STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
MARINE RESOURCES LABORATORY
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04575-0008

JANET T. MILLS
GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

August 18, 2023

Atlantic Coastal Cooperative Statistics Program
1050 N. Highland St. Ste. 200 A-N
Arlington, VA 22201

Dear ACCSP,

I am pleased to submit the proposal titled "Characterizing Atlantic Cod Discards in the Maine Lobster Fishery for use in Atlantic Cod Stock Assessment" for your consideration. This is a new proposed project to support a collaboration between the Maine Department of Marine Resources (ME DMR) and the University of Maine to utilize existing fisheries dependent datasets stored by ACCSP and characterize discards of Atlantic cod in the Maine lobster fishery for the Northeast Fisheries Science Center Groundfish Stock Assessment process.

Prior work has been published to estimate cod bycatch in the lobster fishery, but those models are based on historical effort and bycatch data ending in 2013. Both the cod resource and the lobster fishery have experienced changes since that time. This project would support a masters level University of Maine graduate student under the supervision of Dr. Lisa Kerr to revisit and update the models and to develop a workflow that would allow integration of new fisheries dependent data moving into the future.

Thank you for the review of our preproposal submitted in June. The budget has been increased slightly due to the subrecipient revision of costs. Any changes in the body of the proposal are highlighted. Please find a brief summary of the responses to the review panels questions (in italics) below.

1. *Atlantic cod is not in the upper quartile of the matrix. Please justify the priority (necessity) for the sampling of this species.*
   o Atlantic cod has important historical importance in Northeast fisheries. While Atlantic cod is not considered a top priority in the ACCSP Biological Matrix, lobster is a top priority on the Biological Matrix and lobster pots are priority number 2 in the Bycatch Matrix. The lobster fishery could potentially be impacted by future cod management if lobster effort is determined to have a large impact on cod mortality.
   o Atlantic cod recently went through a research track assessment which altered the stock boundaries and established a new Eastern Gulf of Maine cod stock off the coast of Maine. It is estimated that a significant portion of the catch comes from discards in the lobster fishery, but that has not been directly estimated using available lobster effort and bycatch data in the last decade. Acquiring this data was noted to be a high priority in the recent peer review of the cod research track stock assessments. Finfish bycatch is already being collected by Maine DMR Commercial Lobster At-sea Sampling Program. Better estimating

2. *Is this information already being collected in the lobster fishery? Please clarify and, if so, provide additional justification for additional data collection.*

    o   ME DMR Commercial At-Sea Sampling program has collected information on finfish bycatch in the lobster fishery since 2006. Lobster landings data have been collected at 100% for dealer data and roughly 10% for harvester data until 2023 when harvester data shifted to 100% mandatory reporting. While these data sources continue to be collected and we are not proposing new data collection in addition to current requirements, additional data processing and model development are required to quantify the interaction of these two species in lobster effort and estimate a discard time series of cod from the lobster fishery for use in stock assessment.

3. *Please clarify why this work is not being done under the research track assessment. How is this work different?*

    o   The previous work to estimate cod discards in the lobster fishery only included data through 2013 and the lobster fishery has changed since in the last decade to experience a peak in landings and effort and shifting distribution of effort so it was determined inappropriate and inadequate to use the historical data. The research track cod assessment did not have the time or capacity to develop an updated time series of discards from the lobster fishery.

    o   Estimating a time series of cod discards for inclusion in the stock assessment is most relevant for the Eastern Gulf of Maine cod stock assessment and is not a trivial process. This work will require close collaboration between ME DMR, the state agency responsible for this data collection within the lobster fishery, quantitative fisheries scientist responsible for estimating the magnitude of cod discards in the fishery, and the federal scientists responsible for integrating this information in the context of the stock assessment. The Peer Review Panel for the recent cod assessment identified this as a high priority and recommended that estimates of dead discards in the lobster fishery be addressed for integration into the management track process.

The Atlantic cod Research Track Assessment Peer Review Panel is currently completing their report, but the indications from the discussion are that the cod discards from the lobster fishery in eastern Maine may be a required input for the upcoming Cod Management Track Assessment. **If chosen for funding, this project would benefit from initiation of work sooner than later.**

Please contact Kathleen Reardon at the MEDMR with any questions. Thank you for your consideration of this proposal.

Sincerely,

Kathleen M. Reardon
Maine Department of Marine Resources
Marine Resources Scientist III
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Atlantic Coastal Cooperative Statistics Program
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Characterizing Atlantic Cod Discards in the Maine Lobster Fishery for use in Atlantic Cod Stock Assessment

Total Cost: $72,136.15

Submitted by:

Kathleen M. Reardon
Maine Department of Marine Resources
PO Box 8, 194 McKown Point Rd.
West Boothbay Harbor, ME 04575
Kathleen.Reardon@maine.gov

Applicant Name: Maine Department of Marine Resources (Kathleen Reardon)

Project Title: FY24: Characterizing Atlantic Cod Discards in the Maine Lobster Fishery for use in Atlantic Cod Stock Assessment

Project Type: New project

Requested Award Amount: $72,136.15

Requested Award Period: One year after receipt of funds

Date Final Submitted: August 18, 2023

Objective:

The goal of this research is to enhance the utilization of existing datasets and generate a new data stream of Atlantic cod discard estimates from the lobster fishery for use in the cod stock assessment. The proposed work will utilize finfish discard data from the Maine Department of Marine Resources (ME DMR) Commercial Lobster At-Sea Sampling Program in conjunction with lobster landings from ME DMR Landings Program to generate a discard data time series of Atlantic cod for use in the cod stock assessment.

Specific objectives include:
1. Estimation of Atlantic cod discards (total and dead discards) from the Maine lobster fishery over time and lobster management zones.
2. Development of a workflow for data processing and model estimation such that this time series can be easily updated and provided in a timely manner for use in future management track assessments for Atlantic cod by the Northeast Fisheries Science Center (NEFSC).
3. Incorporation of this additional data stream (i.e., Atlantic cod discards from the lobster fishery) into the eastern Gulf of Maine (EGOM) cod stock assessment.

Need:

Atlantic cod and American lobster are iconic fishery species in New England. Today, American lobster is one the most valuable fisheries in the nation, with an ex-vessel average annual value of $505 million for the last five years. Historically, Atlantic cod was one of the principal stocks in the New England groundfish fishery and a mainstay of the regional economy. Given the overlap in benthic habitat, the lobster trap fishery has potential interactions with the cod resource, and this raises questions about the magnitude of mortality due to bycatch in the lobster fishery. In addition, **American lobster is in the top 25% of the ACCSP Biological Review Matrix of priorities and bycatch in American lobster traps ranks second in the ACCSP Priority Bycatch Matrix of priorities.** While Atlantic cod is not considered a top priority in the ACCSP Biological Matrix, the lobster fishery could potentially be impacted by future cod management if lobster effort is determined to have a large impact on cod mortality.

