



## Larval transport pathways from three prominent sand lance habitats in the Gulf of Maine



Tammy Silva, Dave Wiley, Mike Thompson Ben Haskell, Pete DeCola  
Stellwagen Bank National Marine Sanctuary

# High collocation of sand lance and protected top predators: Implications for conservation and management

Tammy L. Silva<sup>1,2</sup> | David N. Wiley<sup>1</sup> | Michael A. Thompson<sup>1</sup> | Peter Hong<sup>1</sup> | Les Kaufman<sup>3</sup> | Justin J. Suca<sup>4</sup> | Joel K. Llopiz<sup>4</sup> | Hannes Baumann<sup>5</sup> | Gavin Fay<sup>2</sup>



ICES Journal of Marine Science (2021), 78(3), 1023–1037. doi:10.1093/icesjms/fsaa251

## Sensitivity of sand lance to shifting prey and hydrography indicates forthcoming change to the northeast US shelf forage fish complex

Justin J. Suca<sup>1,2\*</sup>, David N. Wiley<sup>3</sup>, Tammy L. Silva<sup>3,4</sup>, Anna R. Robuck<sup>5</sup>, David E. Richardson<sup>6</sup>, Sarah G. Glancy<sup>1</sup>, Emily Clancey<sup>7</sup>, Teresa Giandonato<sup>8</sup>, Andrew R. Solow<sup>1</sup>, Michael A. Thompson<sup>3</sup>, Peter Hong<sup>3</sup>, Hannes Baumann<sup>9</sup>, Les Kaufman<sup>10</sup>, and Joel K. Llopiz<sup>1</sup>

Downloaded from



Received: 18 September 2021

Revised: 12 February 2022

Accepted: 17 February 2022

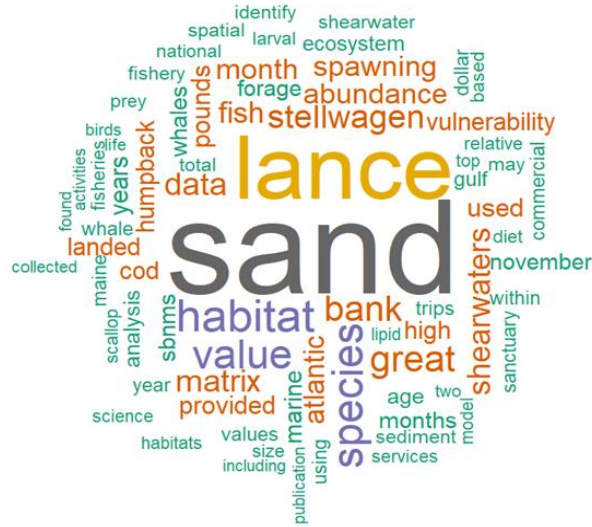
DOI: 10.1111/fog.12580

## ORIGINAL ARTICLE

# Larval transport pathways from three prominent sand lance habitats in the Gulf of Maine

Justin J. Suca<sup>1,2,3,4</sup> | Rubao Ji<sup>1</sup> | Hannes Baumann<sup>5</sup> | Kent Pham<sup>6,7</sup> | Tammy L. Silva<sup>8</sup> | David N. Wiley<sup>8</sup> | Zhixuan Feng<sup>1,9</sup> | Joel K. Llopiz<sup>1</sup>

# Assessing the biological and oceanographic processes that drive fisheries productivity in New England sand shoals and the potential for dredging related disruption



