Title: Changes in availability of Mid-Atlantic fish stocks to fisheries-independent surveys

Applicant name:

Janet A. Nye
School of Marine and Atmospheric Science
Stony Brook University
Stony Brook, NY 11794
Ph: 631-632-3187
Email: janet.nye@stonybrook.edu

Applicant FEIN #: 14-1368361

Applicant contact:

Anne DePietri
Contracts Administrator
Research Foundation for The State University of New York
Office of Sponsored Programs
Stony Brook University
Stony Brook, NY 11794-3362
Ph: 631-632-4702
Fax: 631-632-6963
Email: annette.depietri@stonybrook.edu

Applicant type: nonprofit educational institution

Principal investigators:

Janet Nye, Stony Brook University
Michael Frisk, Stony Brook University
Skyler Sagarese, NOAA NMFS Southeast Fisheries Science Center (receiving no funds)

MAFMC research area being addressed

1. Investigate NEFSC trawl survey efficiency, catchability, and availability relative to summer flounder, black sea bass, and spiny dogfish.

Proposed Start Date: 5/15/16
Proposed End Date: 12/15/17

Amount requested: $ 75,645

Executive summary

Title: Changes in availability of Mid-Atlantic fish stocks to fisheries-independent surveys

This proposal addresses Research Need #1 to "Investigate NEFSC trawl survey efficiency, catchability, and availability" for three of the species identified in this priority; summer flounder, black sea bass and spiny dogfish. It is often assumed that abundance indices from fisheries-independent trawl surveys are not prone to the pitfalls of fisheries-dependent catch rates. That is, we assume that catchability does not change with fish density or interannual environmental variability. This assumption is dangerous in light of the fact that many stocks in the Northeast US have shifted their distributions and/or have experienced range contractions and expansions that are related to both population size and rapid warming (Nye et al. 2009). The implications for these shifts in distribution have not been fully addressed despite there being important ramifications for stock assessments (Link et al. 2011). In particular, shifts in distribution can alter availability and subsequently catchability of a stock to fisheries-independent surveys upon which many stock assessments are dependent, especially for seasonally migrating stocks whose distributions may fall outside of the survey area (Walters 2003, Wilberg et al. 2009).

Like many Mid-Atlantic species, our three focal species (summer flounder, black sea bass and spiny dogfish) all undertake seasonal migrations where in winter they move generally south and offshore to the edge of the continental shelf where water temperature is warmer than in the coastal ocean. This offshore movement can potentially shift a proportion of their population out of the NEFSC trawl survey area. The NEFSC bottom trawl survey extends from Cape Hatteras to the Gulf of Maine and occurs over a two-month interval in both the spring and the fall when the temperature on the shelf is rapidly changing. Thus, the timing of the survey combined with variability in the timing and rate of spring warming and fall cooling in each season may impact availability of species to the survey, particularly those with temperature-induced migration patterns. Because temperature strongly modifies their movement offshore and south in the winter, there is high interannual variability in their distribution on the shelf, consequently changing the availability of each of these species to the survey. Here we propose to quantify the degree to which multiple habitat variables affect availability and catchability in the NEFSC trawl survey for summer flounder, black sea bass and spiny dogfish. Evaluation of time-varying catchability in these three species is critical to the stock assessments for each species, but also enables a comparison of the degree to which time-varying catchability among fishes with different life histories and habitat requirements might impact stock assessments.

Temperature is likely the most important variable influencing distribution and availability to the NEFSC survey of fishes in this region. Indeed, developing a habitat model based on temperature improved the biomass estimates and reduced uncertainty for the pelagic butterfish. However, our three focal species are more demersal in nature and furthermore, other variables have been identified as important habitat requirements. For summer flounder and black sea bass, access to estuaries and bottom habitat type are also important determinants of distribution and availability. Both species use estuaries as nursery habitat and forage there as adults. Summer flounder are known to prefer sandy habitat whereas black sea bass are known to aggregate on high-complexity habitat. Salinity is also an important factor in predicting black sea bass abundance (Miller et al. 2016). For spiny dogfish, habitat associations revealed a selection for warmer, more saline, and more southerly locations during spring (Sagarese et al. 2014b). In contrast, during autumn, larger dogfish occupied relatively warmer, shallower, and less saline waters. Seasonal occurrence was tightly linked to environmental factors such as bottom temperature

during both spring and autumn, with ecological factors (e.g., squid abundance) also influential during autumn (Sagarese et al. 2014a). To summarize, it is vital to assess the importance of both dynamic variables (temperature, salinity, oceanographic fronts) and static variables (distance to estuary and bottom type) in determining the availability of these species to the NEFSC survey. As dynamic variables change and static variables do not, the spatial mismatch between multiple variables may dramatically change the availability of each species to the survey.

Brief overview of methods

For each species, we will take a similar approach to understand how habitat modifies their availability to the NEFSC trawl survey in three steps or objectives. Briefly, we will:

1. Identify habitat variable(s) for which each species and if necessary each sex, age or size class selects for habitat using cumulative distribution functions (cdfs).
2. Develop a habitat model for each species using Generalized Additive Models (GAMs) that will allow incorporation of multiple habitat parameters if necessary.
3. Create hindcasts of availability to the survey by combining habitat models with hindcasts of dynamic oceanographic variables (temperature, salinity and fronts) to create a time series of catchability during the spring and fall NEFSC surveys.

The use of cdfs will allow us to determine if fishes are actively *selecting* for habitat variables while GAMs are a flexible modeling technique that allows for the incorporation of multiple habitat variables, the functional form of which may vary from strictly linear to complex nonlinear relationships.

