Environmental Studies Program: Ongoing Study

Title	Assessing Biological and Oceanographic Processes that Drive Fisheries Productivity on New England Sand Shoals and the Potential for Dredging Related Disruption (MM-17-05a; MM-17-05b)
Administered by	Headquarters
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Principle Investigator(s)	David Wiley; Les Kaufman
Conducting Organization(s)	NOAA Stellwagen Bank National Marine Sanctuary; Boston University
Total BOEM Cost	$1,275,000
Performance Period	FY 2017-2020
Final Report Due	September 1, 2020
Date Revised	December 1, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Connectivity between forage species dependent on sand habitat and protected species which forage on those species are not well understood.
Intervention	Integrate opportunistic observational, fisheries independent and dependent data featuring these species movements to hone model accuracy.
Comparison	This is measured against the intervention. Think of hypothesis testing, control vs. treatment, and/or natural change.
Outcome	Improved model for use in environmental impact assessments for understanding the impacts to species which forage largely on sand lance.
Context	MidAtlantic North to Cape Cod

BOEM Information Need(s) to be Addressed: BOEM's Atlantic Sand Assessment Project identified potential OCS sand resources that could be used for future coastal resiliency needs. The use of offshore sand resources to support coastal resiliency efforts in the NE region have historically been constrained due to uncertainty surrounding the potential implications to high valued fisheries. Investing in baseline biological and oceanographic data to parameterize fishery productivity in sand shoals and their resilience to potential physical disturbance will improve BOEM's capabilities relative to the MMP following our initial sand resource evaluation investments. The results of this study would better inform the current perceptions regarding dredging impacts to commercial fisheries by understanding the processes of productivity in sand shoal areas and the associated risks to fisheries landings. In addition, an understanding of these processes and their spatial/temporal annual fluctuations provides the opportunity to identify low impact environmental windows during which resource extraction could have reduced fishery

impact. The results of this study will be utilized in NEPA analyses and associated consultations. In addition, this study further supports Regional Ocean planning by "identifying best dredging practices, and ways to minimize impacts" as well as working "to better engage the fishing industry through specific mechanisms and improved data." (Draft New England Region Ocean Action Plan)

Description:

Background: While we know that offshore sand features are habitat for forage fish, we do not know the impacts that may occur to the forage fish from altering this habitat. In the Northeast United States, there are several key forage species including, sand lance, *Ammodytes* spp; longfin squid, *Loligo* spp; and herringlike fishes, *Clupeidae*; that occur over potential sand borrow areas. This study would identify forage fish that occur in potential borrow areas. Many forage fish have demersal eggs and dredging can disrupt egg masses, suspending and transporting them out of the system, negatively impacting fisheries production. This aspect of the prey cycle needs to be better understood prior to effective modeling of potential fishery impacts. The degree to which forage fish populations are internally-supported (self-recruiting), within the sand shoal, or externally driven (reliant on spawning from outside group), e.g. a source or sink is currently unknown. This knowledge gap is an impediment to our current ability to understand potential fishery impacts of dredging in the NE.

Trophic connections and recovery rates among species dependent or influenced by sand habitat productivity are not understood. There are a whole suite of questions to be answered including: is productivity locally driven, is it based on outside or internal recruitment, does disruption lead to a shift in prey species and, if so, are there impacts from that shift? Combining life history data obtainable through otolith analysis with hydrodynamic models affords the tracing of larval sand lance movement addressing problems of population sources and sinks. Such information is vital to assessing the importance and resilience to commercial fisheries of borrow areas as well as the spatial scale and temporal opportunities at which dredging should be considered.

This study focuses on the collection and analysis of biological and oceanographic data that might indicate the drivers for forage fish distribution and abundance on sand shoals. In addition, this study will examine potential changes in these parameters following borrow area use and how these changes could impact commercial fishes and fisheries. These data will be used to inform decision-scenario models to predict the potential for disturbance to impact commercial fisheries. Finally, this study will ask whether or not there are low impact windows of opportunity that might exist.

Objectives: Leverage existing spatial, fisheries, oceanographic data and model frameworks to evaluate the potential environmental and economic impacts to sand dredging in New England by: a) Quantifying habitat use patterns of commercial and ecologically important fisheries, including key prey species and the system dynamics that explain inter-annual variation. b) Within known habitat, identifying driving factors for abundance (biomass) fluctuations of these key prey species. c) Understand larval dispersal patterns and life-stages in sand borrow areas for forage species to identify optimal dredge windows. d) Combine existing long-term fisheries data with life history results of this study (i.e. spatial/temporal variation in prey species dynamics) into a framework to predict impacts to fisheries resulting from various dredge scenarios.

Methods: Methods would include incorporating comprehensive benthic sampling data that has been completed by USGS, UMass Dartmouth, NMFS, and others; completing finer scale benthic grabs to ground truth sampling; SEABOSS sediment grabs for live forage fishes and collection of water quality data; otolith microstructure analysis; employing a dynamic model, such as MIMES or EcoSIMM. Additional methods employed will utilize existing methodology for quantifying prey density through visual and acoustic survey. The source/sink investigations will also take advantage of the cooperative agreement between BOEM and the University of Massachusetts at Dartmouth that is evaluating regional currents. The results could be applied to determine how disturbance and physical oceanography alter larval dispersion.

Current Status: The field work is 75% complete and a contract for the modeling work was completed in Q4 2019 due to complications with NOAA being able to implement the interagency agreement as originally agreed.