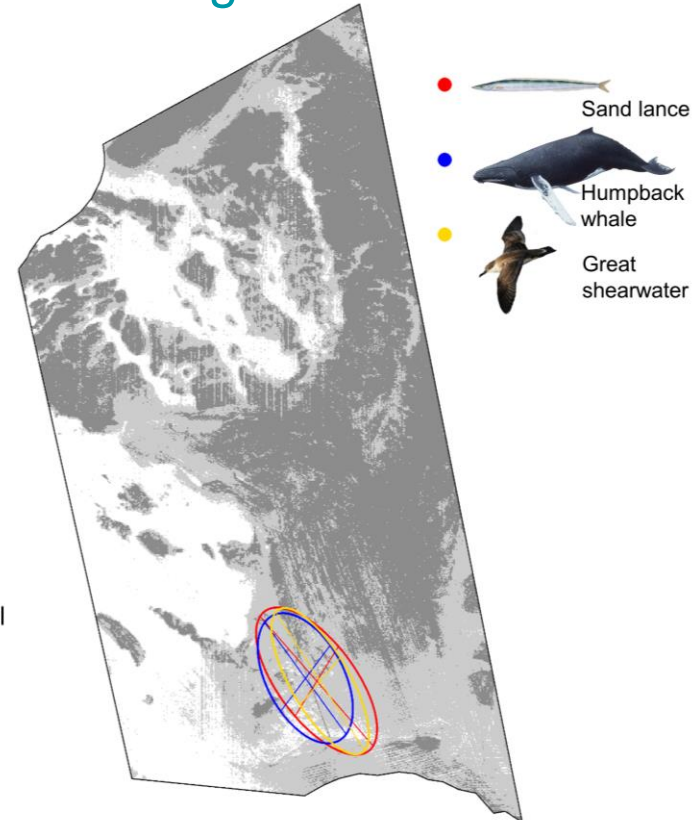
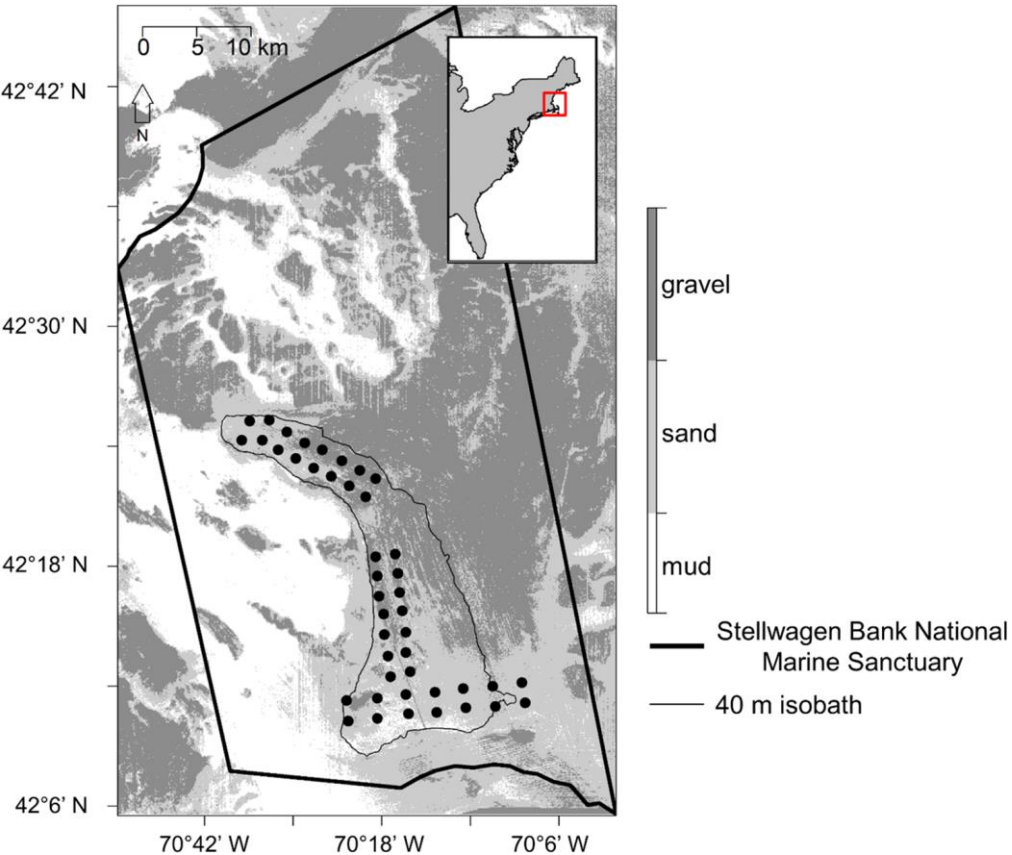
David N. Wiley, Tammy L. Silva, Michael A. Thompson,  
Hannes Baumann, Les Kaufman, Joel K. Llopiz, Justin J. Suca, Page Valentine

