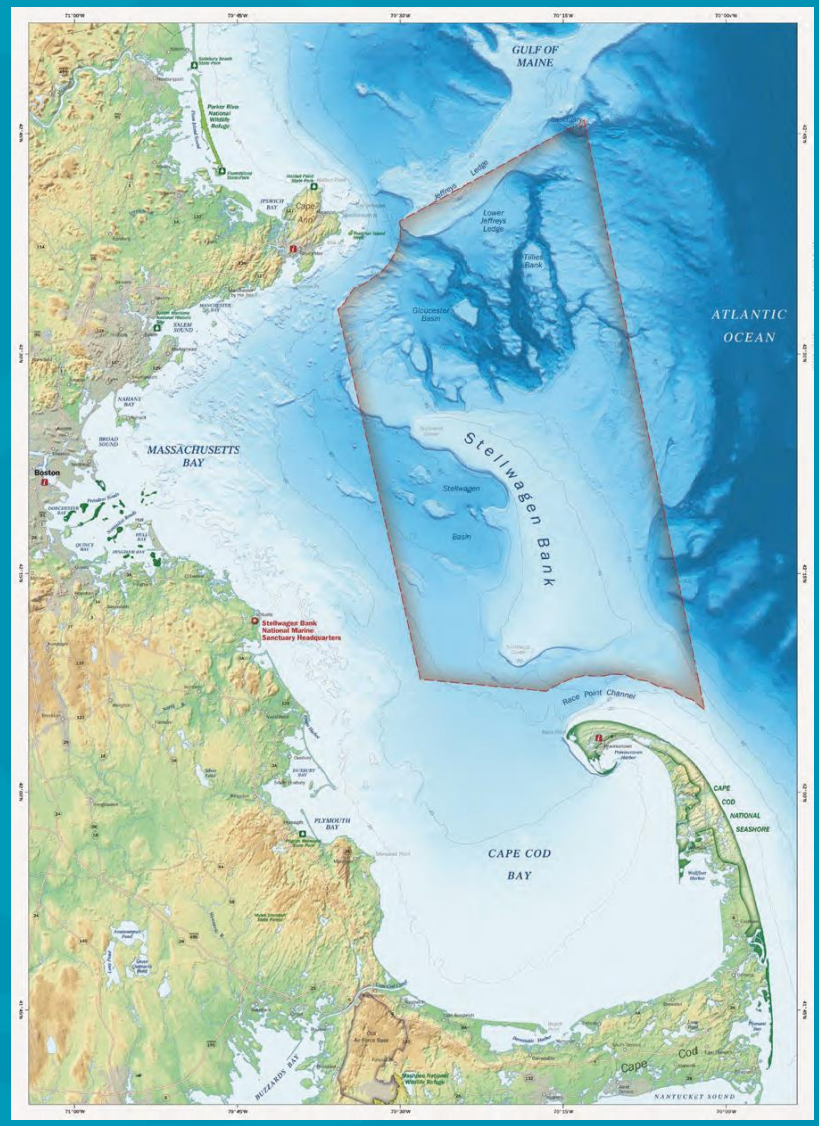
Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

Stellwagen Bank National Marine Sanctuary

- Summary of Sand Habitat Research
- Findings of 2020 Condition Report
- Update on Management Plan Review

Pete DeCola, Superintendent
Ben Haskell, Deputy Superintendent
David Wiley, Research Coordinator



Productivity and Ecology of Sand Habitats

Funding: Bureau of Ocean Energy Management

2018 – 2020; $1,197,000

Partners:

Stellwagen Bank NMS – lead – Wiley/Silva/Thompson
Boston University – Kaufman/Klien
University of Connecticut – Baumann/ Murray
University of Massachusetts: Dartmouth – Fay/Silva
Woods Hole Oceanographic Institute – Llopiz/Suca

Are Sand Habitats Productive?

- **Fisheries**
- **Protected Species**

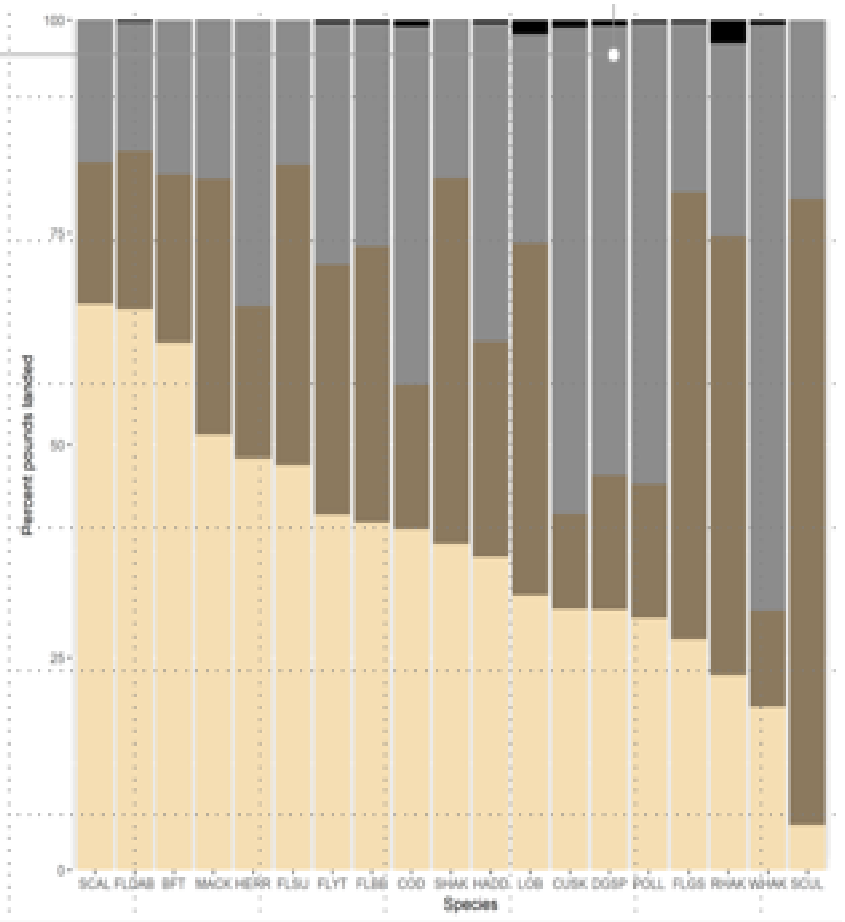
Why are sand habitats productive?

- **Sand lance**

Decision support tools

- **Vulnerability Matrix**
- **MIMES – Boston University**

BFT -- BLUEFIN TUNA
CAT -- WOLFISH
COD -- COD
CUSK -- CUSK
DGSP -- SPINY DOGFISH
HADD -- HADDOCK
HERR -- HERRING
LOB -- LOBSTER
MACK -- MACKEREL
MONK -- MONKFISH
FLBB -- FLOUNDER BLACK BACK WINTER
FLDAB -- FLOUNDER AMERICAN PLACIE DAB
FLGS -- FLOUNDER GRAY SOLE WITCH
FLYT -- YELLOWTAIL FLOUNDER
POLL -- POLLUCK
RHAK – RED HAKE
SCAL -- SEA SCALLOPS
SHAK -- HAKE SILVER
WHAK – WHITE HAKE

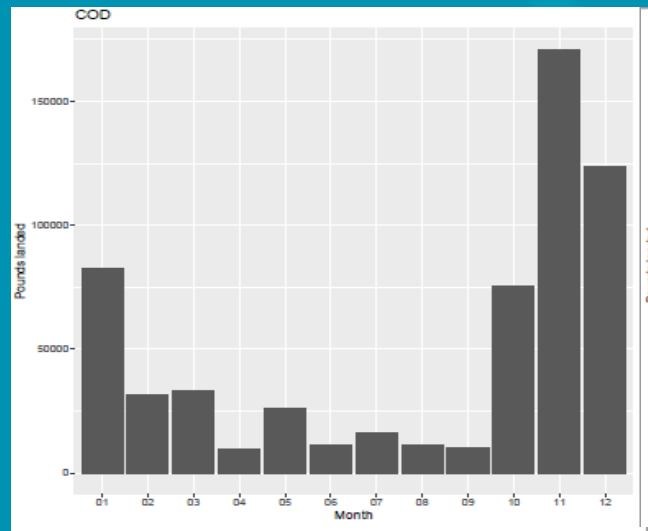


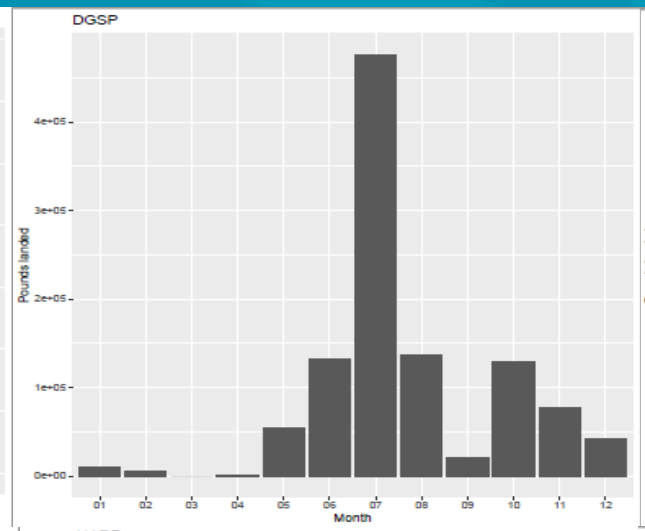
Percent pounds by species landed in sand, gravel, mud and boulder habitats for 19 commercial fish species for the years 2007 - 2016. Data calculated from National Marine Fisheries Service vessel trip reports for SBNMS. Data provided by the Greater Atlantic Regional Fisheries Office, Gloucester, MA.

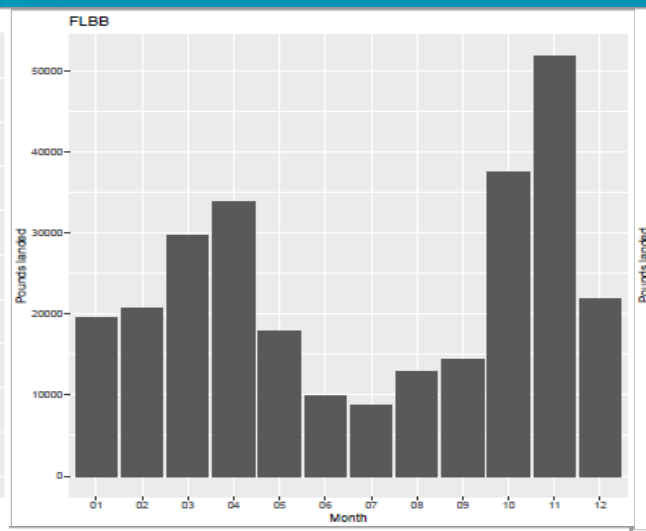
		Percentage of Pounds Landed			
Species abbreviation	Species name	Sand	Gravel	Mud	Boulder
BFT	Bluefin Tuna	62.0	18.1	19.9	0.0
COD	Cod	40.1	42.2	16.9	0.8
CUSK	Cusk	30.7	57.2	11.3	0.9
DGSP	Spiny Dogfish	30.6	52.8	15.9	0.7
HADD	Haddock	36.8	37.4	25.4	0.4
HERR	Herring	48.4	33.6	17.9	0.0
LOB	Lobster	32.3	24.6	41.4	1.7
MACK	Mackerel	51.2	18.6	30.1	0.0
FLBB	Flounder Black Back Winter	40.9	26.2	32.4	0.4
FLDAB	Flounder American Plaice Dab	66.0	15.2	18.6	0.3
FLGS	Flounder Gray Sole Witch	27.2	19.9	52.6	0.3
FLYT	Flounder Yellowtail	41.9	28.4	29.4	0.4
FLSU	Flounder Summer	47.7	17.1	35.2	0.0
POLL	Polluck	29.6	54.3	15.8	0.3
SCAL	Sea Scallops	66.6	16.7	16.6	0.0
SHAK	Hake Silver	38.4	18.5	43.1	0.1
WHAK	Hake White	19.2	69.0	11.3	0.5
RHAK	Hake Red	22.9	22.7	51.7	2.7

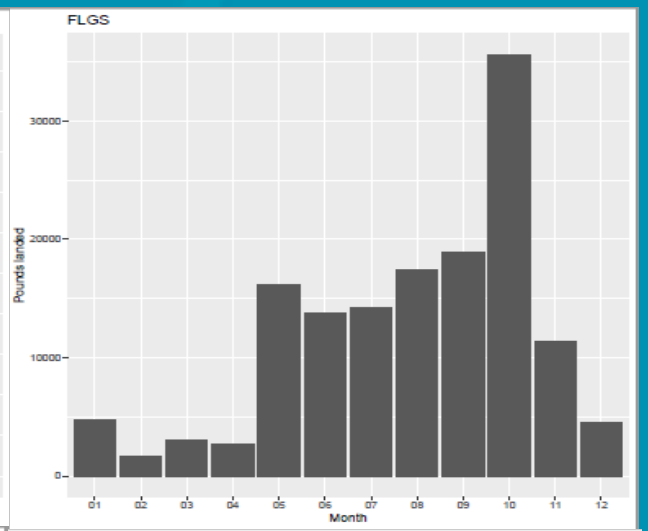
Pounds landed by habitat type showing the relative importance of sand habitat as compared to gravel, mud, and boulder habitats. Sand habitat provided the most pounds landed in 8 of the 19 species (blue text), including the highly valuable bluefin tuna and scallop fisheries.
Sand habitat was the second most productive habitat in 10 other species, including cod and haddock.