Measurable outcomes

1. Critical habitat needs for three economically and ecologically important species: black sea bass, summer flounder and spiny dogfish
2. Time series of catchability for three Mid-Atlantic species that can be directly incorporated into each stock assessment
3. Habitat models for three species that can be used in applications other than changing availability to the stock assessment
4. A model of availability of summer flounder to shore-based recreational fishers
5. Training of at least one student in quantitative fisheries science
6. At least three peer-reviewed publications in fisheries and ecology journals

Qualifications

Nye, Frisk and Sagarese have been studying fish distribution, developing habitat models and modeling fish population dynamics for a combined total of over 35 years. Nye is a Fisheries Oceanographer who will lead the project and has developed GAMs for other Northeast US fish stocks such as Atlantic croaker, cusk and river herring. Nye and Frisk are currently developing similar models for estuarine-dependent species. Frisk's experience on the Science and Technical Committee for the MAFMC brings a wealth of knowledge about the issues with the stock assessments for each species. Frisk and Sagarese are both NOAA Sea Grant fellows in Population Dynamics with Sagarese's dissertation work focused on developing stage and sex specific habitat models for spiny dogfish. She is currently an assessment scientist for the Southeast Fisheries Science Center and as such has the skills and knowledge to develop habitat models and catchability indices that can be incorporated into stock assessments.

Changes in availability of Mid-Atlantic fish stocks to fisheries-independent surveys

Background

It is often assumed that abundance indices from fisheries-independent trawl surveys are not prone to the pitfalls of fisheries-dependent catch rates. That is, we assume that catchability does not change with fish density or interannual environmental variability. This assumption is dangerous in light of the fact that many stocks in the Northeast US have shifted their distributions and/or have experienced range contractions and expansions that are related to both population size and rapid warming (Nye et al. 2009). The implications for these shifts in distribution have not been fully addressed despite there being important ramifications for stock assessments (Link et al. 2011). In particular, shifts in distribution can alter availability and catchability of a stock to fisheries-independent surveys upon which many stock assessments are dependent, especially for seasonally migrating stocks whose distributions may fall outside of the survey area (Walters 2003, Wilberg et al. 2009).

Despite the recognition of this pervasive problem, only a few studies have illustrated that consideration of oceanographic processes and habitat models can greatly improve stock assessments and management advice. By incorporating an accurate model of habitat availability to adjust catchability, the estimate of population size for butterfish changed and importantly, uncertainty in the estimate of total biomass was greatly reduced in the most recent stock assessment (NEFSC 2014). The combined finding of high biomass and reduction in uncertainty allowed fisheries managers to increase the catch limit for butterfish with confidence. Similarly, in Gulf of St. Lawrence cod, temperature-dependent availability was incorporated into an age-structured model that affected abundance estimates, but to a lesser degree than butterfish (Swain et al. 2000). Although the implementation was different in these two cases, the effect of time-varying habitat and its effect on catchability improved both stock assessments, and notably, impacted management advice for butterfish.

Like many Mid-Atlantic species, our three focal species (summer flounder, black sea bass and spiny dogfish) all undertake seasonal migrations where in winter they move generally south and offshore to the edge of the continental shelf where water temperature is warmer than in the coastal ocean. This offshore movement can potentially shift a proportion of their population out of the NEFSC trawl survey area. The NEFSC bottom trawl survey extends from Cape Hatteras through the Gulf of Maine and occurs over a two-month interval in both the spring and the fall when the temperature on the shelf is rapidly changing. Thus, the timing of the survey combined with variability in the thermal transition in each season may impact availability of species to the survey, particularly those with temperature-induced migration patterns. Because temperature strongly modifies their movement offshore and south in the winter, there is high interannual variability in their distribution on the shelf, consequently changing the availability of each of these species to the survey depending on their life history and migratory behavior. Here we propose to quantify the degree to which oceanographic features and particularly temperature affect availability and catchability in the NEFSC trawl survey for summer flounder, black sea bass and spiny dogfish. Evaluation of time-varying catchability in these three species enables a comparison among different life histories and habitat requirements.

Temperature is likely the most important variable influencing distribution and availability to the NEFSC survey of fishes in this region. Indeed, developing a habitat model based on temperature alone improved the biomass estimates and reduced uncertainty for the pelagic butterfish (Adams

et al. 2014). However, our three focal species are more demersal in nature and furthermore, other variables have been identified as important habitat requirements. For summer flounder and black sea bass, access to estuaries and bottom habitat type are also important determinants of distribution. Both species use estuaries as nursery habitat and forage there as adults. Summer flounder are known to prefer sandy habitat whereas black sea bass aggregate on high-complexity habitat. Salinity was also an important factor in predicting black sea bass abundance (Miller et al. 2016). For spiny dogfish, habitat associations revealed a selection for warmer, more saline, and more southerly locations during spring (Sagarese et al. 2014b). Therefore, it is vital to assess the importance of both dynamic variables (temperature, salinity, oceanographic fronts) and static variables (distance to estuary and bottom type) in determining the availability of these species to the survey. As dynamic variables change and static variables do not, the spatial mismatch between multiple variables may dramatically change the availability of each species to the survey.

Objectives

For each species, we will take a similar approach to understand how habitat modifies their availability to the NEFSC trawl survey in three steps or objectives:

1. Identify habitat variable(s) for which each species and if necessary each sex, age or size class selects for habitat using cumulative distribution functions (cdfs)
2. Develop a habitat model for each species using Generalized Additive Models (GAMs) that will allow incorporation of multiple habitat parameters if necessary.
3. Create hindcasts of availability to the survey by combining habitat models with hindcasts of dynamic oceanographic variables (temperature, salinity and fronts) to create a time series of catchability during the spring and fall NEFSC surveys

Methods

Our methods are based on the fundamentals of fisheries science, specifically that abundance (N) is a function of the catch (C), sampling effort (E) and catchability (q) according to the following equation:

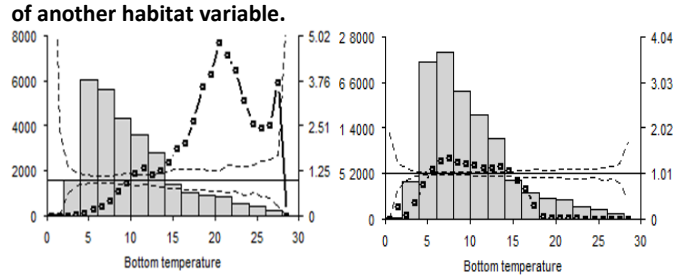
$$N=C/Eq$$

Catchability is one of the most important parameters in stock assessment models and can be further decomposed into availability (q_a) and sampling efficiency (q_e):

$$q=q_a \times q_e$$

We will create time series of catchability by modifying q_a, habitat availability, to the survey for 3 different stocks, all of which have different habitat requirements and as such the model used to alter q_a will have different impacts on their respective stock assessments. Stock assessment models have evolved to enable direct linkage of environmental variables to processes such as catchability and recruitment, greatly enhancing our ability to incorporate ecosystem considerations within stock assessments as mandated by the Reauthorized Magnuson-Stevens Fishery Conservation and Management Act of the United States.

