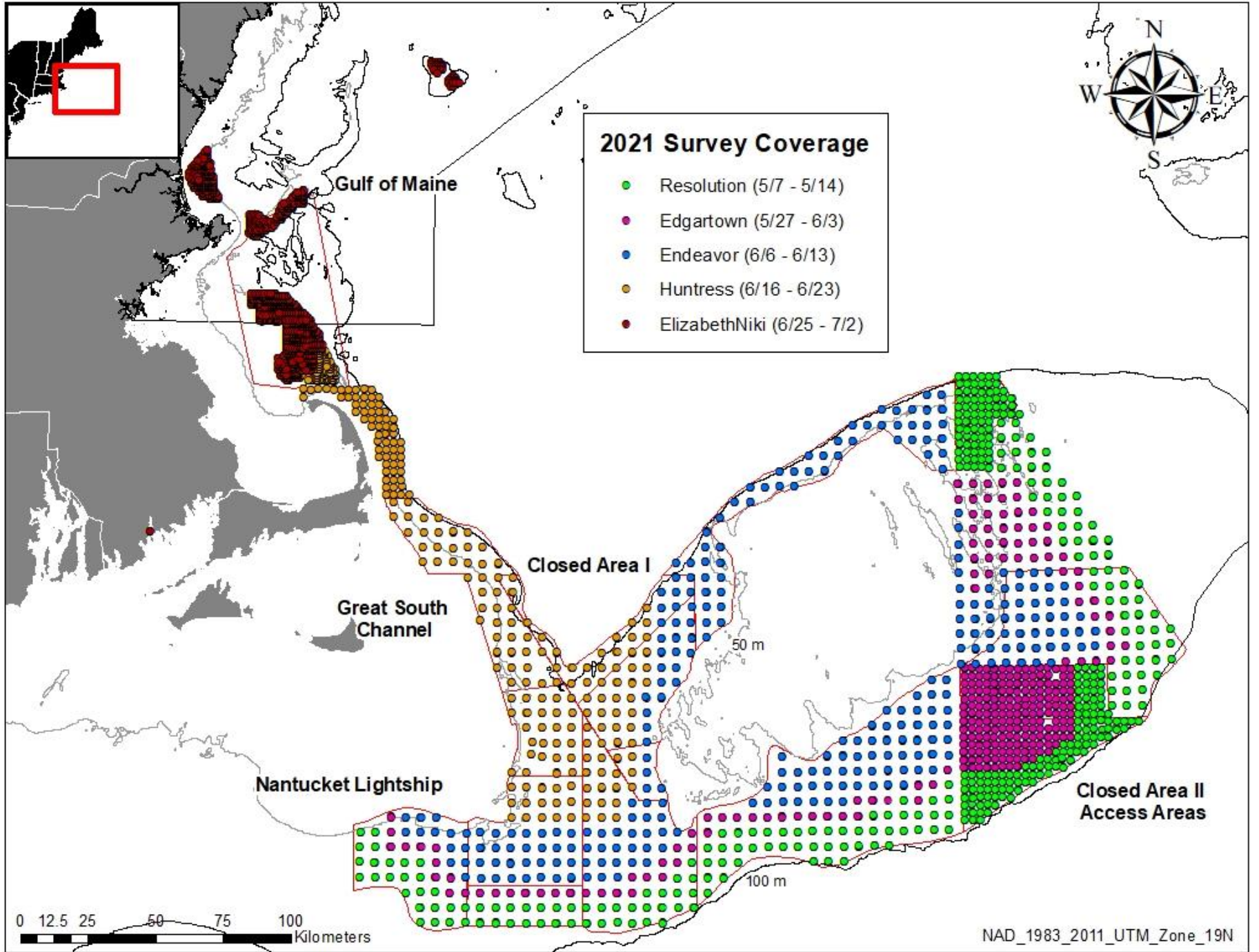


2021 SMAST Drop Camera Survey Results

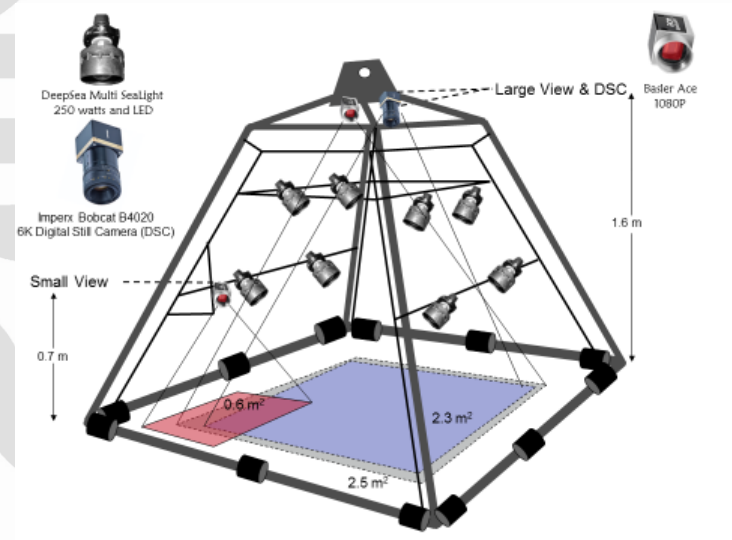
**Kyle S. Cassidy and Kevin D.E. Stokesbury
Scallop PDT Meeting
September 1, 2021**



**Department of Fisheries Oceanography
School for Marine Science and Technology
University of Massachusetts Dartmouth**



Drop Camera Survey Pyramid



Large View (2.5 m²)



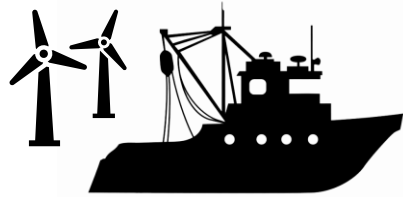
Small View (0.6 m²)



GB3
Station: 17 Quadrat: 1
Temperature: 7.23°C
Depth: 42.04 Fathom
40.442425N 69.296777W
9:51:15.000 AM 5/19/2017

Digital Still Camera (2.3 m²)

Remote Processing



At-Sea Data Collection



Upload survey data to webserver

- 1. Image Annotation
- 2. Video replay for accuracy
- 3. QA/QC

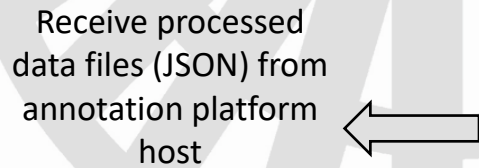
All occurs on the Web Interface to prevent unnecessary personal contact



Finalized Data Product



Import finalized data to Umass database



Receive processed data files (JSON) from annotation platform host



2021 Shell Height – Meat Weight Equations

NLS-South

$$\text{SARC65: } W = \exp(-11.84 + 3.167 * \ln(\text{shell height}))$$

$$\text{VIMS: } W = \exp(-22.64 + (2.87 * \ln(\text{shell height})) + (-0.23 * \ln(\text{depth}) + (0.33 * \text{latitude}) - 0.24))$$

Georges Bank

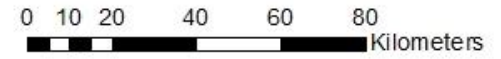
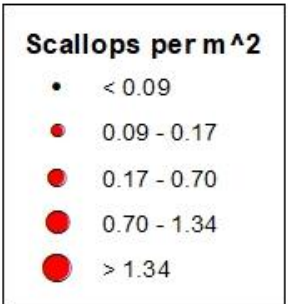
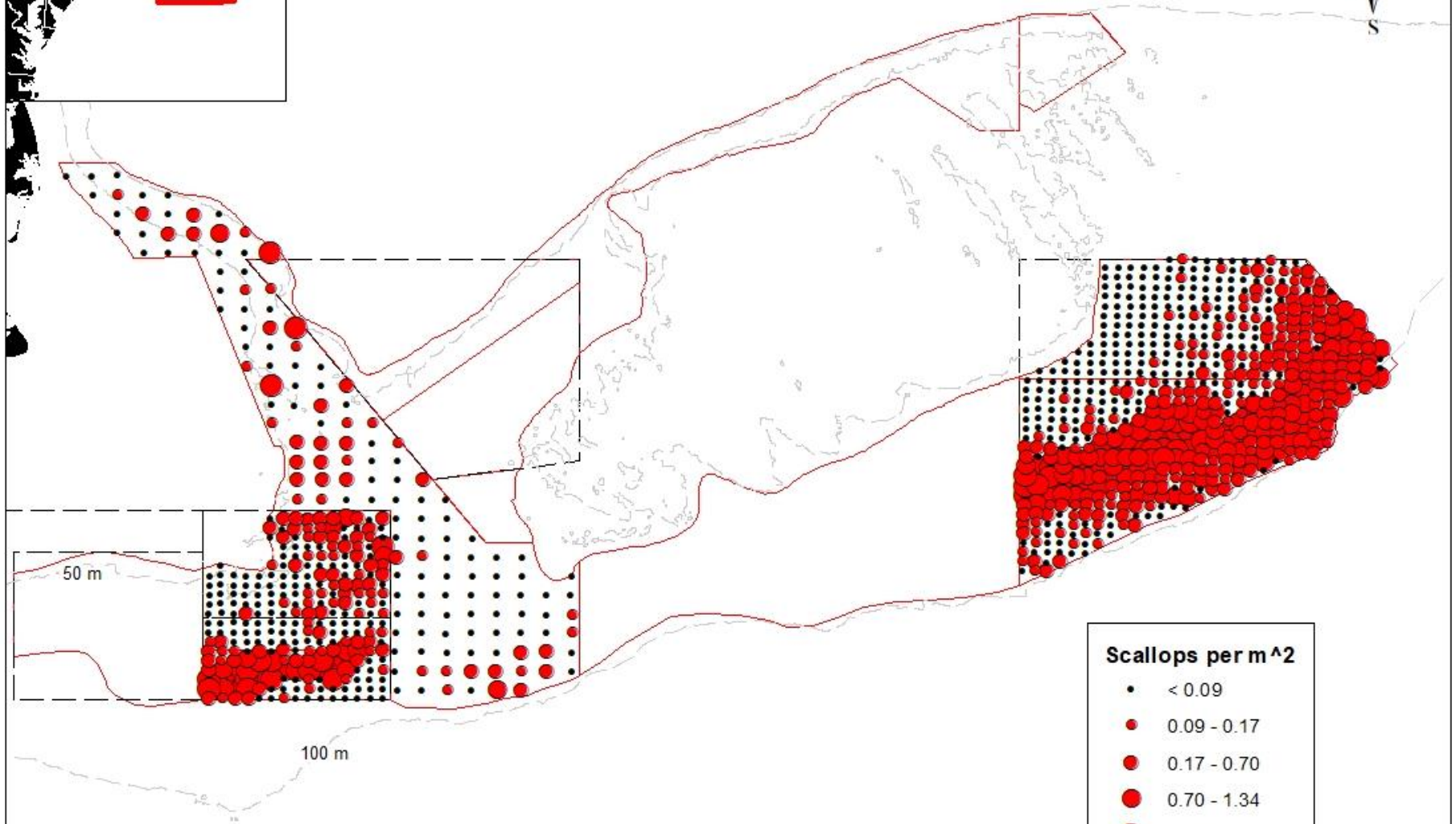
$$W = \exp(-6.69 + 2.878 * \ln(\text{shell height}) + -0.0073 * \text{depth} + -0.073 * \text{latitude} + 1.28 * \text{Clop} + -0.25 * (\ln(\text{shell height}) * \text{Clop}))$$



*40mm cutoff	Quad Area	mean SH	# Measu	Density per m2	Stations	SE	CV%	Area km2	Latitude	Depth
GB NLS-North-3nm SAW 65	2.48	90.4	12	0.06	42	0.033	50.58	1297	40.7	67.7
GB NLS-West-3nm SAW 65	2.49	93.0	3	0.01	49	0.054	821.78	1513	40.5	64.6
GB NLS-South_Deep-3nm SAW 65	2.48	91.2	308	3.10	21	1.303	41.99	648	40.4	76.3
GB NLS-South_Deep-3nm VIMS equ	2.48	91.2	308	3.10	21	1.303	41.99	648	40.4	76.3
GB CAI-South-3nm SAW 65	2.34	47.2	1	0.01	8	0.013	100.00	247	40.9	75.0
GB CAI-Sliver-3nm SAW 65	2.41	69.7	23	0.15	29	0.050	33.95	895	41.3	94.5
GB CAI-Access-3nm SAW 65	2.47	89.3	17	0.05	39	0.027	50.53	1204	41.1	80.7
GB NF-3nm SAW 65	2.48	90.3	16	0.06	54	0.021	36.87	1667	41.8	76.9
GB SF-3nm SAW 65	2.47	89.2	185	0.18	129	0.045	24.56	3982	40.8	81.6
GB CL2-North-3nm SAW 65	2.43	76.9	32	0.27	16	0.104	38.54	494	42.1	51.2
GB CL2-Access-SE-3nm SAW 65	2.45	82.9	189	0.29	85	0.080	27.83	2624	41.2	90.0
GB CL2-Ext-1.5nm SAW 65	2.49	92.7	985	0.79	179	0.101	12.75	1381	40.9	81.4
GB CL2-Access-SW-1.5nm SAW 65	2.52	103.5	578	0.59	134	0.103	17.51	1034	41.0	72.9
GB Outer CC-1.5nm SAW 65	2.48	91.4	20	0.04	66	0.011	26.28	509	42.0	67.9
GB Eastern NonSAMS-3nm SAW 65	2.40	66.9	10	0.01	99	0.008	58.56	3056	41.9	60.5
GB GSC-South-3nm SAW 65	2.47	89.0	24	0.04	76	0.014	31.15	2346	40.6	85.0
GB GSC-Middle-3nm SAW 65	2.50	98.1	47	0.23	27	0.056	24.63	833	41.0	61.5
GB GSC-North-3nm SAW 65	2.48	90.9	60	0.17	47	0.038	22.20	1451	41.5	57.1
GSC split Totals			131		150			4630		
GB-GSC-All-3nm SAW 65	2.49	93.2	131	0.12	150	0.019	16.05	4630	41.2	63.4

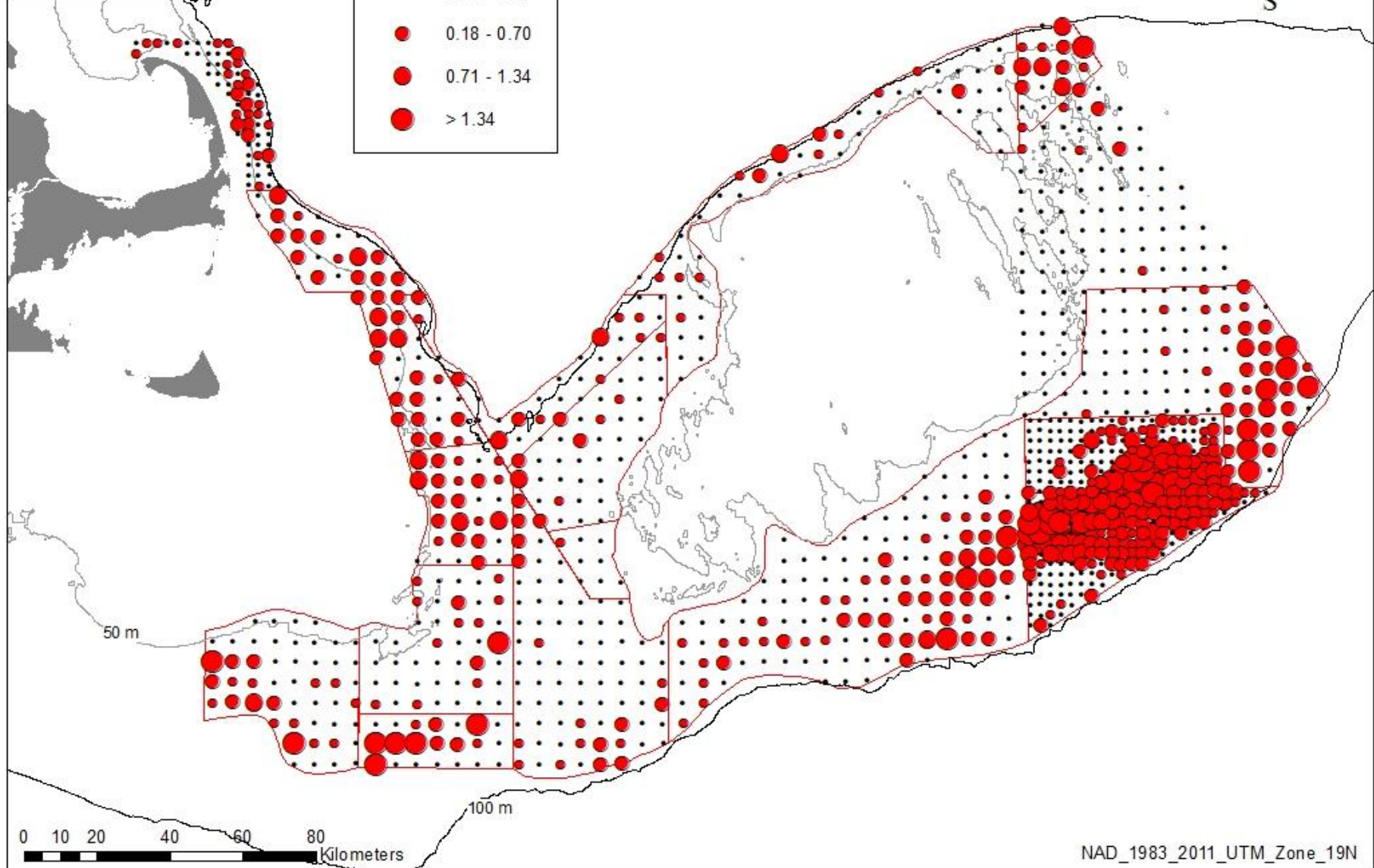
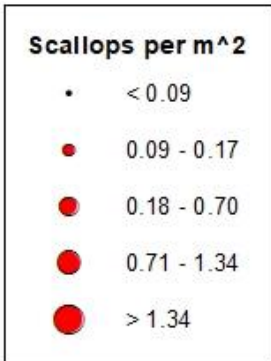
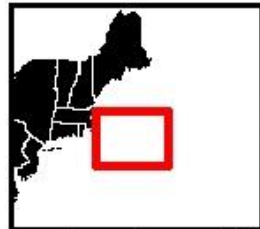
	Estimation of Total Biomass					Estimation of Exploitable Biomass				
	mean mwt	mill lbs	in mt	SE	NumMils	mean mwt	mill lbs	in mt	SE	NumMils
GB NLS-North-3nm SAW 65	22.0	4.0	1,830	926	83	37.7	2.9	1,328	672	35
GB NLS-West-3nm SAW 65	20.4	0.4	202	1,658	10	26.2	0.2	97	799	4
GB NLS-South_Deep-3nm SAW 65	12.1	53.5	24,263	10,188	2,012	14.0	19.7	8,957	3,761	638
GB NLS-South_Deep-3nm VIMS equ	11.4	50.7	23,009	9,662	2,012	13.1	18.5	8,383	3,520	638
GB CAI-South-3nm SAW 65	1.8	0.0	6	6	3	1.8	0.0	0	0	0
GB CAI-Sliver-3nm SAW 65	8.6	2.5	1,125	382	131	23.5	1.2	530	180	22
GB CAI-Access-3nm SAW 65	19.2	2.8	1,254	634	65	38.5	1.9	864	437	22
GB NF-3nm SAW 65	17.7	3.7	1,665	614	94	32.2	2.3	1,062	391	33
GB SF-3nm SAW 65	15.7	25.4	11,516	2,829	734	21.6	11.2	5,061	1,243	235
GB CL2-North-3nm SAW 65	14.1	4.2	1,886	727	134	30.3	2.0	919	354	30
GB CL2-Access-SE-3nm SAW 65	12.6	20.9	9,464	2,634	753	23.4	10.3	4,673	1,300	199
GB CL2-Ext-1.5nm SAW 65	17.4	41.9	18,983	2,420	1,093	23.2	21.0	9,513	1,213	410
GB CL2-Access-SW-1.5nm SAW 65	24.2	32.5	14,724	2,578	608	28.3	20.5	9,292	1,627	329
GB Outer CC-1.5nm SAW 65	21.3	1.0	449	118	21	41.6	0.7	324	85	8
GB Eastern NonSAMS-3nm SAW 65	9.8	0.9	386	226	40	21.9	0.3	154	90	7
GB GSC-South-3nm SAW 65	17.2	3.9	1,775	553	103	25.6	2.3	1,046	326	41
GB GSC-Middle-3nm SAW 65	25.7	10.7	4,872	1,200	190	37.1	7.5	3,387	834	91
GB GSC-North-3nm SAW 65	23.2	12.6	5,716	1,269	246	43.5	9.0	4,081	906	94
GSC split Totals		27.3	12,363		539		18.8	8,514		226
GB-GSC-All-3nm SAW 65	22.9	27.2	12,338	1,980	539	37.5	18.7	8,481	1,361	226