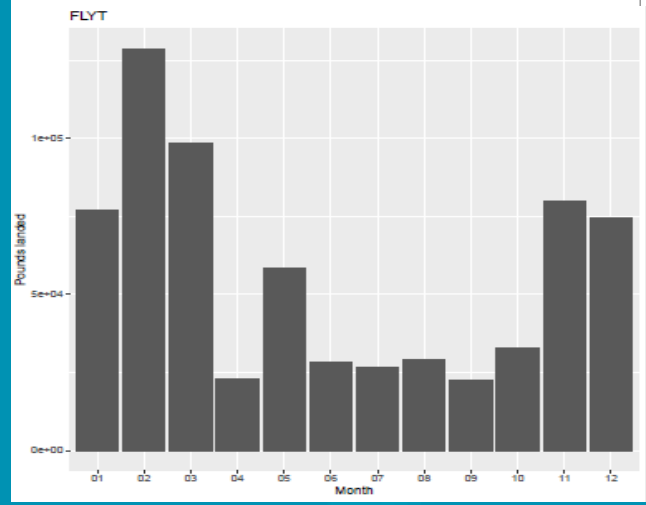
Pounds landed in sand habitat by species / month

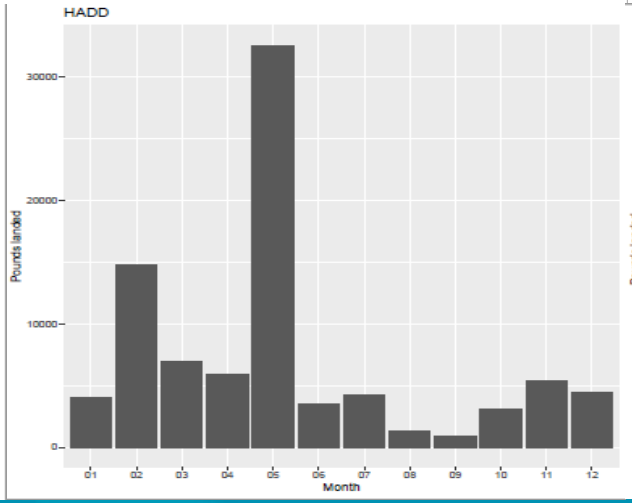


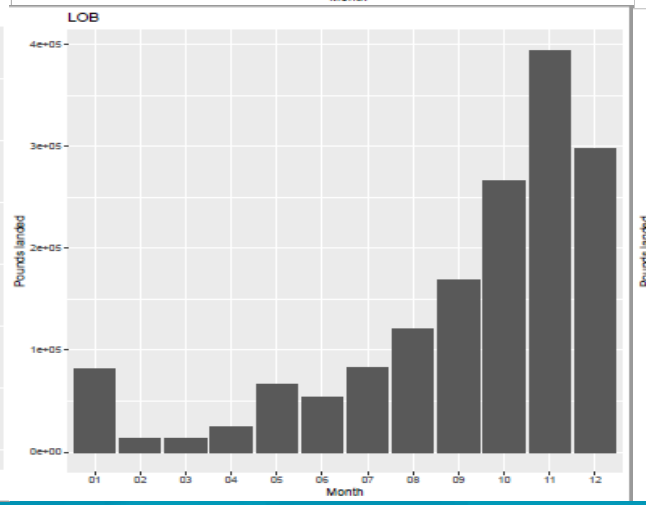


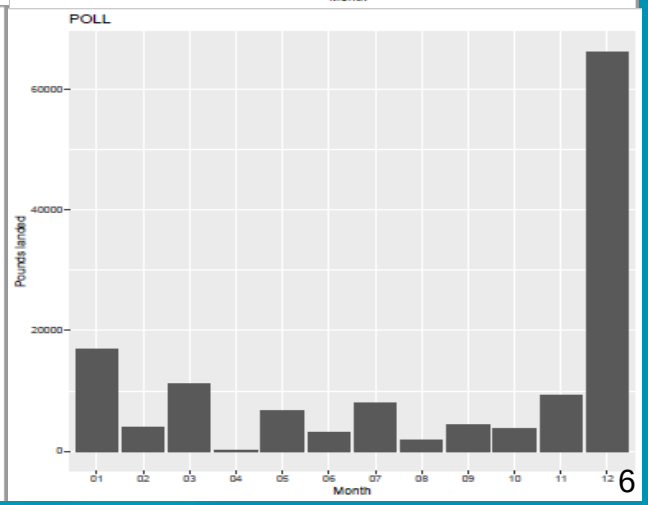


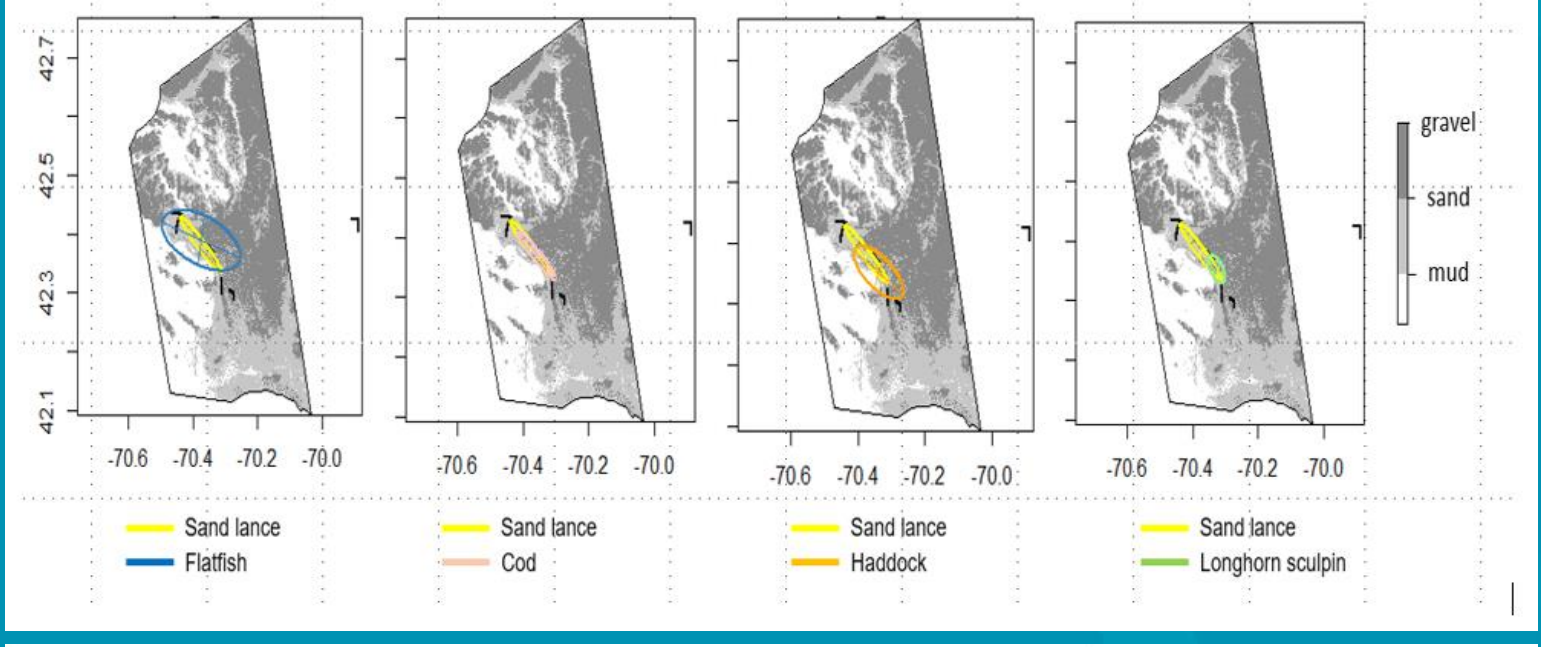






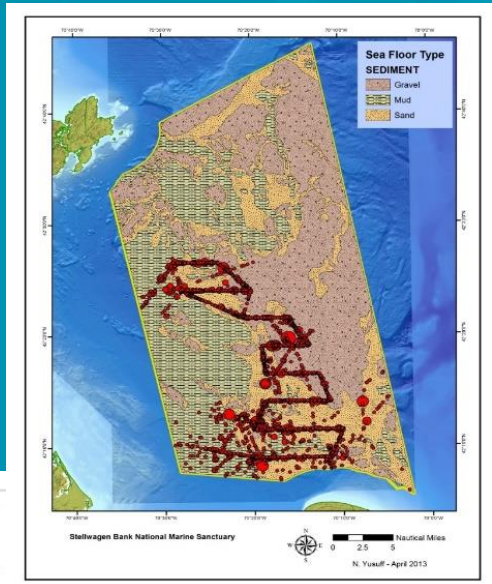




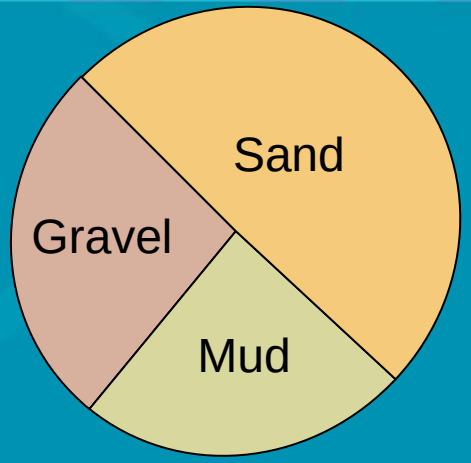


Species	Local Index of Colocation	Global Index of collocation
sand lance - flatfish	0.526363	0.997
sand lance - cod	0.5790597	0.968
sand lance - haddock	0.1611071	0.861
sand lance - sculpin	0.5986944	0.716

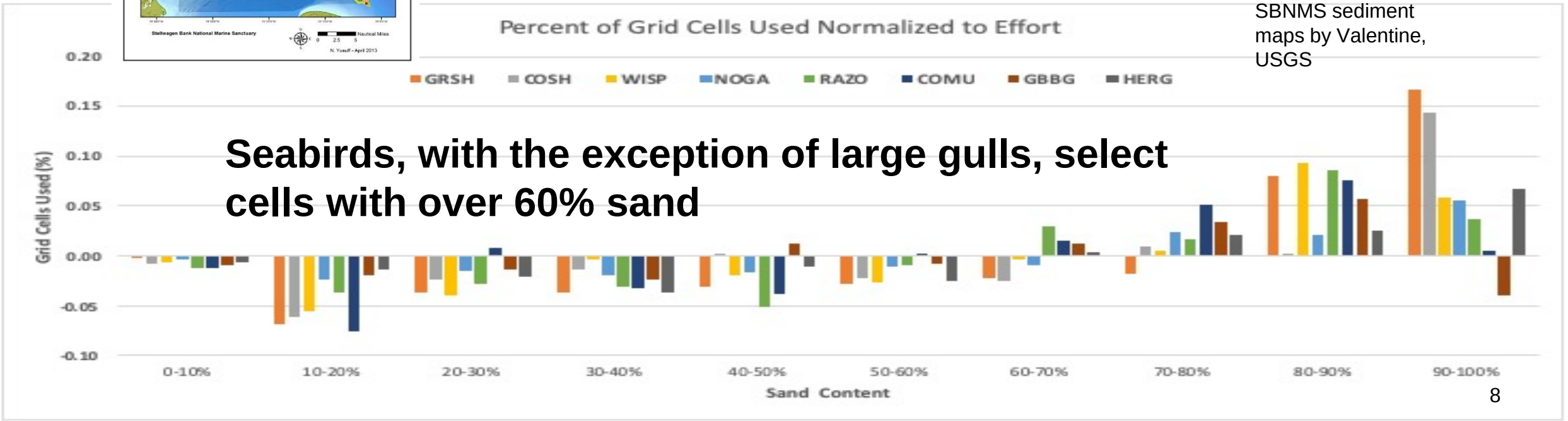
Distributions of the center of gravity and inertia for sand lance and select commercial fish species in and around SBNMS. Data comes from closed trawl video surveys conducted in April 2017 by K. Stokesbury. Black points = trawl locations. The center of gravity is the mean location of the population (located at center of cross hairs). The inertia is the variance of locations and describes the dispersion of the population around the center of gravity (ellipse). Sand lance overlaps with all fish species here, particularly cod and flatfish.



Are seabirds preferentially selecting sand habitat ?