Recent stock assessments of cod in the Gulf of Maine indicate that the stock is overfished despite low catch limits in recent years (NEFSC 2021a). The groundfish fishery targets multiple demersal species, thus depletion of the cod resource is not only a problem for the targeting of cod, but also for the complex of species targeted by this fishery. The cod stock in this region has also

experienced significant ocean warming which has well documented impacts on cod productivity and is projected to continue to impact this fishery resource (Pershing et al. 2015; Hare et al. 2016). Advances in stock identification of Atlantic cod and the recent synthesis of this work has revealed additional biological stock structure within the Gulf of Maine management unit (McBride and Smedbol 2022). The ongoing research track stock assessment for cod is changing the scale of assessment to align with the current state of knowledge on cod stock structure and assessing the resource as four units with two in the Gulf of Maine: 1) eastern Gulf of Maine (EGOM), 2) western Gulf of Maine (WGOM; Figure 1).

Understanding the magnitude of bycatch of Atlantic cod in the lobster fishery and the implications of this unaccounted catch on the resource has been a concern over several cod assessment cycles (NEFSC 2021b). However, this has become more of a focus in the most recent research track assessment due to the changes in the spatial scale of the Atlantic cod stock assessment, particularly with EGOM cod now being assessed as its own stock. Due to changes in the distribution of landings in the lobster fishery, with higher and more variable landings occurring in eastern Maine in the last decade, coupled with the decline of cod landings and the groundfish fishery in that area, cod bycatch in the lobster fishery may represent an important source of catch for EGOM cod. Updated estimates of cod bycatch in the lobster fishery in eastern Maine are needed to develop accurate assessment models for this region since current modeled estimates do not reflect the changes that have occurred in the lobster fishery in recent years.

Boenish and Chen (2018a) modeled the spatiotemporal dynamics of the effective lobster fishing effort in Maine. Building off that work, Boenish and Chen (2018b) used the lobster effort model and additional data to develop estimates of cod bycatch from the Maine lobster fishery. This model-based approach used the ME DMR Commercial Lobster At-Sea Sampling dataset (2006-2013) which includes lobster catch composition and records of finfish bycatch in traps along with fishery dependent Maine lobster landings to calculate discards in each month and year by Maine lobster management zone (Figure 2). In general, the cod bycatch rate was low in the lobster fishery (7.5-7.8 cod per 10,000 trap hauls) and Boenish and Chen (2018b) found total cod discards were driven more by temporal changes in lobster fishery effort than by likelihood of catching cod. Total discards peaked in summer/fall (July-October) when lobster effort was highest.

Boenish and Chen (2020) subsequently explored the impact of incorporating these estimates of cod discards from the lobster fishery on the Gulf of Maine cod assessment. This required hindcasting and forecasting discards across time and reconstruction year specific discards at age. The study incorporated this data-stream into the assessment models previously used for Gulf of Maine cod (ASAP models assuming M=0.2 and M-ramp) under two scenarios, one which assumed a discard mortality of 50% and another that assumed 100% mortality. Although discards did not comprise a large amount to the total catch, for particular age classes (ages 2 and 3) they were an important source of mortality. Additionally, the percent of catch that comes from lobster fishery discards was forecasted to increase and was more influential in recent years. Overall, including lobster fishery discards improved the retrospective patterns in the cod stock assessment and the results of the model including this time series indicated an improved status of the cod resource.

It is important to note that the implications of discards in the lobster fishery to the cod stock assessment and resource are highly dependent on the realized discard mortality. New estimates have been published since the Boenish and Chen 2020 paper. Sweezy et al. (2020) estimated cod discard mortality from commercial lobster traps in an acoustic array. They assessed cod for injury and quantified At Vessel Mortality (AVM) and used acoustic telemetry to track delayed mortality. Using

these two factors, they estimated a discard mortality rate of 25%. They then combined this discard mortality rate with discard estimates (Boenish and Chen, 2018) to estimate that 9,920-12,400 individuals, approximately 10.3-12.9 metric tons, of cod were removed by the lobster fishery per year.

There is a recognized need to update and re-estimate the cod discard time series from the lobster fishery for incorporation into Atlantic cod stock assessments. However, the current Maine lobster fishery has experienced significant changes since the end of the time series (2013) used to develop the prior models by Boenish and Chen. This includes the shifting geographic distribution of lobster landings, with eastern Maine landings peaking in 2016 then decreasing while western Maine landings have remained stable (Figure 3). There have also been significantly less overall lobster trips in recent years (Figure 4) making it challenging to project forward using information on bycatch- and catch-per-unit effort derived from historical activity of the fishery. It is expected that the lobster fishery will continue to evolve as it faces regulatory and ecosystem changes. There have also been changes in the distribution of the cod stock, notably the contraction of cod to areas of western Gulf of Maine and reduced prevalence in eastern Gulf of Maine.

With changes in both stocks and fisheries, the existing model is outdated and needs to incorporate the new and more recent data. The research track cod assessment did not have the time or capacity to develop an updated time series of discards from the lobster fishery. Estimating a time series of cod discards for inclusion in the stock assessment is most relevant for the Eastern Gulf of Maine cod stock assessment and is not a trivial process. The Peer Review Panel for the recent cod assessment identified this as a high priority and recommended that estimates of dead discards in the lobster fishery be addressed for integration into the management track process.

To support an updated analysis, the Commercial at-Sea Sampling Program data continues to be collected annually and the Maine landings data has experienced improved reporting through 100% harvester logbooks in 2023 with finer scale spatial data. It was recognized that, for this project to be a useful endeavor, an updated model would need to be developed in tandem with a formal workflow where new annual data could be integrated and easily updated with each Atlantic cod management track stock assessment.
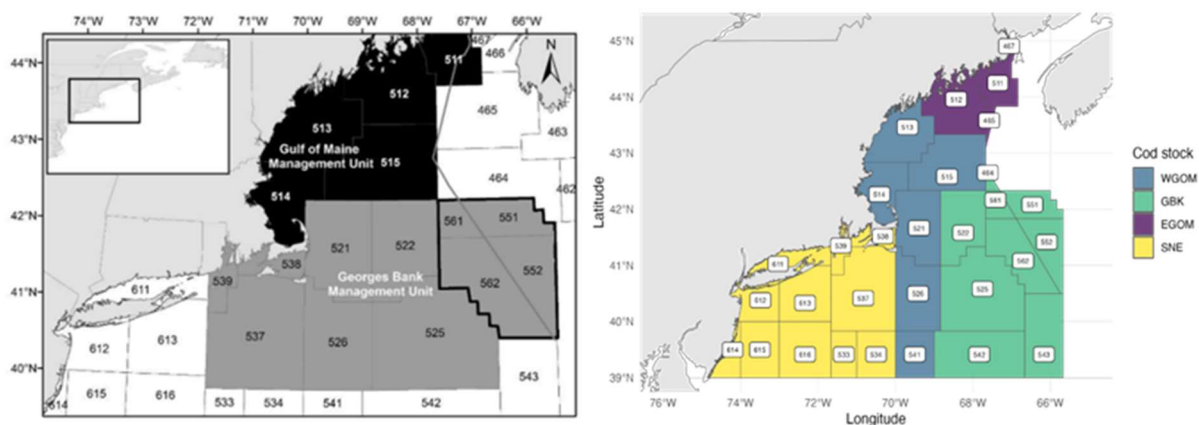