2020

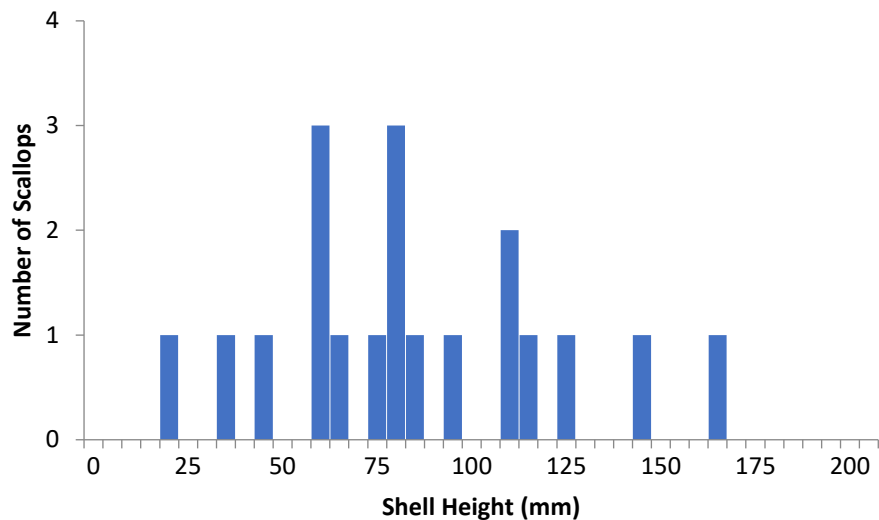


NAD_1983_UTM_Zone_19N

2021

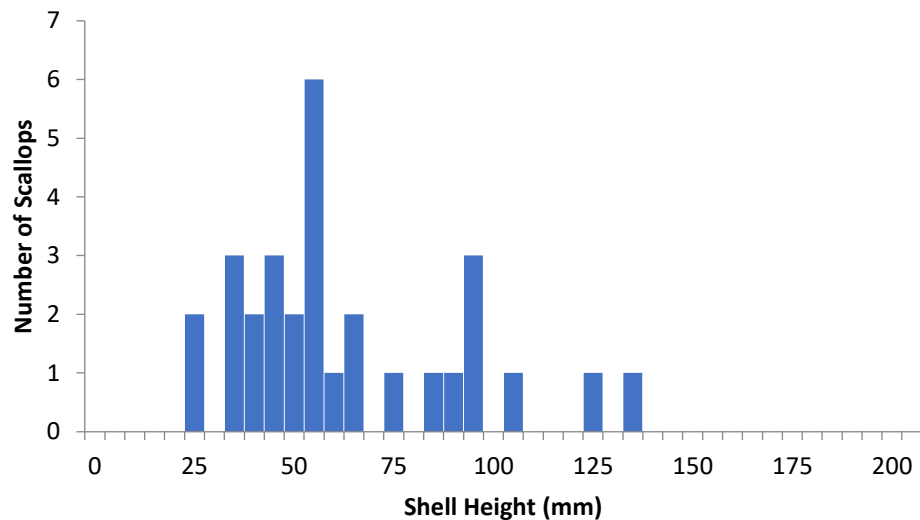


GB CL1 Access 2021



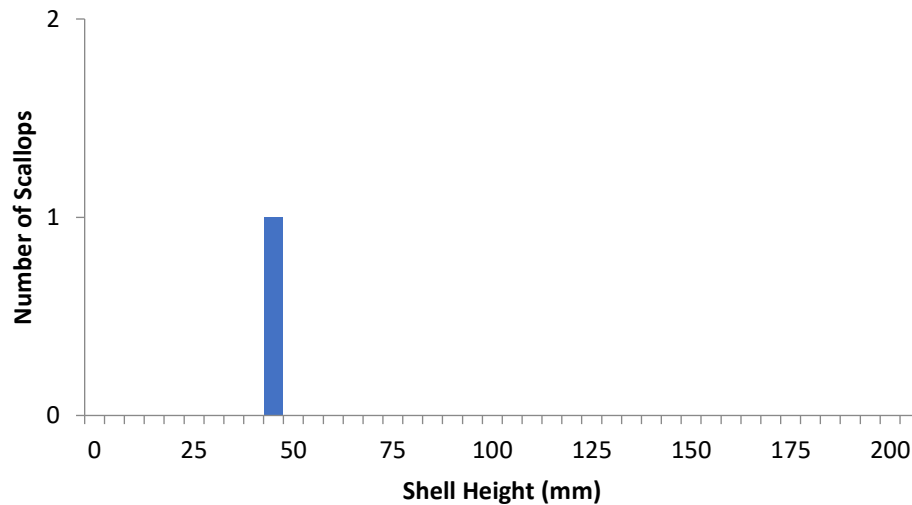
Avg = 82.7mm
N = 19

GB CL1 Sliver 2021



Avg = 60.8mm
N = 30

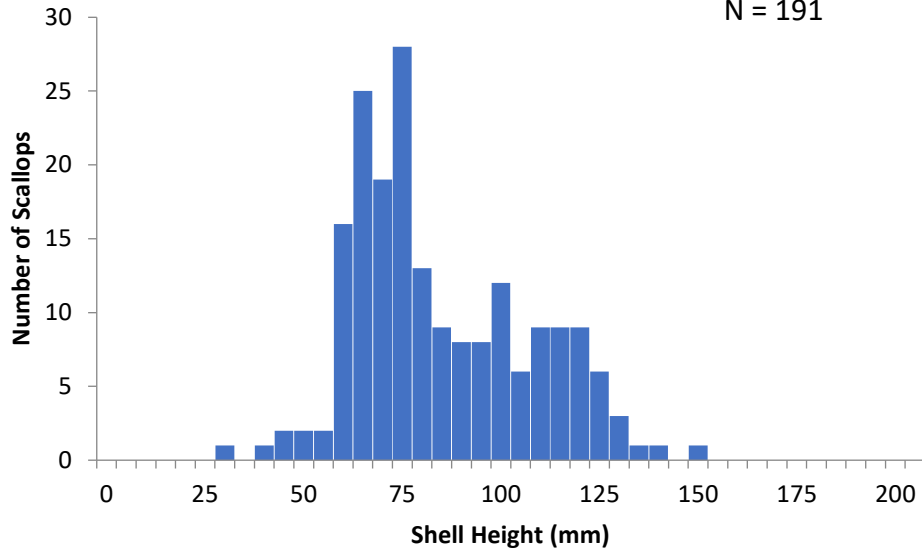
GB CL1 South 2021



Avg = 47.7mm
N = 1

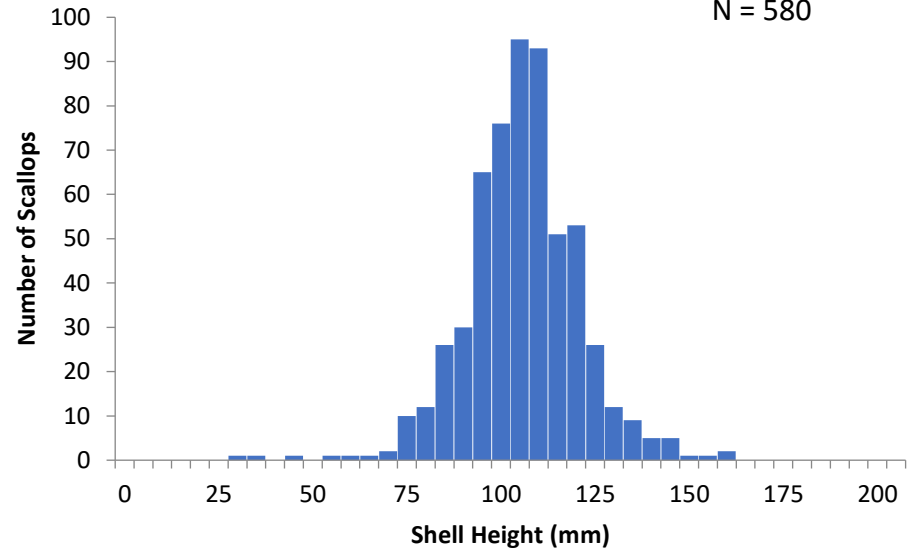
GB CL2 Southeast 2021

Avg = 82.3mm
N = 191



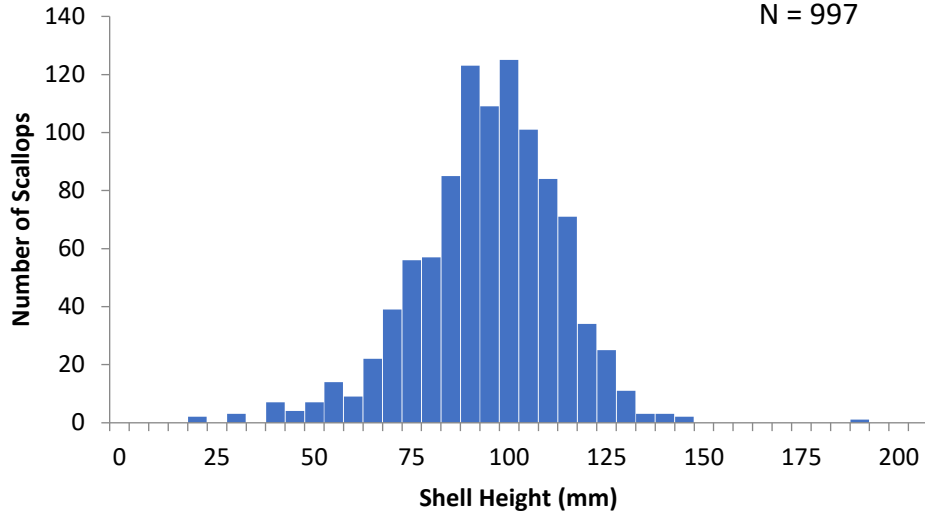
GB CL2 Southwest 2021

Avg = 103.2mm
N = 580



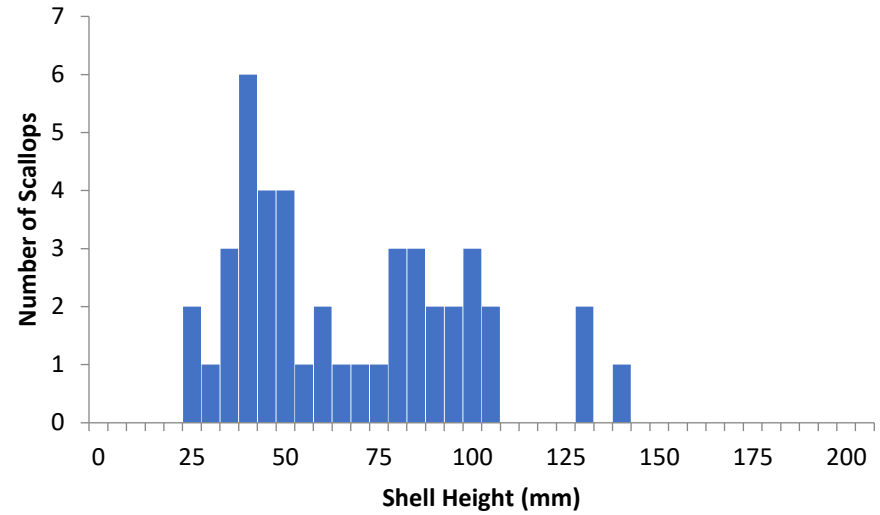
GB CL2 Ext. 2021

Avg = 92.0mm
N = 997



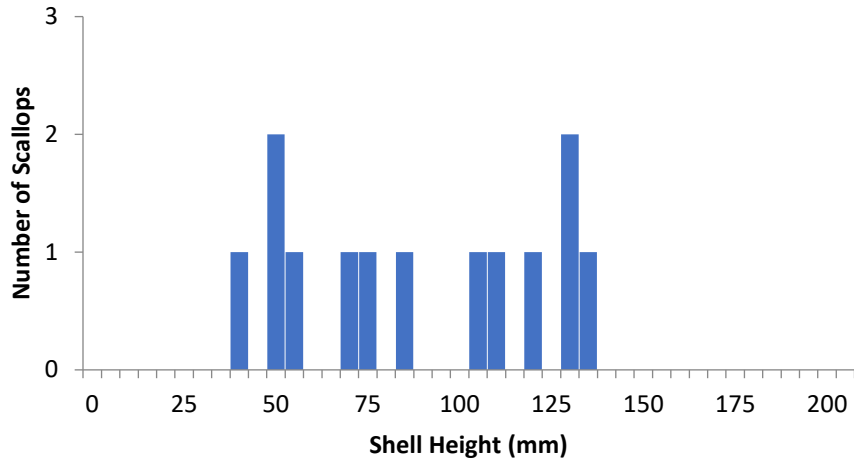
GB CL2 North 2021

Avg = 65.1mm
N = 44



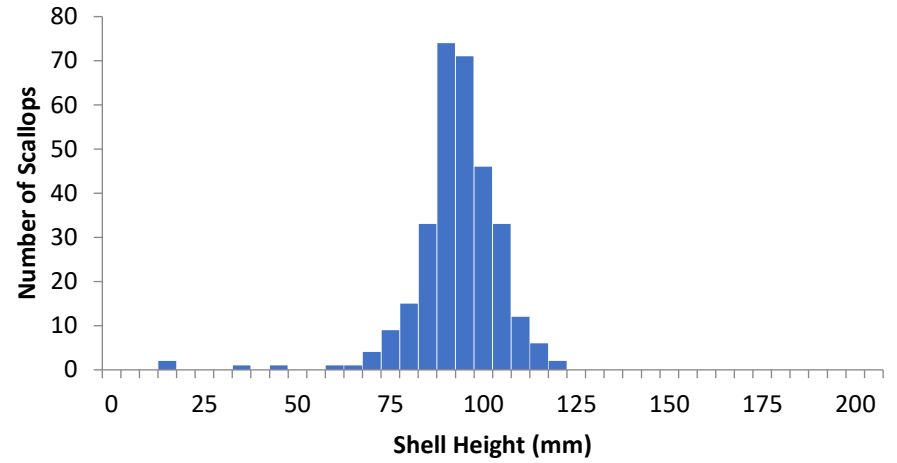
GB NLS North 2021

Avg = 86.2mm
N = 13



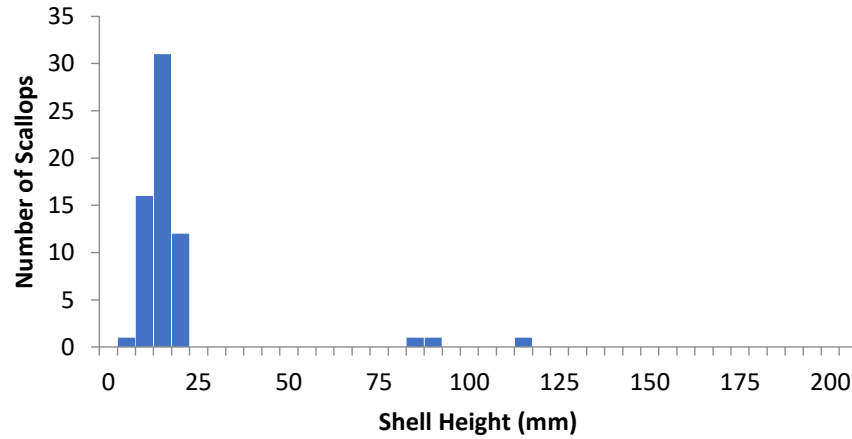
GB NLS South 2021

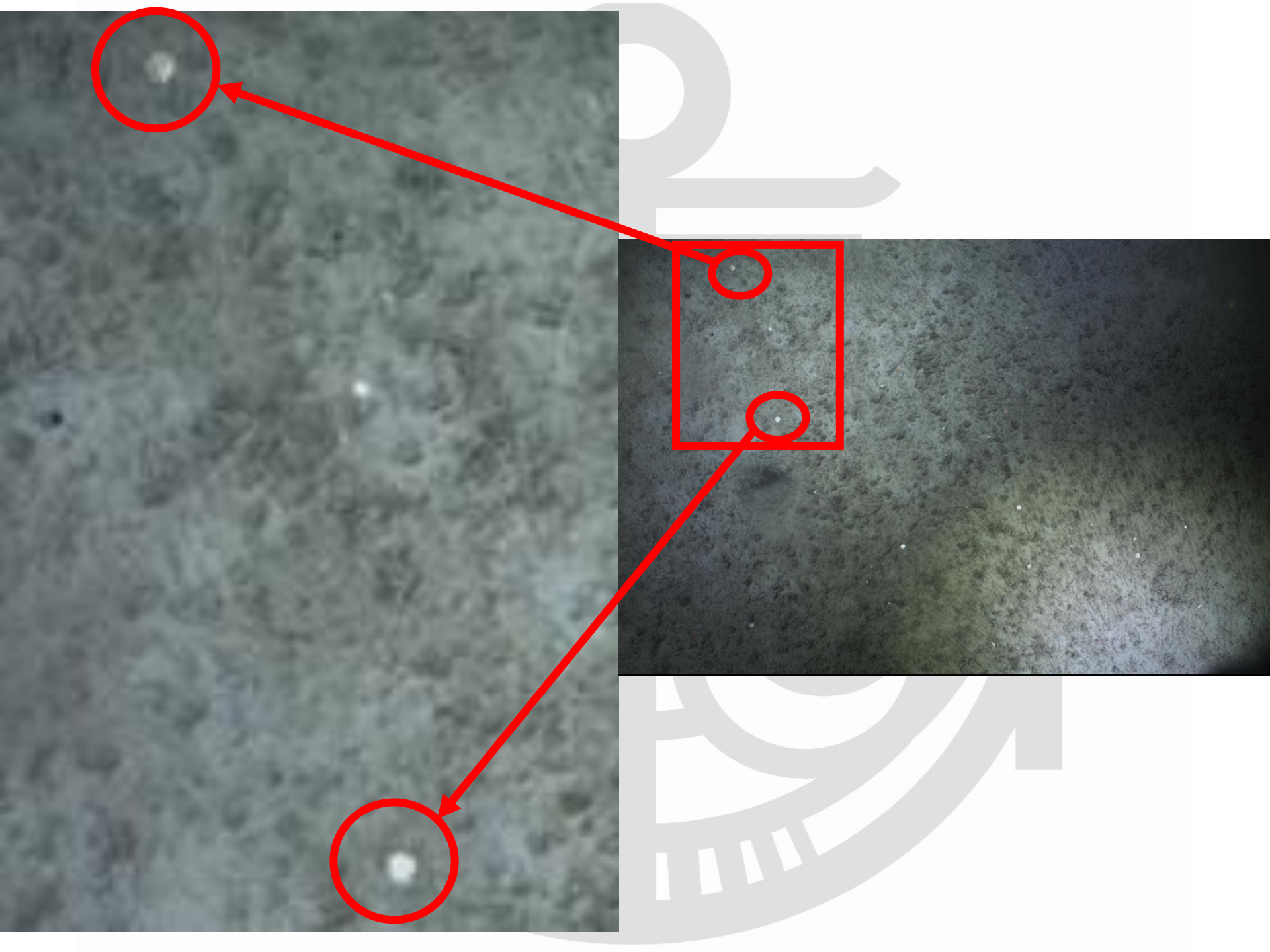
Avg = 90.5mm
N = 311



GB NLS West 2021

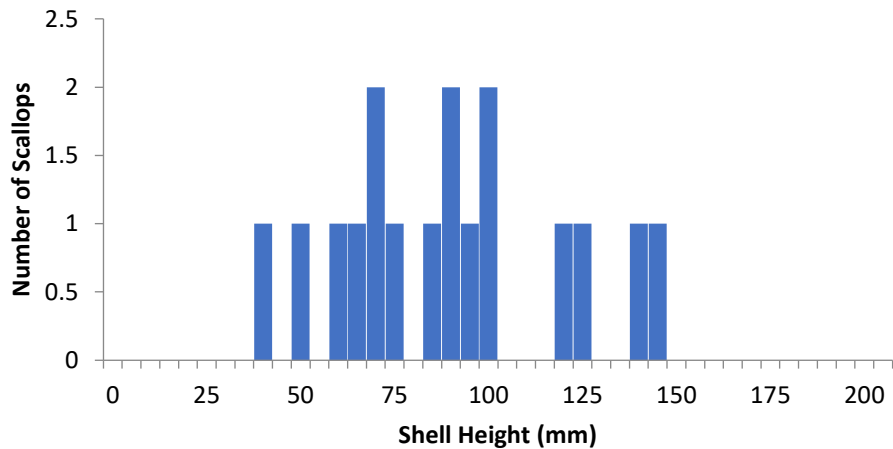
Avg = 15.8mm
N = 63





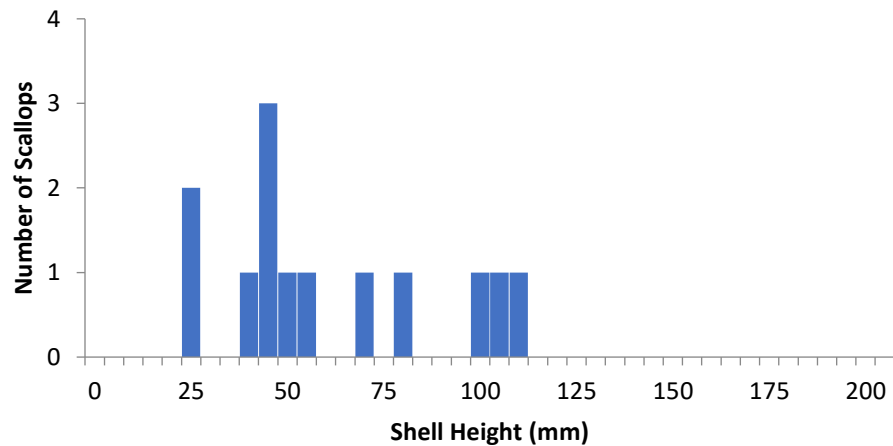
GB NF 2021

Avg = 87.3mm
N = 17



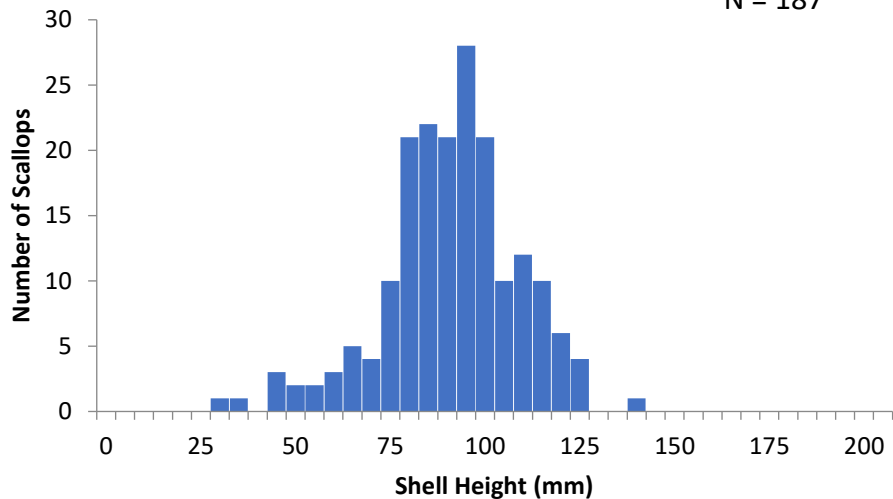
Eastern GB 2021

Avg = 57.8mm
N = 13



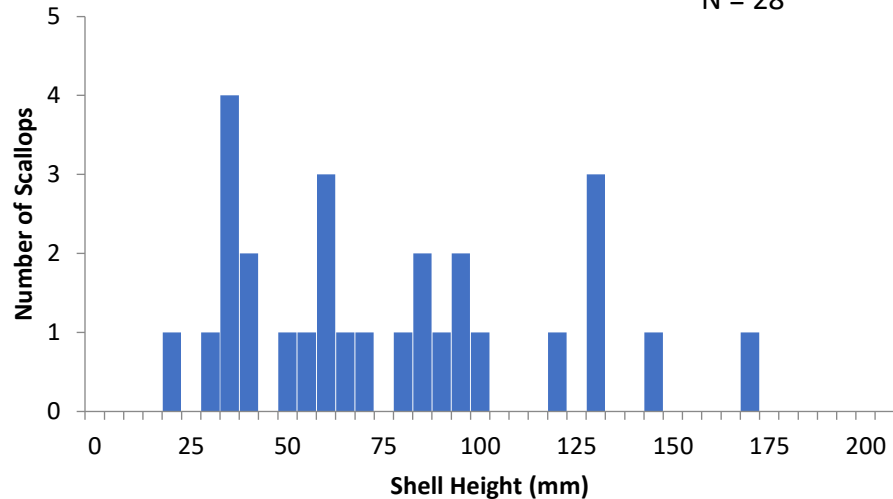
GB SF 2021

Avg = 88.6mm
N = 187



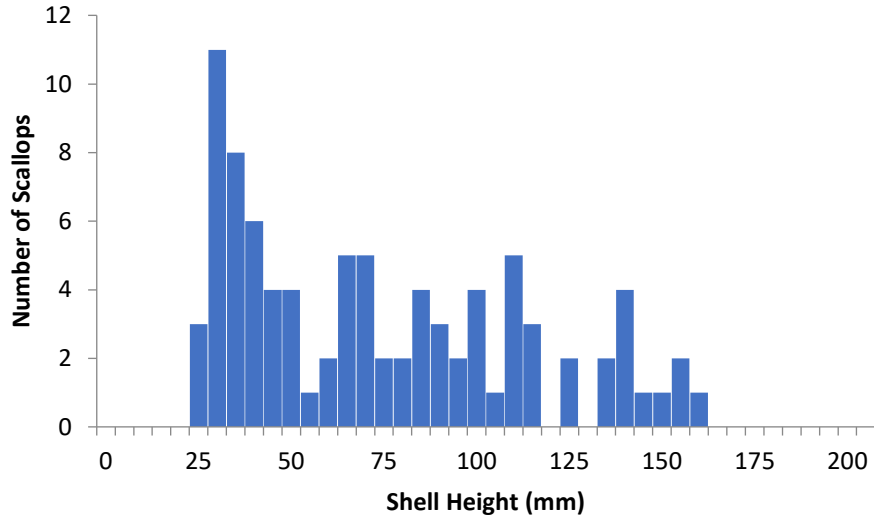
Outer Cape Cod 2021

Avg = 74.3mm
N = 28



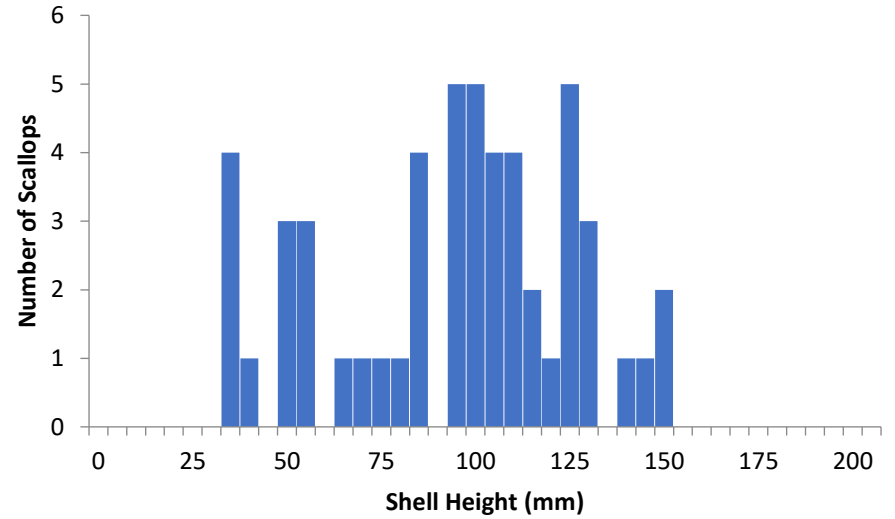
GB GSC North 2021

Avg = 71.7mm
N = 88



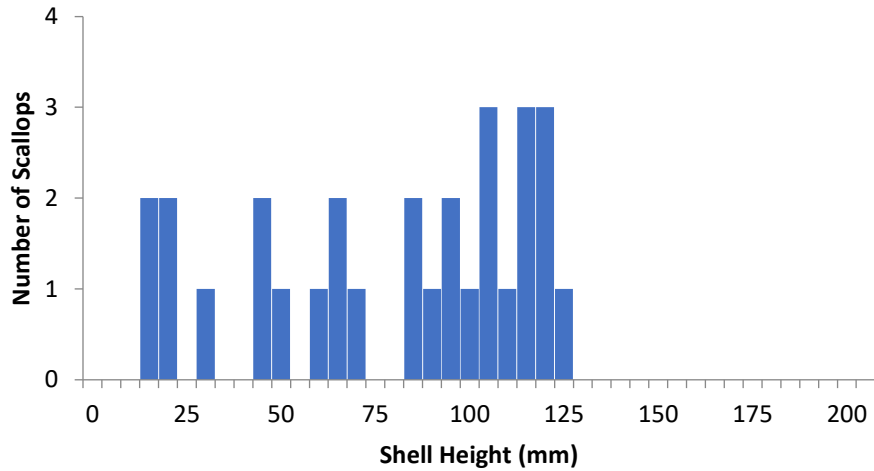
GB GSC Middle 2021

Avg = 91.8mm
N = 52



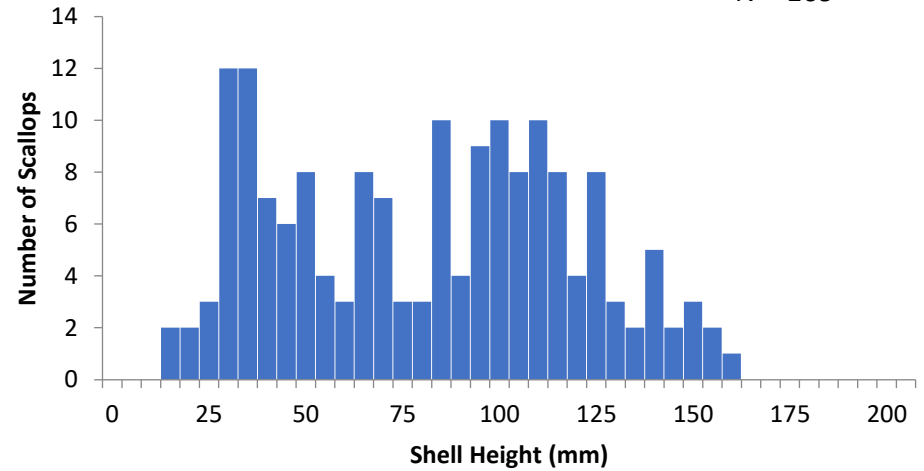
GB GSC South 2021

Avg = 76.8mm
N = 29

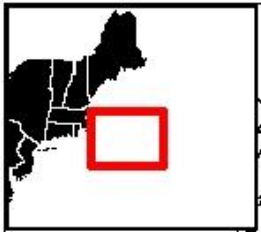