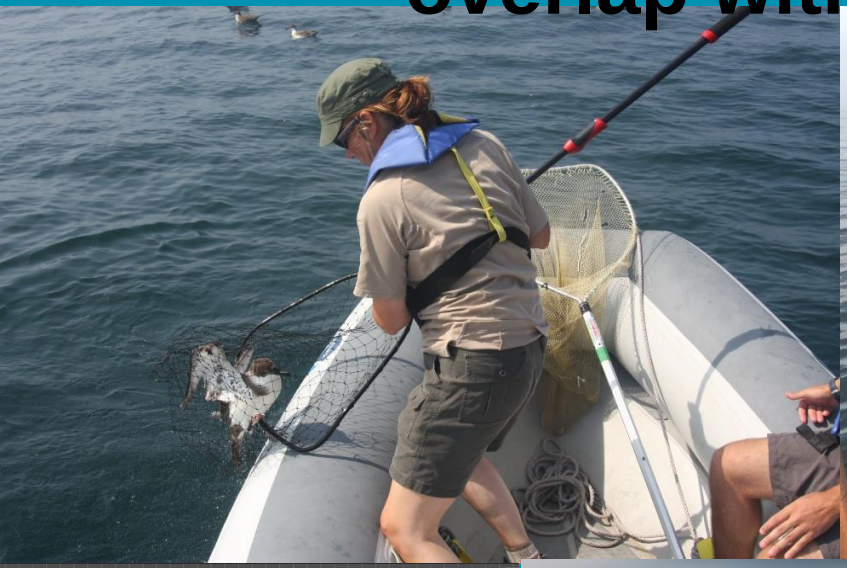


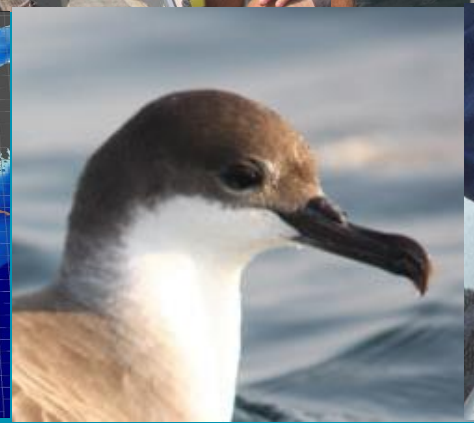
SBNMS sediment maps by Valentine, USGS

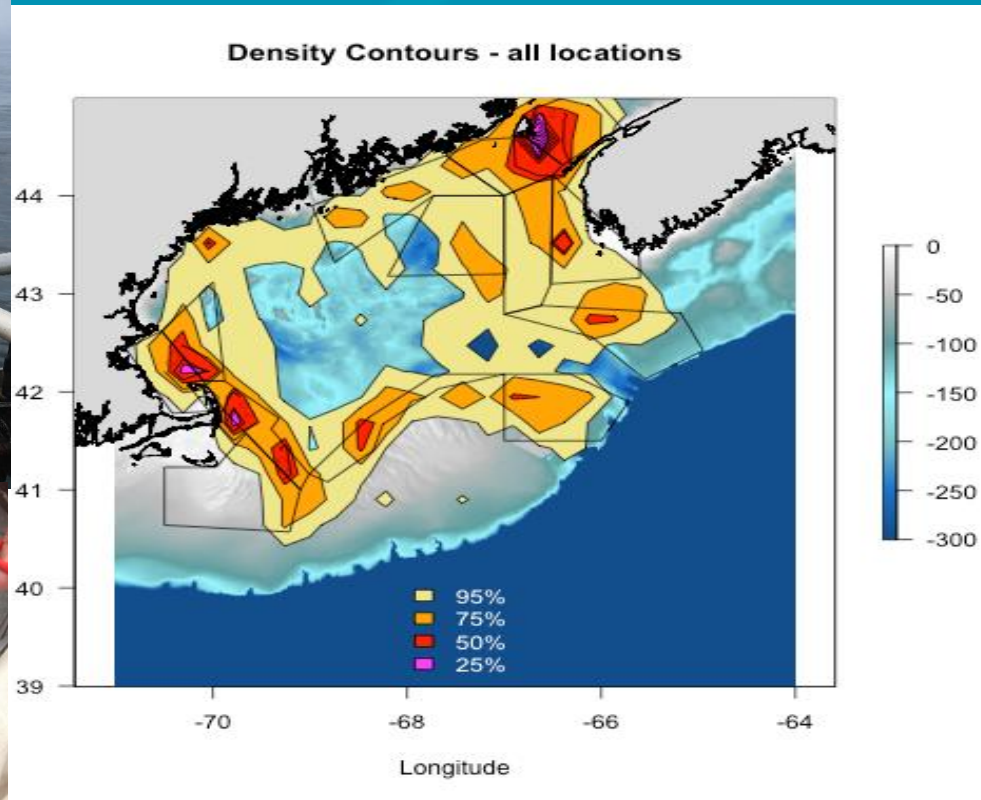


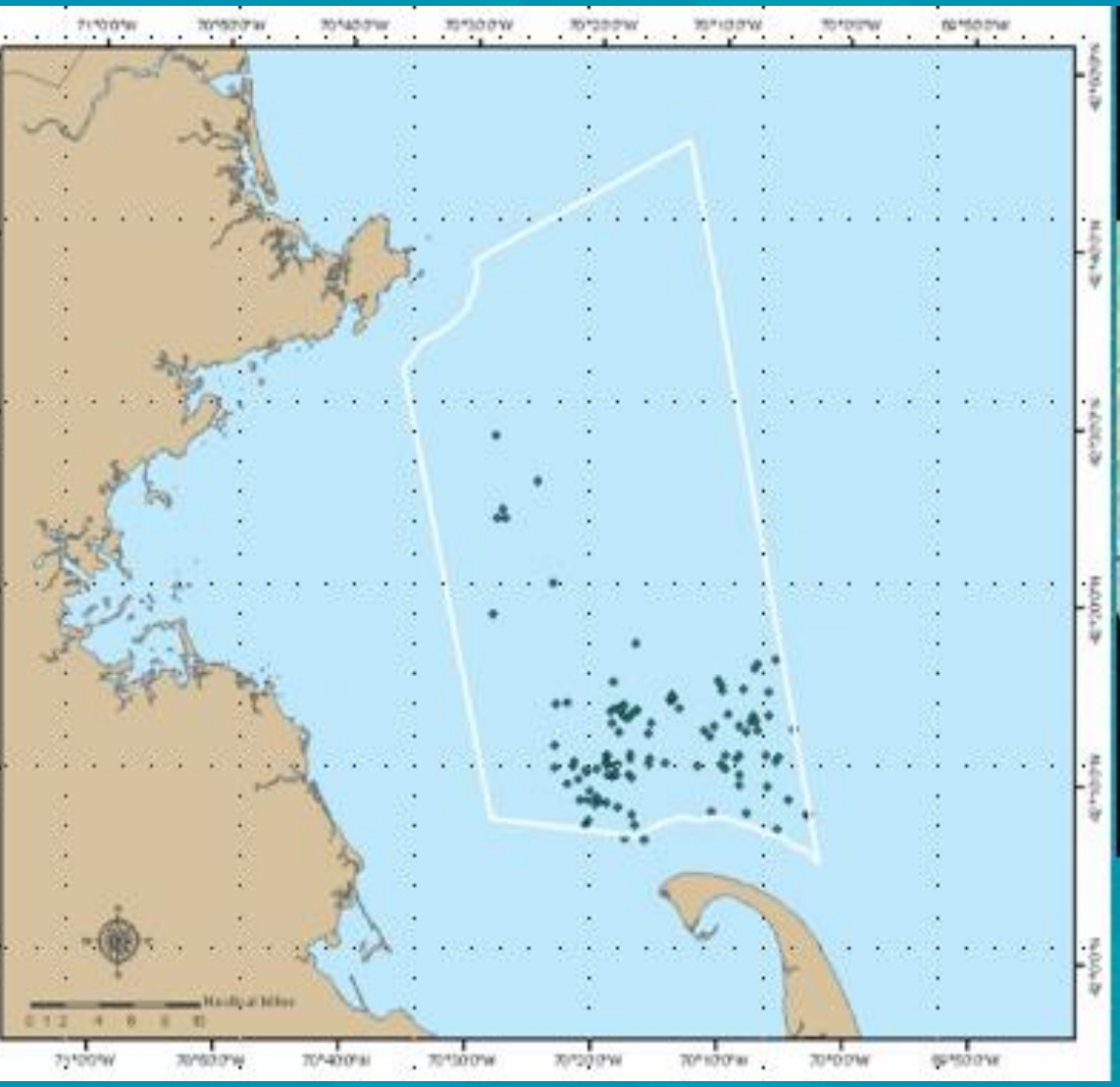
Seabirds, with the exception of large gulls, select cells with over 60% sand

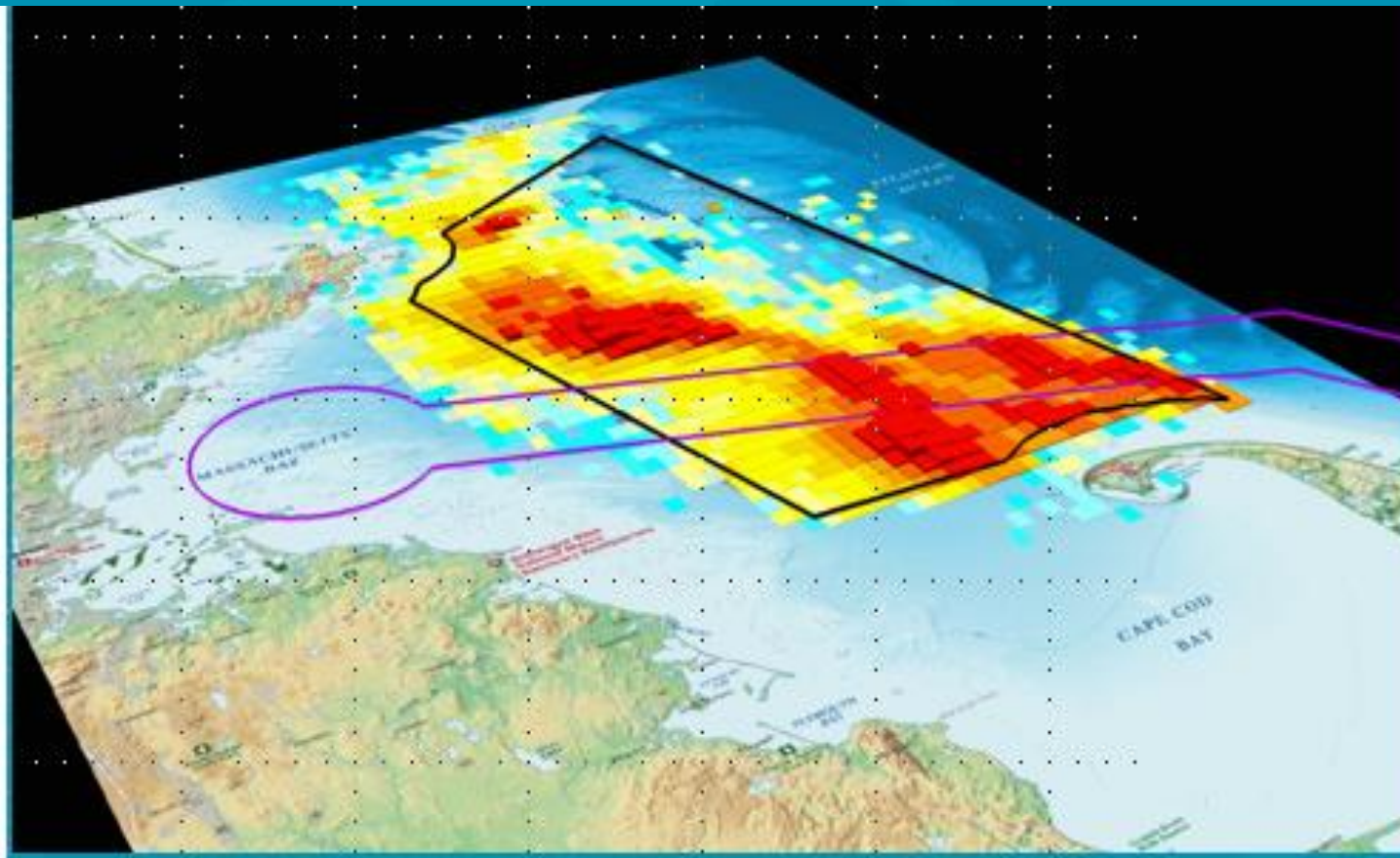
Satellite tagging and tracking of Great Shearwater seabirds show overlap with sand habitats in the Gulf of Maine











Baleen whales and commercial whale watching occur over sand habitat.

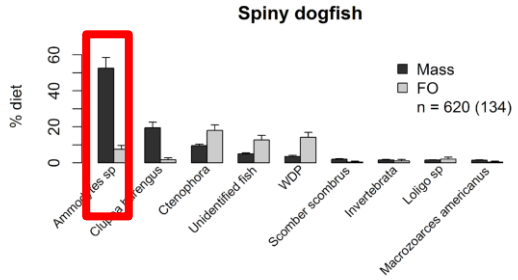
Why are sand habitats productive?

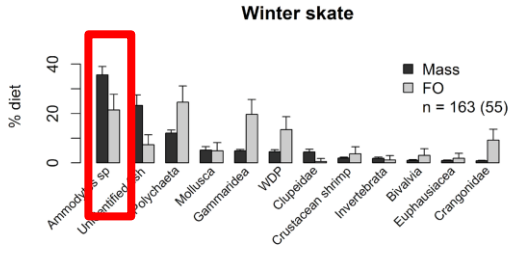
Small (11-20 cm) bentho-pelagic forage fish

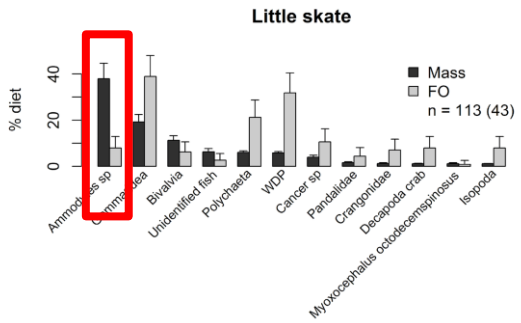
Require coarse-grained sand for burying

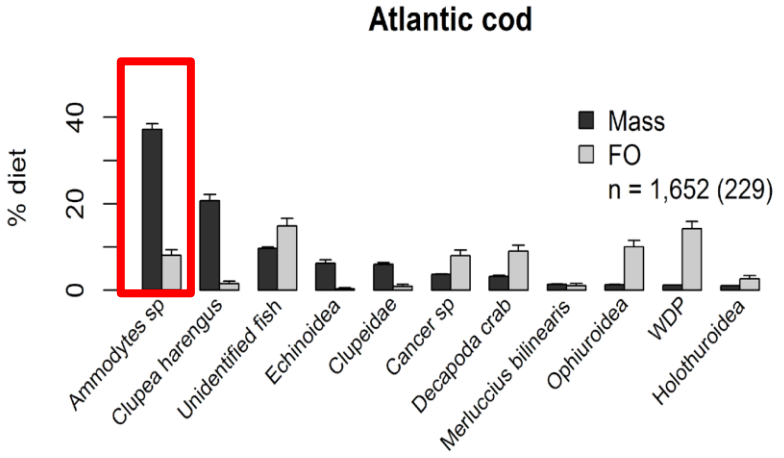
Restricted to sandy banks

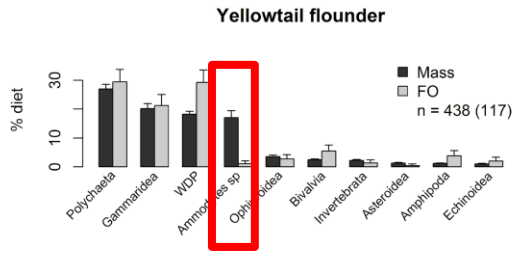
Northern sand lance (eel) (*Ammodytes duibius)*

