

# Assessment and Management of American Lobster Fisheries

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## Development of a user-friendly stock assessment model for the American lobster

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## Abstract

The American lobster (*Homarus americanus*) supports one of the most valuable commercial fisheries in the United States. A Bayesian size-structured stock assessment model has recently been developed. The model is sex-specific and uses season as time step. It can generate estimates of various key fisheries parameters such as legal biomass, fishing mortality, and recruitment and their associated uncertainty, and can also project the dynamics of the lobster population under different levels of catch or fishing mortality. The model has been tested extensively and adopted by the Atlantic States Marine Fisheries Commission for the assessment of American lobster in the northeastern United States. As a model of high complexity, this new model requires a large amount of input data and generates a large quantity of outputs, which becomes an obstacle for the model being used by biologists and managers. In an attempt to overcome this problem, we design and develop a user-friendly version of the

model and test its performance. We apply the user-friendly model to assess the lobster stock in the Gulf of Maine. This new software provides a new tool to lobster biologists and managers in their assessment of lobster population dynamic.

## **Developing and evaluating biological reference points for the American lobster fishery management**

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### **Abstract**

The American lobster (*Homarus americanus*) supports one of the most valuable commercial fisheries in the United States. There is a great controversy in the biological reference point (BRP) used in assessing the lobster stock status over the last two decades. The status of the lobster stock determined based on the current BRP  $F_{10\%}$  is considered inconsistent with reality of the lobster fishery in the Gulf of Maine (GOM), calling for the evaluation of the current BRP and development of new BRPs. In this study we simulate a lobster fishery based on the data collected from the GOM lobster fishery from 1981 to 2003 and apply different BRPs in managing the simulated fishery. The BRPs considered in the evaluation include biomass-based and fishing mortality-based BRPs, and survey abundance index-based and fishery CPUE-based references points. Different scenarios are considered in the simulation, including the length of testing period (5 and 25 years), temporal variations in recruitment, natural mortality, growth rates, and gear selectivity. We then compare the performance of different BRPs in managing the simulated lobster fisheries, and identify the effectiveness of each BRP in managing the GOM lobster stock.

## **Modeling ecosystem dynamics for American lobster (*Homarus americanus*) in the Gulf of Maine**

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### SEA GRANT PROJECT SUMMARY FORM

(1) INSTITUTION:	UM Sea Grant Program		(1a) ICODE:	2300	
(2) PROJECT TITLE:	Modeling ecosystem dynamics for American lobster ( <i>Homarus americanus</i> ) in the Gulf of Maine				
(3) PROJECT NUMBER:	(Office Use Only)		(4) REVISION DATE:	(Office Use Only)	
(5) PROJECT STATUS:	New		(6) INITIATION DATE:	2/1/08	
			(7) COMPLETION DATE:	1/31/10	
(8) SUB PROGRAM:	(Office Use Only)				
(9) PRINCIPAL INVESTIGATOR:	Yong Chen				
(9a) EFFORT: (in months)	Year One:	3	Year Two:	3	Total: 6
(9b) AFFILIATION:	School of Marine Sciences, University of Maine				
(9c) AFFILIATION CODE:	(Office Use Only)				
(10) CO-PRINCIPAL INVESTIGATOR:	Carl Wilson				
(10a) EFFORT: (in months)	Year One:	1	Year Two:	1	Total: 2
(10b) AFFILIATION:	Maine Department of Marine Resources				
(10c) AFFILIATION CODE:	(Office Use Only)				
(13) SEA GRANT FUNDS:			(14) NON-FEDERAL MATCHING FUNDS:		
YEAR ONE:	\$67439	YEAR ONE:		\$34390	
YEAR TWO (if applicable):	\$67941	YEAR TWO (if applicable):		\$36110	
TOTAL:	\$135380	TOTAL:		\$70500	
(15) LAST YR'S SG FUNDS:			(16) LAST YR'S MATCHING FUNDS:		
(17) PASS-THRU FUNDS:			(18) LAST YR'S PASS-THRU FUNDS:		
(19) RELATED PROJECTS:					
(20) PARENT PROJECTS:					
(21) SEA GRANT STRATEGIC PLAN CLASSIFICATION* (see below):					
Key Words* (limit to 10):	American lobster, Gulf of Maine, ecosystem dynamics, groundfish, ecosystem modeling, ecosystem-based management				

**(22) OBJECTIVES:** The objectives of this proposed project are to develop and parameterize an ecosystem model to quantify the ecosystem dynamics for American lobster in GOM and to use the estimated model to forecast the ecosystem- and population-level consequences of various fisheries management alternatives. Two hypotheses will be tested: (1) if lobster population dynamics are influenced by the population dynamics of other species (e.g., groundfish species) in the ecosystem, and thus changes in the management strategy for other species may affect lobster population dynamics and vice versa; and (2) if lobster population dynamics are influenced by discarded herring baits used in the lobster fishery.

**(23) METHODOLOGY:** We will develop and fine-tune an ecosystem dynamic model (Ecosim) capable of quantifying the ecosystem dynamics for the GOM lobster ecosystem from 1980 to 2006 to elucidate the status and functioning of this ecosystem. We will develop ecosystem and population level predictions to forecast the outcomes of different management scenarios. We will explicitly include climate as a factor used to “tune” the model and standardize data. Finally, we will use the proposed model to evaluate the impacts of a possible recovery of groundfish species and the use of artificial baits on the lobster fishery in the Gulf of Maine.