Figure 1. Current (left panel; Gulf of Maine and Georges Bank) and revised (right panel) spatial assessment units for Atlantic cod off New England (NOAA), including: 1) western Gulf of Maine (WGOM), 2) eastern Gulf of Maine (EGOM), 3) Georges Bank (GBK), and 4) southern New England (SNE: Map courtesy of Atlantic cod Research Track Working Group).
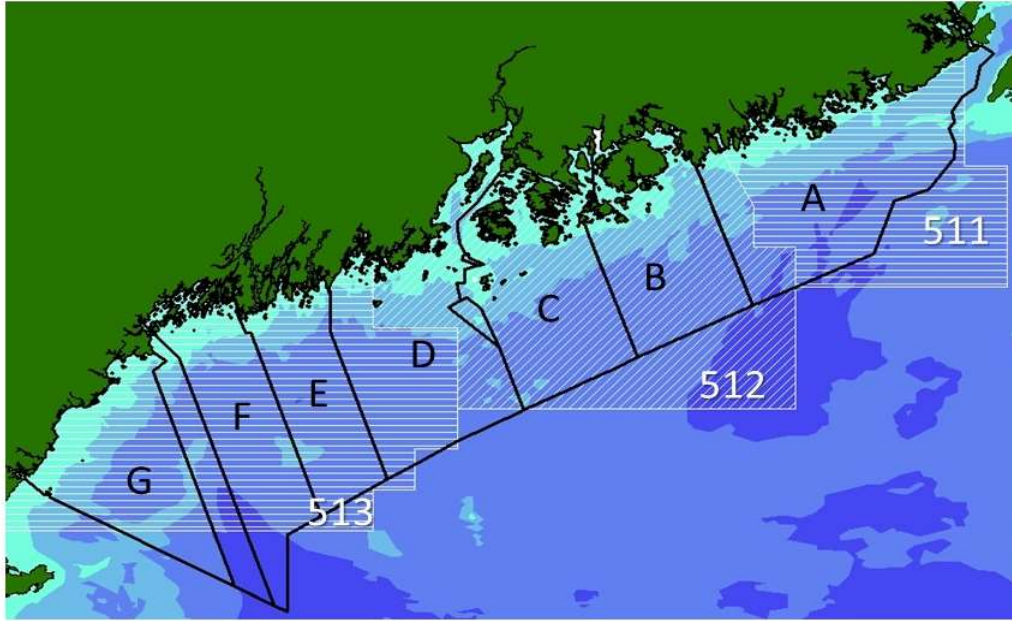
Figure 2. Map of Maine Lobster Management Zones (black outlines) and NMFS Statistical Areas (white outlines) along the Maine coast.
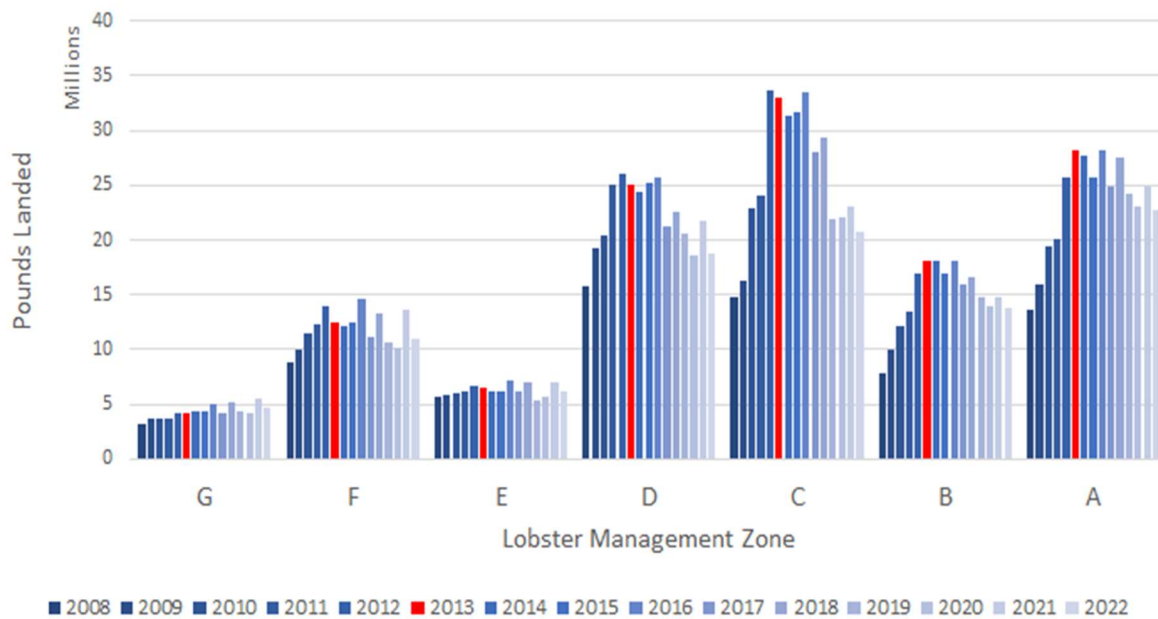

Figure 3. Maine lobster (*Homarus americanus*) landings by annual pounds (millions) landed per Lobster Management Zone (2008-2022). The year 2013 is marked as red to note this was the last year included in the Boenish and Chen 2018a and 2018b models.
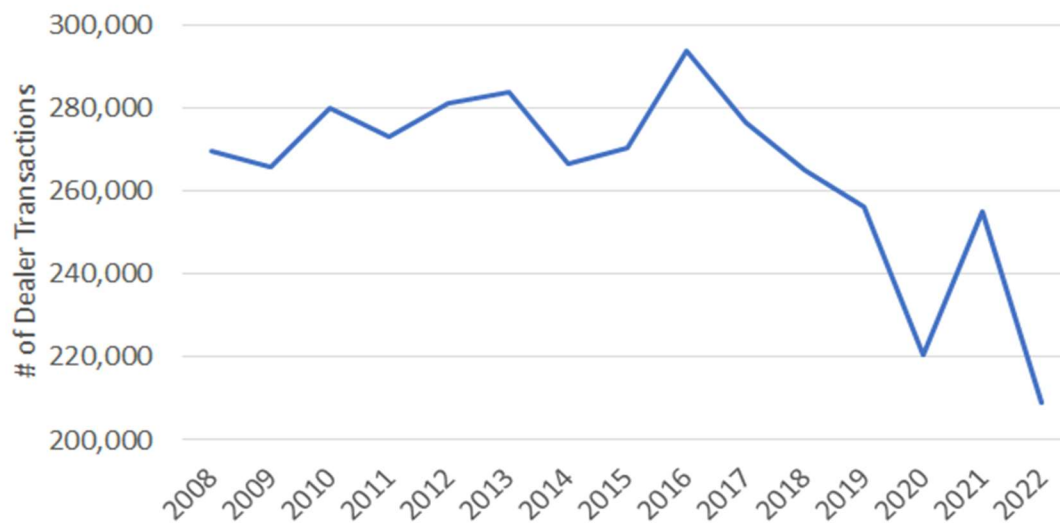
Figure 4. Number of dealer transactions reported to the ME DMR Landings Program as proxy of number of trips (2008-2022).

