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Understanding Copepod Life-history and Diversity Using a Next-generation Zooplankton Model

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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:	0962074
Project Title:	Understanding copepod life-history and diversity using a next-generation zooplankton model
PD/PI Name:	Andrew J Pershing, Principal Investigator
Recipient Organization:	University of Maine
Project/Grant Period:	04/01/2010 - 03/31/2014
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Submitting Official (if other than PD\PI):	Andrew J Pershing Principal Investigator
Submission Date:	07/06/2014
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Andrew J Pershing

Accomplishments

* What are the major goals of the project?

The main goal of our project is to understand the patterns of diversity and biogeography in marine copepods. To achieve this goal, we developed a unique modeling framework to simulate the trade-offs between growth, development, and fecundity in marine copepods.

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

Major Activities: We developed a new approach to modeling growth and development in metazoans. We applied this approach to marine copepods, and used it to understand relationships between copepod body size and temperature, copepod biodiversity patterns, and copepod biogeography. This project also provided support for experiments to look at how copepod body size impacts the particle size spectrum.

Specific Objectives: We used our model to explain why marine copepods and other organisms with strong associations between body size and temperature should be expected to deviate from the temperature-diversity relationship that emerges from classic metabolic theory. We also used a novel emergent modeling approach to explore how temperature and chlorophyll cycles influence copepod biogeography.

Significant Results:

Key outcomes or
Other achievements:

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

This project provided significant support for early career scientist Dr. Frederic Maps. Dr. Maps began working on this project as a postdoc and has continued this line of work as a faculty member at the University of Quebec, Laval.

This project supported Dr. Nicholas Record's Ph. D. research and it continued to support him during his startup as a senior scientist at the Bigelow Laboratory for Ocean Sciences. It also provided travel support, supplies, and some ship time for graduate student Karen Stamieszkin (supported by an NSF GRF).

The project also supported three undergraduate interns.

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

This project produced 7 peer reviewed publications. We organized sessions at two Ocean Sciences meetings and one ASLO meeting. We also produced regular updates on our work and musings about marine science on our blog: seascapemodeling.org.

Data management

Our project was focused on developing new modeling approaches, and generating new data was not one of our key goals. Our models are fully documented in our papers, including tables of parameters. As part of graduate student Karen Stamieszkin's research, she will be conducting experiments to document the impact of copepod grazing on the particle size spectrum. We have submitted a request to BCO-DMO to have our project listed, and we intend to submit the grazing experiment data to BCO-DMO when it is available (expected in late 2014).

Products

Books

Book Chapters

Conference Papers and Presentations

Maps, F (2010). *Toward and integrative numerical framework in pelagic ecology*. ICES Working Group on Integrated Physical-Biological (WGIPEM) annual meeting, Paris, France. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Maps F, Pershing AJ, Record NR (2013). *Tradeoff between metabolism and development explains global patterns of pelagic calanoid copepods dormancy*. ASLO 2013 Aquatic Sciences Meeting. New Orleans, LA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Inventions

Journals

Barton, AD, Pershing, AJ, Litchman, E, Record, NR, Edwards, KF, Finkel, ZV, Kiorboe, T, Ward, BA (2013). The biogeography of marine plankton traits. *ECOLOGY LETTERS*. 16 (4), . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Maps F, Record NR, Pershing AJ (2014). Trade-off between metabolism and development explains global patterns of pelagic calanoid copepods dormancy. *Journal of Plankton Research*. in rev. n/a. Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Maps, Frederic; Record, Nicholas R.; Pershing, Andrew J. (2014). A metabolic approach to dormancy in pelagic copepods helps explaining inter- and intra-specific variability in life-history strategies. *JOURNAL OF PLANKTON RESEARCH*. 36 (1), 18. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Record NR, Pershing AJ, Maps F (2013). Emergent copepod communities in an adaptive trait-structured model. *Ecological Modeling*. 260 11. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Record NR, Pershing AJ, Maps F (2014). The paradox of “the paradox of the plankton”. *ICES Journal of Marine Science*. 71 236. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Record, Nicholas R.; Pershing, Andrew J.; Maps, Frederic (2012). First principles of copepod development help explain global marine diversity patterns. *OECOLOGIA*. 170 289. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Record, Nicholas R.; Pershing, Andrew J.; Maps, Frederic (2014). Plankton post-paradox. *ICES JOURNAL OF MARINE SCIENCE*. 71 (2), 296. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Licenses