Figure 1: Comparison of temperatures sampled by the NEFSC trawl survey (gray bars) to black sea bass (left panels) and spiny dogfish (right panels) occurrence using presence-absence data (open circles and lines). Note that the occurrence as a function of temperature for both species is somewhat bimodal indicating differences in distributions by sex or size class or the importance of another habitat variable.



For each species, we will first identify the habitat variables for which each species selects such as sea surface temperature, bottom temperature, oceanographic fronts and bottom type, accounting for differences in habitat selection for different stages of each species. To test the hypothesis that fish select for certain habitat variables we will use cumulative distribution functions, which is an objective method to compare the range of environmental conditions sampled in a trawl survey to the environmental conditions at which fishes are found (Perry and Smith 1994). If the distribution of environmental conditions is different from the distribution at which the species is found, the fish is selecting for a particular habitat type. As is the case with black sea bass, the temperatures sampled in the spring NEFSC survey (gray bars) are much lower than the temperatures at which black sea bass are found (points connected with line in Figure 1). It is also important to consider the impact of size class on preferences. Both black sea bass and spiny dogfish have somewhat bimodal distributions (Figure 1). In spiny dogfish, this is supported by previous work that indicated that males and females as well as different life history stages had different habitat preferences (Sagarese et al. 2014b).

Once we determine whether each species is selecting for certain variables, we will develop habitat models using Generalized Additive Models (GAMs) with which the PIs have considerable experience (Hare et al. 2012, Lynch et al. 2014, Sagarese et al. 2014b). GAMs are flexible non-parametric techniques that are especially useful to model the nonlinear combined effects of multiple habitat variables. We will use stepwise backward selection of variables for each species and the best model will be based on the lowest Akaike information criteria. We will evaluate the predictive performance of these models by retaining a portion of the data as a test dataset. We will follow a similar approach to Adams et al. (2014) and express the availability of the stock to the survey for each species as the index, ρ_h:

$$\rho_h = \sum_{k=1}^{o} \frac{HSI_{k_{j,i}} * \frac{Area\ of\ sample\ strata_k}{p}}{\sum_{j=1}^{n} HSI_{j,i} * Area\ of\ j}$$

where HSI is a value ranging from 0-1 that represents the modeled estimate of habitat suitability for sample *k*, occurring in location *j* on day *i*. Values closer to 0 indicate poor habitat suitability and values closer to 1 indicate high suitability. This value is essentially extrapolated to the area of the survey, *k*, divided by the total number of samples, *p*, taken within a strata sampled for each survey.

We will use hindcasts of daily bottom water temperature and daily bottom salinity between 1959 and 2012 from the Regional Ocean Modelling System parameterized for the Northeast US hindcast. ROMS is a 'free surface, terrain following primitive equations ocean model" (http://www.myroms.org/index.php) and for the Northeast shelf ROMS has a resolution of 7 km x 7 km and is able to estimate bottom water temperature at depths within 1m from the seafloor. This ROMS model has already been "debiased" to correct for slight differences in the modeled temperature from observed temperature and projected to a smaller spatial scale so that a value can be obtained for each survey station (Adams et al. 2014). A terrain ruggedness index will be used as a measure of bottom type for each species following Hare et al. (2012). Below we discuss the specific objectives and habitat modeling that will be conducted for each species.

Summer flounder- Summer flounder is an estuarine-dependent flatfish that uses estuaries as nursery habitat as juveniles and as foraging grounds in the summer as adults. The stock was at low abundance in the 1990s, but with effective management, the stock recovered. As the stock recovered to historic population sizes, their range expanded and center of biomass shifted north

(Nye et al. 2009). Although there is some debate on the role of climate, it is generally believed that the northward shift is primarily caused by the expansion of age structure and recovery of the population (Bell et al. 2014), density dependent range expansion does not explain the range contraction in the southern part of its range off North Carolina (Figure 2). In addition to this uncertainty, the most recent stock assessment conducted for summer flounder in 2014 indicates that overfishing is occurring (Terceiro 2015).

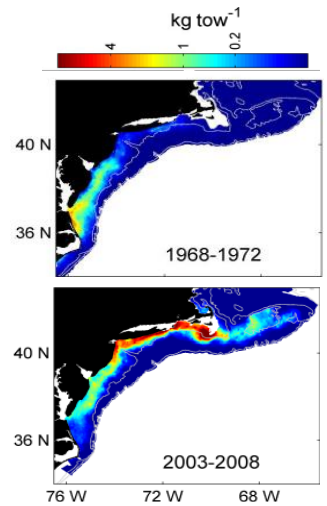


Figure 2: Fall distribution of summer flounder for 2 time periods (NEFSC survey)

As the most important commercial fishery in the Mid-Atlantic, allocation of catch to individual states is quite contentious and will only worsen if catch limits decrease. Therefore, understanding environmentally-induced changes in spatial distribution has two consequences. First, even small changes in availability of summer flounder to the NEFSC survey may induce observation error that can affect biomass estimates and increase uncertainty in the stock assessment. Quantifying a portion of this observation error will refine biomass estimates and reduce uncertainty that will allow managers to more precisely set catch limits. Second, environmentally-induced changes in spatial distribution also impact the availability of summer flounder to the fishery and have important ramifications for state allocation issues. Therefore, in addition to estimates of habitat suitability and time-varying catchability, we will provide spatially explicit estimates of the biomass available to recreational fisheries as a function of distance from the shoreline of each state, temperature, depth and fish size. This builds on work investigating the potential impact of climate on stock structure of summer flounder as part of a Regional Sea Grant awarded to Nye and colleagues.