GB GSC Original 2021

Avg = 78.8mm
N = 169



2021 Total Biomass



Outer Cape
449 mt

CL2-North
1886mt
NF
1665mt

Eastern GB-NonSAMS
386 mt

GSC-North
5716mt

CL1-Sliver
1125mt

CL2-Access-Southeast
9464mt

CL1-Access
1254mt

CL2-Access-Southwest
14724mt

GSC-Middle
4872mt

CL1-South
6mt

SF
11516mt

CL2-Ext
18983mt

NLS-West
202mt

NLS-North
1830mt

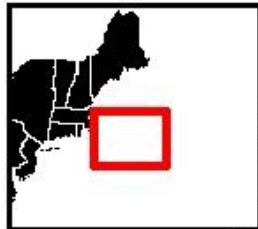
GSC-South
1775mt

NLS-South-Deep
24263mt

100 m



2021 Exploitable Biomass



Outer Cape
324 mt

CL2-North
919 mt

NF
1062 mt

Eastern GB-NonSAMS
154 mt

GSC-North
4081 mt

CL1-Sliver
530 mt

CL2-Access-Southeast
4673 mt

CL1-Access
864 mt

CL2-Access-Southwest
9292 mt

GSC-Middle
3387 mt

CL1-South
0 mt

CL2-Ext
9513 mt

SF
5061 mt

NLS-West
97 mt

NLS-North
1328 mt

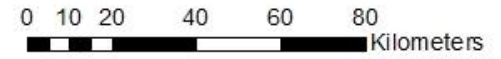
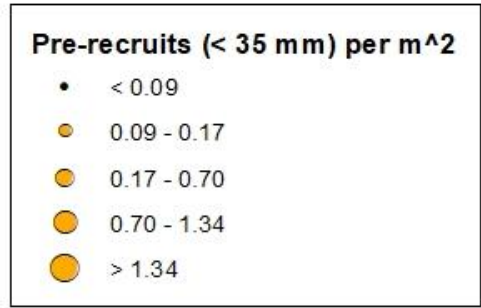
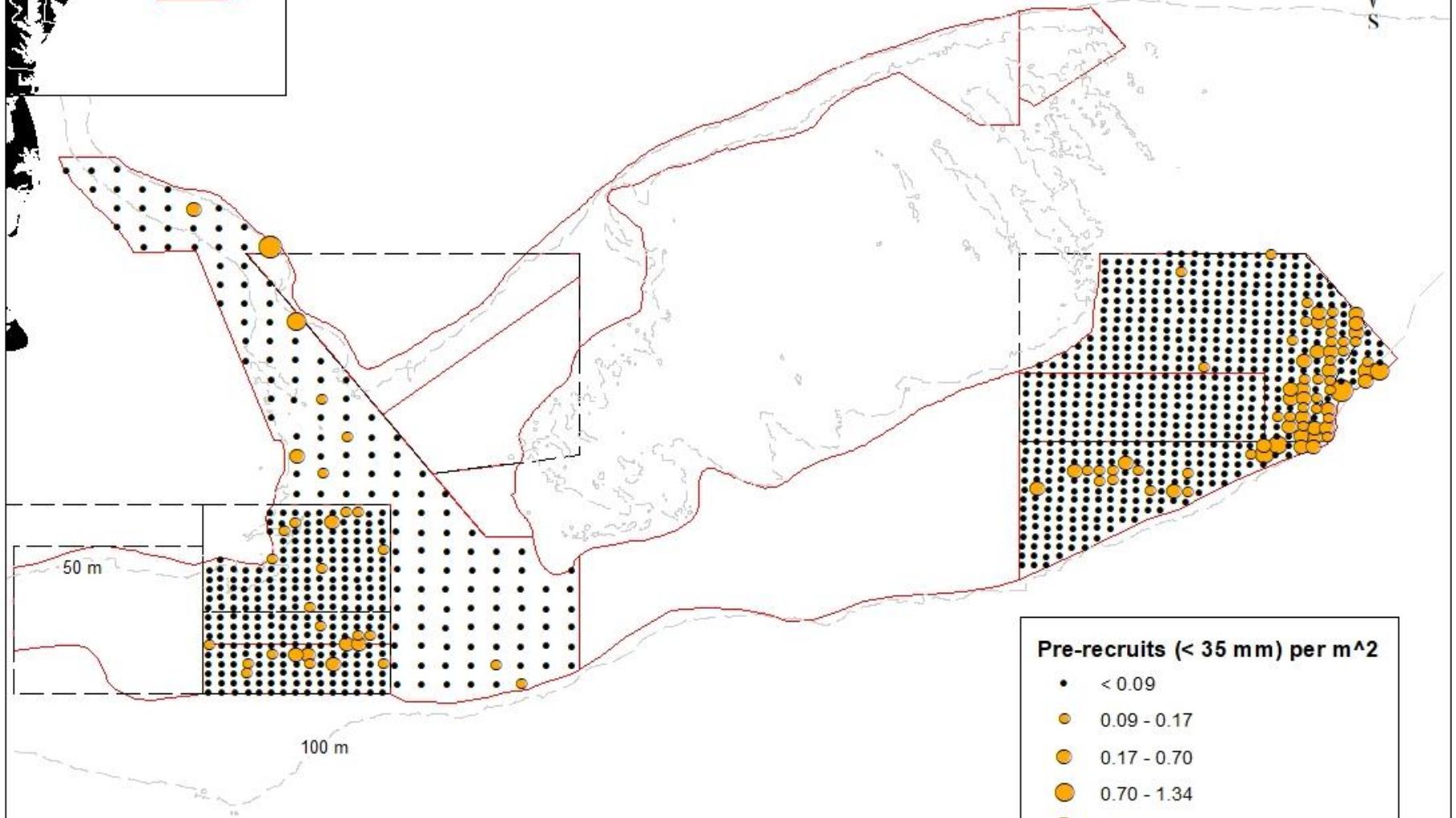
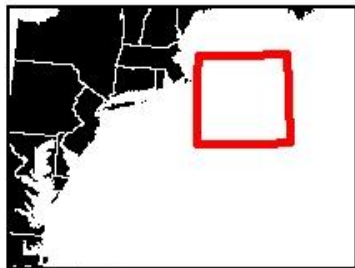
GSC-South
1046 mt

NLS-South-Deep
8957 mt

100 m

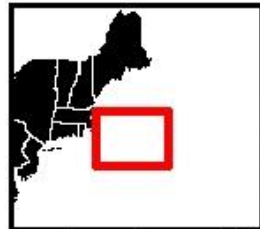


2020



NAD_1983_UTM_Zone_19N

2021



Pre-recruits (< 35mm) per m²

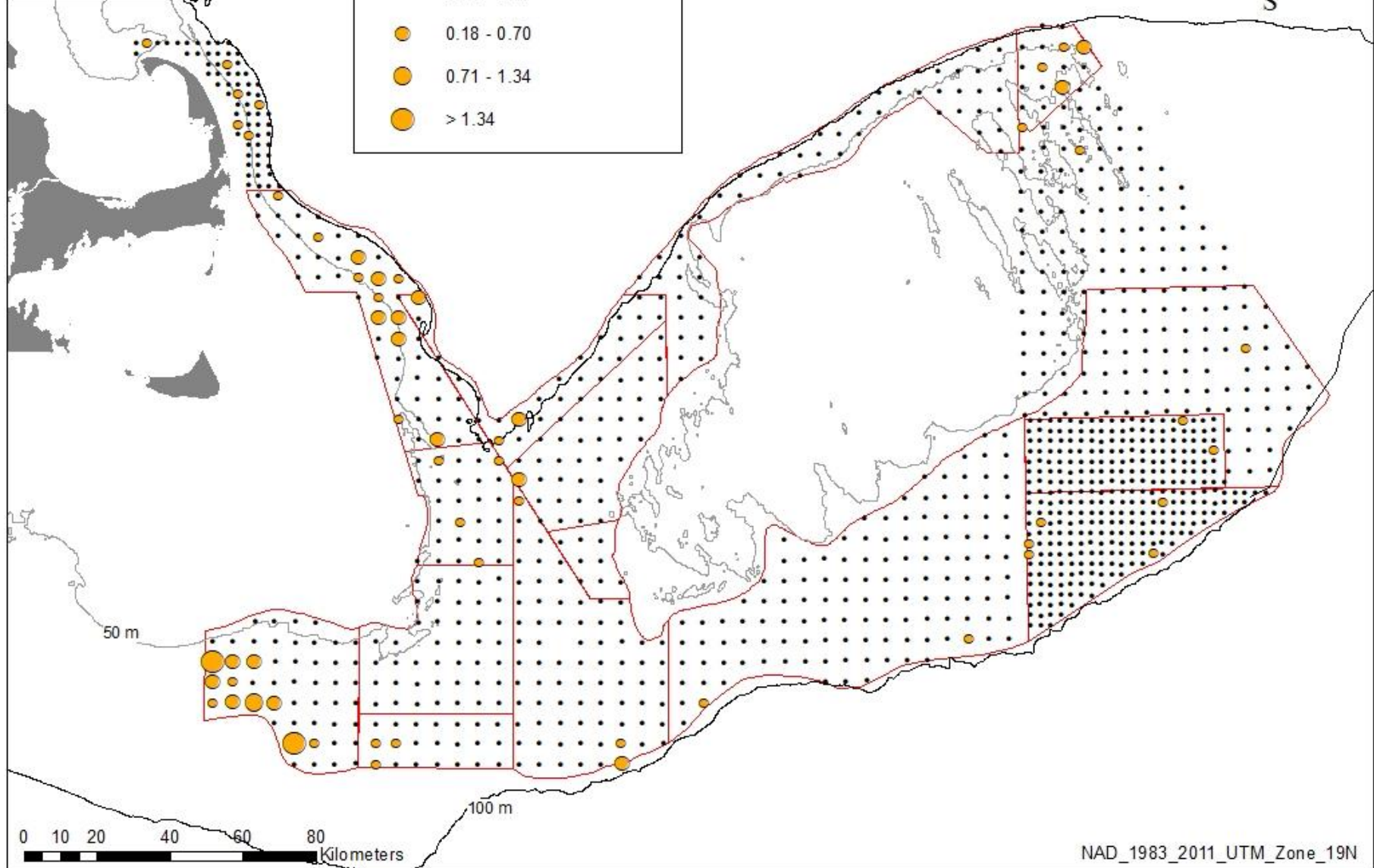
• < 0.09

● 0.09 - 0.17

● 0.18 - 0.70

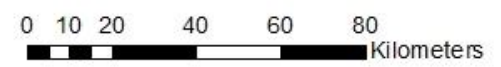
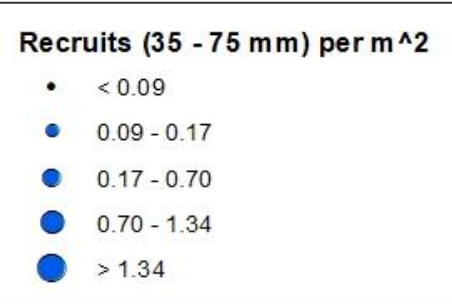
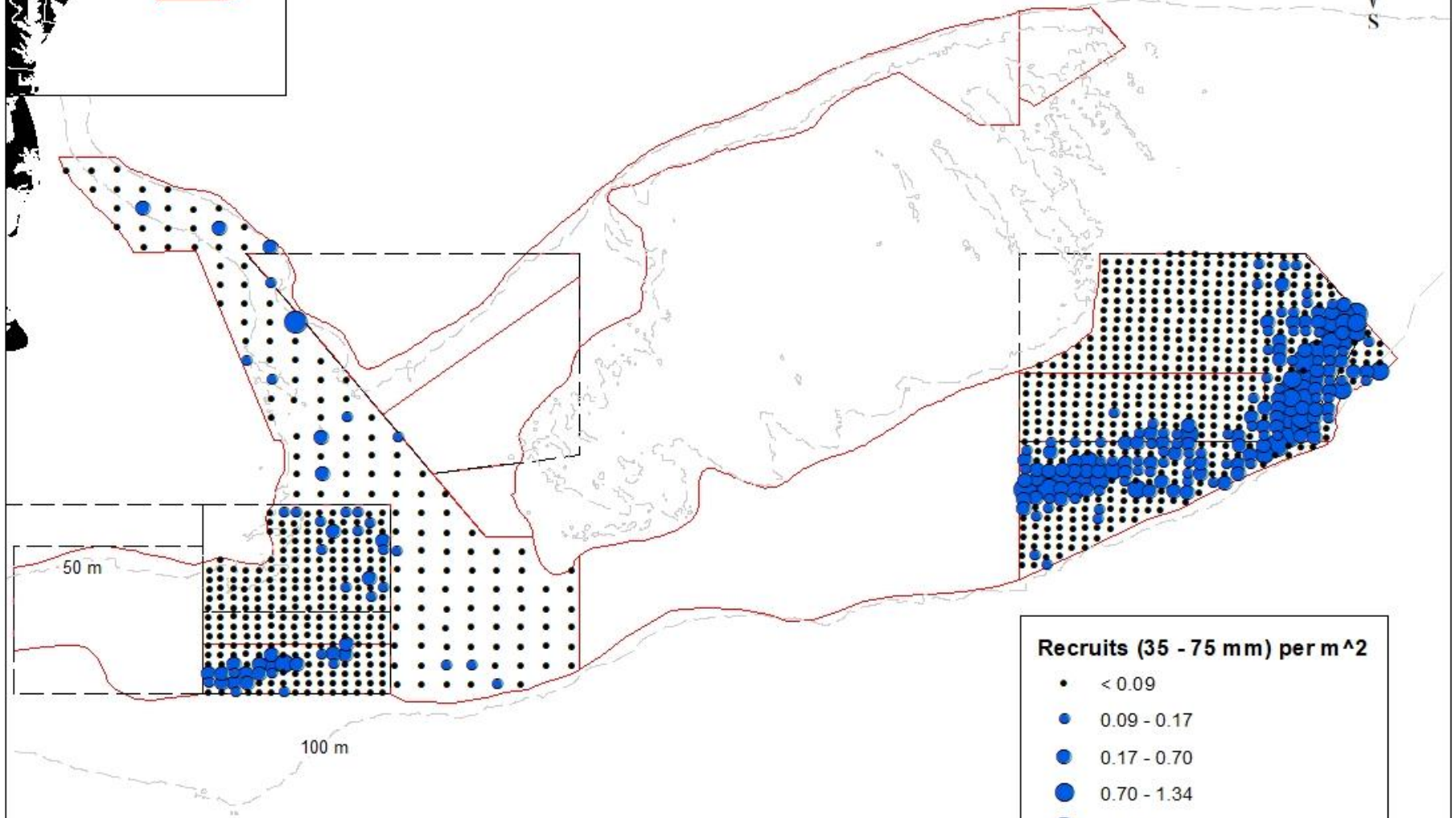
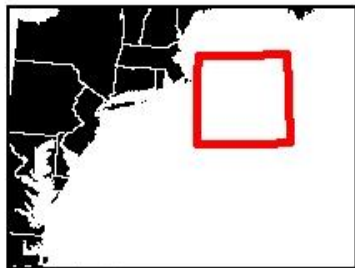
● 0.71 - 1.34

● > 1.34



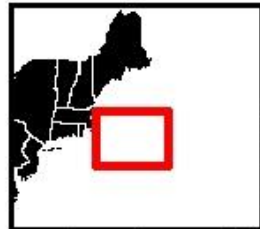
NAD_1983_2011_UTM_Zone_19N

2020



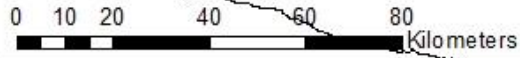
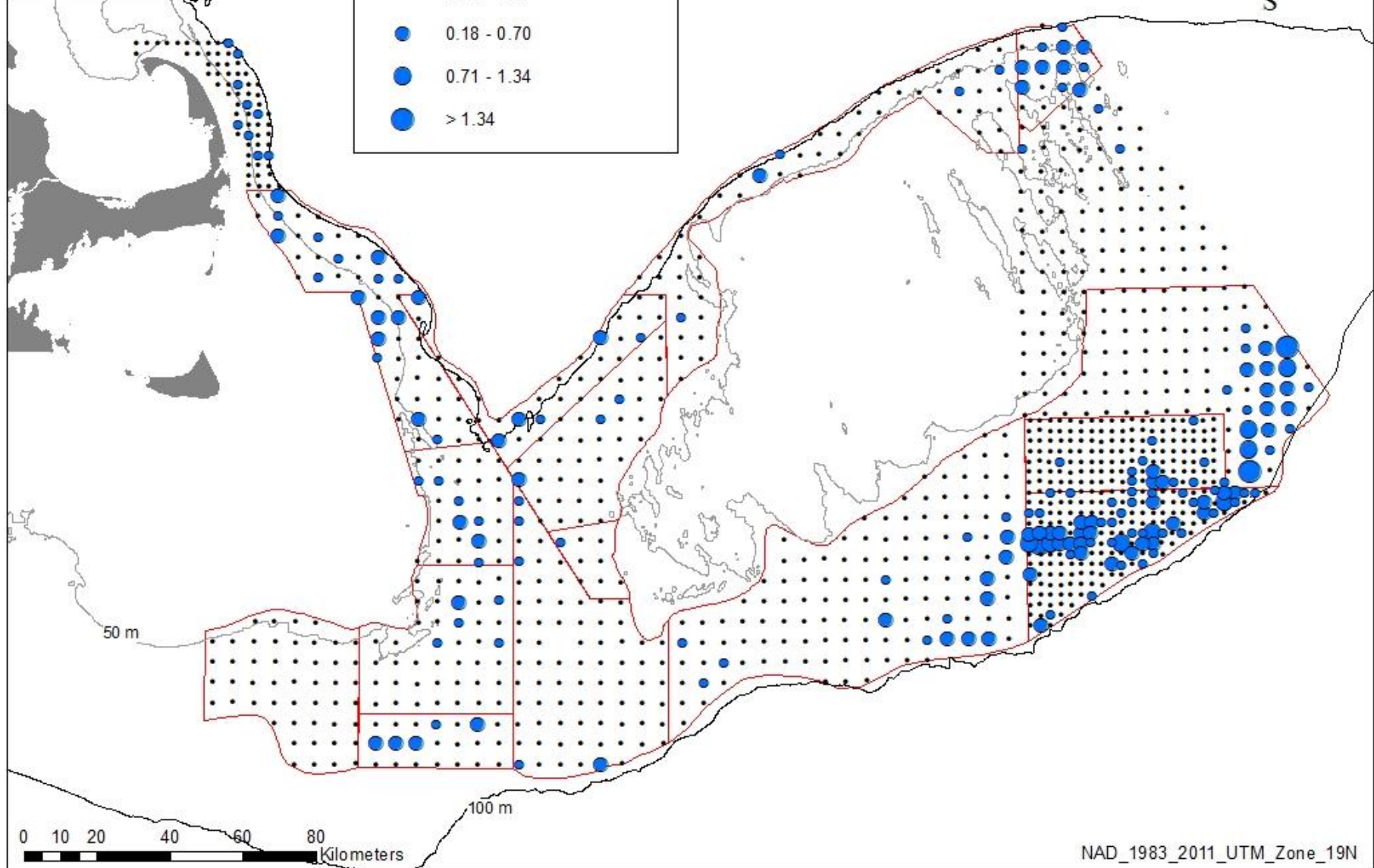
NAD_1983_UTM_Zone_19N