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Websites

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Pershing, Andrew	PD/PI	1
Maps, Frederic	Co-Investigator	3
Record, Nicholas	Co-Investigator	4

Stamieszkin, Karen

Graduate Student (research assistant)

12

Full details of individuals who have worked on the project:

Andrew J Pershing**Email:** andrew.pershing@maine.edu**Most Senior Project Role:** PD/PI**Nearest Person Month Worked:** 1**Contribution to the Project:** Led the project. Participated in the conceptualization and the application of the model Organized special sessions at international meetings.**Funding Support:** University of Maine, Gulf of Maine Research Institute**International Collaboration:** No**International Travel:** No

Frederic Maps**Email:** frederic.maps@gmail.com**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 3**Contribution to the Project:** Frederic developed the original compupod model and has led its application on questions related to copepod life history.**Funding Support:** Frederic has been supported by DFO in Canada and the University of Laval during the past year.**International Collaboration:** Yes, Canada**International Travel:** Yes, Canada - 1 years, 0 months, 0 days

Nicholas R Record**Email:** nickrecord@gmail.com**Most Senior Project Role:** Co-Investigator**Nearest Person Month Worked:** 4**Contribution to the Project:** Nick helped develop the original compupod model and has led its application to copepod community dynamics and biodiversity.**Funding Support:** Bigelow Laboratory for Ocean Sciences**International Collaboration:** No**International Travel:** Yes, Denmark - 0 years, 0 months, 7 days; Netherlands - 0 years, 0 months, 5 days

Karen Stamieszkin**Email:** karen.stamieszkin@maine.edu**Most Senior Project Role:** Graduate Student (research assistant)**Nearest Person Month Worked:** 12**Contribution to the Project:** Karen is conducting preliminary experiments to measure the impact of copepods on the particle size spectrum. This will be used to build the next generation of our compupod model.**Funding Support:** NSF Graduate Research Fellowship

International Collaboration: No

International Travel: Yes, Denmark - 0 years, 0 months, 7 days

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Bowdoin College	Academic Institution	Brunswick, ME
Gulf of Maine Research Institute	Other Nonprofits	Portland, ME
University of Laval	Academic Institution	Quebec, Ontario, Canada

Full details of organizations that have been involved as partners:

Bowdoin College

Organization Type: Academic Institution

Organization Location: Brunswick, ME

Partner's Contribution to the Project:

Facilities

More Detail on Partner and Contribution: Dr. Record was a visiting professor at Bowdoin during the last academic year.

Gulf of Maine Research Institute

Organization Type: Other Nonprofits

Organization Location: Portland, ME

Partner's Contribution to the Project:

Facilities

More Detail on Partner and Contribution: Dr. Pershing's lab is based at the Gulf of Maine Research Institute

University of Laval

Organization Type: Academic Institution

Organization Location: Quebec, Ontario, Canada

Partner's Contribution to the Project:

Facilities

More Detail on Partner and Contribution: Dr. Maps is now a faculty member at Laval

What other collaborators or contacts have been involved?

NO

Impacts

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

We developed a new approach to modeling zooplankton growth, development, and population dynamics. This approach is now being expanded to include a wider range of species and integrated into ecosystem models.

What is the impact on other disciplines?

Our work linking metabolic theory and biodiversity could apply generally, beyond just plankton. Our size-based approach is now being applied to zooplankton fecal pellet production, providing a link between community structure and the biological carbon pump.

What is the impact on the development of human resources?

The early career scientists supported by this project are already emerging as leaders in their field.

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?

Nothing to report.

Changes/Problems

Changes in approach and reason for change

We rebudgeted the project in our final year to allow a subaward to support Nick Record at Bigelow. This allowed the project to continue when Dr. Record began a new position.

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.