Black sea bass- Adult black sea bass (BSB) in the northern extent of their range spawn in the coastal ocean in August-October after which juveniles rapidly grow in estuaries and the coastal ocean. In the southern extent of their range, BSB have high site fidelity and do not undertake extensive migrations, but in the northern Mid-Atlantic stock, adults and presumably juveniles migrate to the edge of the shelf to overwinter where bottom temperature is warmer. In contrast to summer flounder, hard substrate is known to be a desired habitat for BSB. Recent work has shown the importance of environmental factors in predicting the abundance and distribution of black sea bass, but the importance of bottom habitat type was not investigated nor how available habitat may impact survey indices of abundance (Miller et al. 2016).

A habitat model will be developed that will incorporate at least two variables that have been shown to be important to BSB; a dynamic variable, bottom temperature, and a static variable, bottom rugosity. A similar approach was used for a fish species at the southern extent of its range (Cusk; *Brosme brosme*) that predicted a steep decline in suitable habitat as water temperatures warm because of the spatial mismatch between suitable water temperatures and high complexity habitat (Hare et al. 2012). We hypothesize the opposite may be true for BSB where high complexity habitat at the northern edge of its range may become more available for settlement of juvenile BSB as water temperatures warm, opening up habitat that was previously unavailable. Furthermore, if both of these variables are important habitat parameters for BSB, it is critical that we identify the areas with both high bottom complexity *and* optimal thermal habitat. Considering only one of these variables would incorrectly estimate the amount of habitat available to BSB. Incorporation of time varying catchability in the black sea bass stock assessment is particularly

important because the estimates of spawning stock biomass and stock status for the last stock assessment in 2011 were not accepted and so the status of the stock is unknown (Shepherd 2012). This assessment is also highly dependent on the survey index of abundance.

Spiny dogfish - A habitat model using GAMs that includes both biotic and environmental variables has already been developed for different sexes and life stages of spiny dogfish (Sagarese et al. 2014a). The availability of spiny dogfish to the NEFSC survey varies with environmental conditions, particularly bottom temperature. Even a small change in temperature and/or the timing of the survey changes the availability of the stock to the survey (Figure 3). Relatively warmer spring temperature cues earlier migration from wintering grounds off of Cape Hatteras to feeding grounds in northern US and Canada. Thus, earlier migration may initiate movement into Canadian waters that are outside the area of the survey.

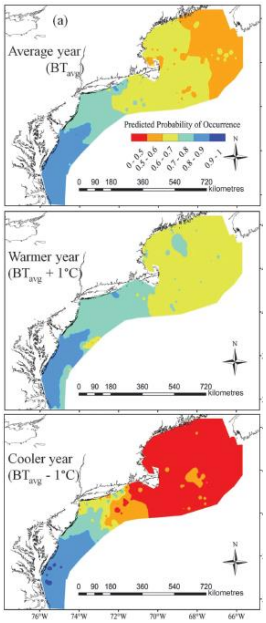


Figure 3: Predicted occurrence of mature female spiny dogfish in an average, warm or cold year.

The stock assessment for this species is highly dependent on the NEFSC survey abundance index and, although we know that distribution changes interannually in response to biotic and abiotic variables, this knowledge has not been incorporated into the stock assessment. For this stock we will (1) refine the existing habitat models for spiny dogfish to predict biomass availability to the NEFSC trawl survey and (2) create a time series of availability that can be included in the next stock assessment.

Specific results expected

1. Critical habitat needs for three economically and ecologically important species: black sea bass, summer flounder and spiny dogfish
2. Time series of catchability for three Mid-Atlantic species that can be directly incorporated into each stock assessment
3. Habitat models for three species that can be used in applications other than changing availability to the stock assessment such as projecting effects of climate change
4. A model of availability of summer flounder to shore-based recreational fishers
5. Training of at least one student in quantitative fisheries science
6. At least three peer-reviewed publications in fisheries and ecology journals

Timeline and work plan

	May-July	August-October	November-January	February-April
Year 1	Develop habitat model for summer flounder		Develop habitat model for black sea bass	
	Refine habitat model for spiny dogfish			
Year 2	Combine habitat models with ROMS hindcasts to create time series of time varying catchability		Present results to stock assessment scientists and MAFMC	
	Estimate proportion of summer flounder available to fishery by state			
	Prepare manuscripts for publication		End of project	

Budget

Item	Total cost	ASMFC/MAFMC requested
PI summer salary	**$ 2,096**	**$ 2,096**
Student salary	**$ 43,500**	**$ 43,500**
PI Fringe benefits	**$ 314**	**$ 314**
Student fringe benefits	**$ 7,830**	**$ 7,830**
Tuition (no IDC applied)	**$ 6,282**	**$ 6,282**
Travel	**$ 1,750**	**$ 1,750**
Equipment and supplies	--	--
Administrative personnel	--	--
Indirect costs (IDC at 25%)	**$ 13,873**	**$ 13,873**
Total	**$ 75,645**	**$ 75,645**

Personnel

Summer salary is requested in each year for approximately 4% of Nye's effort to advise the student on data analysis and oversee the project.

The bulk of the funds requested is to support a student to perform the habitat modeling. Salary is requested for 1 MS student a full year in Year 1 ($29,000) and ½ a year in Year 2 ($14,500)

Fringe Benefits

The University charges 15% for faculty summer fringe benefits and 18% for graduate student fringe benefits.

Permanent Equipment

NONE

Travel

Funds for travel to communicate our work to the MAFMC and stock assessment scientists at the NEFSC and for partial travel to one regional or national fisheries meeting such as AFS.

Other Direct Costs

Tuition for 1 student for a full year in Year 1 and for half a year in Year 2 is requested.

Indirect costs (Facilities and Administrative Costs)

The agreed upon rate by the sponsor is 25%.