2021



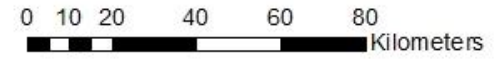
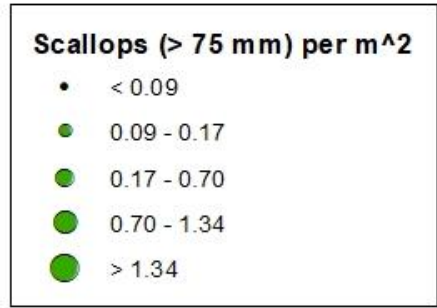
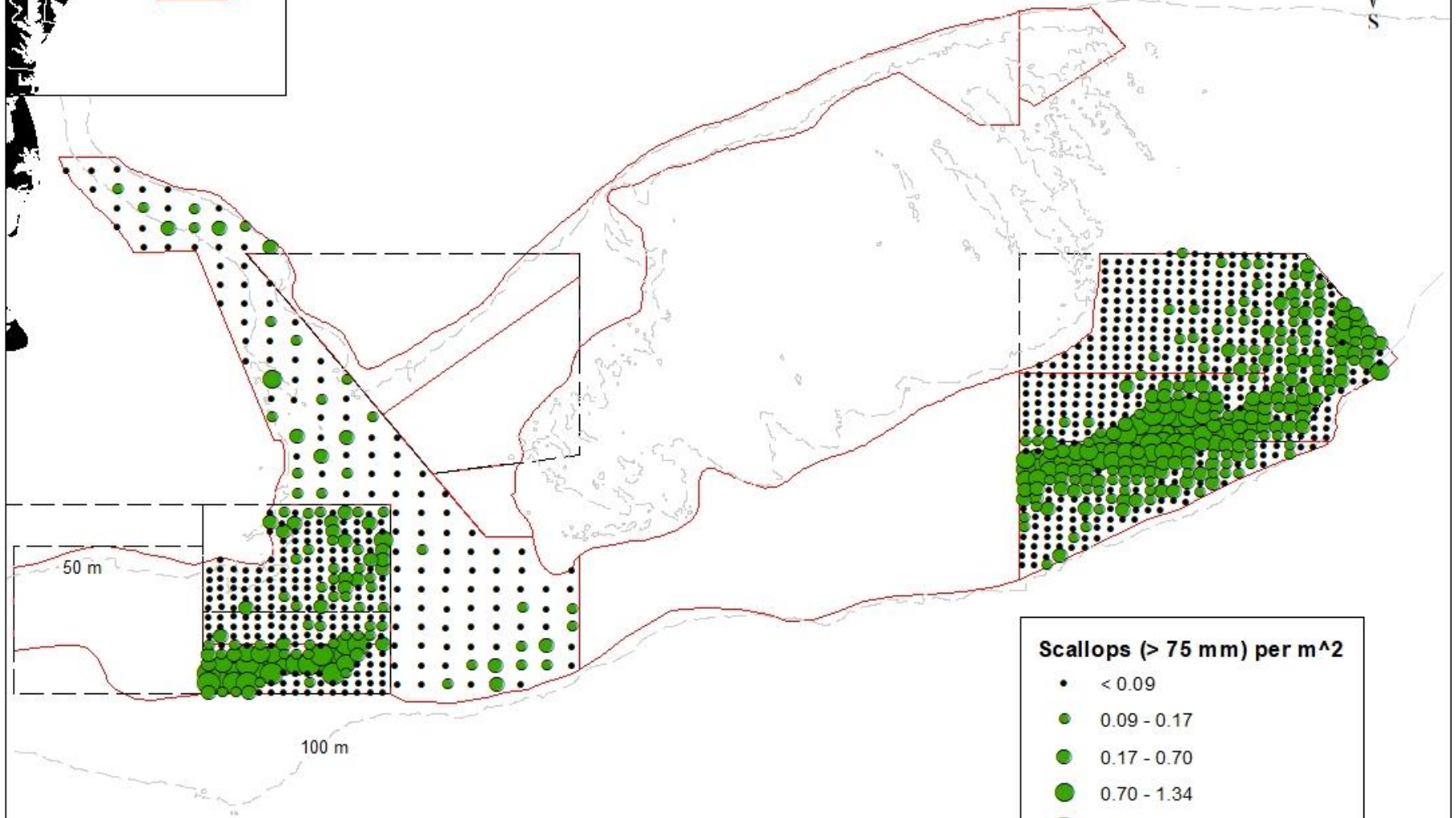
Recruits (35 - 75 mm) per m²

- < 0.09
- 0.09 - 0.17
- 0.18 - 0.70
- 0.71 - 1.34
- > 1.34



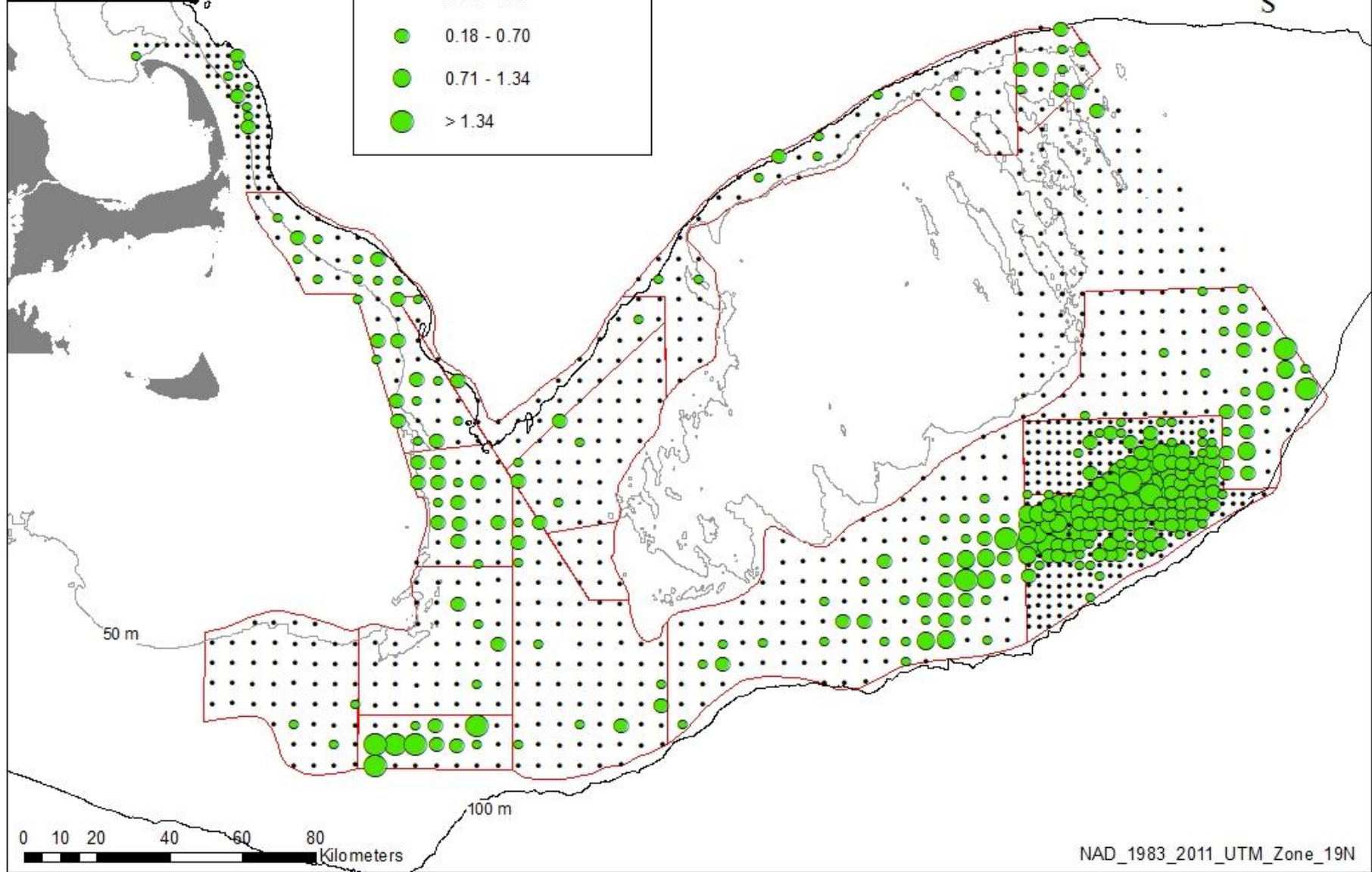
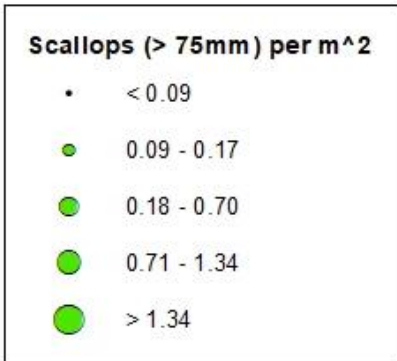
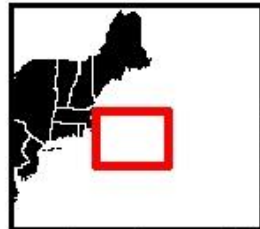
NAD_1983_2011_UTM_Zone_19N

2020



NAD_1983_UTM_Zone_19N

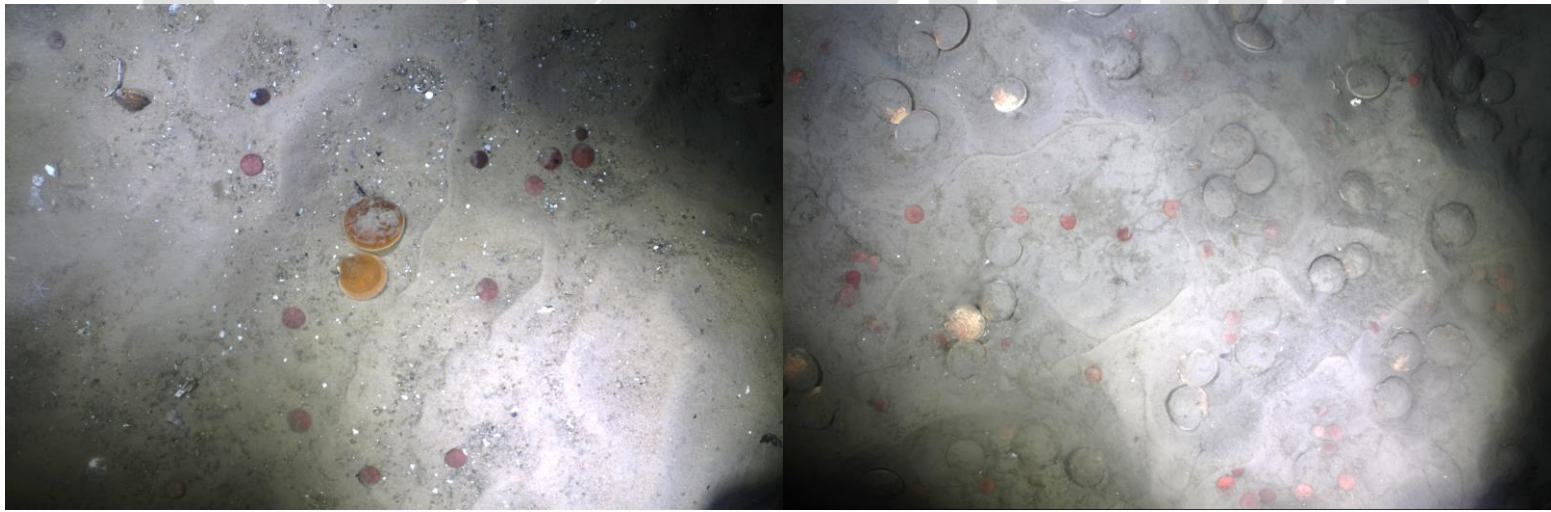
2021



Georges Bank Additional Analysis

	SARC 65 SH/MW BmsMT (SE)	VIMS SH/MW 2016-2021 BmsMT (SE)
NLS-South	24,263 (10,188)	23,009 (9,662)

	NumMil	BmsMT	SE	MeanWt	Avg. Size (mm)	Scallop density (m ²)	# Stations
GSC-North	246	5,716	1,269	23.2	90.9	0.17	47
GSC-Middle	190	4,872	1,200	25.7	98.1	0.23	27
GSC-South	103	1,775	553	17.2	89.0	0.04	76
Split GSC Total	539	12,363					150
GSC original	539	12,338	1,980	22.9	93.2	0.12	150



Gulf of Maine 2021 Survey

*40mm cutoff	quad area	mean SH	# Measu	Density per m2	Stations	SE	CV%	Area km2	Latitude	Depth
Stellwagen-NGOM-AgreedArea-ST-1 km_Hart20 eq	2.47	88.3	875	0.66	169	0.221	33.21	169	42.4	32.6
Jeffreys-NGOM-ST-1 km_Hart20 eq	2.50	96.9	97	0.14	108	0.025	17.89	108	42.7	45.0
Platts-NGOM-ST-1 km_Hart20 eq	2.50	97.3	53	0.22	34	0.048	22.44	34	43.2	63.6
Ipswich NGOM-ST-1 km_Hart20 eq	2.48	89.9	78	0.10	93	0.021	19.93	93	42.8	38.0
Ipswich MA State-ST-1 km_Hart20 eq	2.47	88.1	26	0.13	25	0.036	27.63	25	42.8	26.5
GOM-South 42 20-ST-1 km_Hart20 eq	2.49	93.9	259	0.11	291	0.006	5.61	291	42.2	37.1
WGOM Closure-ST-1 km_Hart20 eq	2.52	103.9	819	1.77	60	0.267	15.10	60	42.3	35.8
NGOM total			1103		404			404		

	Estimation of Total Biomass					Estimation of Exploitable Biomass				
	mean mwt	mill lbs	in mt	SE	NumMils	mean mwt	mill lbs	in mt	SE	NumMils
Stellwagen-NGOM-AgreedArea-ST-1 km_Hart20 eq	13.4	3.3	1,508	501	112	18.4	1.3	579	192	32
Jeffreys-NGOM-ST-1 km_Hart20 eq	17.7	0.6	268	48	15	27.5	0.4	181	32	7
Platts-NGOM-ST-1 km_Hart20 eq	14.7	0.2	108	24	7	21.8	0.2	78	18	4
Ipswich NGOM-ST-1 km_Hart20 eq	14.7	0.3	143	28	10	25.8	0.2	92	18	4
Ipswich MA State-ST-1 km_Hart20 eq	12.7	0.1	41	11	3	17.6	0.0	17	5	1
GOM-South 42 20-ST-1 km_Hart20 eq	17.5	1.2	547	31	31	24.1	0.7	306	17	13
WGOM Closure-ST-1 km_Hart20 eq	21.7	5.1	2,308	349	106	24.3	3.2	1,430	216	59
NGOM total		4.47	2,026		144		2.1	931	261	45



2021 Shell Height – Meat Weight Equations

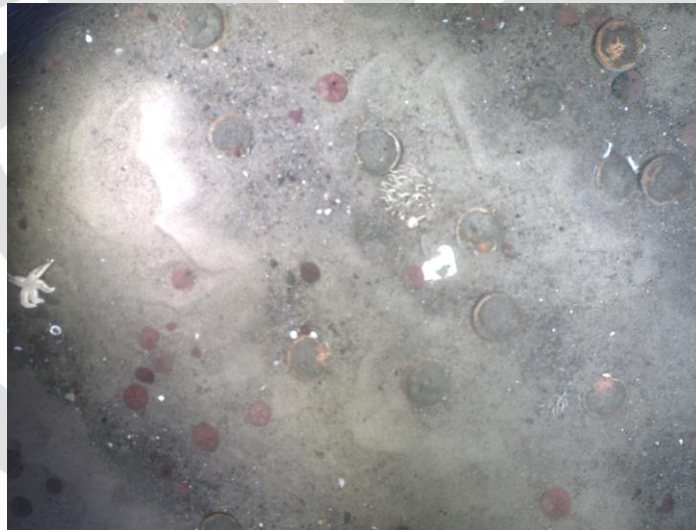
Gulf of Maine

Hart 2020: $W = \exp(-281.905 + 72.415 * \ln(\text{latitude}) - (0.212 * \ln(\text{depth})) + (71.13 - (18.16 * \ln(\text{latitude}))) * \ln(\text{shell height}))$

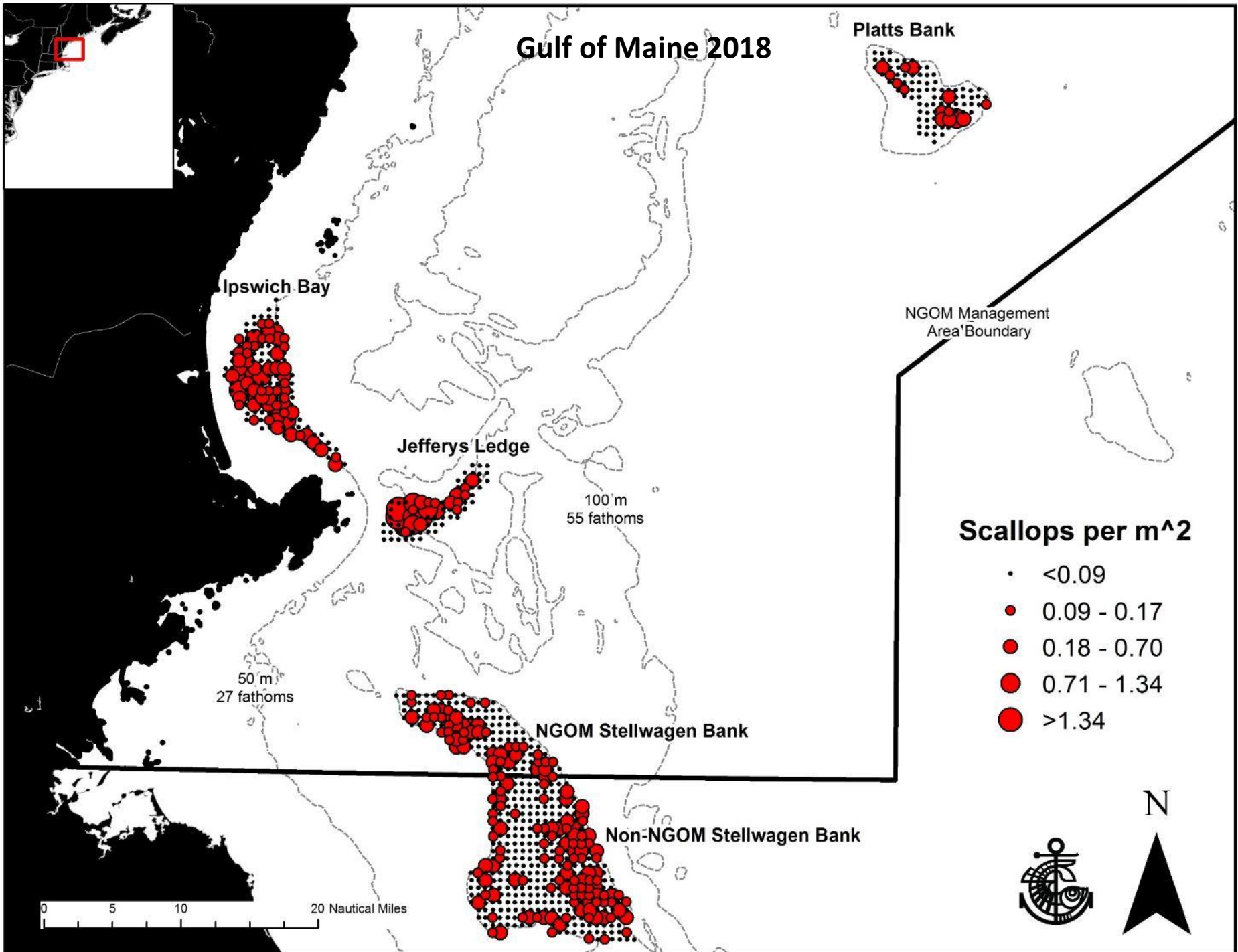
Stellwagen Area of Interest (Umaine/DMR)

covariates: $W = \exp(90.21118 + 2.894163 * \ln(H) - 26.79 * \ln(L) - 0.07074 * \ln(D))$