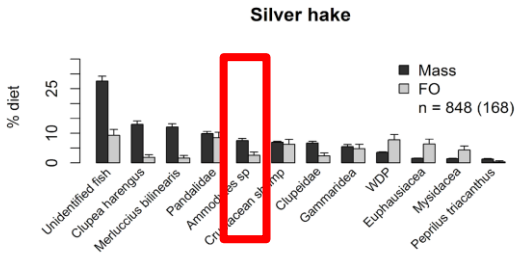


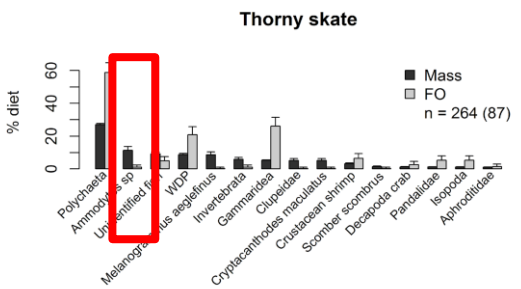


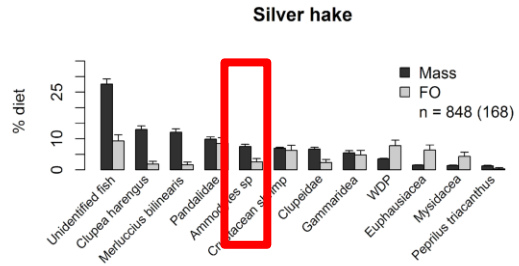


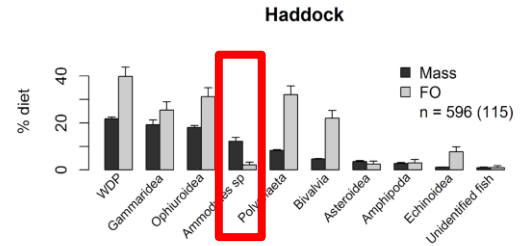


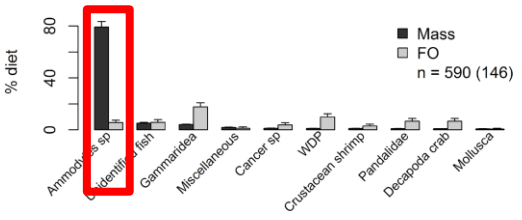










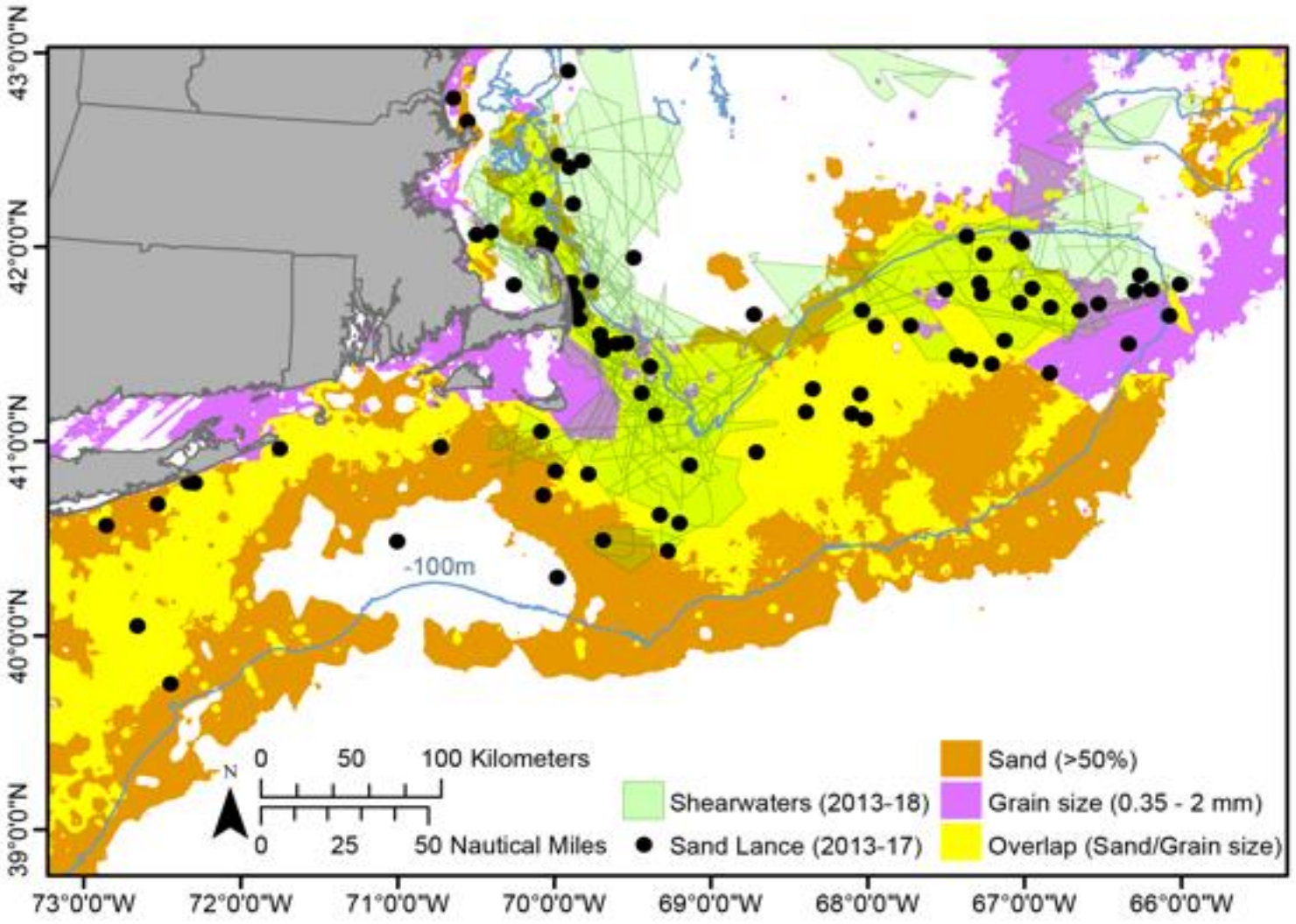


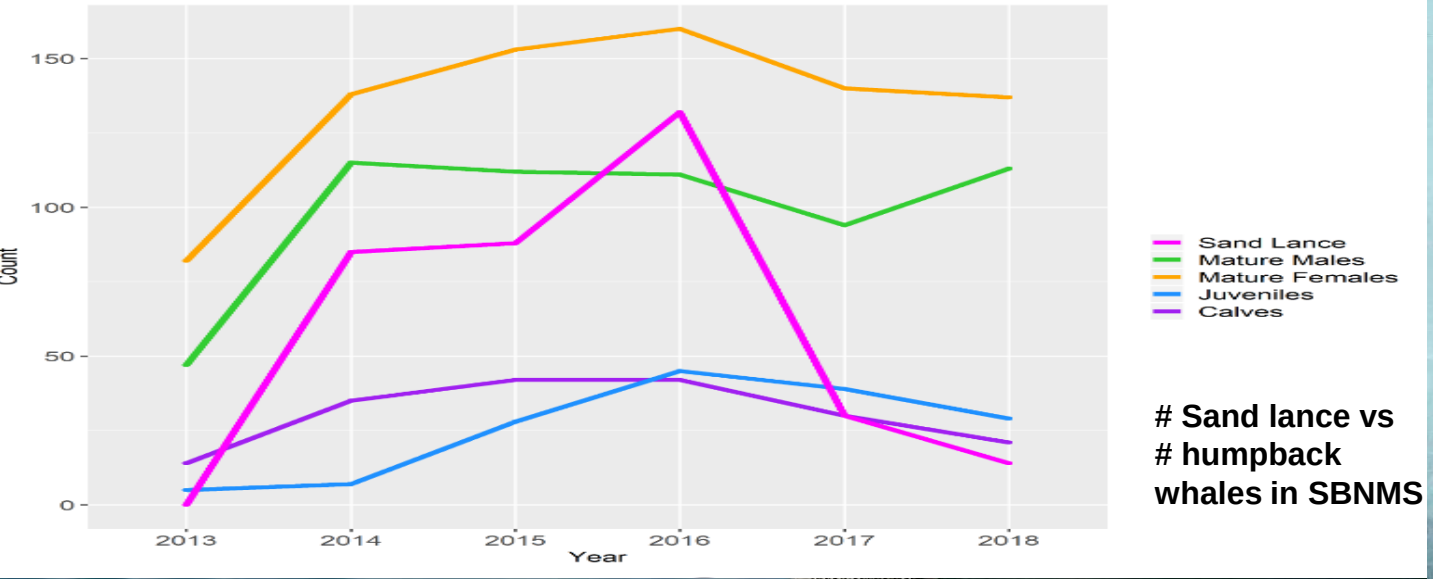
Sand lance (eel) are a major component of commercial fish diets in SBNMS.

Data provided by Brian Smith; NEFSC

Prey group	Common name	Count	FOO
Ammodytes spp.	Sand lance	25	71.40%
Brevoortia tyrannus	Atlantic menhaden	17	48.60%
Scomber scombrus	Atlantic mackerel	11	31.40%
Leucoraja erinacea	Little skate	7	20.00%
Peprilus triacanthus	Atlantic butterfish	3	8.60%
Clupea harengus	Atlantic herring	2	5.70%
Squalus acanthias	Spiny dogfish	2	5.70%
Morone saxatilis	Striped bass	1	2.90%
Merluccius bilinearis	White hake	1	2.90%
Pleuronectiformes	Flatfishes (flounders)	1	2.90%
Tautogolabrus adspersus	Cunner	1	2.90%

Great Shearwater seabirds:
DNA analysis of fecal material and satellite tracked movements show importance of sand lance.





 # Sand lance vs # humpback whales in SBNMS

Humpback whales feed on sand lance at the surface and along the seabed.

Received: 23 September 2019 | Revised: 24 January 2020 | Accepted: 28 January 2020
DOI: 10.1111/faf.12445

ORIGINAL ARTICLE

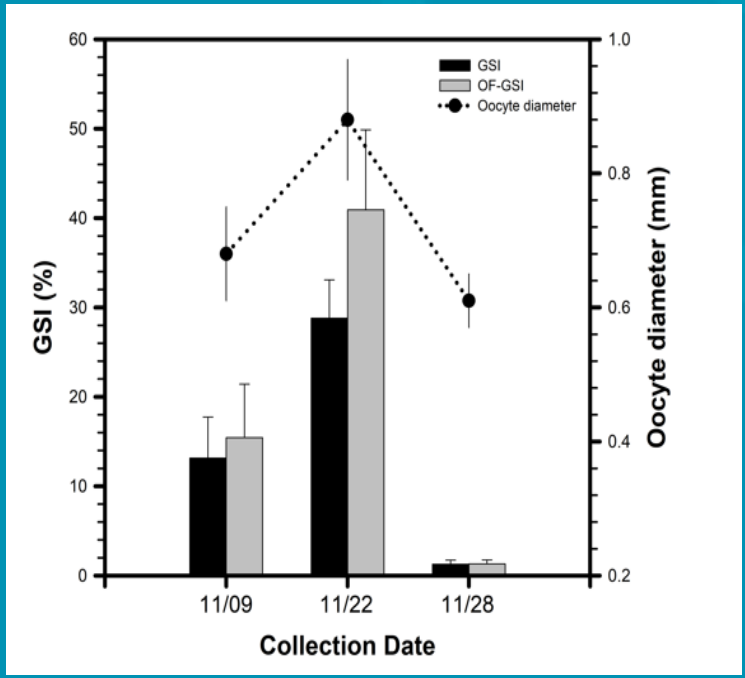
FISH and FISHERIES WILEY

The role of sand lances (*Ammodytes* sp.) in the Northwest Atlantic Ecosystem: A synthesis of current knowledge with implications for conservation and management

Michelle D. Staudinger[1,2] | Holly Goyert[2] | Justin J. Suca[3,4] | Kaycee Coleman[5] | Linda Welch[6] | Joel K. Llopiz[3] | David Wiley[7] | Irit Altman[8] | Andew Applegate[9] | Peter Auster[10,11] | Hannes Baumann[11] | Julia Beaty[12] | Deirdre Boelke[9] | Les Kaufman[8] | Pam Loring[13] | Jerry Moxley[14,15] | Suzanne Paton[13] | Kevin Powers[7] | David Richardson[16] | Jooke Robbins[17] | Jeffrey Runge[18] | Brian Smith[19] | Caleb Spiegel[5] | Halley Steinmetz[2]

Overall, 72 regional predators including 45 species of fishes, two squids, 16 seabirds and nine marine mammals were found to consume *Ammodytes*.

Sand Lance Life History

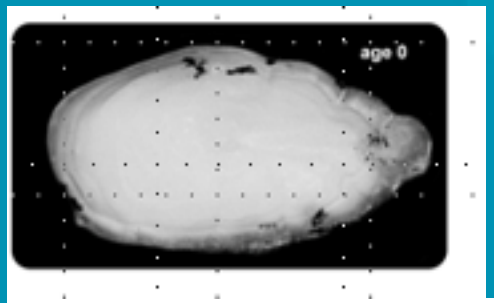


Gonado-somatic index, shows sudden increase and then immediate decrease at the end of November, consistent with a single, short spawning peak

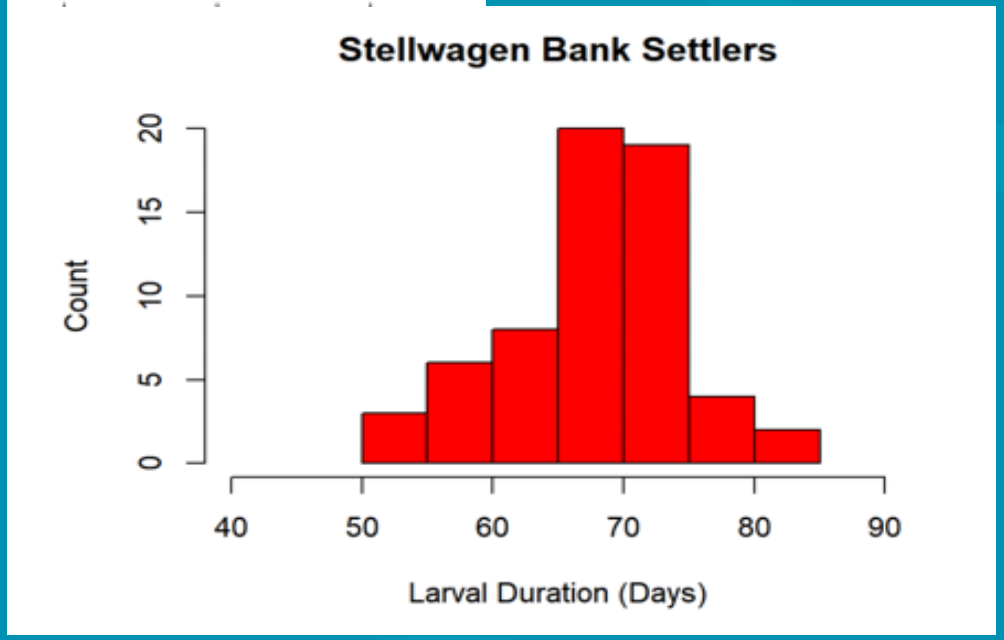
Histology of the ovary of a northern sand lance female prior to spawning. All Oocytes are of the same size and developmental stage, supporting the single, narrow spawning window for this species.

