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# Collaborative Proposal: CAMEO: Using interdecadal comparisons to understand trade-offs between abundance and condition in fishery ecosystems

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## Preview of Award 1041731 - Final Project Report

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### Cover

|   |  |
|---|--|
| Federal Agency and Organization Element to Which Report is Submitted:   | 4900   |
| Federal Grant or Other Identifying Number Assigned by Agency:   | 1041731  |
| Project Title:  | Collaborative Proposal: CAMEO: Using interdecadal comparisons to understand trade-offs between abundance and condition in fishery ecosystems |
| PD/PI Name:   | Andrew J Pershing, Principal Investigator<br>Jeffrey Runge, Co-Principal Investigator  |
| Recipient Organization:   | University of Maine  |
| Project/Grant Period:   | 08/01/2010 - 07/31/2014  |
| Reporting Period:   | 08/01/2013 - 07/31/2014  |
| Submitting Official (if other than PD\PI):  | Andrew J Pershing<br>Principal Investigator  |
| Submission Date:  | 01/22/2015   |
| Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions) | Andrew J Pershing  |

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### Accomplishments

#### \* What are the major goals of the project?

The main goal of our project is to understand what processes drive changes in herring abundance and condition

(length:weight or length-at-age) and how these changes propagate up and down the food chain. We are assembling and analyzing time series of abundance and condition in Gulf of Maine herring and comparing the seasonal, interannual, and interdecadal changes to time series of bluefin tuna condition and copepod abundance. We are also building models to test hypotheses about how changes at one level (for example, herring abundance) influence changes at another level (e.g. copepod abundance).

**\* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

**Major Activities:** We analyzed time series of plankton and herring abundance and herring and bluefin tuna condition. From this analysis, we developed a bioenergetic model of herring condition as a function of copepod abundance and temperature. We also developed an optimal foraging model to explain the paradox of how bluefin tuna condition declines when herring (their main prey) are abundant.

**Specific Objectives:** DATA MANAGEMENT—Our project focused on analyzing and developing models from long time series of publicly available fisheries data. The project did support some data collection on herring condition and Calanus lipid volume. The former has been reported to BCO-DMO through the University of Vermont. The latter is included under the data management plan for Runge's RAPID grant.

**Significant Results:** We found that the composition of the plankton community in the northwest Atlantic changes in a consistent manner in response to hydrographic variability. We found that the size composition of the herring population is more important to determining bluefin tuna condition than the total abundance or biomass.

**Key outcomes or Other achievements:**

**\* What opportunities for training and professional development has the project provided?**

This project supported two postdoctoral researchers, Dr. Walter Golet (UMaine) and Dr. Rebecca Tien (Ohio State).

**\* How have the results been disseminated to communities of interest?**

Dr. Golet has made several presentations on bluefin tuna to 5th and 6th grade students participating in GMRI's LabVenture program. He has also presented several public lectures regarding these findings to fishing organizations and public lecture series in several New England States. This work was recently presented at the 64th annual tuna conference in Lake Arrowhead California. Changes in bluefin condition as it relates to biological and environmental conditions are part of ongoing discussions at the International Convention for the Conservation of Atlantic Tunas (ICCAT) due to the prominent role foraging grounds have on bluefin reproductive output. The incorporation of additional indices into the bluefin tuna assessment model are currently in discussion. Time series of bluefin tuna condition as a result of this study have been suggested to be used as potential indicators of fecundity and migratory capability in future ecosystem related models.

## Products

### Books

### Book Chapters

### Conference Papers and Presentations

Walter Golet, Nicholas R. Record, Sigrid Lehuta, Molly Lutcavage, Benjamin Galuardi, Andrew B Cooper, Andrew J. Pershing (2012). *The Paradox of the Pelagics: Why Bluefin Tuna can go Hungry in a Sea of Plenty*. Lake Arrowhead Tuna Conference. Lake Arrowhead, CA. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Pershing, A. J., Greene, C. H., Maps, F., Mills, K. E., Record, N. R., Stamieszkin, K. S. (2014). *Zooplankton community dynamics in a changing climate*. ASLO Annual Meeting. Portland, OR. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

## Inventions

### Journals

Runge, J., A. Pershing, R. Jones, N. Record, P. Jekielek and C. Thompson (2015). Abundance, distribution and lipid concentration of the planktonic copepod, *Calanus finmarchicus*, along the coast of the Gulf of Maine in summer. *Continental Shelf Research*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Sigrid Lehuta, Walter J. Golet , Andrew Pershing (2014). Environmental effects on life history traits of Atlantic herring (*Clupea harengus*) in the Gulf of Maine-Georges Bank region. *Fisheries Oceanography*. In prep NA. Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Walter Golet, Nicholas R. Record, Sigrid Lehuta, Molly Lutcavage, Benjamin Galuardi, Andrew B Cooper, Andrew J. Pershing (2013). The Paradox of the Pelagics: Why Bluefin Tuna can go Hungry in a Sea of Plenty. *Marine Ecology Progress Series*. in pres NA. Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Walter J Golet, Benjamin Galuardi, Andrew B Cooper, Molly E. Lutcavage (2013). Changes in the Distribution of Atlantic Bluefin Tuna (*Thunnus thynnus*) in the Gulf of Maine 1979-2005. *PLoS One*. 8 (9), NA. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: [10.1371/journal.pone.0075480](https://doi.org/10.1371/journal.pone.0075480)

## Licenses

## Other Products

## Other Publications

## Patents

## Technologies or Techniques

## Thesis/Dissertations

Phoebe Jekielek. *Interannual and Seasonal Variability of Calanus finmarchicus Lipids in the Gulf of Maine*. (2012). University of Maine. Acknowledgement of Federal Support = Yes