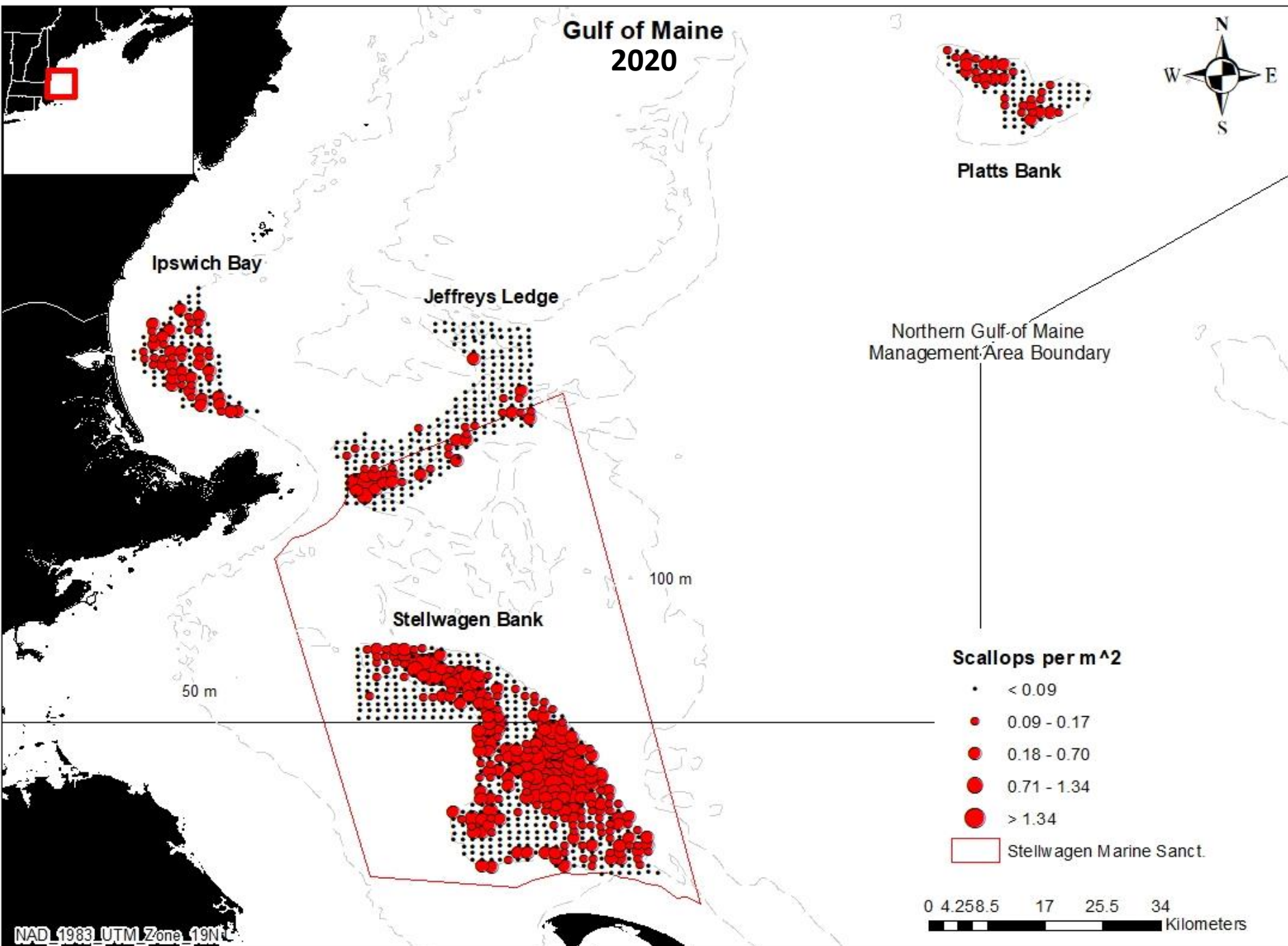
w/o covariates: $W = \exp(-10.3796 + 2.894025 * \ln(H))$