Publications Completed:

- Hong, Peter, David N. Wiley, Kevin D. Powers, Robert H. Michener, Les Kaufman and Kent A. Hatch. 2019. Stable Isotope Analyses of Multiple Tissues of Great Shearwaters (*Ardenna gravis*) Reveals Long-Term Dietary Stability, Short-Term Changes in Diet, and Can be Used as a Tool to Monitor Food Webs. *Diversity*, 11, 163; doi:10.3390/d11090163.
- Murray, C.S., Wiley, D., and Baumann, H. 2019. **High sensitivity of a keystone forage fish to elevated CO_2 and temperature.** *Conservation Physiology* doi:10.1093/coz084
- Silva, Tammy; Wiley, David; Thompson, Michael; Hong, Peter; Kaufman, Les; Suca, Justin; Llopiz, Joel; Baumann, Hannes; Fay, Gavin. *In Review*. **High collocation of sand lance and protected top predators: implications for conservation and management**. *Conservation Science and Practice*
- Staudinger, Michelle; Goyert, Holly; Suca, Justin; Coleman, Kaycee; Welch, Linda; Llopiz, Joel; Wiley, David; Altman, Irit; Applegate, Andrew; Auster, Peter; Baumann, Hannes; Beaty, Julia; Boelke, Deirdre; Kaufman, Leslie; Loring, Pam; Moxley, Jerry; Paton, Suzanne; Powers, Kevin; Richardson, David E.; Robbins, Jooke; Runge, Jeff; Smith, Brian E.; Spiegel, Caleb; Steinmetz, Halley. *In Review*. **The role of sand lances (Ammodytes sp.) in the Northwest Atlantic Ecosystem: A synthesis of current knowledge with implications for conservation and management.** *Fish and Fisheries*
- Kevin D. Powers, David N. Wiley, Anna R. Robuck, Zachary H. Olson, Linda J. Welch and Les Kaufman. *In Prep*. **Spatiotemporal characterization of non-breeding great shearwaters *Ardenna gravis* within their wintering range**

Presentations:

- Baumann, H., Wiley, D., Murray C.S. 2019. **The Unusual Sensitivity of Northern Sand Lance, a Keystone Forage Fish, to Acidification and Warming**" Northeast Coastal Acidification Network's Sea Grant Webinar series. The presentation can be found at http://necan.org/seagrantwebinars or https://youtu.be/Tkss8l6swHc
- Suca J. J., Llopiz J. K., Wiley D. N., Giandonato T., Thompson M. A., Hong P., Silva T. L. **Bottom-up drivers of sand lance distribution on Stellwagen Bank and the northeast US shelf.** 4th Climate Impacts on Oceanic Top Predators Symposium. Location: National Taiwan Ocean University, Keelung, Taiwan. 15-19 October 2018.

- Suca, J.J., Wiley, D.N. Giandonato, T., Glancy, S., Thompson M.A., Hong, P., Silva T.L., Richardson, D.E., Baumann, H., Kaufman, L.S., Llopiz, J.K. 2018. **The relationship of *Calanus* and sand lance on Stellwagen Bank and the northeast US shelf**. Regional Association of Research in the Gulf of Maine Annual Science Meeting: Drivers of Change in Gulf of Maine Ecosystems. October 26, 2018 Location: University of Southern Maine, Portland, ME
- Silva, T., Wiley, D., Thompson, M., Hong, P., Kaufman, L., Suca, J., Llopiz, J., Baumann, H., Fay, G., 2019. **High collocation of sand lance and protected top predators in the southwestern Gulf of Maine.** November 6, 2019. Gulf of Maine 2050 International Symposium. Portland, ME.
- Silva, T., Wiley D., Thompson M., Hong P., Kaufman L., Suca J., Llopiz J., Baumann H., Fay G., Powers K., Robbins, J. 2019. **A sand lance story: relationships with top predators and implications for conservation and management.** November 13, 2019. Fisheries Oceanography Department Seminar. School for Marine Science and Technology, UMass Dartmouth, New Bedford, MA.
- Wiley, D, H. Baumann, G. Fay, P. Hong, L. Kaufman, J. Llopix, C. Murray, K. Powers, J. Robbins, T. Silva, J. Suca, M. Thompson and A. Zerini. 2019. Sand lance, shearwaters and humpbacks, Oh My: An ecosystem-based look at climate change implications for NOAA's Stellwagen Bank National Marine Sanctuary. NOAA Climate Connections Workshop 20-21 November 2019, Silver Spring Civic Building
- Powers K, Wiley D, Welch L, Olson Z, Kaufman L, Thompson M, Hong P, Williams S, Robuck A, Hatch K, Silva T**.** 2019. **Annual variation in spatial use of the Gulf of Maine by great shearwaters.** April 11, 2019. World Seabird Twitter Conference (Twitter presentation)
- Silva TL, Wiley D, Thompson M, Hong P, Kaufman L, Suca J, Llopiz J, Baumann H, Fay G. 2019. **High collocation between sand lance and top predators in Stellwagen Bank National Marine Sanctuary.** April 4, 2019. Intercampus Marine Science Research Symposium. School for Marine Science and Technology, UMassD, New Bedford, MA, USA. (poster)
- Silva TL, Wiley D, Thompson M, Hong P, Kaufman L, Suca J, Llopiz J, Baumann H, Fay G. **High collocation between sand lance and top predators in the southwestern Gulf of Maine.** December 11, 2019. World Marine Mammal Conference. Centre de Convencions Internacional de Barcelona, Catalonia, Spain.

Affiliated WWW Sites: https://sanctuaries.noaa.gov/news/jan17/sand-lance-stellwagen-bank.html

Revised Date: December 2, 2019