Histology of the ovary of a northern sand lance female post-spawning at the end of November 2017. Only small, primary “reservoir” oocytes remain. This is consistent with a single spawning peak.

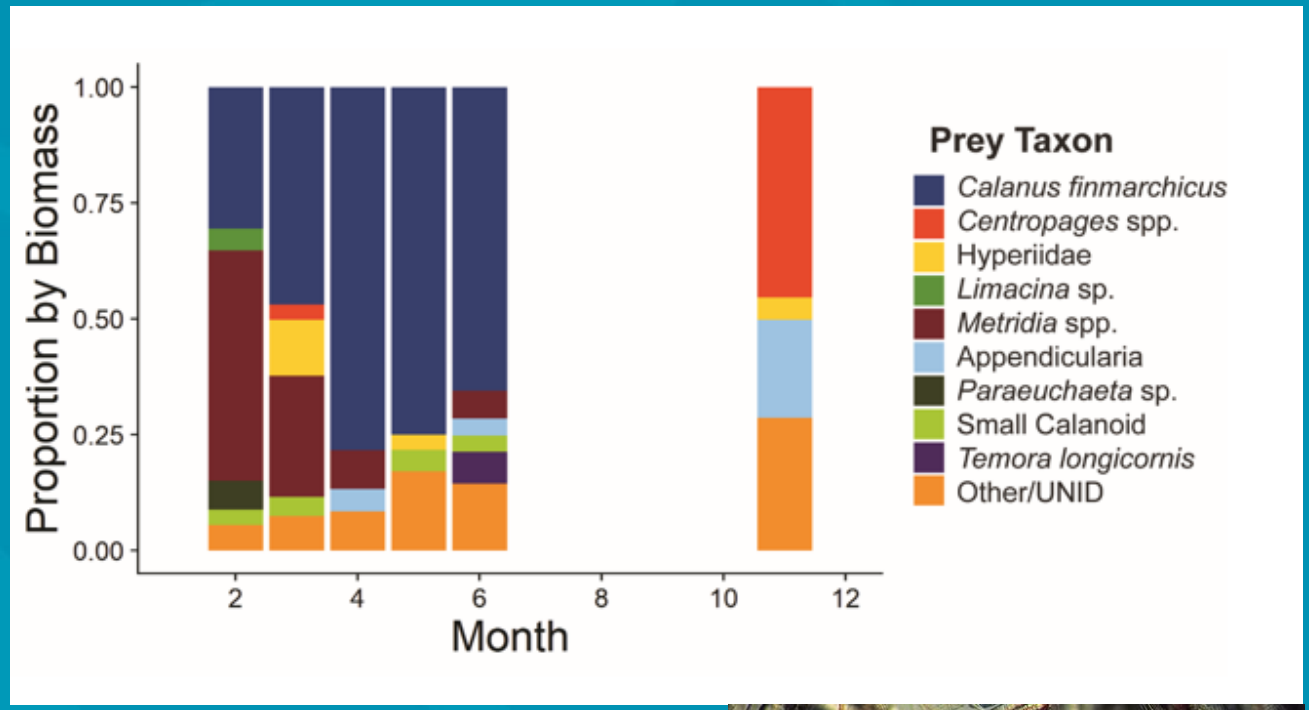
Single, brief spawning period (<2 weeks) in November.



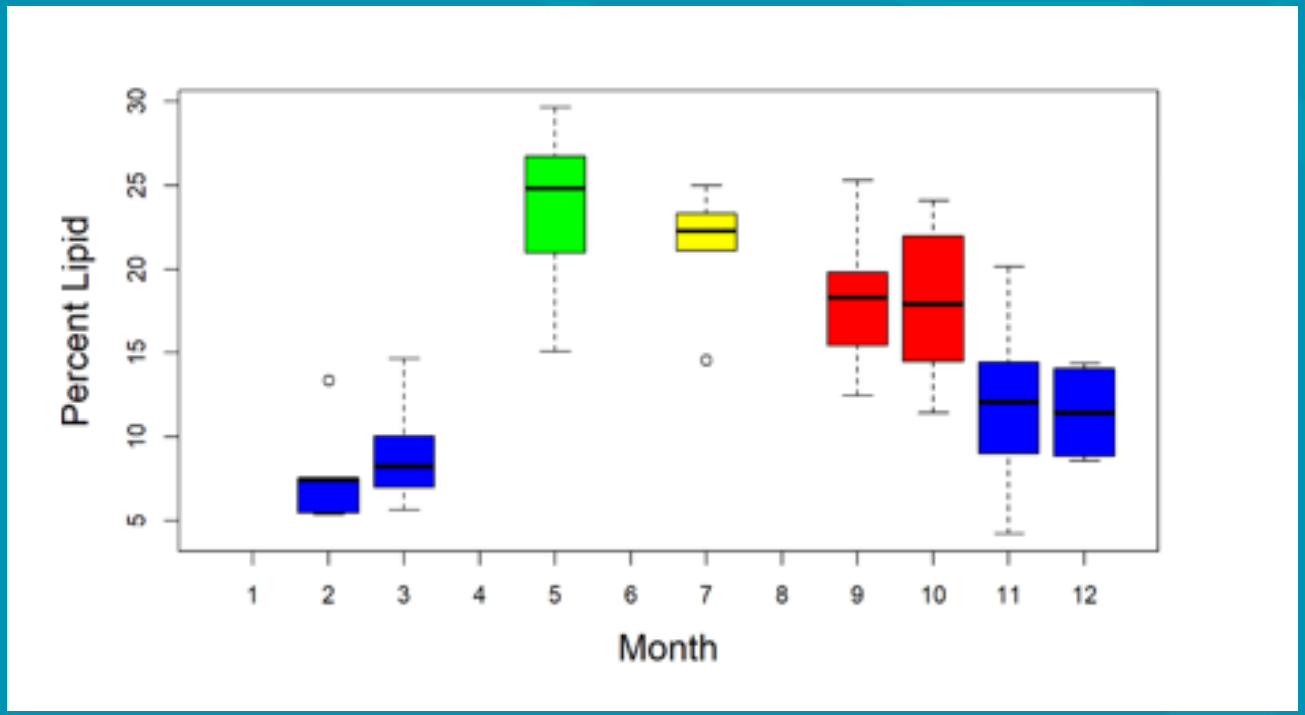
Otoliths were used to calculate larval SL settled on SB after ~ 70 days.



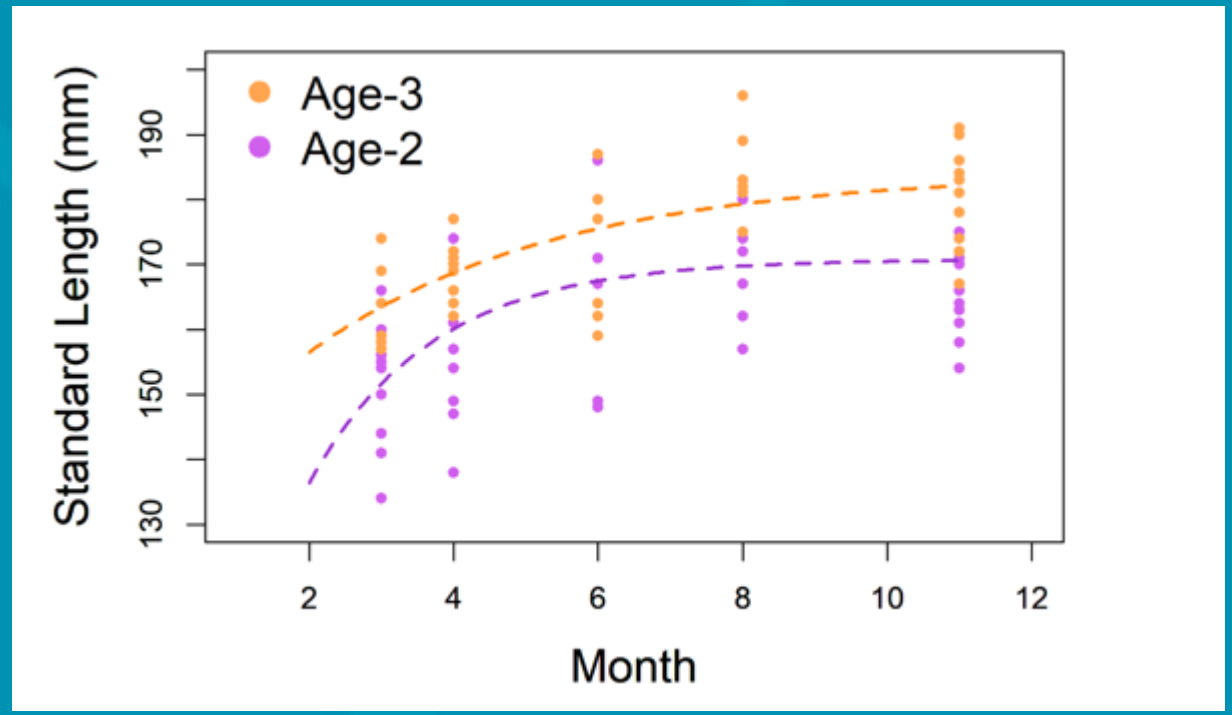
Spawning in late November, 6-week demersal egg period, 70-day pelagic larvae period = settlement on SB in March / April.



Diet by biomass by month of adult sand lance collected in 2019. Dominated by Calanus.

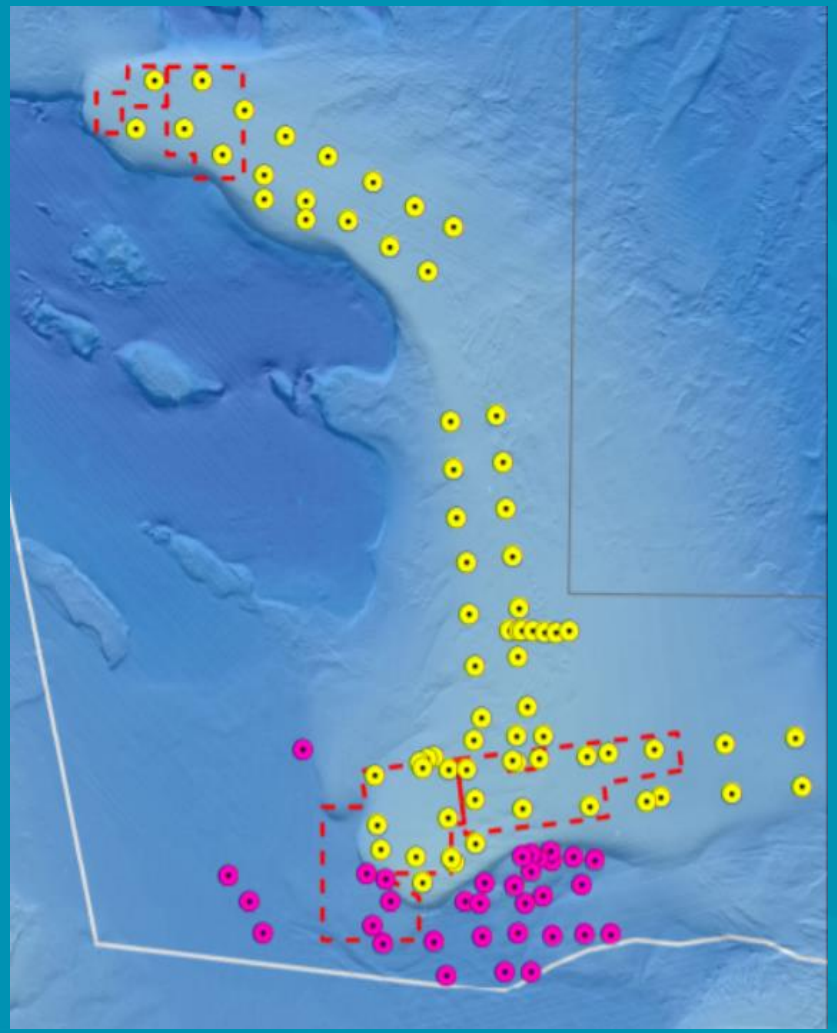


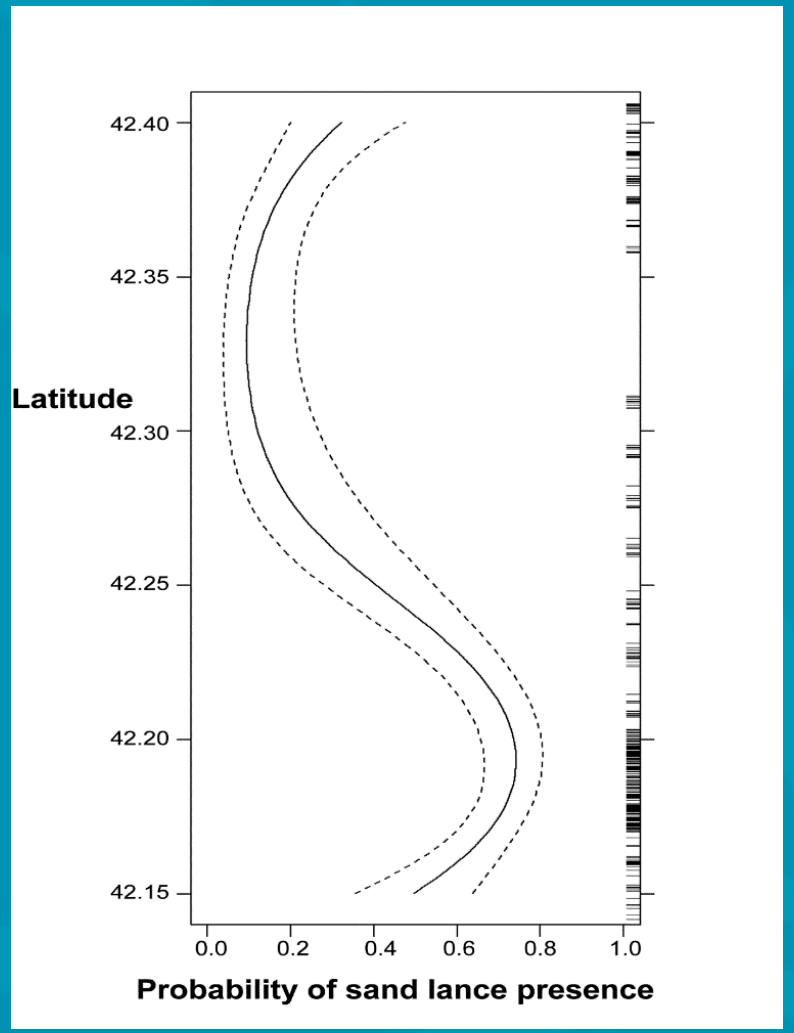
Monthly percent lipid composition of sand lance (total body).