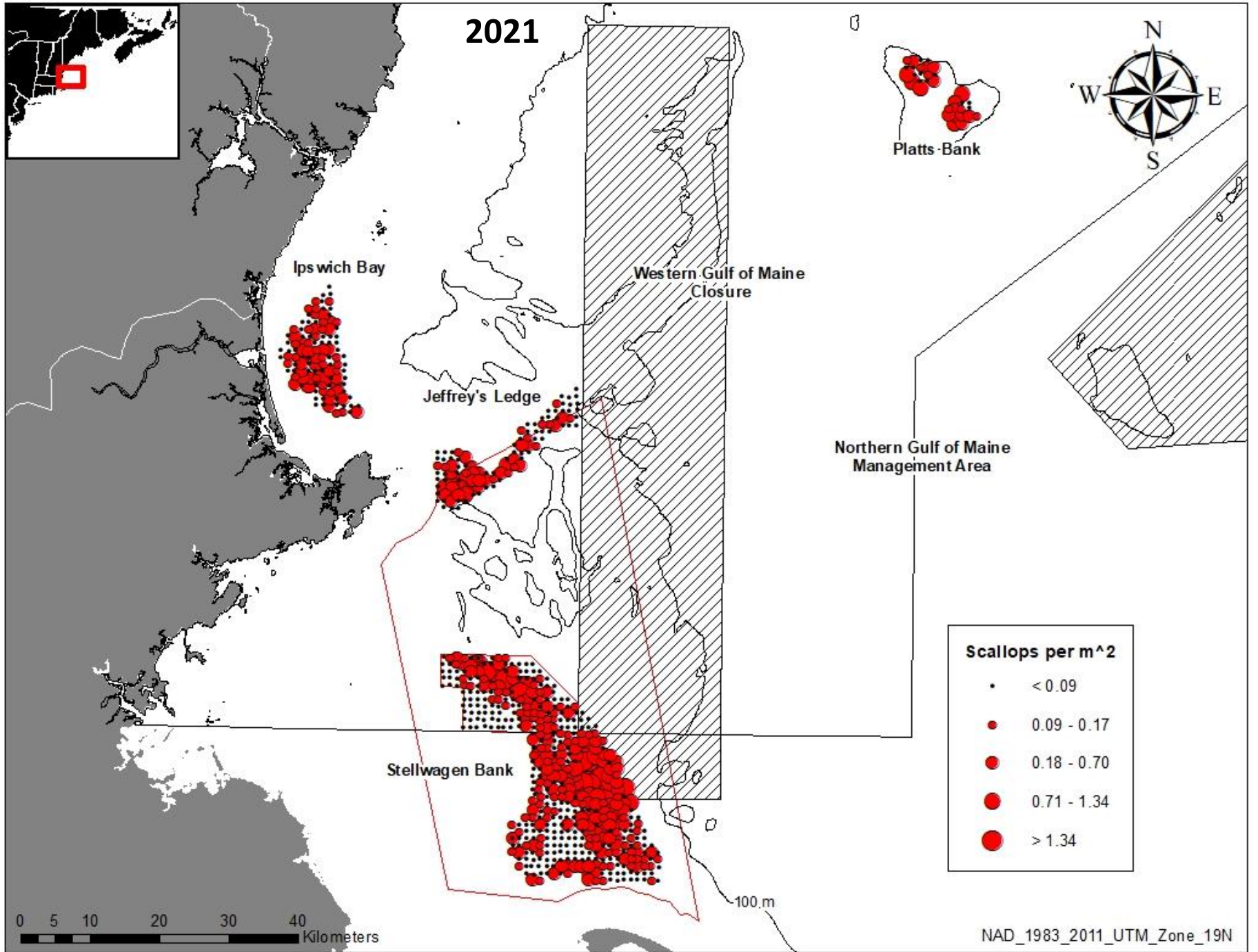


Gulf of Maine 2018



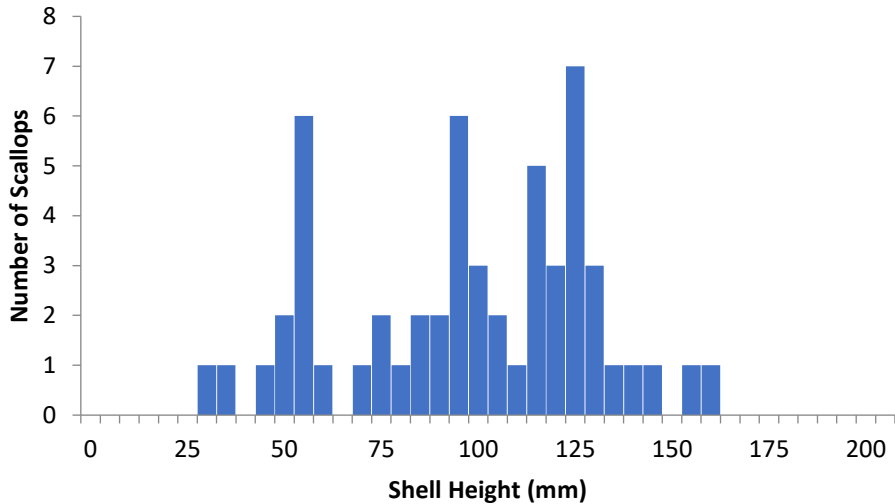
Gulf of Maine 2020





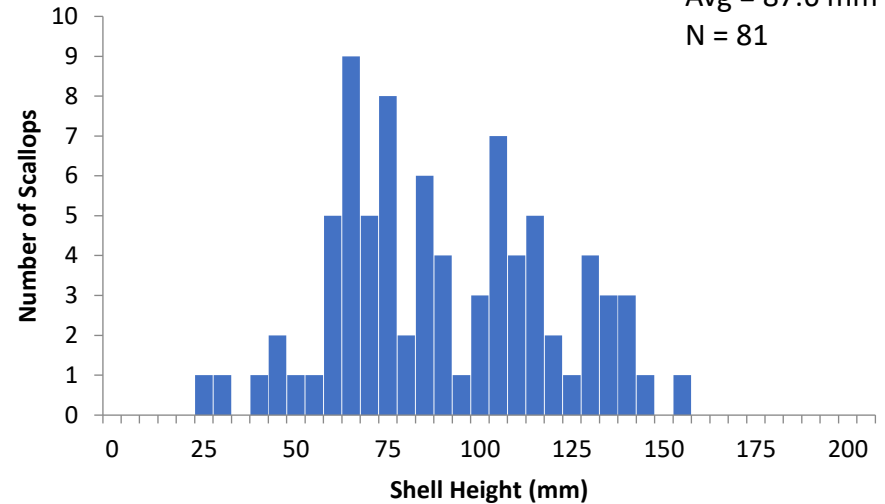
Platts Bank 2021

Avg = 94.8 mm
N = 55



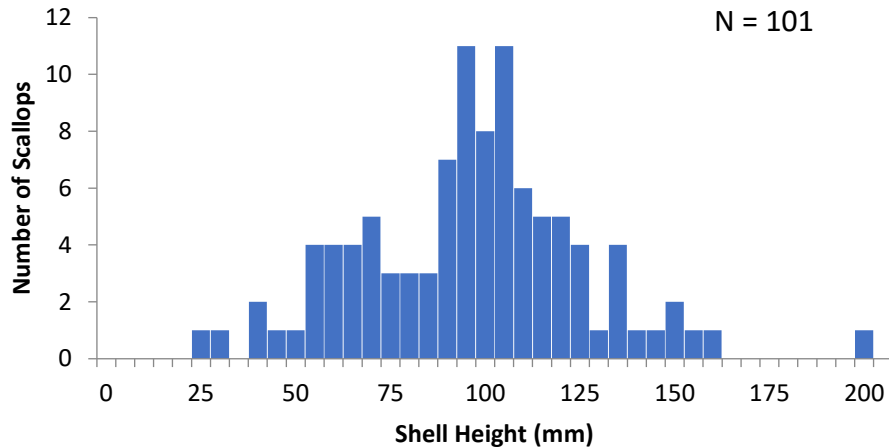
Ipswich Bay NGOM 2021

Avg = 87.6 mm
N = 81



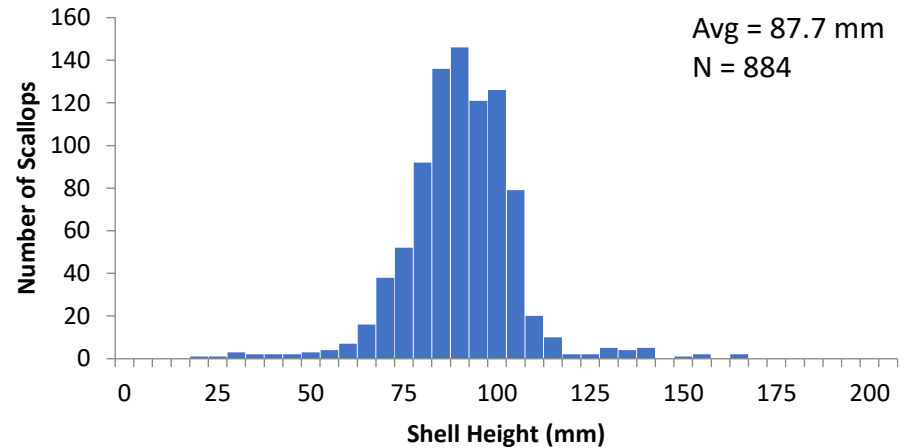
Jeffreys NGOM 2021

Avg = 94.3 mm
N = 101



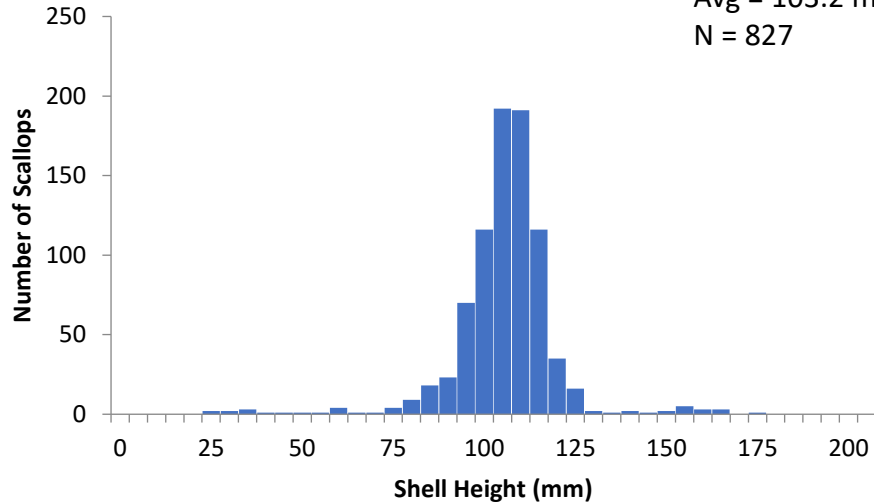
Stellwagen (Agreed Area) NGOM

Avg = 87.7 mm
N = 884



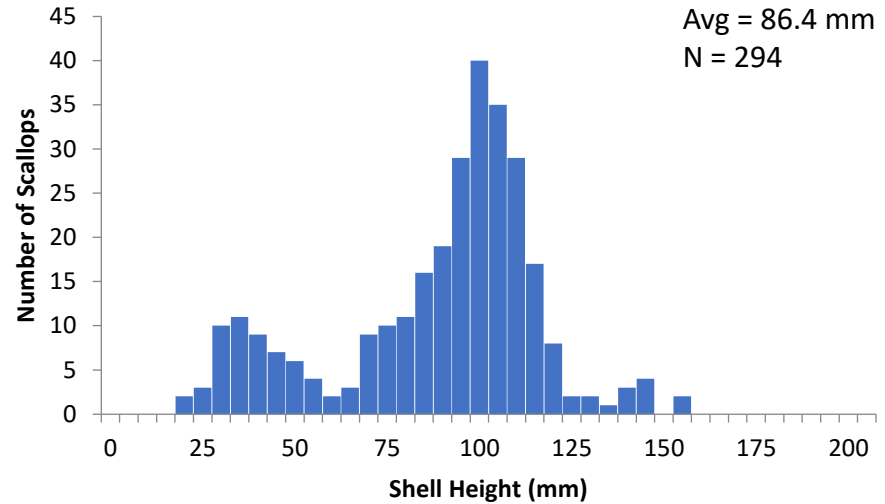
WGOM (Non-NGOM) 2021

Avg = 103.2 mm
N = 827



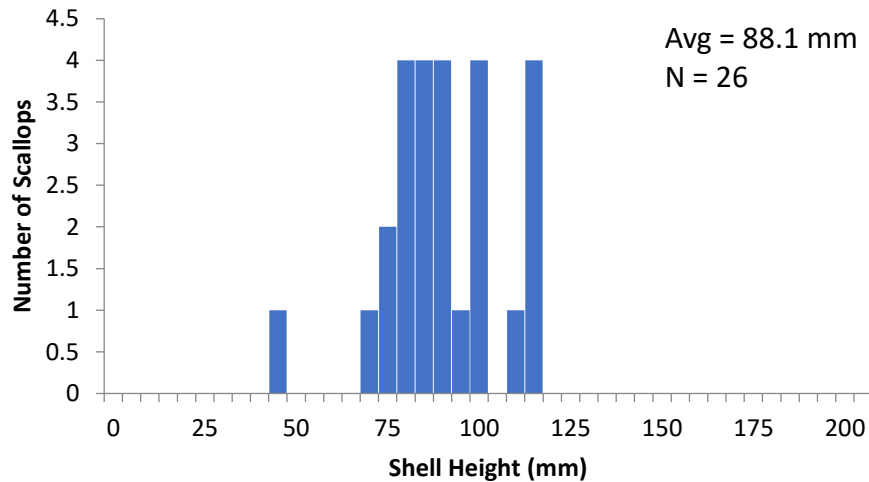
Stellwagen South (Non-NGOM) 2021

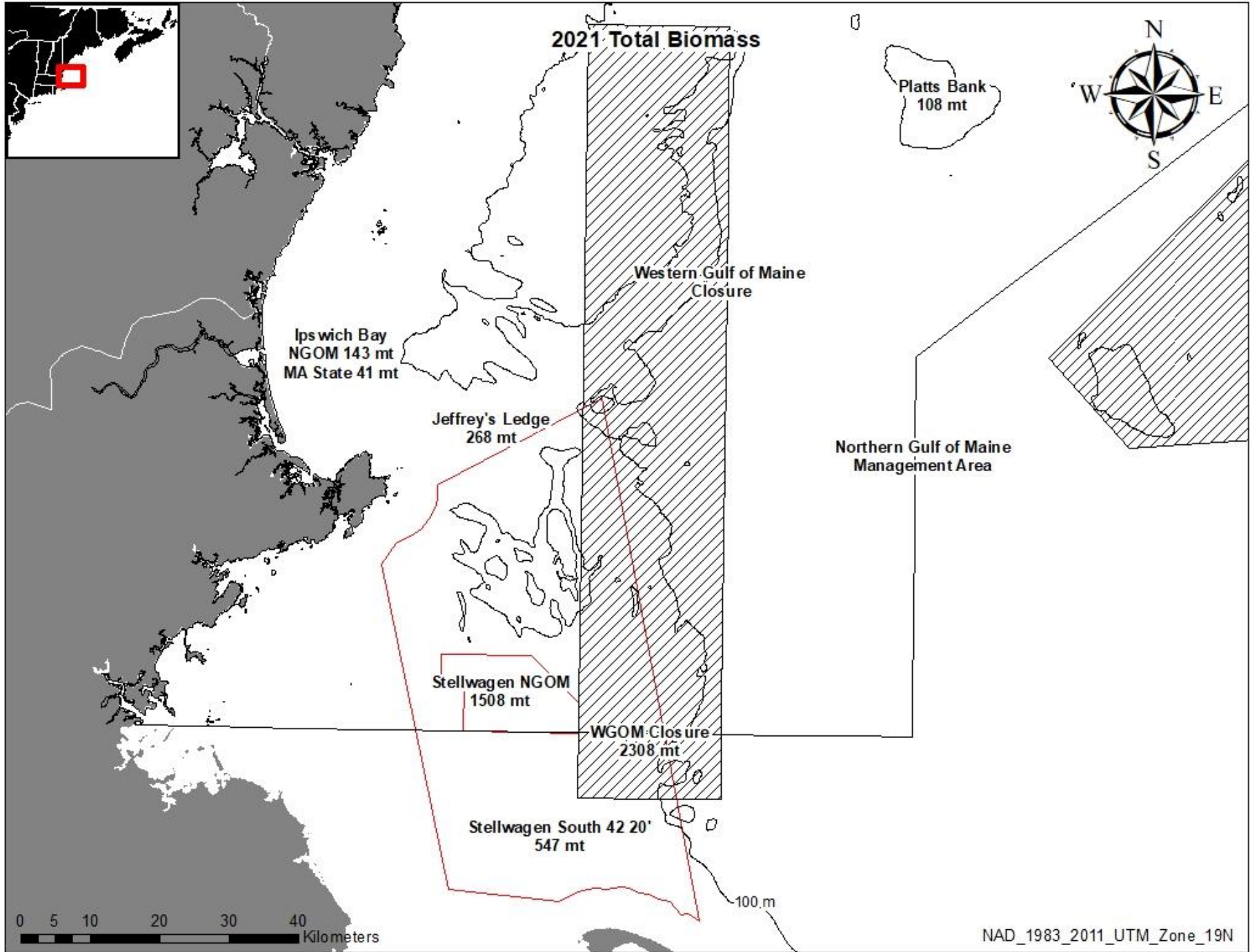
Avg = 86.4 mm
N = 294



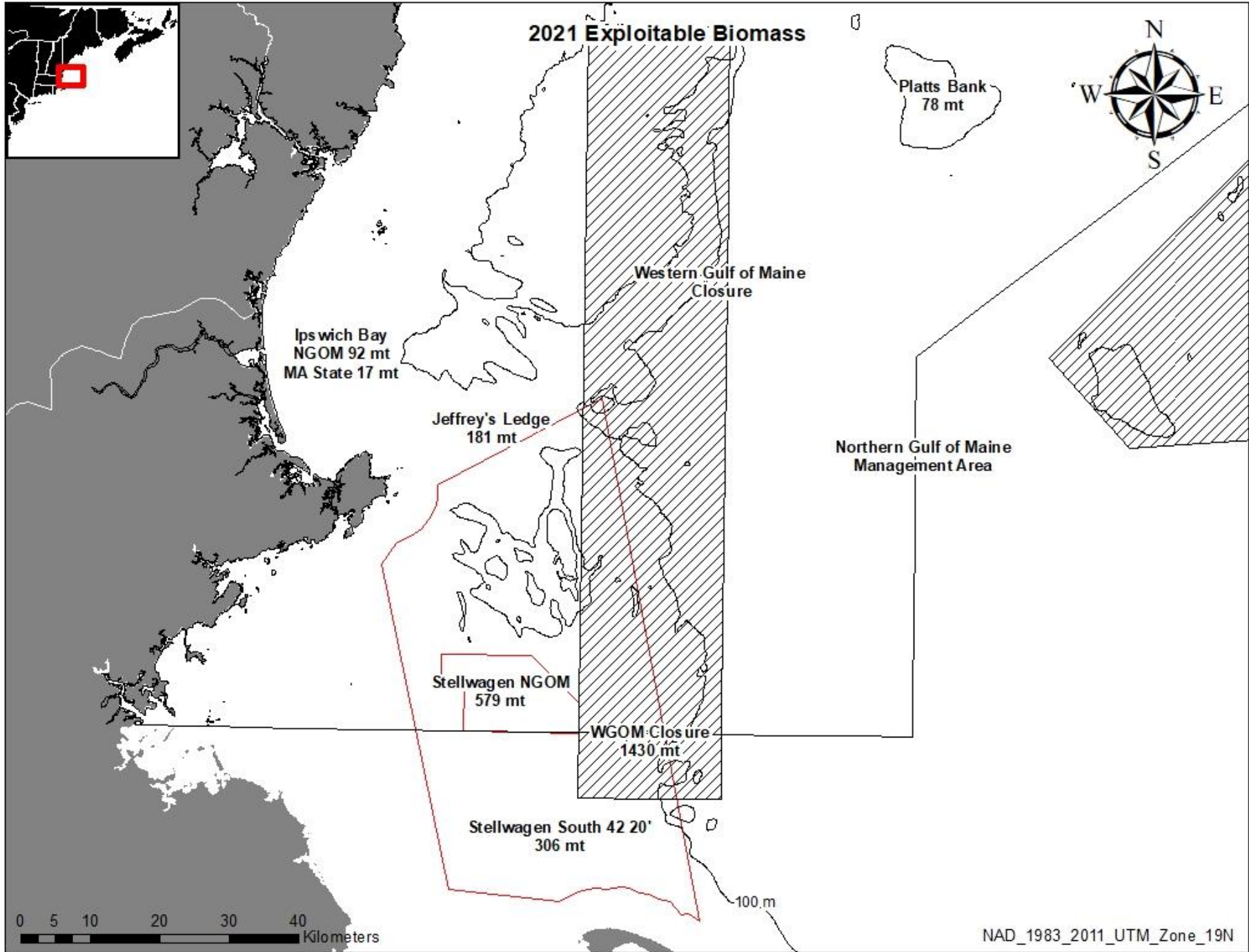
Ipswich Bay (Non-NGOM) 2021

Avg = 88.1 mm
N = 26





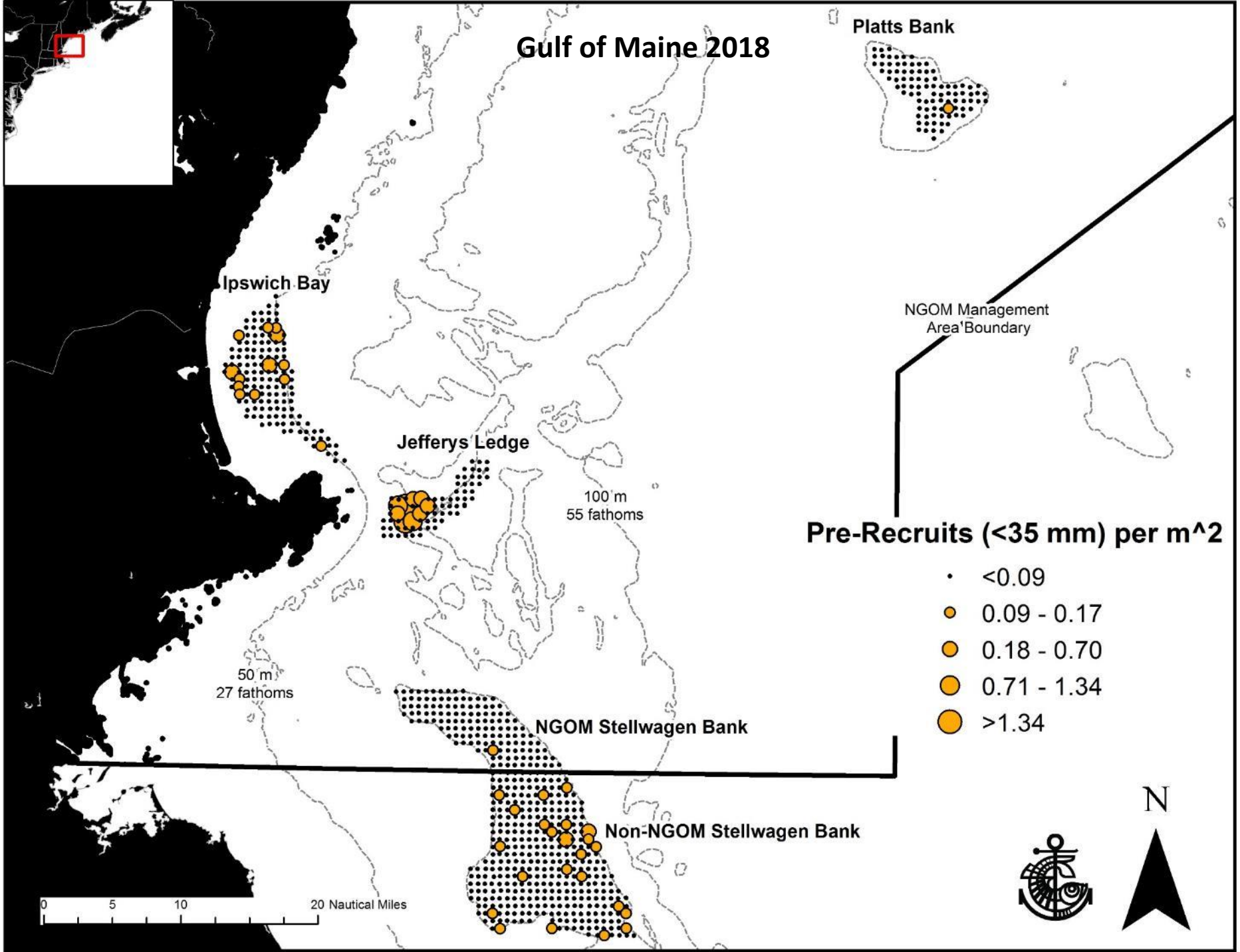
2021 Exploitable Biomass



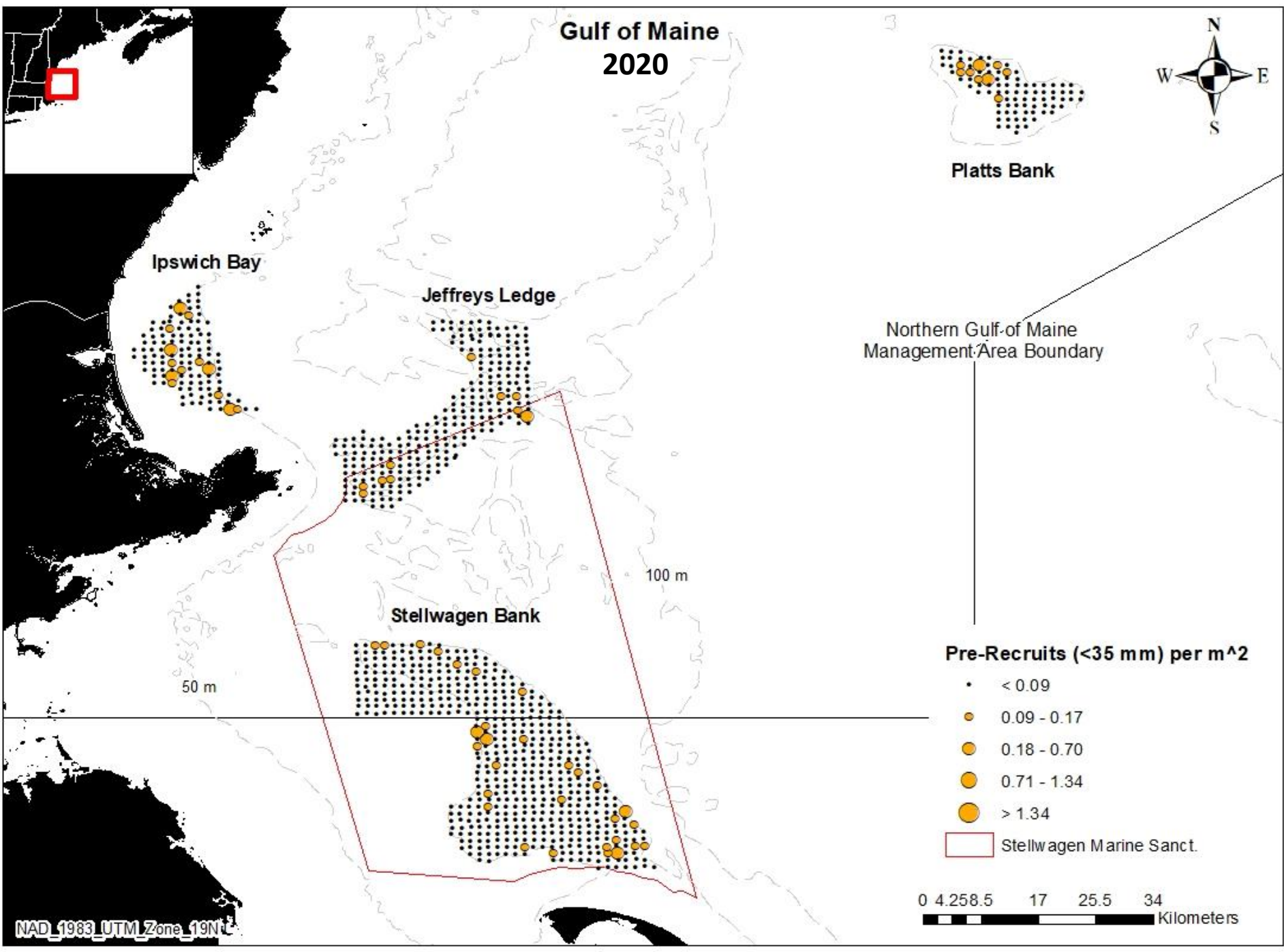
0 5 10 20 30 40 Kilometers