Results and Benefits:

We propose to update and expand on the work by Boenish and Chen 2018a, 2018b, 2020. Anticipated results and benefits of this work include:

- **Leverage current available data and enhance data utilization:** Utilization of lobster biological data and finfish discard data from the ME DMR Commercial At-Sea Sampling Program and lobster landings from the Maine Landings Program for NEFMC groundfish stock assessment. Maine lobster landings and lobster bio samples from At-Sea Sampling are uploaded and stored in ACCSP Data Warehouse.
- **Generation of new data stream**: Estimates of cod discards (total and dead discards) from the Maine lobster fishery over time and lobster management zones.
- **Improvement in model output timeliness:** Development of a workflow for data integration, processing, and discard estimation such that this time series can be easily updated and provided in a timely manner for use in future management track assessments for Atlantic cod.
- **Impact on stock assessment:** Incorporation of Atlantic cod discards from the lobster fishery into the new EGOM cod stock assessment and evaluation of relative importance of this source of mortality.
- **Collaboration between American lobster and Atlantic cod assessments: This proposal represents a new research initiative that will bring together the partners on this project who are in leadership roles in both assessment processes.** Both will disseminate the results with relevant research and management bodies at regional and national meetings to further engage these communities in this effort moving forward.

This proposed project will efficiently fill a data gap in the NEFSC Atlantic Cod Stock Assessment that has been a subject of uncertainty for multiple assessments using an established modeling approach, incorporating ACCSP landings data and commercial sea sampling data for a priority species and gear type as identified in the ACCSP RFP.

Data Delivery Plan:

This proposed project will leverage ==available== data in the ACCSP Data Warehouse to produce a new data product through updating and modifying previously developed models. The partners will meet on a monthly basis to continue progress on the project and provide semi-annual progress reports to ACCSP on the model developments. Ultimately, **the project will develop an operational model that can be run by ME DMR to integrate new lobster landings and cod bycatch data for the cod assessment process.** This model process and outcomes will be shared with the NEFMC Groundfish Plan Development Team and the ASMFC Lobster Technical Committee.

Approach:

This proposal will support a University of Maine masters level graduate student to expand this team's analytical capacity to use existing and continually collected Maine lobster fisheries dependent data to update models of estimated cod bycatch in the lobster fishery. To complete this work, an update is needed to estimate the effective catch per unit effort of lobster and the bycatch catch per unit of lobster effort of cod. **This proposal will leverage existing data from ACCSP to provide value added analyses and address RFP Priorities 1a. catch, effort and landings data (30%), 1b. biological data(30%), and 2. bycatch data (40%).**

Data

The ME DMR Commercial ==Lobster== At-Sea Sampling program began collecting at-sea catch/effort and biological information on legal and discarded lobsters from the near shore Maine lobster fishery in 1985. The sea sampling program was initiated at the request of industry, managers and scientists to gain insight into the discarded portion of the lobster population that supports the most economically important single-species fishery in Maine coastal waters. Since 1999, the program has been a standardized quota-based design where three sampling trips are scheduled to be completed for each management zone (A-G) in each month from May through November. Since 2006, winter sampling schedules one trip per statistical area per month December through April. Also, since 2006, the program has collected data on finfish bycatch observed in traps. The study area is defined by the Maine territorial sea and nearshore Federal Lobster Management Area 1 where the majority of annual landings are caught. All bio sample data collected by this program are submitted to the ACCSP Data Warehouse.

Historically, Maine's lobster landings were collected on a voluntary basis with dealers reporting monthly, while a subsample of effort data was collected through port and sea sampling programs. In 2004, Maine instituted mandatory monthly reporting at the dealer level. In 2008, Maine implemented a mandatory 100% Dealer Reporting Program at the trip level and 10% random selection of each Maine lobster license type in each of Maine's seven fishing zones for Maine's Harvester Logbook Program. In 2019, the selection for the Harvester Logbook Program became optimized for active harvesters and in 2023, 100% electronic harvester reporting was implemented. From 2008-2019, spatial information on harvester logbooks was reported by zone and distance from shore (0-3nm, 3-12nm and >12nm). Since 2020, spatial information has been reported by ten-minute degree square blocks. Lobster landings data are found in the ACCSP Data Warehouse.

Discard Estimation and Workflow Development

The Boenish and Chen (2018a and 2018b) studies used a delta generalized additive model (delta GAM) approach in each lobster management zone to standardize Atlantic Cod bycatch per unit effort (BCPUE, cod abundance/trap haul) and lobster CPUE (lobster kg/trap haul). The delta GAM approach models presence–absence separately from positive biomass. GAMs estimate relationships between independent and dependent variables by use of spline functions, allowing them flexibility to model relationships beyond the parametric forms common to generalized linear model (Wood 2017). Lobster landings were multiplied by the ratio of standardized catch rates (BCPUE/CPUE) to calculate discards in each month and year by lobster management zone. We will update the data used in this analysis and reexamine the model structure used in this study with the aim of updating and improving on this analysis.

We will develop a workflow that will be easy to deploy for future users and automate estimation of the cod discard time series as data updates are available and auto-generates desired data visualizations. The workflow will be formalized in a well-documented R script that works with standard data inputs.

Stock Assessment Modeling

We propose to evaluate the influence of cod discard estimates derived from spatio-temporal modeling of cod bycatch in the lobster fishery on the performance of the EGOM stock assessment and resulting information on EGOM Atlantic cod stock status. We will compare this assessment model to a fit of the stock assessment model without lobster fishery discard mortality. The EGOM cod assessment model is currently under development but is being fit with a state-space age-structured stock assessment model fit developed using the Woods Hole Assessment Model (WHAM; Miller and Stock 2020).

We will update the data that informs the EGOM stock assessment and conduct hypothesis testing using the assessment model to determine whether incorporation of discards from the lobster fishery improves model performance and changes that perception of the stock. Model comparisons will be based on a suite of assessment model diagnostics, including model convergence. In addition, biological realism of model outputs will be examined in conjunction with performance metrics.

Geographic Location:

The project will be administered through ME DMR and the work will be conducted collaboratively between ME DMR Kathleen Reardon, Lisa Kerr (UMaine), with a UMaine graduate student implementing the analyses.