Statement of qualifications and staffing plan

Nye, Frisk and Sagarese have been studying fish distribution, fish population dynamics and developing habitat models for fishes for a combined total of over 35 years. Nye, a Fisheries Ecologist and Oceanographer, will lead the project and has developed GAMs for other Northeast US fish stocks such as Atlantic croaker, cusk and river herring. Nye and Frisk are currently developing similar models for estuarine-dependent species for Great South Bay, New York. Frisk serves on the Science and Technical Committee for the MAFMC. Frisk and Sagarese are both NOAA Sea Grant fellows in Population Dynamics. Sagarese's dissertation work involved developing stage and sex specific habitat models for spiny dogfish. Now she is an assessment scientist for the Southeast Fisheries Science Center and as such has the skills and knowledge to develop habitat models and catchability indices that can be incorporated into stock assessments.

Skyler Sagarese will be responsible for refining the habitat model for all life stages and sexes of spiny dogfish. A student, Emily Markowitz, has already been identified to conduct the habitat modelling work for summer flounder and black sea bass as soon as funding is available. She has experience working with the statistical techniques outlined in the proposal and as an undergraduate at Stony Brook University examined NEFSC CTD data and the ROMS output. Nye, Frisk and Sagarese work frequently with the lead stock assessment scientists for each species at the NEFSC and will communicate with them as progress is made on the habitat models for each species so that our measures of time-varying catchability can be considered in the next stock assessment for each species. We will also present the results in at least one public forum on Long Island and of course to the MAFMC.

Dr. Janet A. Nye
School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11794
phone: (631)-632-3187 email: janet.nye@stonybrook.edu

Professional Preparation

Undergraduate:	Duke University	Biology	B.S.	1996
Graduate:	U. of Delaware	Marine Biology & Biochemistry	M.S.	2002
	U. of Maryland	Marine, Estuarine & Environmental Science	Ph.D.	2008
Postdoctoral:	NOAA NMFS	Woods Hole, MA	2008-2010	

Appointments

2012—present	Assistant Professor, School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY
2010—2012	Research Ecologist, Environmental Protection Agency, Atlantic Ecology Division, Narragansett, RI
2008—2010	Research Associate, NOAA National Marine Fisheries Service Northeast Fisheries Science Center, Woods Hole, MA

Publications

Pershing, A.J., M.A. Alexander, C.M. Hernandez, L.A. Kerr, A. Le Bris, K.E. Mills, **J.A. Nye**, and 4 others (2015) Slow adaptation in the face of rapid warming leads to the collapse of an iconic fishery. *Science* 350 (6262): 809-812.

Xu, H., Hye-Mi Kim, **JA Nye**, S Hameed (2015) Impacts of North Atlantic Oscillation on Sea Surface Temperature on the Northeast US Continental Shelf. *Continental Shelf Research* 105: 60-66.

Lynch PD, **Nye JA**, Hare JA, Stock CA, Alexander MA, Scott JD, Curti KL, Drew K (2015) Projected ocean warming poses a challenge to anadromous river herring populations. *ICES Journal of Marine Science* doi:10.1093/icesjms/fsu134

Tommasi, D., **J.A. Nye**, C. Stock, J. Hare, M. Alexander, K. Drew (2015) Effect of environmental conditions on river herring freshwater survival: a coastwide perspective. *Canadian Journal of Fisheries and Aquatic Sciences* 72(7): 1037-1047.

Nye, J.A., M. Baker, R. Bell, A. Kenny, K.H. Kilbourne, K.D. Friedland, E. Martino, M. Stachura, K.S. Van Houtan, R. Wood (2014) Ecosystem effects of the Atlantic Multidecadal Oscillation. *Journal of Marine Systems* 133: 103-116

Alexander, M., **J.A. Nye**, and K. Kilbourne (2014) AMO: Measurement, Mechanisms and Relations to other Climate Patterns. *Journal of Marine Systems* 133: 14-26.

K.H. Kilbourne, M.A. Alexander, **J.A. Nye** (2014) A low latitude paleoclimate perspective on Atlantic multidecadal variability. *Journal of Marine Systems* 133: 4-13

Friedland, K.D., B. V. Shank, C. D. Todd, P. McGinnity, **J.A. Nye** (2014) Differential response of continental stock complexes of Atlantic salmon (*Salmo salar*) to the Atlantic Multi-decadal Oscillation. *Journal of Marine Systems* 133: 77-87

Alheit, J., Drinkwater, K.F., **J.A. Nye** (2014) Introduction to Special Issue: Atlantic Multidecadal Oscillation-mechanism and impact on marine ecosystems. *Journal of Marine Systems* 133: 1-3.

Friedland, K.D., J. Kane, J.A. Hare, R.G. Lough, P.S. Fratantoni, M.J. Fogarty, **J.A. Nye (**2013) Thermal habitat constraints on zooplankton species associated with Atlantic cod (*Gadus morhua*) on the US Northeast Continental Shelf. *Progress in Oceanography* 113: 1-13.

Mills K, Pershing A, Brown C, Chen Y, Chiang F, Holland D, Lehuta S, **Nye J**, Sun J, Thomas A (2013) Fisheries management in a changing climate: Lessons from the 2012 ocean heat wave in the Northwest Atlantic. *Oceanography* 26(2): 191-195.

McClure MM, Alexander M, Borggaard D, Boughton D, Crozier L, Griffis R, Jorgensen JC, Lindley ST, **Nye J**, Rowland MJ (2013) Incorporating climate science in applications of the US Endangered Species Act for aquatic species. *Conservation Biology* 27:1222-1233

Snover AK, Mantua NJ, Littell JS, Alexander MA, Mcclure MM, **Nye J (**2013) Choosing and Using Climate-Change Scenarios for Ecological-Impact Assessments and Conservation Decisions. *Conservation Biology* 27:1147-1157

Fogarty, M.J. and 13 others (2012) Status of the Northeast U.S. Continental Shelf Large Marine Ecosystem: An Indicator-Based Approach (In: Advancing an Ecosystem Approach in the Gulf of Maine. American Fisheries Society Symposium 79)

Hare, J., J. Manderson, **J.A. Nye**, M. Alexander, P. Auster, D. Borggaard, A. Capatondi, and 7 others (2012) Cusk (*Brosme brosme*) and climate change: assessing the threat to a data poor candidate species under the Endangered Species Act. *ICES Journal of Marine Science* 69(10): 1753-1768.