# Project objectives

- 1. Monitor abundance and distribution of sand-dependent forage species at existing sentinel sites and specified areas with sand shoals and features of interest**
- 2. Document diets, feeding success, and nutritional condition of sand-dependent forage species to identify bottom-up drivers of abundance and distribution**
3. Identify the spawning/reproductive cycle of sand-dependent forage species
4. Identify origin of sand-dependent forage species using genetic analysis to localize fish origin
- 5. Model larval movements using the appropriate oceanographic model to determine if an array of sandy geomorphological features are sources or sinks for productivity**
- 6. Develop a Sand Lance Life History Matrix and Ecosystem Services Vulnerability Matrix**
7. Identify the relationship among sand habitat, sand lance forage fish and commercial fisheries
8. Gather spatial and behavioral telemetry data on select species used to identify habitat use, ecosystem connectivity and site fidelity relative to sand habitat productivity
9. Create outreach and education products in support of the non-technical audience

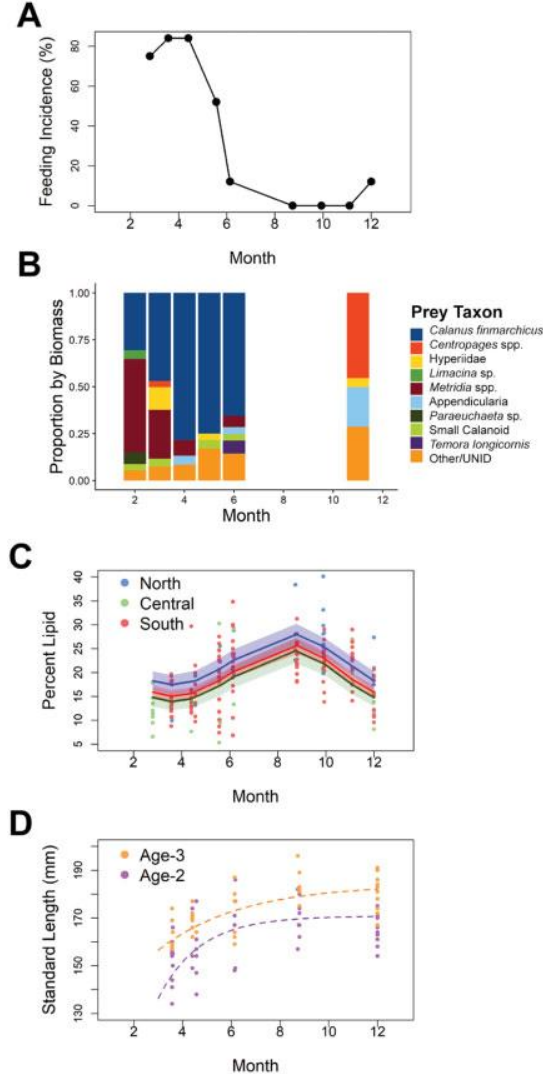
# Spatial distribution-sand lance & protected predators