Milestone Schedule:

Task	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Recruit graduate student	X	X										
Access and explore data		X	X	X								
Review prior model structure		X	X	X	X							
Develop and fit models				X	X	X	X	X	X			
Convert models to workflow									X	X	X	X
Document and synthesize results										X	X	X

Project Accomplishments Measurement:

Project Goals	Metrics
Estimation of Atlantic cod discards	● Data visualization and formatting for modeling ● Review prior model structure and code ● Develop and fit of models in R ● Visualization and synthesis of results
Development of a workflow for data processing and model estimation	● R code and documentation stored and publicly available in Github repository

Cost Summary (Budget):

BUDGET		TOTAL PROJECT COST
Contractual: **Subaward UMaine (*indirect waived)**		
Lisa Kerr	2 weeks salary	$6,869.00
	Fringe	$563.00
Graduate student	Full year salary	$30,000.00
	Tuition	$6,888.00
	Health Insurance	$2,905.00
	Travel	$675.00
	Fringe and F&A costs	$19,563.00
*	**Total Subaward**	$67,463.00
Administration Fee		
	5% on subaward	$3,373.15
*	**Total Admin Fee**	$3,373.15
Travel:		
Meals, lodging, mileage		$1,000.00
	Total Travel:	$1,000.00
	SUBTOTAL (indirect assessed)	**$1,000.00**
	SUBTOTAL (indirect waived)	**$70,836.15**
	Indirect (30%)	**$300.00**
	Requested Award	**$72,136.15**

ME DMR In Kind Partner Contribution				
Project PI	K. Reardon	072002282	Scientist IV (25% time)	$33,243
Landings Staff	R. Watts	072002431	Scientist III (15% time)	$19,990
	L. White, Jr	072002453	Scientist II (15% time)	$18,976
				$72,210

Budget Narrative

Subaward with the University of Maine

The work proposed in this proposal primarily supports a graduate student at the University of Maine. The contract will support a M.S. graduate student and will provide for 12 months of a graduate student stipend (12 months of M.S. support: $30,000). Support for graduate school tuition is requested (12 credits/ year * $574 credit =$ 6,888/year). Costs for student health insurance are estimated at $2,905. Requested travel funds include costs for the graduate student to attend and

present results at a regional meeting. Estimated travel costs for the meeting include hotel at $300 ($150 per night x 2 nights); meals at $225 ($75 per diem (meals and incidentals) x 3 days); other travel expenses at $150 (mileage reimbursed at UMaine's rate of $.46/mile).

Dr. Kerr is the senior University of Maine personnel and partner for this project. Dr. Kerr will direct the project activities and serve as the primary mentor for the graduate student. She will lead the synthesis of research and the write-up of results in reports. The request is for two weeks of summer salary ($6,869) plus the University of Maine fringe benefit rate for regular employees is 49.8% and 8.2% for temporary employees and faculty summer salary ($563). Fringe benefits do not apply to graduate students.

The total direct costs estimated for the subaward are $47,900 and the University of Maine's federally negotiated Fringe and F&A (indirect rates) of 47.7% per agreement dated 9/9/2022 modified total direct costs to a total of $67,463 for the subaward.

Administration Fee

The ME DMR waives indirect on subawards, but recognizing that contracts and subawards incur administration costs, an administration fee of 5% on the subaward is requested for a total of $3,373.15.

Travel

Travel funds are requested for PI Reardon to support travel for meetings with Dr. Kerr and the graduate student in addition to any regional meetings for a total estimated cost of $1000.

The data used in this proposal is provided by other programs at the ME DMR including the Commercial At-Sea Sampling Program and the ME DMR Landings Program. ME DMR is committed to continuing to collect these data and support multiple positions with State funds to do so. PI Reardon will be a direct lead on this project working with University of Maine's Dr. Kerr to collaborate, access and share the datasets, interpret the data, and complete the objectives. **The combination of partial salaries supporting this collaboration and ongoing data collection from PI Reardon and two senior level Landings Program Staff salaries provide Partner in-kind contributions of $72,210 to support this effort**. The ME DMR has an indirect cost rate of 34.3%; however, the Commissioner has authorized this proposal to use the lower rate of 30%. The ME DMR will apply 30% indirect on all granted funds except for subawards and administration fee. The requested total award including the subtotal of ME DMR direct costs ($1000), subaward costs ($67,463), administration fee ($3,373.15) and indirect ($300) is $72,136.15.

Maintenance Projects:
This is a new project, but, if awarded, **we anticipate requesting an additional year of funding to support the identified graduate student as a maintenance project. The current proposal is focused on year one as lobster effort and bycatch time series development and year 2 would be assessment modeling.**

Principal Investigator:
Kathleen Reardon is ME DMR's lead lobster fishery scientist overseeing the lobster monitoring programs and interpretation of the State's landings data. She has more than 20 years of experience working directly with the Maine lobster fishery and is the chair of the ASMFC Lobster Technical

Committee and member of the Lobster Stock Assessment Subcommittee. In addition to providing and interpreting these fishery data, she will work directly with Dr. Lisa Kerr at the University of Maine to co-advise the graduate student working on this project. She will also disseminate the results of this work to these groups as well as industry members at the Maine Fishermen's Forum and other targeted industry events.

Collaborator:
Dr. Lisa Kerr is an Associate Professor at University of Maine and the lead collaborating partner on this project. She is an expert in population dynamics and assessment modeling. She is actively involved in the regional fishery assessment and management process (Chair of Atlantic Cod Research Track Stock Assessment Working Group and Chair of the NEFMC Scientific and Statistical Committee). She will lead the team, coordinate project activities, arrange project team meetings, and track progress of project deliverables. She will supervise a UMaine graduate student researcher focused on modeling cod bycatch and integration into the EGOM stock assessment.

Consulting Partner:
Dr. Yong Chen is a Professor at the School of Marine and Atmospheric Sciences at Stony Brook University. He is actively involved in regional management and assessment processes with ASMFC and NEFSC and other management bodies world-wide. As a co-author on the papers describing the models for lobster effort and cod discard estimation, he will be a consulting partner on this project to update the previous work.

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Summary of Proposal for ACCSP Ranking

Applicant Name: Maine Department of Marine Resources (Kathleen Reardon)

Project Title: FY24: Characterizing Atlantic Cod Discards in the Maine Lobster Fishery for use in Cod Stock Assessment

Project Type: New project

Requested Award Amount: $72,136.15

ACCSP Goals and Modules:
   1a. Catch, effort, and landings data (0-10 points)
   1b. Biological Data (0-10 points)
   2. Releases, discards, and protected species data (0-6 points)
This proposal will leverage existing data from ACCSP to provide value added analyses and address RFP Priorities 1a. catch, effort and landings data (30%), 1b. biological data (30%), and 2. bycatch data (40%). This project is not proposing to collect new datasets, but instead use existing data to develop models estimating bycatch that will enhance the utilization of the lobster data for cod assessment. American lobster is in the top 25% of the ACCSP Biological Review Matrix of priorities and bycatch in American lobster traps ranks second in the ACCSP Priority Bycatch Matrix of priorities.

Data Delivery Plan (+2 points):
 This proposed project will leverage available data in the ACCSP Data Warehouse to produce a new data product through updating and modifying previously developed models.