NAD_1983_2011_UTM_Zone_19N

Gulf of Maine 2018



Gulf of Maine 2020



Platts Bank

Ipswich Bay

Jeffreys Ledge

Northern Gulf-of-Maine
Management Area Boundary

Stellwagen Bank

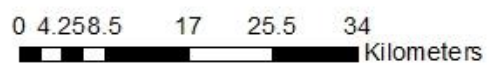
100 m

50 m

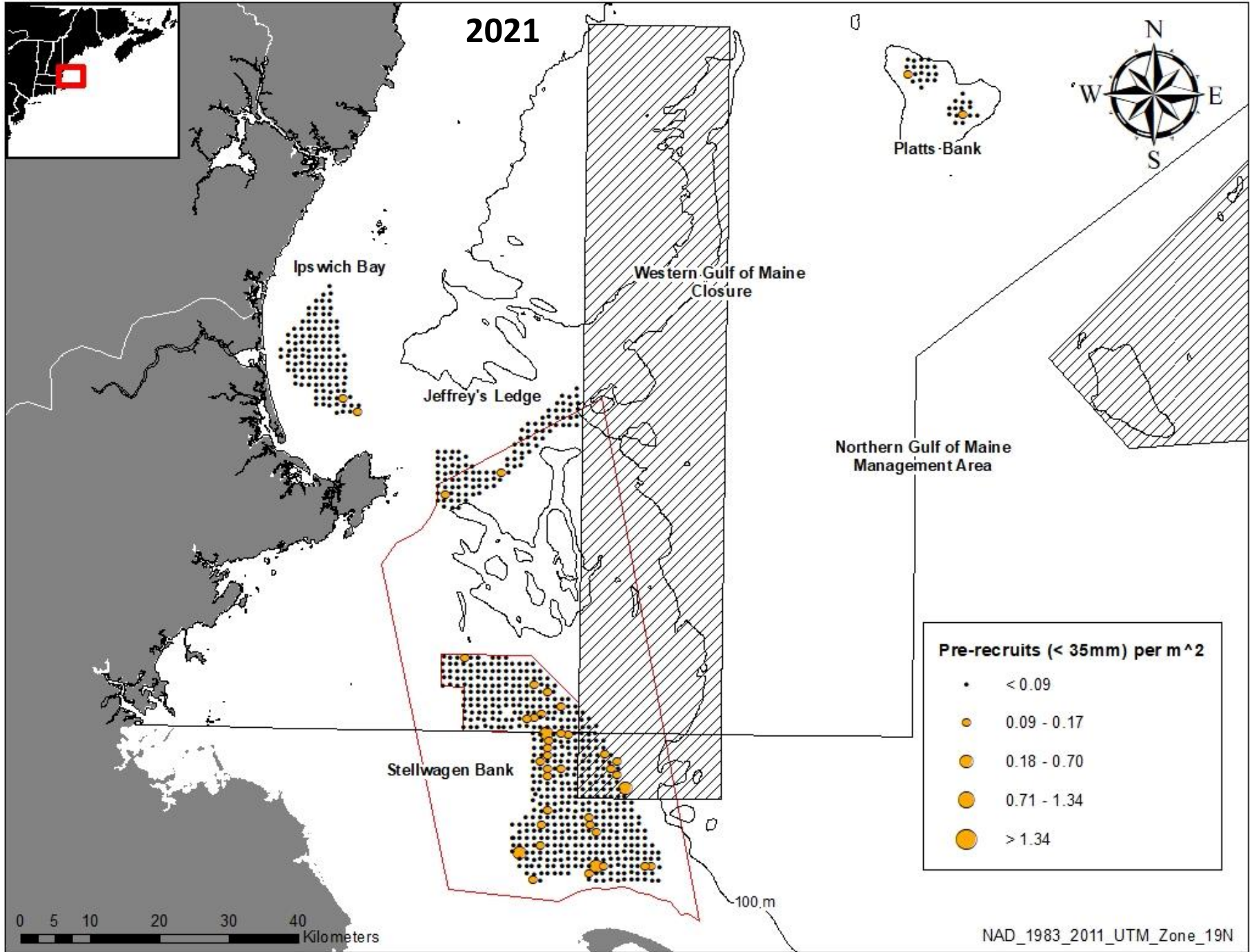
Pre-Recruits (<35 mm) per m²

- < 0.09
- 0.09 - 0.17
- 0.18 - 0.70
- 0.71 - 1.34
- > 1.34

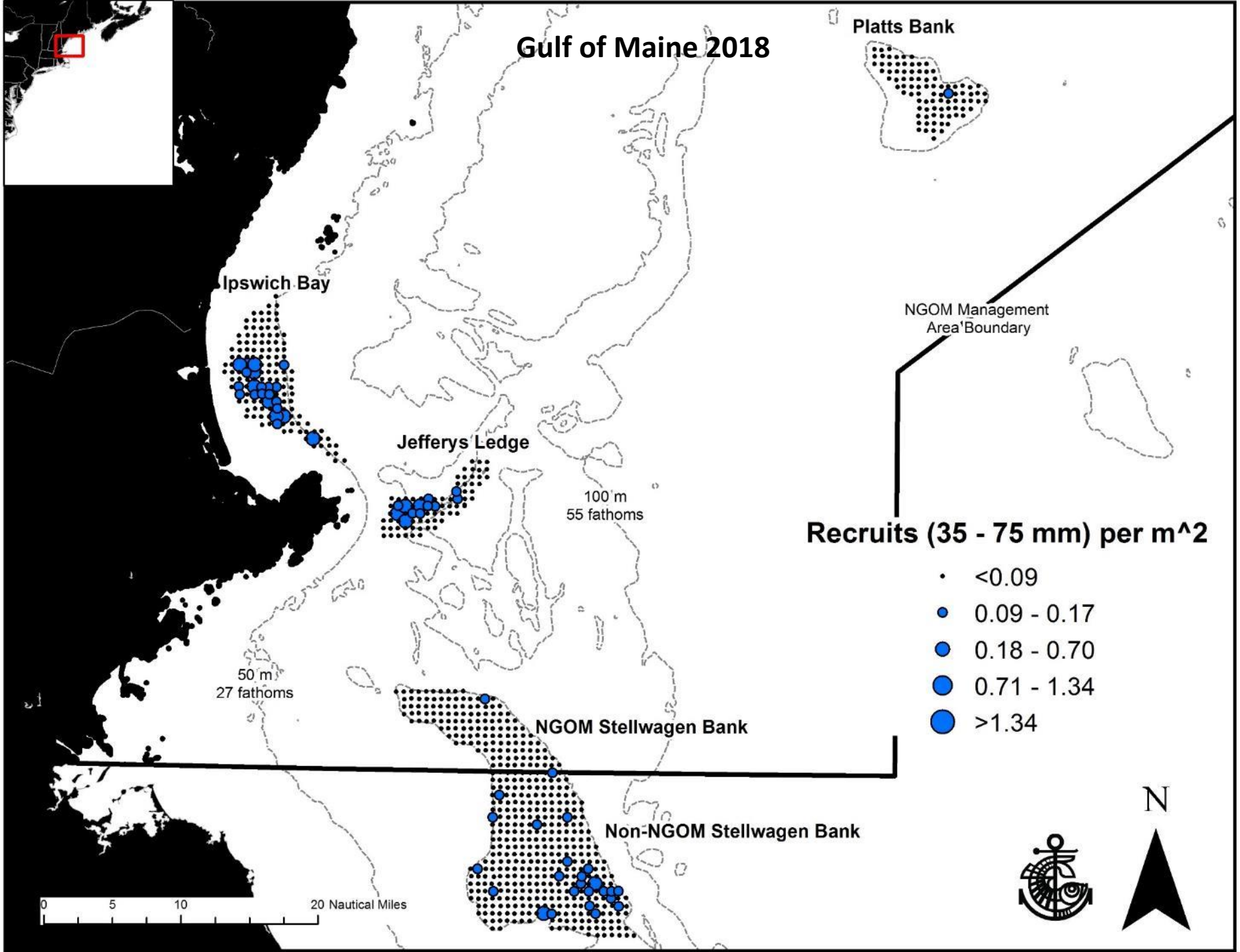
Stellwagen Marine Sanct.



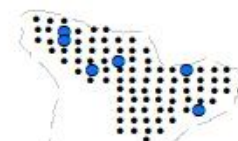
NAD_1983_UTM_Zone_19N



Gulf of Maine 2018



Gulf of Maine 2020



Platts Bank

Ipswich Bay

Jeffreys Ledge

Northern Gulf-of-Maine
Management Area Boundary

Stellwagen Bank

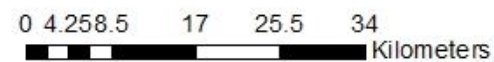
100 m

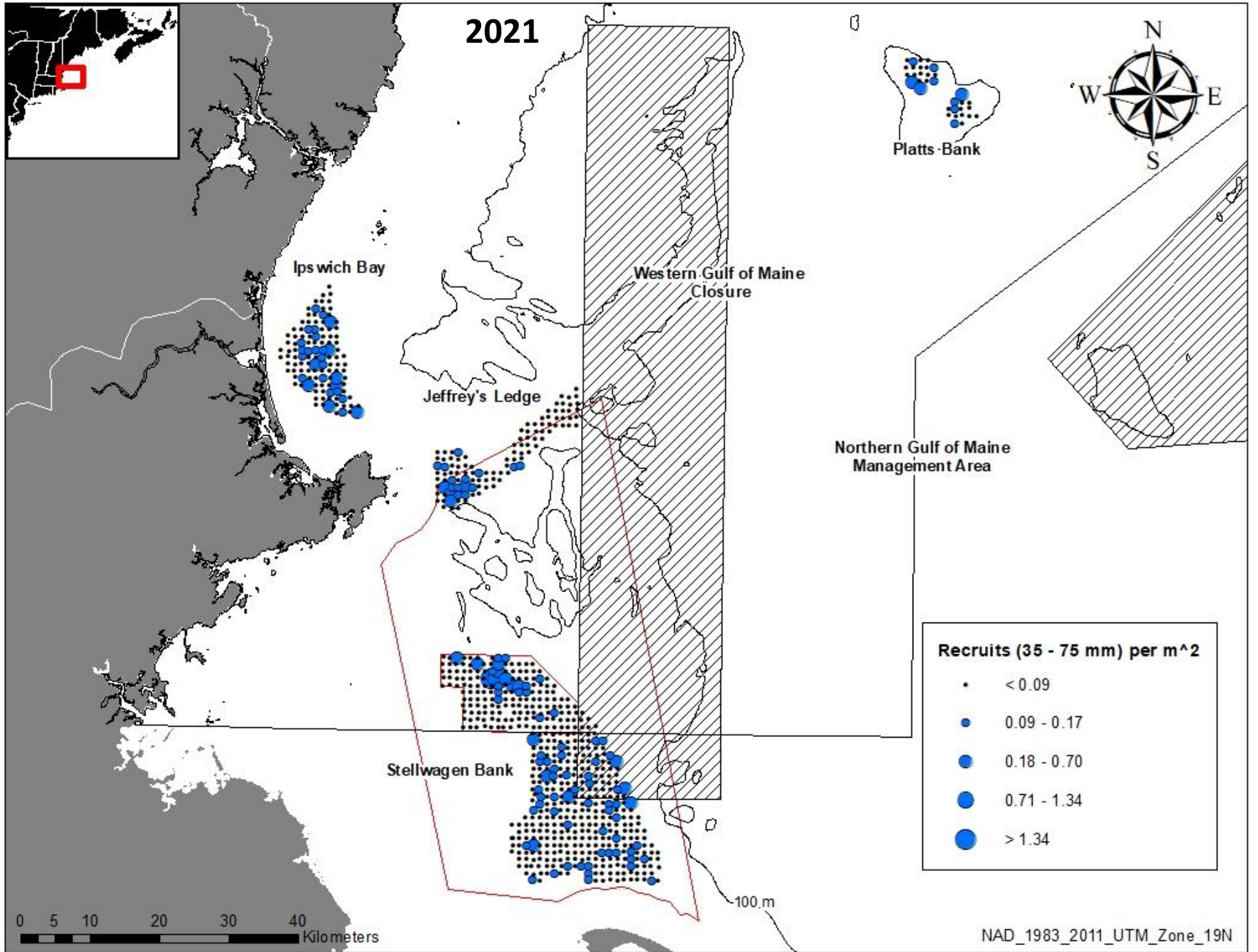
50 m

Recruits (35 - 75 mm) per m²

- < 0.09
- 0.09 - 0.17
- 0.18 - 0.70
- 0.71 - 1.34
- > 1.34

Stellwagen Marine Sanct.





Gulf of Maine 2018



Platts Bank



Ipswich Bay



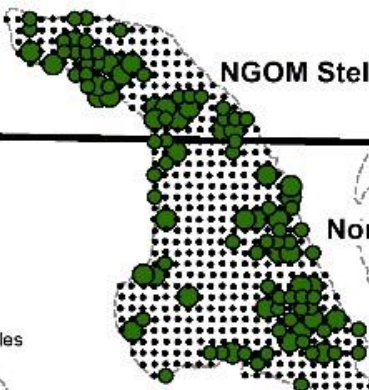
Jefferys Ledge