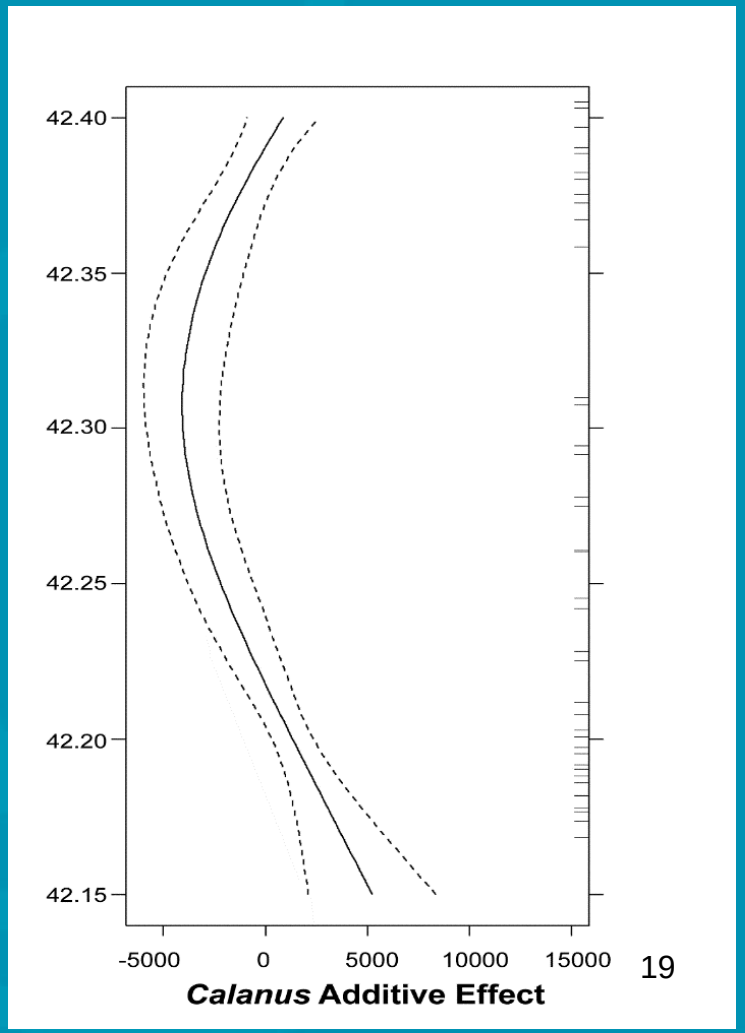


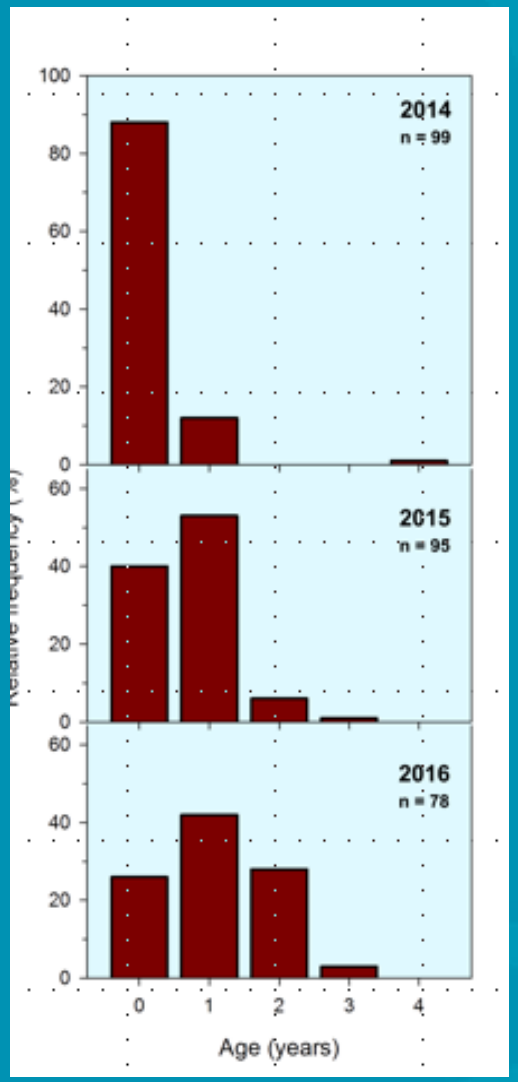
von Bertalanffy curves fitted to length by month for age-2 and age-3 for adult sand lance collected in 2019.

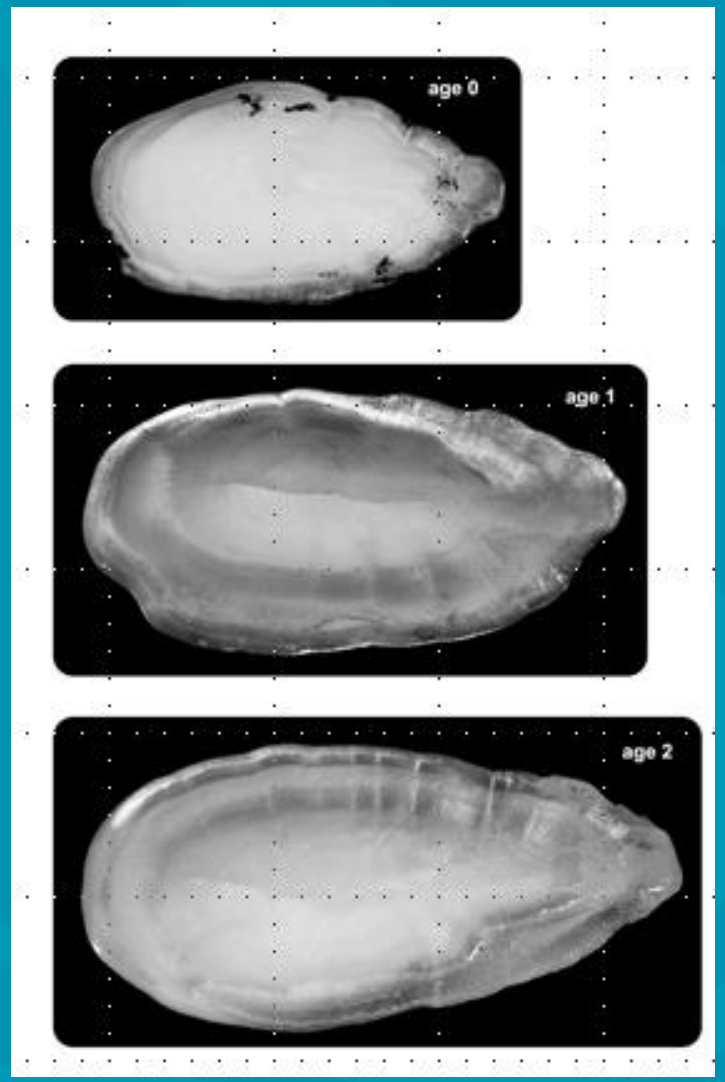
Sand lance presence in SBNMS coincides with *Calanus* abundance





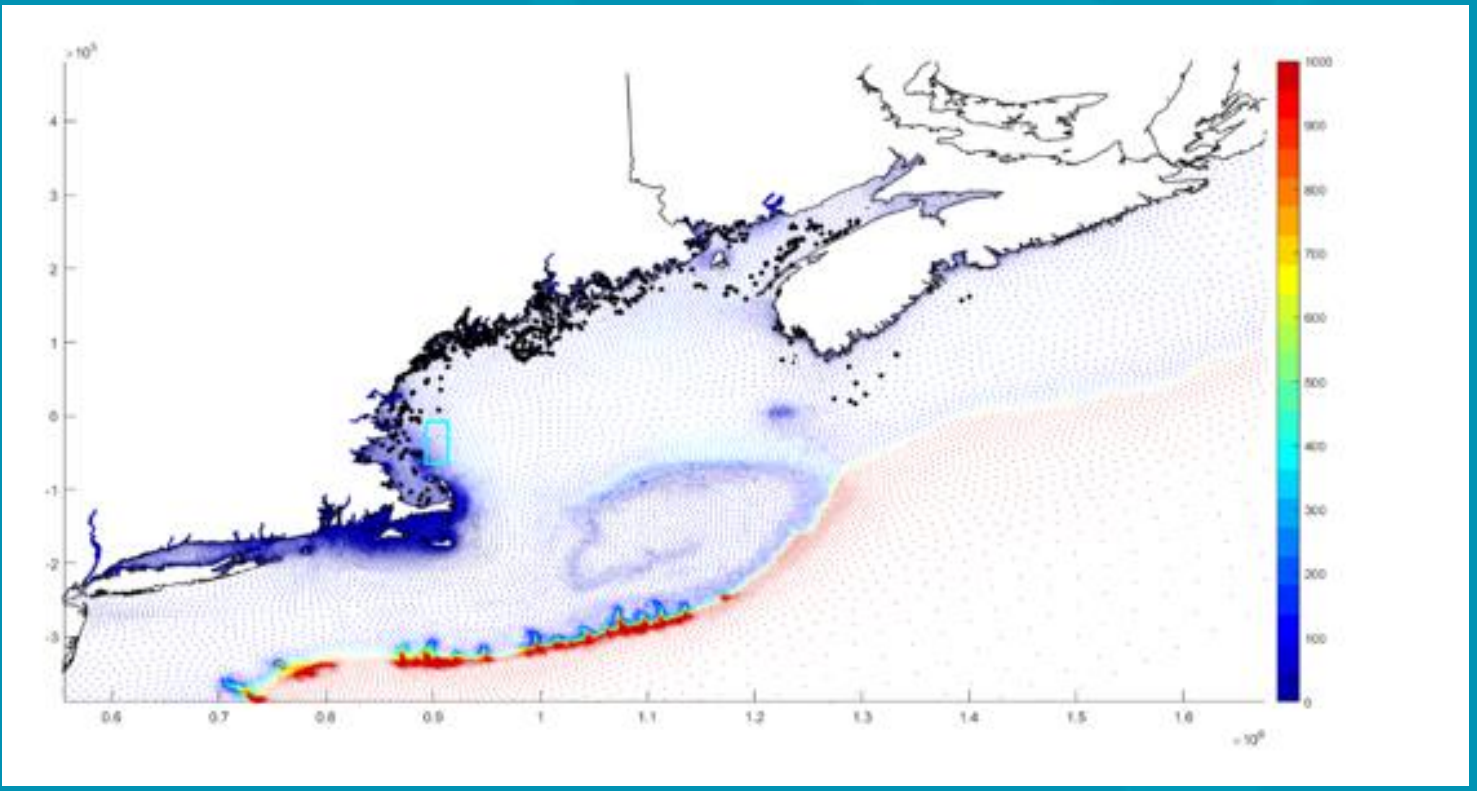




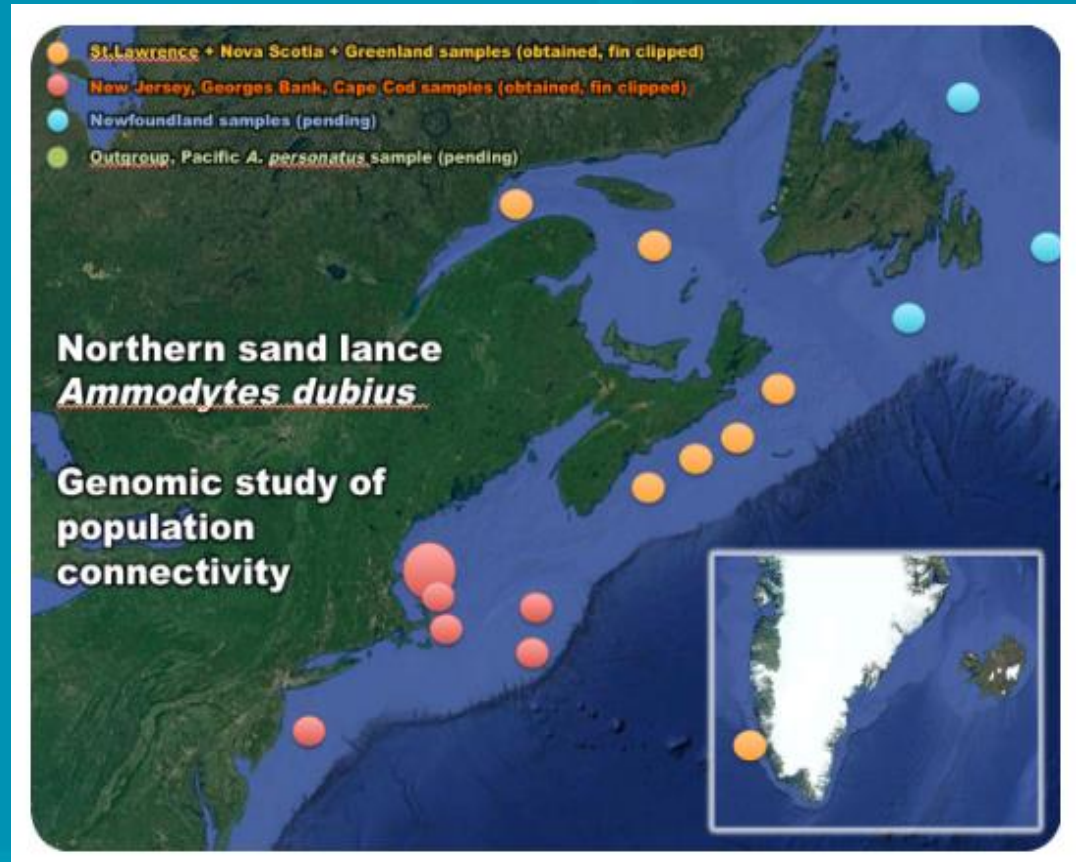


Otolith-based age distributions of northern sand lance on Stellwagen Bank in 2014-2016 (scaled to population sample). In 2014, catches were almost exclusively dominated by the new age-0 cohort, with very few older individuals. That strong year-class is apparent as age-1 in 2015 and age-2 in 2016. These findings are consistent with the hypothesis that large pulses arrive in the sanctuary and then slowly dissipate.