Project Quality Factors:

Multipartner/Regional Impact (0-5 points): This project represents a collaboration between Maine DMR and University of Maine with PIs who serve as the Chair of the ASMFC Lobster Technical Committee and Chair of Atlantic Cod Research Track Stock Assessment Working Group and Chair of the NEFMC Scientific and Statistical Committee, respectively. The anticipated outputs of this project would provide the recommended updated time series of estimated cod discards from the Maine lobster fishery requested by the NEFMC Atlantic Cod Assessment process.

Contains funding transition plan / Defined end-point (0-4 points): This project aims to support a graduate masters student to be completed as a two year project.

In-kind contribution (0-4 points): The combination of partial salaries supporting this collaboration and ongoing data collection from PI Reardon and two senior level Landings Program Staff salaries provide Partner in-kind contributions of $72,210 to support this effort. The full proposal request is $72,136.15.

Improvement in data quality/quantity/timeliness (0-4 points): This project will develop an operational model of cod discards from the lobster fishery that can be run by ME DMR to integrate new lobster landings and cod bycatch data for future cod assessment processes.

Impact on stock assessment (0-3 points): The objective of this project is directly related to improved Atlantic cod Assessment to account for uncertain mortality, especially in eastern Maine. Due to the large scale of the lobster fishery and the multiple changes in the last decade within the fishery, estimating cod discards from the lobster fishery with outdated models could compound the numbers inappropriately and have impacts to future lobster management.

Other Factors:

Innovative (0-3 points): While this project is an update of previously developed models, the proposal to integrate and leverage recently improved landings data and make this process operational to incorporate into cod assessments directly will be new. This proposal represents a new research initiative and collaboration that will bring together the partners on this project who are in leadership roles in both species assessment processes.

Properly Prepared (-1 - +1): MEDMR followed ACCSP guidelines and pertinent documents when preparing this proposal.

Merit (0-3 points): The updated development of models to estimate cod discards from the Maine lobster fishery is a recognized and recommended need to address increasing concern about the interaction between cod and lobster trap effort. This project will update the models and operationalize them to incorporate future data for future assessments. ACCSP holds the fisheries dependent lobster landings and biological data needed for this project.

KATHLEEN M. REARDON

CONTACT
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Harbor, Maine 04575. (207)-350-7440. Kathleen.Reardon@maine.gov

EDUCATION
M.S. Marine Biology, University of Maine, School of Marine Science. Orono, ME. 2006.
M.S. Marine Policy, University of Maine, School of Marine Science. Orono, ME. 2006.
B.A. Biology and Environmental Studies, Williams College. Williamstown, MA. 2000.

EMPLOYMENT
Maine Department of Marine Resources. Lead Lobster Fishery Biologist. March 2015 – current.
Maine Department of Marine Resources. Lobster Monitoring Coordinator. April 2005 – March
2015.
University of Maine. Graduate Research Assistant. Laboratory of Yong Chen. 2003 – April 2005.
Island Institute. GIS Specialist/Marine Resources Associate. October 2002 – January 2004.
Island Institute Fellowship Program. Islesboro Island Fellow. October 2000 – September 2002.

BOARDS AND COMMITTEES
ASMFC Lobster Technical Committee member, TC Chair, September 2016 – current.
ASMFC Lobster Stock Assessment Subcommittee member, March 2015 – current.
ASMFC Plan Review Team member for Lobster and Jonah crab, September 2015 – current.
ASMFC Jonah Crab Technical Committee member, September 2020 – current.
ASMFC Jonah Crab Stock Assessment Subcommittee member, September 2020 – current.
Lobster Institute Board Member, March 2015 – current.

PUBLICATIONS
2022. Mazur, M.D., Tanaka, K.R., Shank, B., Chang, J., Hodgdon, C.T., Reardon, K.M., Friedland, K.D.,
& Chen, Y. Incorporating spatial heterogeneity and environmental impacts into stock-
recruitment relationships for Gulf of Maine lobster. ICES Journal of Marine Science, 79 (2): 362-
372. https://doi.org/10.1093/icesjms/fsab266
2021. McManus, M.C., Kipp, J., Shank, B., Reardon, K., Pugh, T.L., Carloni, J., & McKown, K. A model-
based approach to standardizing American lobster (*Homarus americanus*) ventless trap
abundance indices. Fisheries Research. 238: 105899.
https://doi.org/10.1016/j.fishres.2021.105899
2021. Waller, J.D., Reardon, K.M., Caron, S.E., Jenner, B.P., Summers, E.L. & Wilson, C.J. A
comparison of the size at maturity of female American lobsters (*Homarus americanus*) over
three decades and across coastal areas of the Gulf of Maine using ovarian staging. ICES Journal
of Marine Science, 78(4): 1267-1277. https://doi.org/10.1093/icesjms/fsab034
2021. Stoll, J.S., Oldach, E.J., Witkin, T., Reardon, K.M., Love, D.C., & Pinto da Silva, P. Rapid
adaptation to crisis events: Insights from the bait crisis in the Maine lobster fishery. Ambio, 51:
926-942.
2020. Boenish, R., Willard, D. Kritzer, J.P., & Reardon, K. 2020. Fisheries monitoring: Perspectives
from the United States. Aquaculture and Fisheries, 5(3):131-138.
https://doi.org/10.1016/j.aaf.2019.10.002

2019. Li, B., Chen, Y., Reardon, K., & Wilson, C. 2019. A simulation-based evaluation of sea sampling design for American lobster in the Gulf of Maine. Fisheries Research, 216: 145-154.

2019. Waller, J.D., Reardon, K.M., Caron, S.E., Masters, H.M., Summers, E.L. & Wilson, C.J., Decrease in size at maturity of female American lobsters *Homarus americanus* (H. Milne Edwards, 1837) (Decapoda: Astacidea: Nephropidae) over a 50-year period in Maine, USA. Journal of Crustacean Biology, 39(4): 509-515.

2018. Reardon, K., Wilson, C., Gillevet, P., Sikaroodi, M., & Shields J. Increasing prevalence of epizootic shell disease in American lobster from the nearshore Gulf of Maine. Bull Mar Sci., 94(3):903–921. https://doi.org/10.5343/bms.2017.1144

2017. Le Bris, A., Pershing, A.J., Gaudette, J., Pugh, T.L., & Reardon, K. Multi-scale quantification of the effects of temperature on size at maturity in the American lobster (*Homarus americanus*). Fisheries Research, 186: 397-406.

MEETING PRESENTATIONS

Reardon, K., Russell, R., Peters, R., Glon, H., and Waller, J. DMR Lobster Monitoring Programs. Sea Grant American Lobster Initiative Research Summit. Portland, ME. February 2023.

Reardon, K., Russell, R., Peters, R., Davis, M., and Waller, J. Tracking lobster settlement signal through pre recruit monitoring surveys. Regional Association for Research on the Gulf of Maine Annual Meeting. November 2021.

Reardon, K., Wilson, C., and Shank B. Potential impacts on conservation discards in a growing lobster population in the Gulf of Maine. 11th International Workshop on Lobster Biology and Management. Portland, Maine. June 2017.