100 m
55 fathoms

50 m
27 fathoms

NGOM Stellwagen Bank



Non-NGOM Stellwagen Bank



NGOM Management
Area Boundary

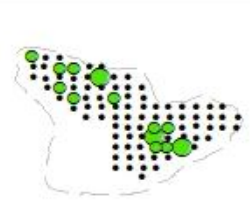
Scallops > 75 mm per m²

- <0.09
- 0.09 - 0.17
- 0.18 - 0.70
- 0.71 - 1.34
- >1.34

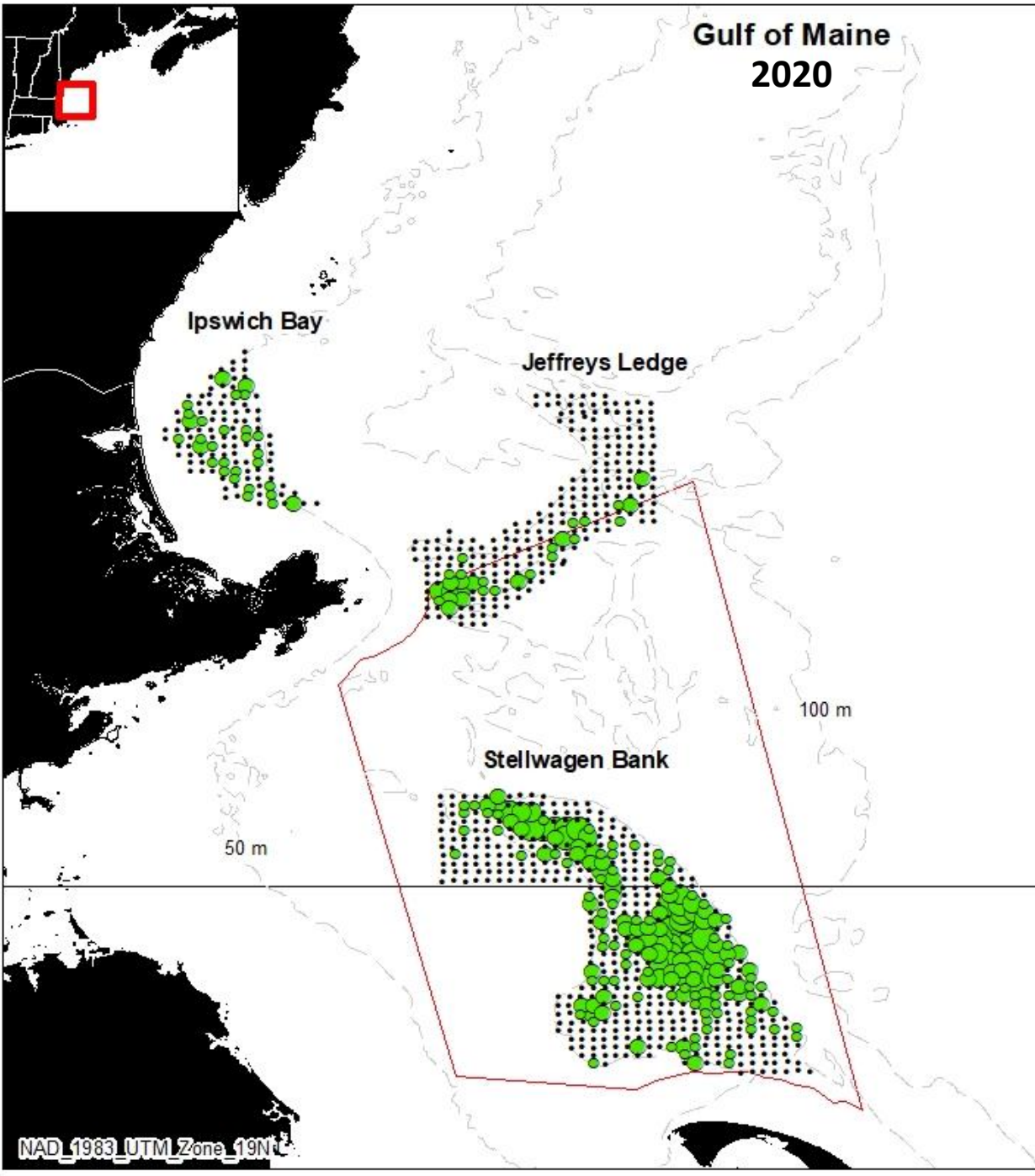
0 5 10 20 Nautical Miles



Gulf of Maine 2020



Platts Bank

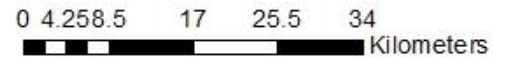


Northern Gulf-of-Maine
Management Area Boundary

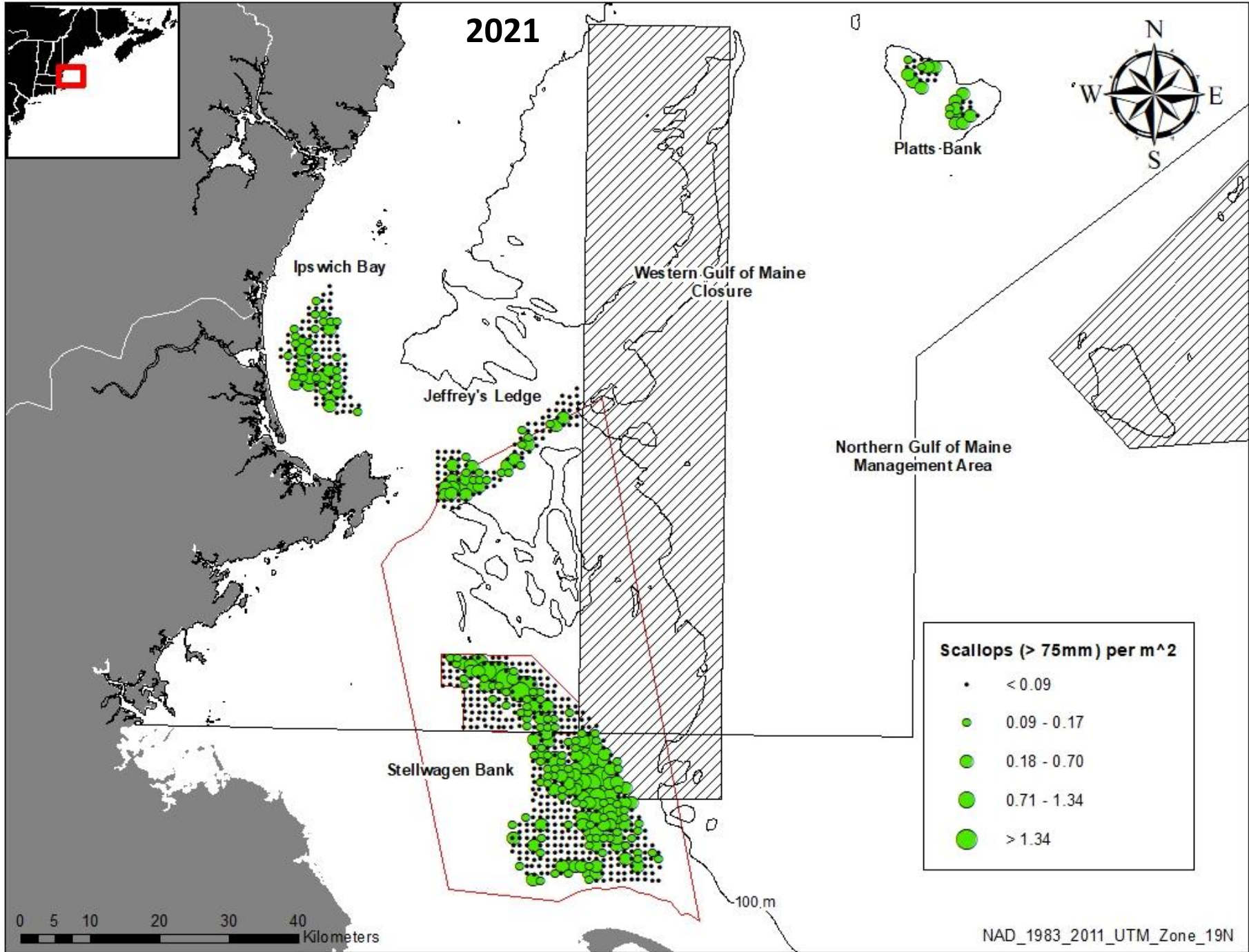
Scallops (> 75 mm) per m²

- < 0.09
- 0.09 - 0.17
- 0.18 - 0.70
- 0.71 - 1.34
- > 1.34

Stellwagen Marine Sanct.



2021



Stellwagen Bank Sensitivity Analysis

	BmsMT (SE): Hart '20 SH/MW	BmsMT (SE): 2021 DMR/UMaine SH/MW w/o covariates	BmsMT (SE): 2021 DMR/UMaine SH/MW w/covariates
NGOM Stellwagen Bank	1,580 (501)	1,602 (532)	1,539 (511)
Non-NGOM Stellwagen Bank (Stellwagen South)	547 (31)	560 (31)	590 (33)
Non-NGOM WGOM Closure	2,308 (349)	2,355 (356)	2,442 (366)