Shackell, N., A. Bundy, **J.A. Nye**, J.S. Link (2012) Coherent responses to climate and fishing across large marine ecosystems of the Northwest Atlantic *ICES Journal of Marine Science* 69(2): 151-162.

Nye, J.A. T.M. Joyce, Y. Kwon, J.S. Link (2011) Silver hake tracks changes in Northwest Atlantic circulation. *Nature communications* 2: 412 doi: 10.1038/ncomms1420

Nye, J.A.., D. Loewensteiner, T.J. Miller (2011) Annual, seasonal and regional variability in the diet of Atlantic croaker *Micropogonias undulatus* in Chesapeake Bay. *Estuaries and Coasts 34:* 691-700.

Synergistic Activities

I am a member of several scientific organizations including the American Fisheries Society. As a member of Graduate Women in Science (GWIS) I served on the fellowship committee and helped coordinate proposal reviews for three years. Now I am involved in Stony Brook Women in Science and Engineering (WISE) program that seeks to increase the involvement of women in science careers at the high school, college and graduate levels, teaching a short course on fish physiology research methods to freshman women in this program. I am also involved in public outreach having given presentations to students and the public on climate change issues on numerous occasions. I have reviewed proposals for the NSF Biological Oceanography Program, NSF CAMEO, the North Pacific Research Board and numerous State SeaGrant organizations. In addition to being a review editor for *Marine Ecology Progress Series*, I am a manuscript reviewer for numerous journals including *PLOS One, Science, Progress in Oceanography, Global Change Biology, Ecological Applications, Fisheries Oceanography, Journal of Fish Biology, Marine and Coastal Fisheries, Estuaries and Coasts, Transactions of American Fisheries Society, North American Journal of Fisheries Management*.

***Curriculum vitae* for Dr. Michael G. Frisk**

School of Marine and Atmospheric Sciences
Stony Brook University, Stony Brook, New York
Email: mfrisk@notes.cc.sunysb.edu
Phone: 631-632-3750

Education:

Ph.D. 2004. Marine, Estuarine and Environmental Science. University of Maryland, College Park, Maryland.
Dissertation Title: Biology, life history and conservation of elasmobranchs with an emphasis on western Atlantic skates. Advisor Dr. Thomas J. Miller.

Professional Experience:

2006-present	Associate Professor School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY.
2004-2006	Post-doctoral researcher UBC Fishery Centre, University of British Columbia, Vancouver, British Columbia.

Publications (*indicates student **indicates post-doctoral researcher supervised by PI Frisk):

Project related publications

Melnychuk, M.C., Dunton, J.C. Adrian Jordaan, A., McKown, K.A. and M.G. Frisk (in prep.). Developing conservation strategies for the endangered Atlantic sturgeon using acoustic telemetry and multi-state mark-recapture models. To be submitted to a journal in January, 2016.

Dunton, K.J., A. Jordaan, K.A McKown, and M.G. Frisk. (in prep.). Spatial-temporal habitat use, residency, and rate of movement of sub-adult Atlantic sturgeon, *Acipenser oxyrhinchus oxyrinchus*, within the Mid-Atlantic Bight. *Proposed Journal: Transactions in American Fisheries.*

Dunton*, K.J., A. Jordaan, D. Secor, T. Kehler, K. Hattela, J. Van Eenennam, M. Fisher, K.A. McKown, D.O. Conover and M.G. Frisk (In Press). Age structure and growth rate of the endangered Atlantic sturgeon in coastal waters of the New York Bight. Target journal: *Marine and Coastal Fisheries*.

Breece, M.W., D.A. Fox, K.J. Dunton, M.G. Frisk, A. Jordaan, and M.J. Oliver. *In Press.* Dynamic Seascapes Predict the Marine Occurrence of an Endangered Species: Atlantic Sturgeon *Acipenser oxyrhinchus oxyrhinchus.*

Dunton*, K.J., A. Jordaan**, D.O. Conover, K.A. McKown, L.A. Bonacci and M.G. Frisk (2015). Marine distribution and habitat use of Atlantic Sturgeon (*Acipenser oxyrhinchus oxyrhinchus*) in New York leads to fisheries interactions and bycatch. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 7:18–32, 2015.

McCauley*, M.M., Cerrato, R.M., Sclafani, M., Frisk, M.G. (2014) Diel Behavior in White Perch Revealed using Acoustic Telemetry. *Transactions of the American Fisheries Society* 143, 1330-1340.

Frisk, M.G., Jordaan**, A., and T.J. Miller (2014). Moving beyond the current paradigm in

marine population connectivity: Are adults the missing link? *Fish and Fisheries*, 15(2): 242-254.

O'Leary, S.J., K.J. Dunton*, T.L. King, M.G. Frisk and D.D. Chapman (2014). Genetic diversity and effective number of breeders of Atlantic sturgeon, *Acipenser oxyrhinchus oxyrhinchus*. *Conservation Genetics* 15(5):1173-1181.

Tomichek, C., J. Colby, M.A. Adonizio, K.J Dunton*, M.G. Frisk, D. Fox, and A. Jordaan (2014). Tagged species detection: approach to monitoring marine species at marine hydrokinetics projects. *Proceedings of the 2nd Marine Energy Technology Symposium*. Seattle, WA, 2014. 8 pages.

Dunton*, K.J., D. Chapman, A. Jordaan**, K. Feldheim, S.J. O'Leary, K.A. McKown and M.G. Frisk. (2012). Genetic mixed-stock analysis of Atlantic sturgeon *Acipenser oxyrhinchus oxyrhinchus* in a heavily exploited marine habitat indicates the need for routine genetic monitoring. *Journal of Fish Biology* 80(1): 207-217.

Dunton*, K.J., A. Jordaan**, D.O. Conover, K.A. McKown, and M.G. Frisk (2010). Abundance and distribution of Atlantic Sturgeon (*Acipenser oxyrhinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. *Fishery Bulletin* 108(4): 450-465.