Reardon, K. and Wilson, C. Characteristics of recent increases of epizootic shell disease in the American Lobster for the inshore Gulf of Maine. 11th International Workshop on Lobster Biology and Management. Portland, Maine. June 2017.

Reardon, K., Wilson, C., Chang, J., and Chen, Y. Impacts of V-notching on the assessment and management of American lobster stock in the Gulf of Maine. The American Lobster in a Changing Ecosystem: A US-Canada Science Symposium. Portland, Maine. November 2012.

Reardon, K. Maine's Commercial Lobster Sea Sampling Program. 6th International Fisheries Observer & Monitoring Conference. Portland, Maine. July 2009.

Reardon, K., Wilson, C., and McCarron, P. Conservation Cornerstone: V-notching in the Maine Lobster Fishery 1985-2006. 8th International Conference & Workshop on Lobster Biology and Management. Charlottetown, PEI, Canada. September 2007.

Lisa A. Kerr

University of Maine, 350 Commercial Street, Portland, ME 04101, lisa.kerr1@umaine.edu

Professional preparation

Tufts University	Biology	B.S., 1997
Moss Landing Marine Laboratories	Marine Science	M.S., 2003
University of Maryland,	Marine Science	Ph.D., 2008
University of Massachusetts Dartmouth	Stock Assessment	Post-doc, 2012

Appointments

Associate Professor, University of Maine School of Marine Science, 2022-present.
Research Scientist, Gulf of Maine Research Institute, 2012-2022.
Adjunct Graduate Faculty, University of Maine, School of Marine Sciences, 2012-present.
Adjunct Graduate Faculty, University of Massachusetts Dartmouth, 2012-present.
Post-doctoral Researcher, University of Massachusetts Dartmouth, 2008-2012.

Publications in last three years

Mazur, M.,…, **Kerr, L.** 2023. Consequences of ignoring climate impacts on New England groundfish stock assessment and management. Fish. Res. DOI:10.1016/j.fishres.2023.106652

Tanaka, K., **Kerr, L.**, Pershing, A. 2023. Implications of Fisheries Allocation Policy on Anticipated Climate Change Impacts. Accepted in Marine Policy. DOI: 10.1016/j.marpol.2022.105402

Kerr, L.A., Barajas,. M., Weidenmann, J. 2022. Coherence and potential drivers of stock assessment uncertainty in Northeast US groundfish stocks. ICES J. Mar. Sci. DOI: 10.1093/icesjms/fsac140

Hansell, A., Becker S, Cadrin, S., Lauretta, M., Walter, J., **Kerr, L.** 2022. Spatio-temporal dynamics of bluefin tuna in US waters of the northwest Atlantic. Fish. Res. 255. DOI: 10.1016/j.fishres.2022.106460

Kerr, L.A, et al. 2020. Mixed stock origin of Atlantic bluefin tuna in the U.S. rod and reel fishery (Gulf of Maine) and implications for fisheries management. Fish. Res. 224. DOI: 10.1016/j.fishres.2019.105461

Morse, M.R., **Kerr, L.A**., et al. 2020. Performance of stock assessments for mixed-population fisheries: the illustrative case of Atlantic bluefin tuna. ICES J. Mar. Sci. DOI: 10.1093/icesjms/fsaa082

Cadrin, S.X., …, **Kerr, L. A.** 2019. "So, where do you come from?" the impact of assumed spatial population structure on estimates of recruitment. Fish. Res. DOI: 10.1016/j.fishres.2018.11.030

Clucas, G., **Kerr, L.A.,** et al. 2019. Adaptive Genetic Variation Underlies Biocomplexity of Atlantic Cod in the Gulf of Maine and on Georges Bank. PLOS ONE. DOI: 10.1371/journal.pone.0216992

Guan, L., …, **Kerr, L.,** Shan, X. 2019. The influence of spatially variable and connected recruitment on complex stock dynamics ... Can. J. Fish. Aquat. Sci. DOI: 10.1139/cjfas-2018-0151

Kerr, L.A., et al. 2019. Strengths and limitations of Before-After-Control-Impact analysis for testing the effects of marine protected areas on managed populations. ICES J. Mar. Sci. DOI: 10.1093/icesjms/fsz014

Five Additional Papers

Kerr, L.A., et al. 2017. Modeling the implications of stock mixing and life history uncertainty of Atlantic bluefin tuna. Can. J. Fish. Aquat. Sci. DOI: 10.1139/cjfas-2016-0067

Pershing, A.J., …**Kerr, L.A**., et al. 2015. Slow adaptation in the face of rapid warming leads to the collapse of Atlantic cod in the Gulf of Maine. Science. DOI: 10.1126/science.aac9819

Kerr, L.A., et al. 2014. Consequences of a mismatch between biological and management units of Atlantic cod off New England. ICES J. Mar. Sci. DOI:10.1093/icesjms/fsu113

Kerr, L.A., et al. 2014. Simulation modeling as a tool for synthesis of stock identification information. In: Stock Identification Methods. 2nd Ed. Elsevier. 566 pp.

Kerr, L.A., et al. 2010. Simulation modeling as a tool for examining the consequences of spatial structure and connectivity to local and regional population dynamics. ICES J. Mar. Sci. 67(8): 1631–1639.

Synergistic Activities

1. I am actively involved in regional and international fisheries management issues. I serve as Chair of the Science and Statistical Committee for the New England Fisheries Management Council (2017-present), member of the ICES Stock Identification Working Group (2013-present), and as a U.S. Delegate to the International Commission for the Conservation of Atlantic Tunas (2015-present).

2. I have developed population models and applied simulation techniques to a range of species, including Atlantic bluefin tuna, Atlantic cod, Atlantic herring, white perch, and alewife, to understand how fishery resources respond to climate variability and change, fishing, complex population structure, and alternative management strategies. My work has been presented to national and international fisheries management and scientific advisement organizations (NEFMC, ICAAT and ICES).

3. I am committed to communicating science. I have published more than 50 peer-reviewed journal publications, 45 reports, and 5 book chapters.

4. I have contributed to education and outreach activities. I currently advise three postdoctoral researchers and serve as a committee member for several M.S. and Ph.D. candidates. I mentor undergraduates each year through the GMRI's NSF Research Experience for Undergraduates Program (2013-present). I am also actively involved in outreach to the fishing industry and the general public.