- Strong & consistent collocation



# Sand lance foraging & diet

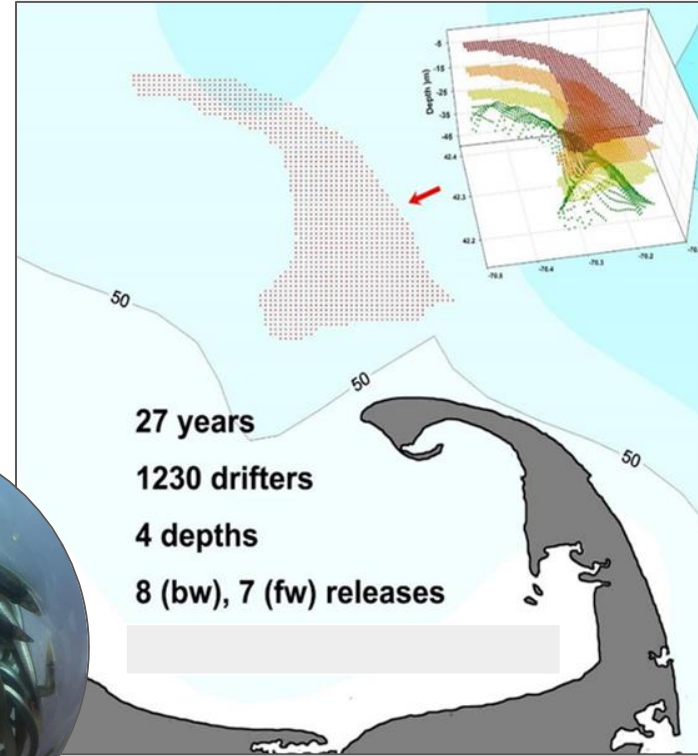
- Peak growth and lipid accumulation February - April
- April = critical time for reproductive success, adult survival





# Larval transport, sources & sinks

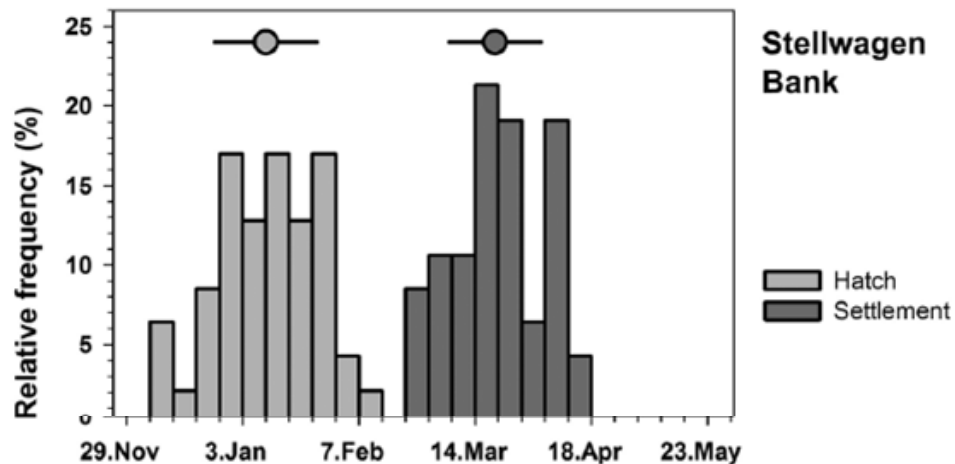
- Year-0 sand lance collected 2019
- Hatch and settlement dates estimated using otolith microstructure
- Gulf of Maine-Finite Volume Community Ocean Model (GOM-FVCOM)
- Forward / backward particle tracking experiments



# Sand lance hatch and settlement

- Hatch dates: Dec 24 to Jan 24
- Larval duration:  $69.23 \pm 5.94$
- Settlement dates: Mar 5 to Apr 2

