10-23-2012

DISSERTATION RESEARCH: Eco-Evolutionary Effects of an Aquatic Consumer: Linking Phenotypic Diversity to Community and Ecosystem Responses

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Final Report for Period: 09/2011 - 08/2012
Submitted on: 10/23/2012
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Award ID: 1011267
Organization: University of Maine
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Title:
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Project Participants

Senior Personnel

Name: Simon, Kevin
Worked for more than 160 Hours: Yes
Contribution to Project:

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Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Tuckett, Quenton
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Undergraduate Student

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Worked for more than 160 Hours: No
Contribution to Project:
This undergraduate student assisted in experiment set up, sample collection, sample analysis, and data entry.

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Contribution to Project:
This undergraduate student assisted in sample analysis and data entry.

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Worked for more than 160 Hours: No
Contribution to Project:
This undergraduate student assisted in experiment set up, sample collection, sample analysis, and data entry.

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Contribution to Project:
This undergraduate student assisted in experiment set up, sample collection, sample analysis, and data entry.

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Contribution to Project:
This undergraduate student assisted in experiment set up, sample collection, sample analysis, and data entry.

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This undergraduate student assisted in experiment set up, sample collection, sample analysis, and data entry.

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This undergraduate student assisted in sample analysis and data entry.

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Contribution to Project:
This undergraduate student assisted in sample analysis and data entry.

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Contribution to Project:

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Contribution to Project:

Technician, Programmer

Name: Anderson, Dennis
Worked for more than 160 Hours: No
Contribution to Project:
Technical support

Name: Wright, Wes
Worked for more than 160 Hours: No
Contribution to Project:
Technical support

Other Participant

Research Experience for Undergraduates

Organizational Partners

ME Department of Environmental Protectio

The DDIG research in this project complements a larger collaborative project with the Maine Department of Environmental Protection (MEDEP). MEDEP personnel collaborated in the experimental design and application of the results to a larger lake biomanipulation project.

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities:

This project was designed to investigate the potential for rapid evolution of fish in response to lake productivity and the ecological consequences of that trait change back on lake ecosystems. Two major research activities were undertaken. First, controlled common garden rearing of white perch was undertaken to reveal morphological and physiological differences between two potentially divergent populations of white perch. Following controlled rearing, mesocosm experiments were carried out over a 4 week period to determine the ecological effects of the examined morphological and physiological diversity. Results from this work were presented to staff of the Maine Department of Environmental Protection and were presented in September 2011 at the annual meetingof the American Fisheries Society and in May 2012 at the annual meeting of the Society for Freshwater Science in Louisville, Kentucky.

Findings:

Surveys of wild fish and common garden rearing of two fish populations from lakes of differing productivity revealed differences in morphology, rates of growth and nutrient excretion rates and ratios of the fish. Mesocosm experiments with the fish found support for the supposition that lake trophic state can modulate ecosystem and community effects of invasive fish. For example, in fertilized treatments (high nutrients), fish from differing populations displayed
divergent ecological roles. Such divergence was not always evident under low nutrient conditions. Thus, we've shown that 1) traits of invasive fishes respond to nutrient enrichment, and 2) that such variation can produce context-dependent effects back on lake ecosystem conditions. Indeed, it appears that eutrophic conditions promote eutrophic phenotypes that themselves reinforce system productivity. We thus provide an example of how contemporary trait changes in invaders might compound other anthropogenic influences on systems.

Training and Development:

The PhD student who designed and conducted the research learned experimental design and a suite of skills ranging from analytical chemistry to morphometric analysis of fish. He also learned skills related to proposal design, worker managment, student mentoring and research presentation skills. The undergraduates on the project learned about controlled ecological experimentation, the role of invasive fish and trophic state in lake ecosystems and a suite of laboratory and data analysis skills.

Outreach Activities:

Preliminary results from this project have been presented to staff from the State of Maine Department of Environmental Protection. Staff at this agency are primarily tasked with managing and protecting aquatic water quality within the state and are often at the interface of public-private interactions shaping policy and water quality decisions. They have been piloting biomanipulation of our study fish for water quality management. Through this research, they've become aware of potential interactions between ecology and evolution which may shape water quality and have gained a better idea of how their management efforts may play out in differing ecosystems.

Journal Publications

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:

We are in final stages of data analysis from the project so only preliminary insights have been presented to the major disciplinary fields of this project(ecology and evolution). However, results so far indicate that contemporary evolution can play a critical role in shaping the effects of consumers in lakes. Importantly, our data suggest trophic state can potentiate rapid evolution of fish and lead to divergence in ecological roles of differing populations. It appears such divergence may then generate ecological feedbacks that re-inforce the roles of the fish and the state of the ecosystems
they inhabit. Such feedbacks between ecology and evolution represent an intense area of investigation (eco-evolutionary dynamics), and our work suggests that such processes may contribution the stability or instability of ecosystem dynamics.

Contributions to Other Disciplines:

Results of this project have important implications for the management of invasive species and trophic state of freshwater ecosystems. This research has been designed to integrate eco-evolutionary theory into the broader context of lake management. For example, this project is being used to inform decisions by State managers regarding lake biomanipulations to remediate problems with lake eutrophication. Our results suggest that invasive fish may rapidly change in response to lake trophic state leading to alteration of their ecological role over time. This suggests that management of these fish, either as invaders or in biomanipulation efforts, must take into account future changes in lake productivity and fish role.

Contributions to Human Resource Development:

This project involved 10 undergraduate students at various stages of the research. Several of these students became involved at the initial stages of project deployment and preparation, thus allowing a greater understanding of the life cycle of a research project from design inception to an end product. All students in the project learned important data collection and analysis skills (e.g. data quality control management, general analytical software). The students also developed an appreciation for the role of theoretical science in applied issues.

Contributions to Resources for Research and Education:

This project has been directly linked to undergraduate and graduate teaching through a course in experimental ecology. The data and materials from the research will be used in class exercises to teach students experimental design. This work demonstrates the ecological consequence of contemporary trait change in wild populations. Evolution is often viewed by the public as an esoteric field dealing with the distant history of life and its origins. This work provides an example of evolution in a context that emphasizes the relevance of evolutionary theory to more immediate human concerns.

Contributions Beyond Science and Engineering:

Results from this research directly inform current environmental management of lake eutrohpication and invasive species by State regualtory agencies. The data from this project complement active whole-lake biomanipulation projects and are being used in strategy planning by the Maine Department of Environmental Protection.

Conference Proceedings

Categories for which nothing is reported:

Any Journal

Any Book

Any Web/Internet Site

Any Product

Any Conference