**(24) RATIONALE:** This study can address many important questions that we are currently unable to answer in the assessment and management of lobster and other species in the Gulf of Maine. The model developed and data collected and compiled will become an effective tool in assessing how organisms in the GOM ecosystem may respond to proposed management plans and help focus information exchange at the science/policy interface. The ecological forecasts derived can help fisheries managers better understand their options and the likely effects of their decisions and help identify the data, information, and predictions with the most significant ecological, economic, and policy implications. The results will have significant impact on the development and implementation of an ecosystem-based assessment and management for the American lobster and other fish species in the Gulf of Maine. The extensive involvement of PIs in the lobster stock assessment and management with state and federal agencies will ensure the use of the results derived in this study in the lobster stock assessment and management.

**A comparative study of different monitoring programs for coherence in  
quantifying the dynamics of American lobster fisheries in the state of  
Maine**

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## SEA GRANT PROJECT SUMMARY FORM

(1) INSTITUTION:	UM Sea Grant Program	(1a) ICODE:	2300
(2) PROJECT TITLE:	A comparative study of different monitoring programs for coherence in quantifying the dynamics of American lobster fisheries in the state of Maine		
(3) PROJECT NUMBER:	(Office Use Only)	(4) REVISION DATE:	(Office Use Only)
(5) PROJECT STATUS:	New	(6) INITIATION DATE:	2/1/10
		(7) COMPLETION DATE:	1/31/12
(8) SUB PROGRAM:	(Office Use Only)		
(9) PRINCIPAL INVESTIGATOR:	Yong Chen		
(9a) EFFORT: (in months)	Year One:	2.75	Year Two: 2.5 Total: 5.25
(9b) AFFILIATION:	School of Marine Sciences, University of Maine		
(9c) AFFILIATION CODE:	(Office Use Only)		
(10) CO-PRINCIPAL INVESTIGATOR:	Carl Wilson		
(10a) EFFORT: (in months)	Year One:	0.5	Year Two: 0.5 Total: 1
(10b) AFFILIATION:	Maine Department of Marine Resources		
(10c) AFFILIATION CODE:	(Office Use Only)		
(13) SEA GRANT FUNDS:		(14) NON-FEDERAL? MATCHING FUNDS:	
YEAR ONE:	\$65,593	YEAR ONE:	\$35,043
YEAR TWO (if applicable):	\$63,775	YEAR TWO (if applicable):	\$31,542
TOTAL:	\$129,368	TOTAL:	\$66,585
(15) LAST YR'S SG FUNDS:		(16) LAST YR'S MATCHING FUNDS:	
(17) PASS-THRU FUNDS:		(18) LAST YR'S PASS-THRU FUNDS:	
(21) SEA GRANT STRATEGIC PLAN CLASSIFICATION* (see below):			
Key Words* (limit to 10):		American lobster, monitoring program, comparative study, optimal sampling design	

**(22) OBJECTIVES:** The overall scientific hypothesis we want to test is that the Maine DMR monitoring programs are coherent in quantifying the temporal and spatial variability of the American lobster stock and fishery along the coast of Maine. Three more specific objectives of this study are to (I) evaluate the design of the four key monitoring programs (port sampling, sea sampling, harvester reporting program and inshore bottom trawl survey) for their effectiveness in sampling the lobster fishery and population; (II) develop analytical approaches consistent with the sampling program designs to estimate mean and variance of key lobster population and fisheries statistics for all the nine programs; and (III) compare the relevant monitoring programs for coherence in quantifying the dynamics of lobster fishery.

**(23) METHODOLOGY:** This study will include the following nine monitoring programs, port sampling, sea sampling, dealer reporting, harvester reporting, inshore bottom trawl survey, juvenile monitoring program, lobster settlement index program, regional ventless trap survey, and volunteer ventless trap survey. Computer simulation studies will be conducted to evaluate the effectiveness of current design and sampling efforts in quantifying the lobster fishery. Statistical methods and relevant computer programs will be developed to analyze the data for each program. Statistical comparison will be conducted to compare different monitoring sampling programs in their quantification of lobster landings, size structure, at-sea discards, sex ratio, and other key lobster population and fishery statistics.

**(24) RATIONALE:** Quantitative fisheries assessment plays central roles in fisheries management. The quality of stock assessment can determine if fisheries management is successful in achieving its management goals. Two of the most important factors influencing the quality of stock assessment are quality and quantity of fisheries data collected in fisheries-dependent and fisheries-independent sampling programs. Thus, sampling programs form the foundation of fisheries stock assessment and management. Nine sampling programs have been developed for collecting data on the lobster fisheries and population in Maine. These programs vary greatly in their history, design, data collected, temporal and spatial scales of data collection, costs, utility of the data collected and their impacts on the lobster stock assessment and management. These programs also share some similarities and overlaps in data collected and targeted populations. A comparative study can lead to improved monitoring program design and optimization of sampling efforts in the Maine DMR lobster program. This may eventually lead to merge of some sampling programs, resulting in the development cost effective sampling program for the American lobster in the state of Maine. This study will potentially significantly improve data quality and quantity, leading to a better understanding of the dynamics of lobster fishery and population and increasing the likelihood of optimal conservation and utilization of living marine resources.

### **Recruitment dynamic of American lobster and its social and economic implication in the Gulf of Maine**

Jui-Han Chang

- (1) develop a comprehensive lobster recruitment dynamic model to quantify and evaluate recruitment dynamics for different life history stages including the egg-settlement stage and settlement-fishery recruitment stage by incorporating environmental, anthropogenic and ecological forces;
- (2) develop a bioeconomic model to estimate the price elasticity of demand for herring baits and evaluate the strength between different markets and its impact to the lobster fishery;
- (3) develop and evaluate management strategies for a lobster-herring linked system; and
- (4) quantify and evaluate the value of the estimation of future recruitment to the lobster industry and management agency and conduct a cost-benefit analysis of improving recruitment forecasting capacity.