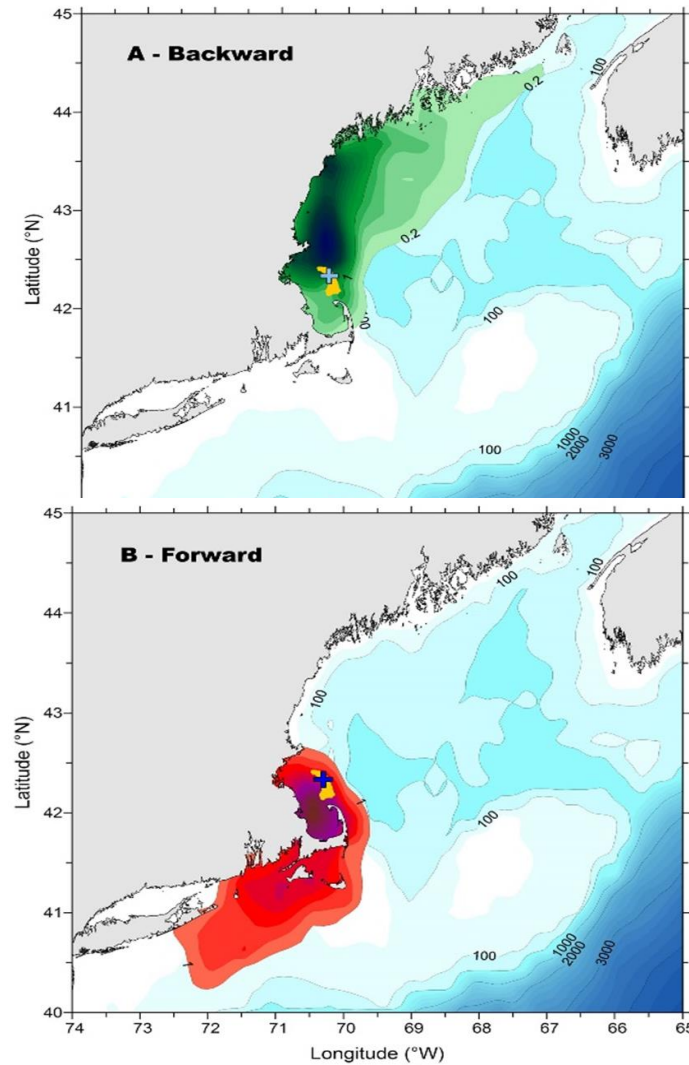
★ Settlement on Stellwagen Bank overlaps with Apr 1 scallop start