What is the origin of sand lance occurring in SBNMS ?



Results from using one hundred and eighty day back-tracking of 1000 particles released at 1 km spacing from the sanctuary (blue box) on May 1st 2016. Black dots indicate predicted hatch locations for the simulated "settlers" (particles).



Location of sand lance samples to be included in the genomic study.

Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SL spawning	0	0	0	0	0	0	0	0	0	4	5	4
SL daily bottom time	3	3	3	3	3	3	4	5	5	5	5	4
SL settlement	0	1	4	5	5	4	0	0	0	0	0	0
SL eggs	5	5	3	2	0	0	0	0	0	0	5	5
SL foraging	4	5	5	5	4	3	3	1	1	1	2	3
SL survivorship (lipids)	5	5	5	4	3	2	1	1	1	1	5	5
SL reproductive success (lipids)	2	4	5	5	5	5	4	1	1	1	1	2
Other stressors? (OA, temp)												
TOTAL SL AVERAGE VULERABILITY	2.7	3.3	3.6	3.4	2.9	2.4	1.7	1.1	1.1	1.7	3.3	3.3
TOTAL SL VULNERABILITY RANK	H	VH	VH	VH	H	M	M	L	L	M	VH	VH

Vulnerability Scale

- None — 0 - None
- Very Low — 1 - Very Low (VL)
- Low — 2 - Low (L)
- Moderate — 3 - Moderate (M)
- High — 4 - High (H)
- Very High — 5 - Very High (VH)

Vulnerability Matrix for sand lance life history categories

Sand lance would be least vulnerable to disturbance in August & September

Growth completed, feeding slowed, lipid concentration high, no spawning or settlement.

Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
greater shearwaters	0	0	0	0	3	4	5	5	4	4	3	1
whale watching trips	0	0	0	3	4	5	5	5	4	3	1	0
recreational boating												
Cod spawning												
Cod landings	5	4	5	1	2	5	4	3	3	2	3	5
Scallop landings	1	2	2	5	4	2	2	1	1	1	1	1
Lobster landings	2	1	1	1	1	1	2	2	3	4	5	5
trap pot fishery	2	1	1	1	2	2	3	3	4	5	5	4
Gillnet fishery	4	4	5	1	2	5	5	4	4	3	3	5
scallop dredge fishery	2	2	4	5	5	4	4	2	1	1	1	1
bottom longline fishery	4	4	5	1	2	1	1	1	1	1	1	2
otter trawl fishery	5	5	5	1	2	5	4	3	2	2	3	5
additional blanks please note that it is setup to word wrap												
TOTAL AVERAGE OTHER VULNERABILITY	2.4	2.2	2.6	2.0	2.8	3.5	3.6	3.0	2.8	2.7	2.6	2.7
TOTAL OTHER VULNERABILITY RANK	H	H	VH	M	H	VH	VH	H	H	H	H	VH

Vulnerability Scale

- None (0 - None)
- Very Low (1 - Very Low (VL))
- Low (2 - Low (L))
- Moderate (3 - Moderate (M))
- High (4 - High (H))
- Very High (5 - Very High (VH))

Vulnerability Matrix for SBNMS use categories

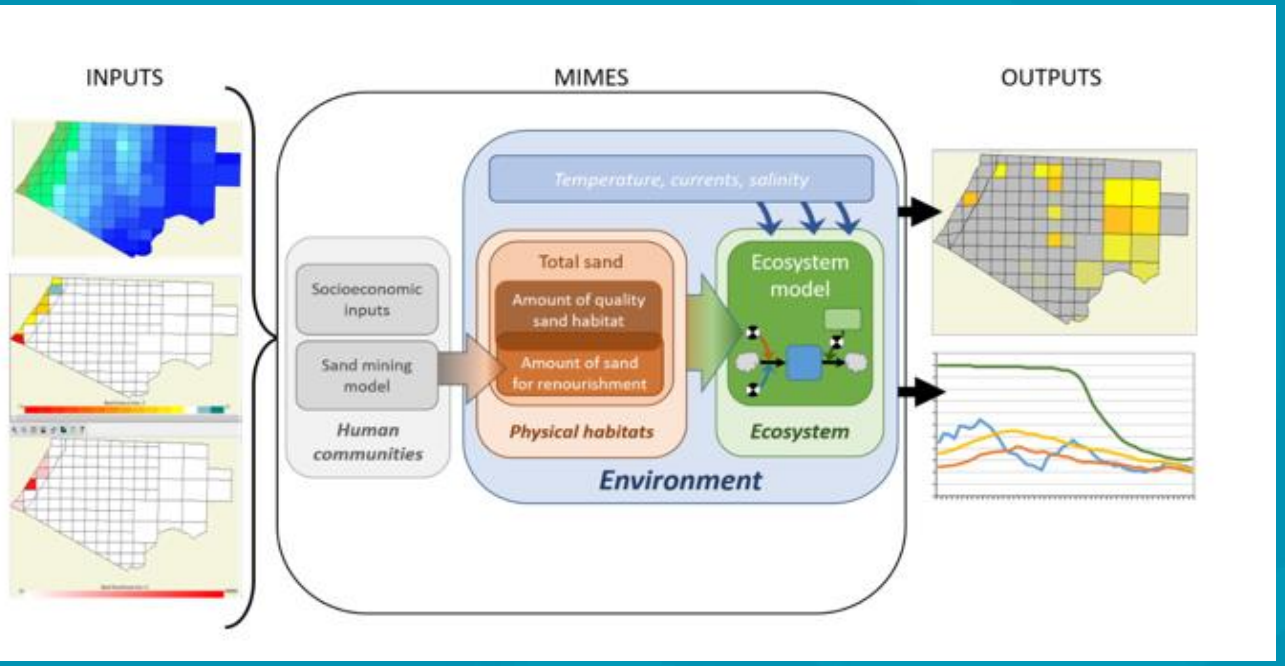
Pounds landed by fishery/month
whale watching trips/month
animal sightings per month

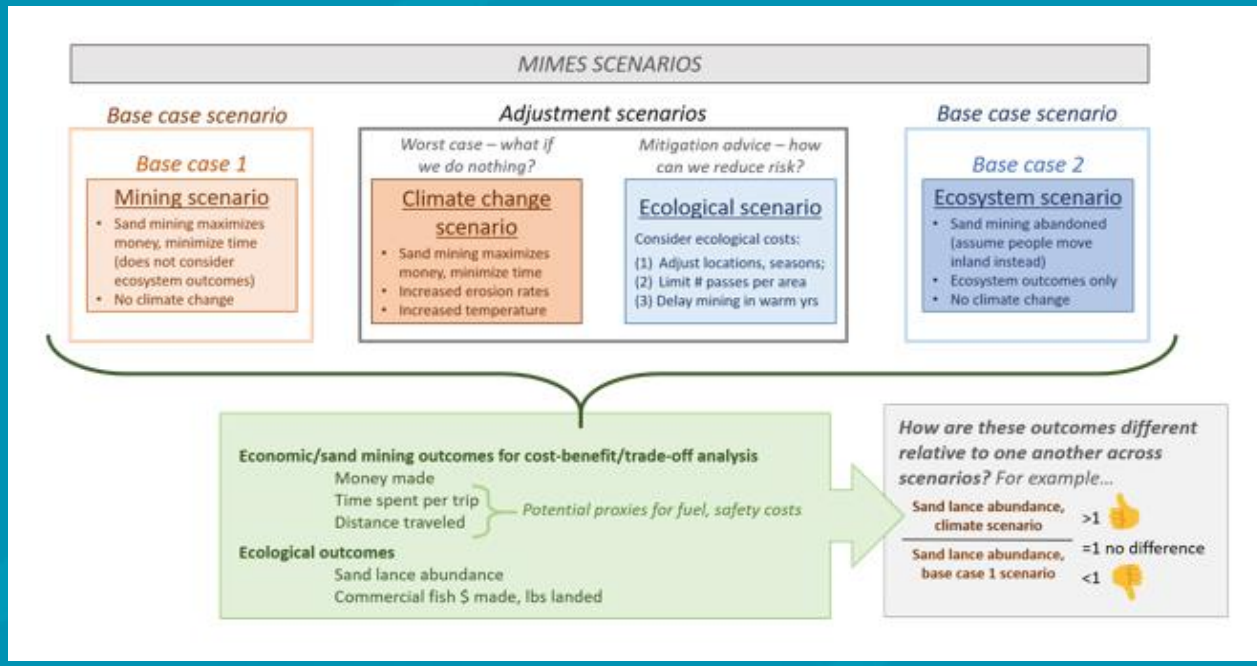
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
COMBINED AVERAGE VULNERABILITY	3.0	3.0	3.5	3.0	3.0	3.0	2.5	1.8	1.8	2.1	3.0	3.0

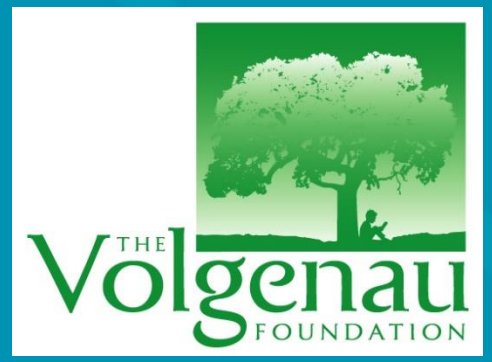
Combined average vulnerabilities indicate August and September would be least disruptive to ecosystem services.

Multiscale Integrated Model of Ecosystem Services (MIMES)

Boumans R, & J Roman, I Altman, L Kaufman (2015). **The Multiscale Integrated Model of Ecosystem Services (MIMES): Simulating the interactions of coupled human and natural systems**. *Ecosystem Services* 12: 30-41. http://dx.doi.org/10.1016/j.ecoser.2015.01.004.





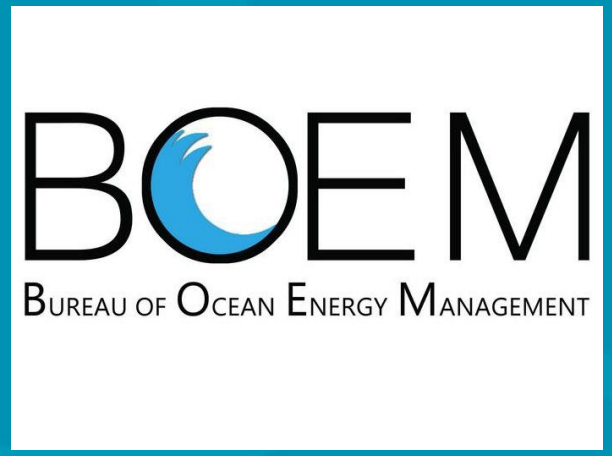

THE
Volgenau
FOUNDATION


NATIONAL MARINE
SANCTUARIES
STELLWAGEN BANK


BOSTON
UNIVERSITY

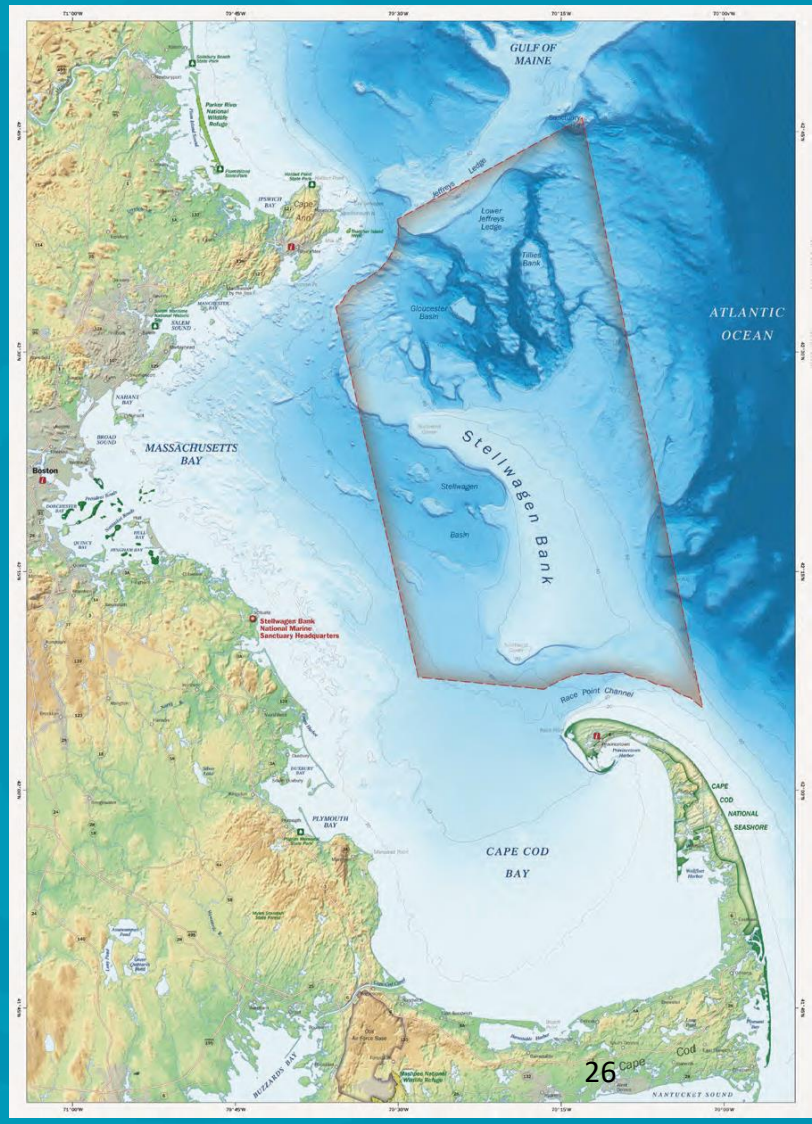

UCONN


WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930


BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT


NSF

Questions on Sand Habitat Research?



