Nonconsumptive Predator Effects in a Pelagic Community: an Integrated Laboratory, Field and Modeling Approach

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Overview

This study will address a fundamental issue in how species interactions influence communities. Classical approaches, including the vast majority of experimental and modeling studies, focus on how species affect the density of other species through predator-prey interactions. But this approach ignores a growing body of work that documents how prey modify their phenotype (traits) in response to predators to reduce predation risk, and how this, in turn, can profoundly influence the consequences of species interactions. There is abundant evidence that such "nonconsumptive effects" (NCEs, also trait-mediated or nonlethal) of predators could be important in pelagic Great Lakes and marine ecosystems. But whereas the underlying mechanism is well known (induced trait changes), there is little understanding of the influence of the potential consequent NCEs, and almost no studies of NCEs in large pelagic ecosystems. The existence of NCEs could strongly affect the qualitative and quantitative nature of species interactions and the properties of communities. It is therefore critical that we evaluate the role and operation of NCEs in marine and Great Lake systems.

Objective

Increase number of regional coastal and marine ecosystems delineated with approved indicators of ecological health and socioeconomic benefits that are monitored and understood

Proposed Work

The proposed study examines NCEs caused by an invertebrate predator, the invasive spiny water flea *Bythotrephes*. Our work is guided by these broad questions:

- How do *Bythotrephes* induced effects on prey influence their net effect on Great Lakes communities?
- Are NCEs influential in complex field settings?
- What is the influence of NCEs of an invertebrate predator:
    - On the zooplankton prey assemblages (i.e., on keystone predator effects)?
    - On young-of-year fish competitors (i.e. on interspecific competition)?
- How do factors such as resource level, temperature, and light affect the influence of a predator's
- NCE on a prey assemblage (via effects on competition)?

A comprehensive approach based on three objectives will be used that integrates laboratory studies, field surveys and modeling.

1. Determine the phenotypic responses of key zooplankton species to *Bythotrephes*. This will involve laboratory studies that examine behavioral, morphological and life history responses. Laboratory studies will also quantify *Bythotrephes* predation rates. Optimization modeling will guide and allow interpretation of these laboratory studies.
2. Develop predictive models of the NCEs of *Bythotrephes* on zooplankton prey growth rate and competitive outcomes and test predictions with microcosm and mesocosm experiments. This is a key methodological component: If models accurately predict induced trait changes, and their consequences to species interactions in mesocosm experiments, this increases the ability to form predictive models in natural systems.
3. Determine NCEs of *Bythotrephes* in the field using ecological models based on parameters derived from the aforementioned exercises and field surveys. Field surveys will examine the effect of *Bythotrephes* on zooplankton prey in the field, and classify abundances and parameters such as YOY fish density and position and abiotic factors.

Significant intellectual contributions will result from this study by addressing a potentially key, but poorly understood, component of species interactions in Great Lakes and marine systems. Societal concern and interest over the influence of invasive species including *Bythotrephes* in Great Lakes food webs will facilitate educational outreach.

In addition, close associations of the PIs with institutions with strong outreach components fosters many educational opportunities. For example, many individuals and groups from high schools and management agencies come to GLERL for education and training. Further, a Great Lakes Sea Grant Network extension educator has agreed to work to bridge the research with educators by helping the PIs engage with the Center for Ocean Sciences and Education Excellence Great Lakes (COSEE) Great Lakes and Sea Grant.

We will work with professional educational outreach partners to enhance our capacity to realize broader impacts from the research. COSEE Great Lakes already has a framework in place to reach teachers throughout the region and includes an emphasis on underrepresented groups including tribal educators.

The PIs will present research to these educators who can in turn present it in stimulating and understandable ways to students. COSEE and Sea Grant also are working on a variety of curriculum pieces – the PIs and the extension educator will work together to develop a curriculum item on invasive species and nonconsumptive effects.

Finally, graduate and undergraduate training in research and outreach will undergird the proposed project.