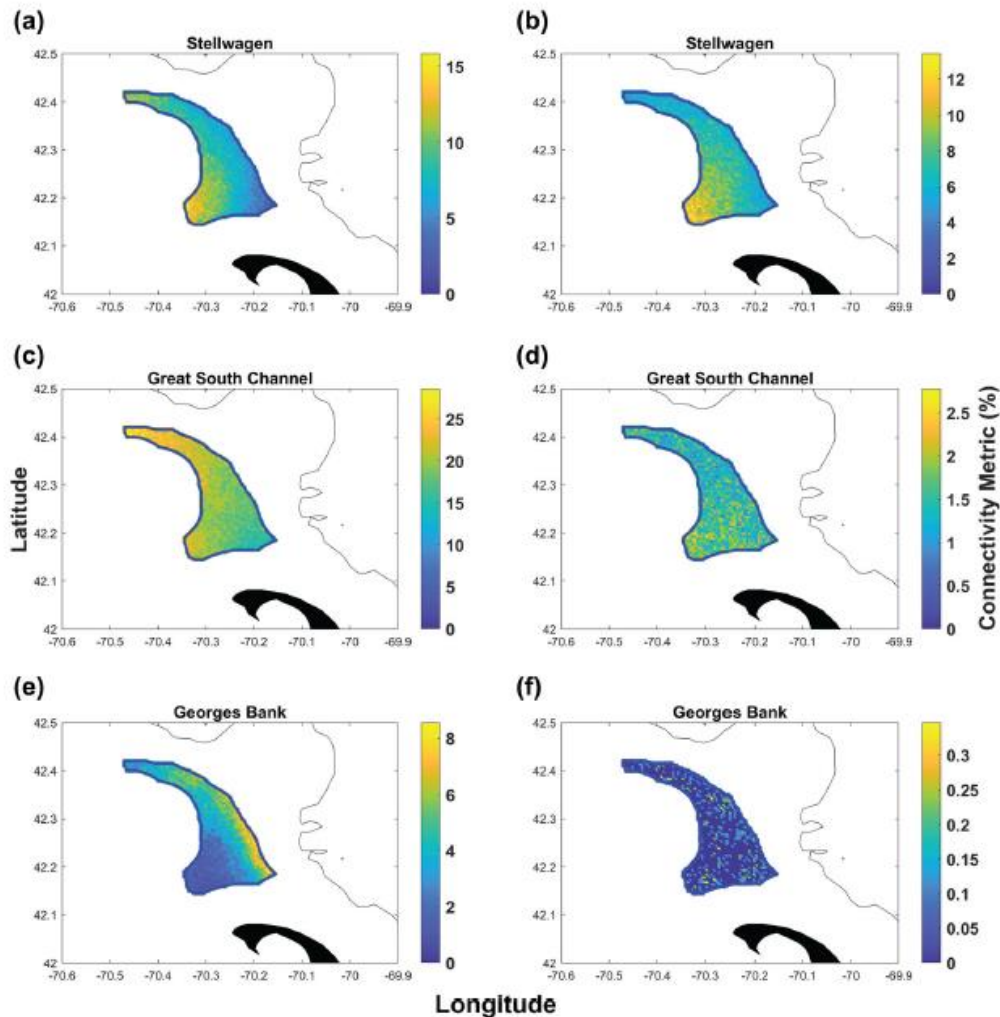
# Sand lance larval transport

- Stellwagen sand lance originate in coastal / northern Gulf of Maine
- Sand lance spawned on Stellwagen are exported south / southeast to coastal Cape Cod, Great South Channel, Southern New England