Sagarese*, S.R. and M.G. Frisk (2011). Movements and residence of adult winter flounder, *Pseudopleuronectes americanus*, within a Long Island (NY) Estuary. *Marine and Coastal Fisheries* 3:295-306.

Related projects

Current:

U.S. Army Corps of Engineers. Total amount: $180,000. PI-Frisk. Duration: 2015-2016. Utilizing acoustic telemetry to explore the spawning behavior of flounder ecology in Mattituck Creek, New York.

NYS Department of Environmental Conservation. Total amount: $184,000. PI-Frisk. Duration: 2015-2016. Determining the connectivity among and fine-scale habitat-use within Atlantic sturgeon aggregation areas in the Mid-Atlantic Bight: Implications for gear restricted management areas to reduce bycatch and improve population status.

Past:

NOAA-NMFS. Total amount: $2,442,460. PI: Frisk. Duration: 2010-2015. Determining the connectivity among and fine-scale habitat-use within Atlantic sturgeon aggregation areas in the Mid-Atlantic Bight: Implications for gear restricted management areas to reduce bycatch and improve population status.

USFW State Grants Program. Total amount: $319,017. PI: Frisk. Duration: 2009-2012. Development of an effective area-based management scenario to reduce bycatch and improve the population status of Hudson River Atlantic sturgeon. CO-PIs: Conover (SoMAS), Jordaan (SoMAS), Dunton (SoMAS) and McKown (NYSDEC).

NYSDEC. Total amount: $250,000. PI: Frisk. Duration: 2007-2009. Survival, growth, movement and the population dynamics of YOY and adult winter flounder, *Pseudopleuronectes americanus*, in coastal bays of Long Island, NY: A genetic and acoustic tagging study.

Skyler Rose Sagarese, Ph.D.

National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149
Telephone: (305) 361-4272 Email: skyler.sagarese@noaa.gov

Professional Preparation

Undergraduate:	U. of Miami	Marine Science and Biology	B.S.	2006
Graduate:	Stony Brook Univ.	Marine and Atmospheric Science	M.S.	2009
	Stony Brook Univ.	Marine and Atmospheric Science	Ph.D.	2013
Postdoctoral:	U. of Miami/ NOAA NMFS	SEFSC Miami, FL	2013 – 2015	

Appointments and Awards

2015 – present	Research Ecologist – National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL
2014	National Marine Fisheries Service Team Member of the Year Award
2013 – 2015	Postdoctoral Research Associate – Cooperative Institute for Marine and Atmospheric Studies (CIMAS), University of Miami (RSMAS), Miami, FL
2009 – 2012	NMFS Sea Grant Fellowship in Population Dynamics to investigate the population ecology of the spiny dogfish in the Northeast (US) shelf large marine ecosystem

Related Publications

Sagarese SR, Frisk MG, Cerrato RM, Sosebee KA, Musick JA, Rago PJ. (in press) Diel variations in survey catch rates and catchability of Spiny Dogfish and their prey species within the Northeast US continental shelf large marine ecosystem. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*.

Sagarese SR, Frisk MG, Cerrato RM, Sosebee KA, Musick JA, Rago PJ. (2015). Spatiotemporal overlap of spiny dogfish (*Squalus acanthias*) and commercial fisheries in the Northeast U.S. shelf large marine ecosystem. *Fishery Bulletin* 113(2) doi:10.7755/FB.113.2.1

Shideler GS, **Sagarese** SR, Harford WJ, Schull J, Serafy JE. (2015). Water quality as a limiting factor for juvenile goliath grouper in mangrove habitats. *Environmental Biology of Fishes* doi: 10.1007/s10641-015-0430-4.

Sagarese SR, Frisk MG, Cerrato RM, Sosebee KA, Musick JA, Rago PJ (2014) Application of generalized additive models to examine ontogenetic and seasonal distributions of spiny dogfish (Squalus acanthias) in the Northeast (US) shelf large marine ecosystem. *Canadian Journal of Fisheries and Aquatic Sciences* 71(6): 847-877

Sagarese SR, Frisk MG, Miller TJ, Sosebee KA, Musick JA, Rago PJ (2014) Influence of environmental, spatial and ontogenetic variables on the habitat selection and management of spiny dogfish (*Squalus acanthias*) in the northeast (US) shelf large marine ecosystem. *Canadian Journal of Fisheries and Aquatic Sciences* 71(4): 567-580

Other Significant Publications

Sagarese SR, Nuttall MA, Geers TM, Lauretta MV, Walter JF III, Serafy JE. (in press) Quantifying the trophic importance of Gulf menhaden (*Brevoortia patronus*) within the northern Gulf of Mexico food

web. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*.

Sagarese SR, Walter JF, Bryan MD, Carruthers TR. (in press) Evaluating methods for setting catch limits for gag: data-rich versus data-limited. *Proceedings of the 30th Lowell Wakefield Fisheries Symposium*.

Sagarese SR, Cerrato RM, Frisk MG. (2011) Diet composition and feeding habits of common fishes in Long Island Bays, New York. *Northeastern Naturalist* 18(3): 291-314.

Sagarese SR and MG Frisk. (2011) Movement patterns and residence of adult winter flounder within a Long Island estuary. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 3(1): 295-306.

Sagarese SR and MG Frisk. (2010) The effect of photoperiod and temperature on vertebral band deposition in little skate, *Leucoraja erinacea. Journal of Fish Biology* 77(4): 935-946.

Feldheim KA, Chapman DD, Simpfendorfer CA, Richards VP, Shivji MS, Wiley TR, Poulakis GR, Carlson JK, Eng R, **Sagarese** S. (2010) Genetic tools to support the conservation of the endangered smalltooth sawfish, *Pristis pectinata*. *Conservation Genetics Resources* 2(1): 105-113.