Biosketch/CV for Yong Chen

Contact Information
>**Address**: Dana Hall, School of Marine and Atmospheric Sciences, Stony Brook University, NY
>Tel: 631-632-3187; email: yong.chen.2@stonybrook.edu

A. Education

Degree	Year	Major	Institution
Bachelor of Agric.	1983	Fisheries Sciences	Ocean Univ. of China
Master of Science	1991	Zoology (Fish Ecology)	University of Toronto, Canada
Doctor of Philosophy	1995	Zoology (Fish. Pop. Dynam.) **Minor** in Statistics	University of Toronto, Canada

B. Appointments

Sept. 1 2021- Present	Professor	Stony Brook University
Sept. 2007 – Aug. 2021	Professor	University of Maine
Sept. 2003 – Aug. 2007	Associate Professor	University of Maine
July 2000 – Aug. 2003	Assistant Professor	University of Maine
May 2001 – present	Adjunct Professor in Biology	Memorial University
July 1997 – June 2000	Assistant Professor	Memorial University of
	NSERCAssociate Chair in Fish. Conserv.	Newfoundland, Canada
May 1996 – July 1997	Senior Population dynamicist	NSW Fisheries, Australia
Jan. 1995 – May 1996	Fisheries Population Dynamicist	NSW Fisheries, Australia

NSW=New South Wales, NSERC =Natural Science and Engineering Research Council of Canada

C. Publications

*C.1. Some relevant publications (names with * are my students or postdoc)*

Chen, Y. 2017. Fish Resources of the Gulf of Mexico. In book: Habitats and Biota of the Gulf of Mexico: Before the Deepwater Horizon Oil Spill, pp.869-1038. C.H.Ward (ed)

*Cao, J., **Y. Chen**, *J. Chang, X. Chen. 2014. An evaluation of an inshore bottom trawl survey design for American lobster (*Homarus americanus*) using computer simulations. Journal of North Atlantic Fisheries Science 46: 27–39

*Li, B., *J. Cao, *J. Chang, C. Wilson, **Y. Chen.** 2015. Evaluation of effectiveness of fixed-station sampling for monitoring American Lobster settlement. North American Journal of Fisheries Management 35(5): 942-957

*Boenish, R. and **Y. Chen**. 2018. Spatio-temporal dynamics of effective fishing effort in American lobster (*Homarus americanus*) fishery along the coast of Gulf of Maine. Fisheries Research *199*: 231-241. https://doi.org/10.1016/j.fishres.2017.11.001

*Boenish, R. and **Y. Chen**. 2018. A standardized quasi-stationary approach to estimating Atlantic Cod (*Gadus morhua*) bycatch in the Maine American Lobster (*Homarus americanus*) trap fishery. North American Journal of Fisheries Management *38*(1): 3-17 (***Editor's Choice***)

*Boenish, R. and **Y. Chen**. 2020. Re-evaluating Atlantic cod mortality including lobster bycatch: where could we be today? *Canadian Journal of Fisheries and Aquatic Sciences DOI: 10.1139/cjfas-2019-0313*

*Li, Z., Z. Ye, R. Wan, *K. Tanaka, *R. Boenish, **Y. Chen**. 2018. Density-independent and density-dependent factors affecting spatio-temporal dynamics of Atlantic cod (*Gadus morhua*) distribution in Gulf of Maine. ICES Journal of Marine Sciences *75*(4): 1329-1340.

*Guan, L., Y. Chen, J. Wilson. 2017. Evaluating spatio-temporal variability in the habitat quality of Atlantic cod (*Gadus morhua*) in the Gulf of Maine. Fish. Oceanography 26: 83-96

*Tanaka, K. R., J-H. Chang, Y. Xue, *Z. Li, L. Jacobson, and **Y. Chen**. 2019. Mesoscale climatic impacts on abundance of *Homarus americanus* in the US inshore Gulf of Maine. Canadian Journal of Fisheries and Aquatic Sciences https://doi.org/10.1139/cjfas-2018-0075

Chen, Y., *M. Kanaiwa, and C. Wilson. 2005. Developing a Bayesian stock assessment framework for the American lobster fishery in the Gulf of Maine. New Zealand Journal of Freshwater and Marine Sciences (Special issue on Lobster Biology and Management) 39:645-660

Le Bris, A., K. E. Mills, R. A. Wahle, **Y. Chen**, M. A. Alexander, A. J. Allyn, J. G. Schuetz, J. D. Scott, A. J. Pershing. 2018. Climate vulnerability and resilience in the most valuable North American fishery. Proc. of the National Academy of Sciences 115(8):1831-1836

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

D. Synergistic Activity

(1) PI and Curator, Historical HRBMP Database and Biological Collections gifted to Stony Brook University.

(2) **Editor-in-Chief**, Canadian Journal of Fisheries and Aquatic Sciences (2013 – present);

(3) **Member**, New England Fisheries Management Council Scientific and Statistical Committee (SSC) (2011- present);

(4) **Member**, NOAA Atlantic Scientific Review Group (ASGR) (2020 – present)

(5) **Authored/co-authored over 300+ original research articles** on peer-reviewed journals since 1992, and completed or currently conducting over **95** funded research projects since 1997;

(6) Center for Independent Experts (CIE) reviewer to review NOAA fisheries stock assessment reports;

(7) Reviewed papers for 20+ peer-reviewed journals and grant proposals for NSF, NSERC, NSF of China, Sea Grant programs, and other funding agencies, and reviewed fisheries as an independent reviewer for ASMFC, Maine DMR, Omani Ministry of Fisheries, etc.;

(8) Taught graduate and undergraduate courses in fisheries sciences (SMS 321), fisheries population dynamics (SMS 562), spatial statistics (SMS 598, SMS 599), applied multivariate statistics (SMS 598, SMS599), general statistics (STAT 2500) and quantitative methods in fisheries (MMS 6002 at Memorial University), fisheries stock assessment (MAR 600), and Ecosystem science for fisheries (MAR 386)

(9) Advised 40+ graduate students. Currently advise 5 PhD and 5 MS students, 3 postdoc, 1 fulltime professional staff, and 2 visiting PhD students

E. The PI's Graduate Advisors

MS Advisor: Dr. H. H. Harvey (Univ. of Toronto, Canada),
Ph.D Advisor: Dr. J. E. Paloheimo (Univ. of Toronto, Canada)

F. Collaborators in the last 5 years

Carl Wilson, Kathleen Reardon, Kevin Staples, Mike Kersula and Erin Summers (Maine DMR); Ann Richards, Burton Shank, Dvora Hart, Kevin Friedland, Bai Li, Kisei Tanaka, and Jui-han Chang (NOAA Fisheries); Andy Pershing, Lisa Kerr, Kathy Mills, Mackenzie Mazur (GMRI), Sam Truesdell (MA DMF); Kristin Kleisner, Jake Kritzer and Robert Boenish (EDF); Sarah Chasis and Lisa Suatoni (NRDC); Jocelyn Runnebaum (TNC), Jeff Kipp and Katie Drew (ASMFC); Jie Cao (NCSU); Yuying Zhang (FL International Univ); Mike Torre (NOAA NWFSC); Tang Yi, Tian Siquan, Shu Su and Chen Xinjun (Shanghai Ocean University); Chonglian Zhang and Ren Yiping (Ocean University of China), Abdulaziz Al-Marzouqi (Omani Ministry of Agriculture & Fisheries); Keith Evans, Teresa Johnson, Rick Wahle, Andy Thomas, Christine Beitl, and Dave Townsend (UM), John Maniscalco, Gregg Kenney and Kim McKown (NYSDEC), Mackenzie Muzer and Adam Cook (Canadian DFO)