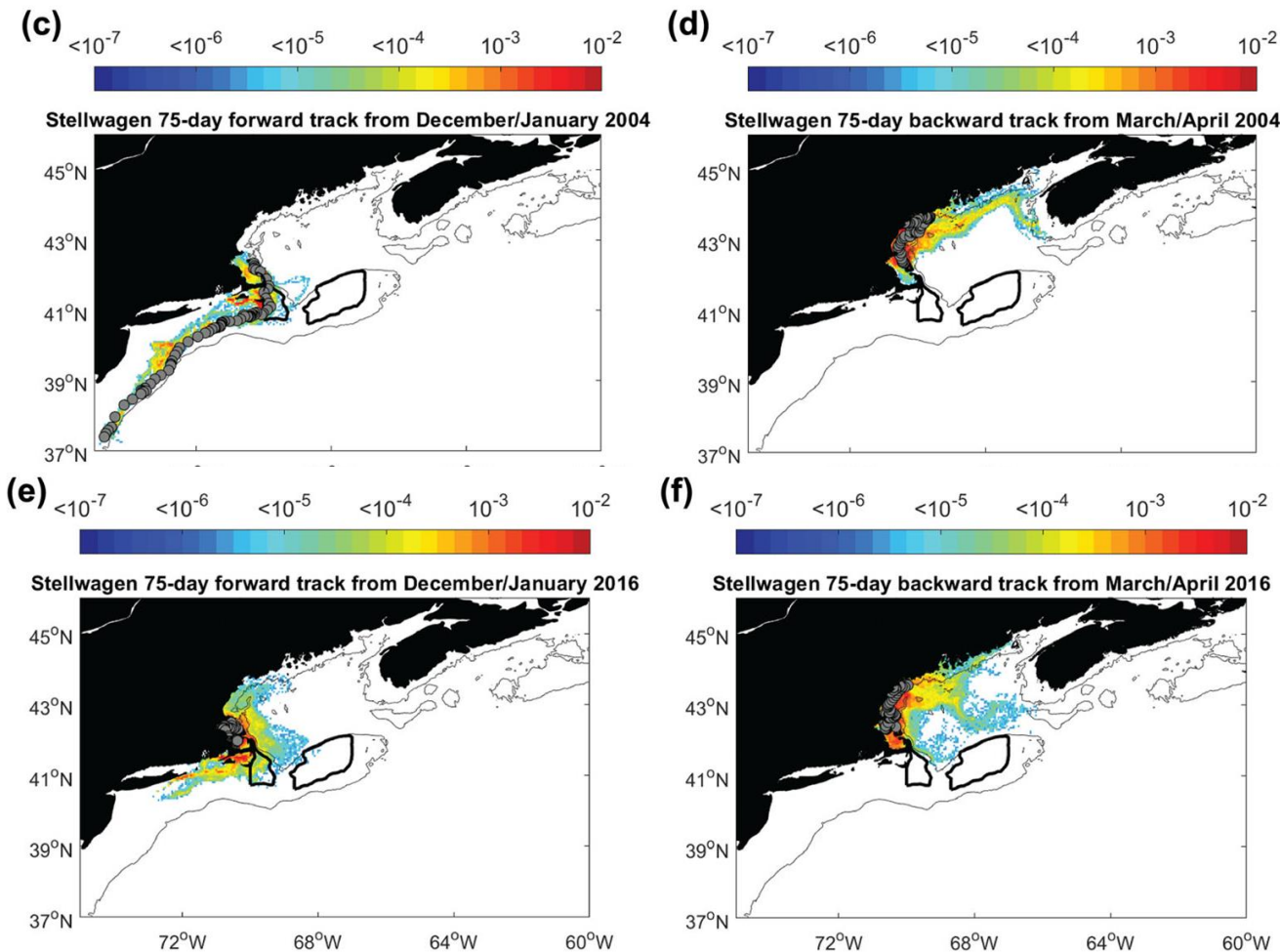


# Habitat connectivity

- Highest retention on SW corner
- NW corner shows greatest connectivity with Great South Channel
- Connections between Stellwagen and all habitats



# Wind and larval retention



- Strong southerly winds lead to increased sand lance retention / self-recruitment on Stellwagen Bank

# Sand lance vulnerability matrix

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	4	5	5	4	3	0	0	0	0	0	0
SL eggs	5	3	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 starvation (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
TOTAL SL SUM VULNERABILITY	19.0	24.0	26.0	24.0	19.0	16.0	12.0	8.0	8.0	12.0	23.0	23.0
TOTAL SL VULNERABILITY RANK	M	H	H	H	M	M	L	L	L	L	H	H
TOTAL VH RANKS	2	2	4	3	1	1	0	1	1	1	4	2

# Ecosystem services vulnerability matrix

Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Humpbacks	1	1	1	3	4	4	5	4	4	4	3	1
great shearwaters	0	0	0	0	1	2	3	5	5	5	1	0
whale watching trips	0	0	0	3	3	4	5	5	4	3	0	0
Cod spawning	4	0	0	4	5	5	4	0	0	4	5	5
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 trips	2	1	1	1	2	2	3	3	4	5	5	4
Gillnet fishery trips	4	4	5	1	2	5	5	4	4	3	3	5
scallop dredge fishery trips	1	2	3	5	5	4	4	2	1	1	1	1
bottom longline fishery trips	4	4	5	1	2	1	1	1	1	1	1	2
otter trawl fishery trips	5	5	5	1	2	5	4	3	2	2	3	5
<b>TOTAL ECOSYSTEM SUM VULNERABILITY</b>	29.0	24.0	28.0	26.0	33.0	40.0	42.0	33.0	32.0	35.0	31.0	34.0
<b>TOTAL ECOSYSTEM VULNERABILITY RANK</b>	M	L	M	M	M	H	H	M	M	M	M	M
<b>TOTAL VH RANKS</b>	2	1	4	2	2	4	3	2	2	2	3	5

# Summary

- Peak sand lance settlement on Stellwagen coincides with start of scallop fishery in N GOM
- Most sand lance spawned on Stellwagen are exported south / southeast
- Increased retention / self-recruitment on Stellwagen in years of strong southerly winds
- April is a critical time for adult sand lance - foraging, lipid accumulation, survival





# Recommendations



1. The Council consider addressing impacts on the sand lance resource in the Gulf of Maine as a future work priority
2. The Council prioritize research on this topic through its five year priority setting process for 2022-2026