Condition Report

- Update to First Condition Report (2007)
- Best available science
- Assesses status and trends from 2007-2018
  - Ratings range from good to poor
- Identifies Gaps In Data and Current Monitoring Efforts
- Identifies Issues and Topics for Management Plan Review

https://sanctuaries.noaa.gov/media/docs/2020-stellwagen-condition-report.pdf

Condition Report

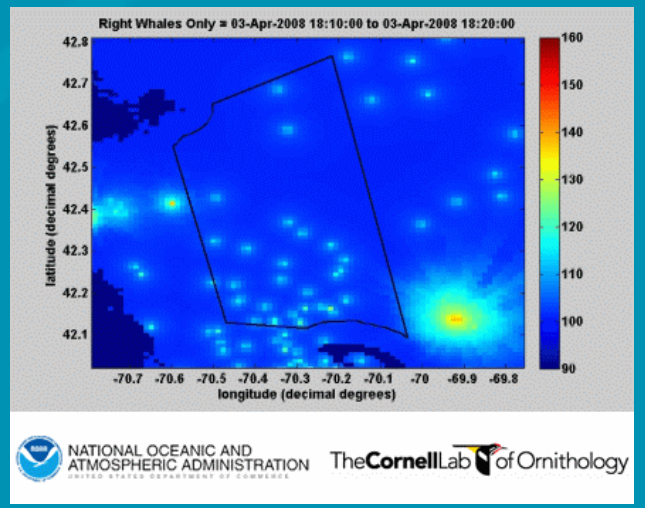
The Good

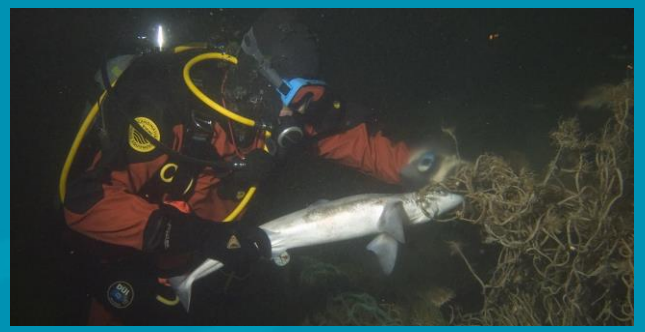
- Water quality does not appear to be impacted by human activities
- Several key species are doing well (Great shearwater, lobster, Atlantic white sided dolphin)
- Food web foundation species are in good to fair condition
- Outreach efforts for shipwreck avoidance appear to be working

Condition Report

The Concerning

- Climate change impacts are measurable and more robust monitoring is necessary
- Noise has detrimental impacts on animals and is increasing
- There is measurable habitat degradation due to impacts of bottom contact fishing activity
- Shipwrecks are a non-renewable resource and every shipwreck shows some signs of impacts with fishing gear
- Several iconic species are in poor condition (North Atlantic right whale, humpback whale, cod)





Condition Report

The Benefits

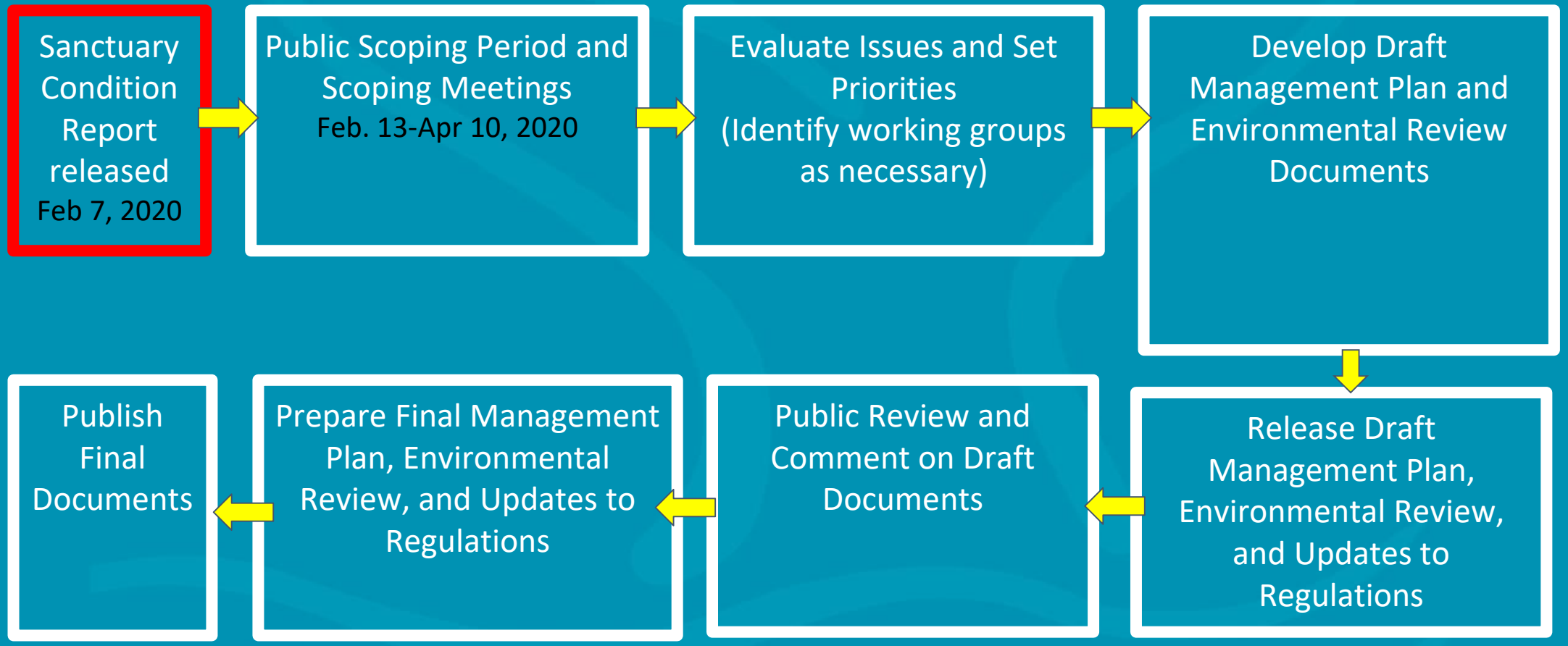
- Ecosystem Services (i.e. the benefits that humans derive from the sanctuary)
  - Measured for first time
- Recreational activities such as whale watching are popular and appear to be increasing
- Concerns about declines in stocks led to fair ratings for commercial & recreational fishing
- Internationally recognized research program
- Strong education programs
- Cultural heritage resources (i.e. shipwrecks) are a valued asset

Condition Report

The Information Gaps

- Emerging contaminants and microplastics: Fate and Effects
- Deepwater ocean acidification monitoring
- Ocean warming effects on food web, particularly copepods
- Habitat productivity/recovery
- Trends in uses
- Economic contributions of SBNMS and closed area
- More outreach/social media needed to increase recognition

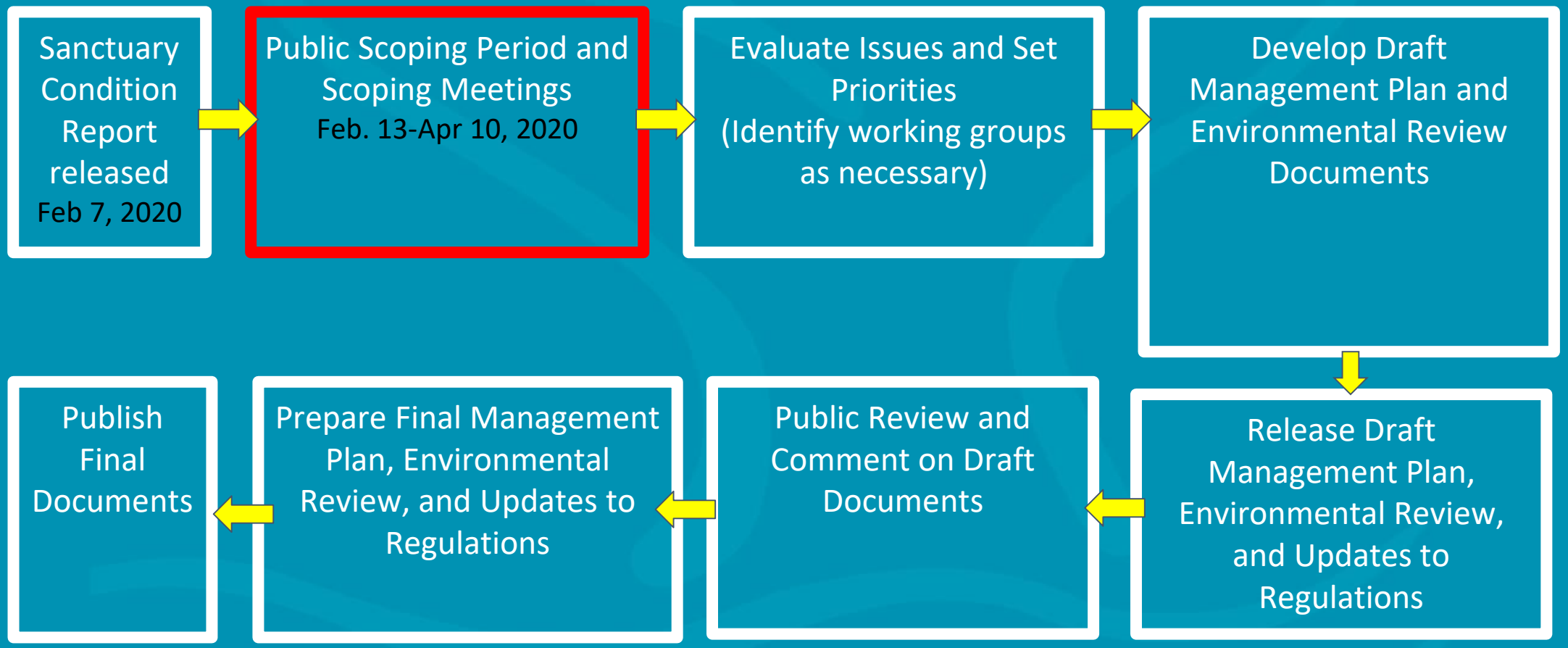
Management Plan Review Process



Topics For Management Plan Review

- Climate Change Impacts
- Water Quality Monitoring
- Education, Outreach, and Citizen Science
- Sanctuary Soundscapes
- Maritime Heritage Management
- Other Items Identified Through Public Scoping
- Updates to Regulatory Language

Management Plan Review Process

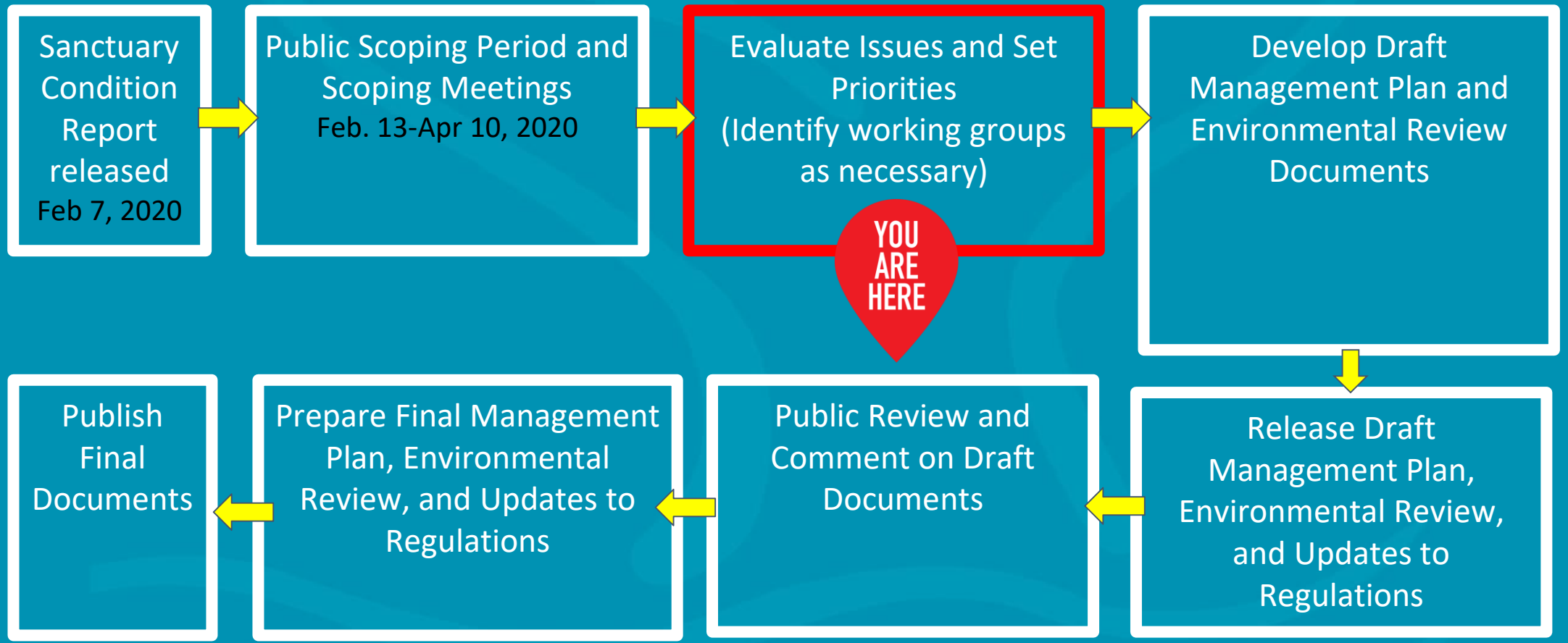


Comments Received During Public Scoping Period

- Continue research to better understand ecosystem dynamics.
- Need to better integrate sanctuary goals into regional ecosystem-based fisheries management
- Increase adaptive management strategies to better address climate change
- Make it a “true sanctuary” by limiting human activity, including fishing and whale watching
- Make no changes to access for fishing

Next Steps

Management Plan Review Process



Questions on Condition Report & Management Plan Review Process?