Mitchell Jones. *MODELING CONSUMPTION RATES OF ATLANTIC HERRING (CLUPEA HARENGUS)*. (2014). University of Vermont. Acknowledgement of Federal Support = Yes

## Websites

## Participants/Organizations

### What individuals have worked on the project?

| Name             | Most Senior Project Role                                      | Nearest Person Month Worked |
|------------------|---|-----------------------------|
| Pershing, Andrew | PD/PI   | 1                           |
| Runge, Jeffrey   | Co PD/PI  | 0                           |
| Golet, Walter    | Postdoctoral (scholar, fellow or other postdoctoral position) | 4                           |

**Full details of individuals who have worked on the project:**

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**Andrew J Pershing****Email:** andrew.pershing@maine.edu**Most Senior Project Role:** PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** PI, lead zooplankton analysis, supervised tuna modeling work**Funding Support:** Gulf of Maine Research Institute institutional funds**International Collaboration:** No**International Travel:** No

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**Jeffrey Runge****Email:** jeffrey.runge@maine.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 0**Contribution to the Project:** Lead the effort to understand lipid dynamics between Calanus and herring**Funding Support:** none**International Collaboration:** No**International Travel:** Yes, Norway - 0 years, 1 months, 0 days

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**Walter Golet****Email:** Wgolet@gmri.org**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)**Nearest Person Month Worked:** 4**Contribution to the Project:** Analysis of herring tuna relationships and primary lead on communicating with tuna management.**Funding Support:** None**International Collaboration:** No**International Travel:** Yes, Canada - 0 years, 0 months, 7 days

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**What other organizations have been involved as partners?**

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| <b>Name</b>                        | <b>Type of Partner Organization</b>       | <b>Location</b> |
|------------------------------------|---|-----------------|
| Gulf of Maine Research Institute   | Other Nonprofits                          | Portland, ME    |
| Northeast Fisheries Science center | Other Organizations (foreign or domestic) | Narraganset, RI |
| Ohio State University              | Academic Institution                      | Columbus, OH    |
| University of Massachusetts        | Academic Institution                      | Amherst, MA     |
| University of Vermont              | Academic Institution                      | Burlington, VT  |

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**Full details of organizations that have been involved as partners:**

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**Gulf of Maine Research Institute****Organization Type:** Other Nonprofits**Organization Location:** Portland, ME**Partner's Contribution to the Project:**

In-Kind Support

Facilities

Collaborative Research

**More Detail on Partner and Contribution:** Pershing, Golet, and Runge are based at GMRI. Pershing now has a full time appointment with GMRI and is on-leave from UMaine.

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**Northeast Fisheries Science center****Organization Type:** Other Organizations (foreign or domestic)**Organization Location:** Narraganset, RI**Partner's Contribution to the Project:**

Collaborative Research

**More Detail on Partner and Contribution:** Drs. Jon Hare, Jonathan Deroba, and David Richardson is a co-PI on this collaborative project.

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**Ohio State University****Organization Type:** Academic Institution**Organization Location:** Columbus, OH**Partner's Contribution to the Project:**

Collaborative Research

**More Detail on Partner and Contribution:** Dr. Rebecca Tien is a co-PI on this collaborative project.

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**University of Massachusetts****Organization Type:** Academic Institution**Organization Location:** Amherst, MA**Partner's Contribution to the Project:**

Collaborative Research

**More Detail on Partner and Contribution:** Dr. Molly Lutcavage is a co-PI on this collaborative project.

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**University of Vermont****Organization Type:** Academic Institution**Organization Location:** Burlington, VT**Partner's Contribution to the Project:**

Collaborative Research

**More Detail on Partner and Contribution:** Jason Stockwell is a co-PI on this collaborative project.

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### **What other collaborators or contacts have been involved?**

YES

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## **Impacts**

### **What is the impact on the development of the principal discipline(s) of the project?**

The major result of our project is that herring body size, or more important the size structure, is critical for the success of bluefin tuna. We expect that similar relationships hold for other predators such as porpoises but not large whales. This is immediately relevant to ecosystem based management and we are actively working to communicate this to fisheries managers.

### **What is the impact on other disciplines?**

Nothing to report.

### **What is the impact on the development of human resources?**

Nothing to report.

### **What is the impact on physical resources that form infrastructure?**

Nothing to report.

### **What is the impact on institutional resources that form infrastructure?**

Nothing to report.

### **What is the impact on information resources that form infrastructure?**

Nothing to report.

### **What is the impact on technology transfer?**

Nothing to report.

### **What is the impact on society beyond science and technology?**

Our project has direct relevance to fisheries management, and we have worked hard to connect our research with management. Convention for the Conservation of Atlantic Tunas (ICCAT) due to the prominent role foraging grounds have on bluefin reproductive output. The incorporation of additional indices into the bluefin tuna assessment model are currently in discussion. Time series of bluefin tuna condition as a result of this study have been suggested to be used as potential indicators of fecundity and migratory capability in future ecosystem related models.

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## **Changes/Problems**

### **Changes in approach and reason for change**

Nothing to report.

### **Actual or Anticipated problems or delays and actions or plans to resolve them**

Nothing to report.

### **Changes that have a significant impact on expenditures**

Nothing to report.

**Significant changes in use or care of human subjects**

Nothing to report.

**Significant changes in use or care of vertebrate animals**

Nothing to report.

**Significant changes in use or care of biohazards**

Nothing to report.