Synergistic Activities

- Habitat modeling of species distributions within the Gulf of Mexico to enable an examination of spatio-temporal overlap between grouper distributions and red tide events.
- Collaborator on a habitat modeling project funded by the Florida Centers of Excellence Research Grants Program titled "Improving the use of products derived from monitoring data in ecosystem models of the Gulf of Mexico", in which species distribution maps will be produced for use in ecosystem models.
- Liaison to the Gulf of Mexico Integrated Ecosystem Assessment Team tasked with incorporating environmental indices into single-species stock assessment models. I helped assess the relationship between sea surface temperature (SST) and king mackerel *Scomberomorus cavalla* distribution and development of environmental indices relating to SST for testing within the assessment model. I have also incorporated red tide mortality into the assessment models for Gulf of Mexico gag and red grouper and conducted hydrodynamic modeling to develop indices of recruitment anomalies based on oceanographic factors for consideration in grouper stock assessments.

Collaborators (last 48 months):

Elizabeth A. Babcock (U Miami – RSMAS), Meaghan D. Bryan (NMFS SEFSC), Shannon Cass-Calay (NMFS SEFSC), Tom R. Carruthers (University of British Columbia), Robert M. Cerrato (Stony Brook University – SoMAS), Nancie Cummings (NMFS SEFSC), Michael G. Frisk (Stony Brook University – SoMAS), Tess. M. Geers, Arnaud Gruss (University of Miami – CIMAS), William J. Harford (University of Miami – CIMAS), John Jeffery Isely (NMFS SEFSC), Mandy Karnauskas (NMFS SEFSC), Matthew V. Lauretta (NMFS SEFSC), Brian Linton (NMFS NEFSC), Hui Liu (Texas A&M University), Thomas J. Miller (University of Maryland), John A. Musick (Virginia Institute of Marine Science), Matthew A. Nuttall (University of Miami – RSMAS), Paul J. Rago (NMFS NEFSC), Michael J. Schirripa (NMFS SEFSC), Jennifer Schull (NMFS SEFSC),Joseph E. Serafy (NMFS SEFSC), Geoffrey S. Shideler (University of Miami – RSMAS), Kathy A. Sosebee (NMFS NEFSC), Jakob C. Tetzlaff (NMFS SEFSC), John F. Walter (NMFS SEFSC)

Graduate thesis advisors

Michael G. Frisk (Masters, Doctoral), Stony Brook University

John F. Walter (postdoctoral advisor), Southeast Fisheries Science Center, Miami, FL

Appendix A: Works cited

Adams, C., T. Miller, J. Manderson, D. Richardson, B. Smith, C. M. Legault, J. Kohut, J. A. Hare, L. Palamara, G. Shepherd, K. Sosebee, M. Terceiro, O. P. Jensen, J. Didden, R. Seagraves, G. DiDomenico, M. L. Traver, A. S. Miller, K. L. Curti, J. J. Deroba, and M. Palmer. 2014. Butterfish stock assessment for 2014.

Bell, R. J., D. E. Richardson, J. A. Hare, P. D. Lynch, and P. S. Fratantoni. 2014. Disentangling the effects of climate, abundance, and size on the distribution of marine fish: an example based on four stocks from the Northeast US shelf. ICES Journal of Marine Science: Journal du Conseil:fsu217.

Hare, J. A., J. Manderson, J. Nye, M. Alexander, P. Auster, D. Borggaard, A. Capotondi, K. Damon-Randall, E. Heupel, I. Mateo, L. O'Brien, D. Richardson, C. Stock, and S. T. Biegel. 2012. Cusk (*Brosme brosme*) and climate change: assessing the threat to a data poor candidate species under the Endangered Species Act. ICES Journal of Marine Science **69**:1753-1768.

Link, J. S., J. A. Nye, and J. A. Hare. 2011. Guidelines for incorporating fish distribution shifts into a stock assessment context. Fish and Fisheries **12**:461-469.

Lynch, P. D., J. A. Nye, J. A. Hare, C. A. Stock, M. A. Alexander, J. D. Scott, K. L. Curti, and K. Drew. 2014. Projected ocean warming creates a conservation challenge for river herring populations. ICES Journal of Marine Science: Journal du Conseil.

Miller, A. S., G. R. Shepherd, and P. S. Fratantoni. 2016. Offshore Habitat Preference of Overwintering Juvenile and Adult Black Sea Bass, Centropristis striata, and the Relationship to Year-Class Success. PLOS One **11**.

Nye, J. A., J. S. Link, J. A. Hare, and W. J. Overholtz. 2009. Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Marine Ecology Progress Series **393**:111-129.

Perry, R. I. and S. J. Smith. 1994. Identifying habitat associations of marine fishes using survey data: an application to the Northwest Atlantic. Canadian Journal of Fisheries and Aquatic Sciences **51**:589-602.

Sagarese, S. R., M. G. Frisk, R. M. Cerrato, K. A. Sosebee, J. A. Musick, and P. J. Rago. 2014a. Application of generalized additive models to examine ontogenetic and seasonal distributions of spiny dogfish (*Squalus acanthias*) in the Northeast (US) shelf large marine ecosystem. Canadian Journal of Fisheries and Aquatic Sciences **71**:847-877.

Sagarese, S. R., M. G. Frisk, T. J. Miller, K. A. Sosebee, J. A. Musick, P. J. Rago, and J. Rosenfeld. 2014b. Influence of environmental, spatial, and ontogenetic variables on habitat selection and management of spiny dogfish in the Northeast (US) shelf large marine ecosystem. Canadian Journal of Fisheries and Aquatic Sciences **71**:567-580.

Shepherd, G. R. 2012. Black Sea bass assessment summary for 2012. Woods Hole, MA.

Swain, D., G. Poirier, and A. Sinclair. 2000. Effect of water temperature on catchability of Atlantic cod (Gadus morhua) to the bottom-trawl survey in the southern Gulf of St Lawrence. ICES Journal of Marine Science: Journal du Conseil **57**:56-68.

Terceiro, M. 2015. Stock Assessment update of Summer flounder for 2015. US Department of Commerce, Woods Hole, MA.

Walters, C. 2003. Folly and fantasy in the analysis of spatial catch rate data. Canadian Journal of Fisheries and Aquatic Sciences **60**:1433-1436.

Wilberg, M. J., J. T. Thorson, B. C. Linton, and J. Berkson. 2009. Incorporating time-varying catchability into population dynamic stock assessment models. Reviews in Fisheries Science **18**:7-24.