Regeneration in the classroom: linking infaunal injury and ocean literacy using integrated concept mapping

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ABSTRACT

Injury and regeneration are fascinating topics that students are eager to learn more about. This allure makes injury a great hook to introduce students to a broader set of biological and ecological concepts. We focus on marine infauna, such as polychaetes, because they are important "ecosystem engineers" that often lose tissue to predators or other disturbances. For example, they influence sediment chemistry, nutrient cycling, and microbial communities as they burrow, feed, defecate, and irrigate their tubes. Evidence suggests that injured infauna are less active while they regenerate and these reductions can have individual, habitat, and community consequences. Concept maps are a useful educational tool to examine the costs and benefits of injury and regeneration, particularly linking the impacts from individuals and ecosystems. Such maps effectively show these linkages and encourage exploration of the processes that control and connect the immediate effects of injury on individual infauna with larger scale habitat and ecosystem changes. Our goal is to expand on the resources that are currently available to middle, high school, and post secondary educators using the COSEE-Ocean Systems (OS) Concept Linked Integrated Media Builder (CLIMB: <http://cosee.umaine.edu/tools/cmb/>) to create an interactive concept map of how injury affects marine benthic invertebrates, communities, and ecosystems. Here we present our initial concept map of how infaunal injury affects marine benthic ecosystems with examples of multimedia content, introduce the COSEE-OS concept mapping tool, suggest inquiry based activities for the classroom, and invite our colleagues to begin building their own concept maps of the integrative biology of injury and regeneration.

BACKGROUND

- Soft-sediment habitats make up the majority of marine benthic environments. These habitats contain complex macrofaunal communities, including large numbers of infaunal invertebrates, such as polychaetes, clams, and brittlestars.
- Infaunal activity influences biogeochemical cycling, recruitment, and competitive interactions.
- Infauna often experience non-lethal tissue loss to predators or other disturbances. Many infauna can regenerate lost tissue, but injuries can affect growth, fecundity, feeding behavior, and sediment disturbance rates. These changes in activity can have indirect effects on the habitat and community (Fig. 1).

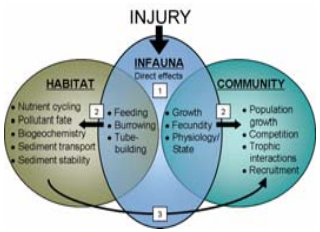


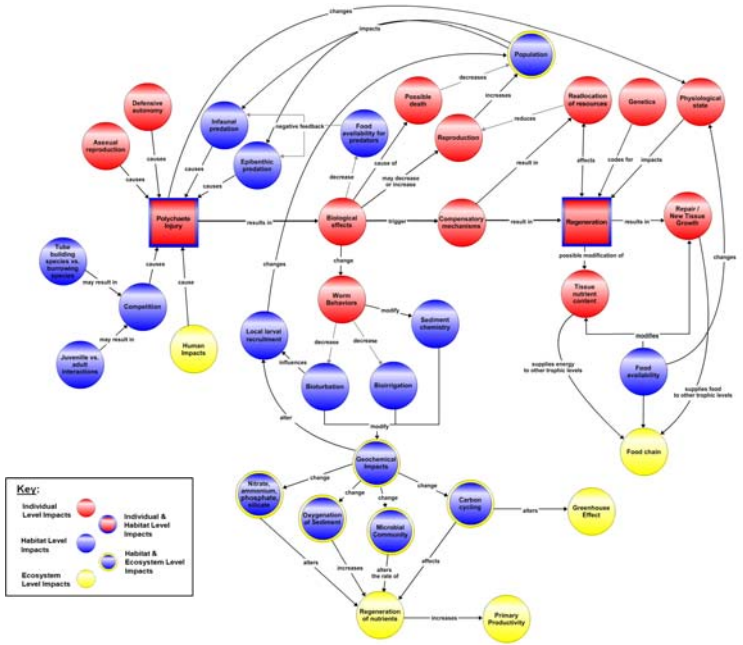
Fig. 1 Complex effects of injury on infauna, sediments and benthic communities.
1) Injury reduces infaunal activity, growth, fecundity, and possibly condition.
2) Changes in infaunal activity and state secondarily impact the surrounding habitat and community interactions.
3) Because competition and recruitment are sediment-mediated, alterations of the habitat also impact these community processes.

- Understanding the ocean's influence on people (and their influence on the ocean) is critical to making informed and responsible decisions about the ocean and its resources (NGS, 2006). Yet, most K-12 curricula and learning standards lack ocean related topics and consequently the general public is often ill-prepared to understand how the ocean affects their lives.
- In 2005, scientists and educators developed essential ocean literacy principles to align with National Science Education Standards. The Centers for Ocean Sciences Excellence in Education-Ocean Systems (COSEE-OS) project recently launched a multimedia web interface that integrates concept maps, visualizations, teaching resources, and news items highlighting the ocean literacy principles.
- Working with COSEE-OS, we are developing web-based interactive educational resources to illustrate how injury affects marine benthic invertebrates, communities, and ecosystems.

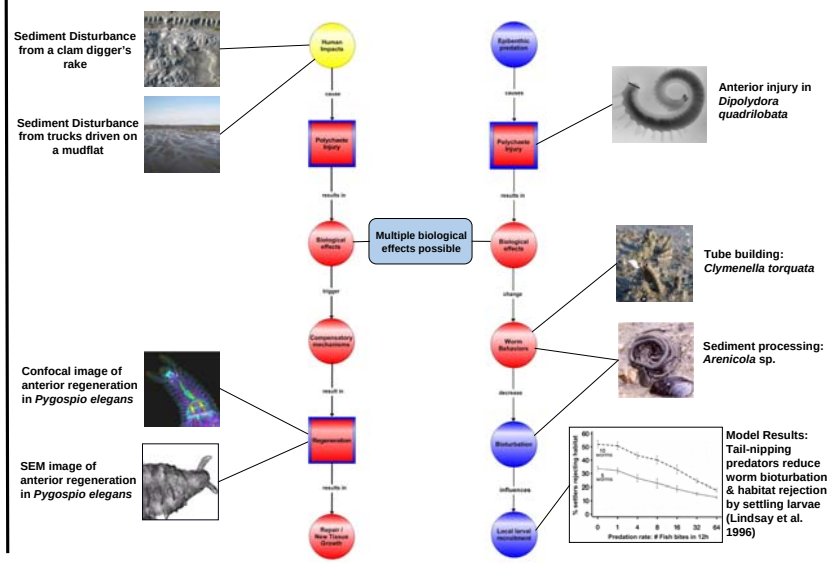
CONCEPT MAPPING: A LEARNING TOOL

- Concept maps are graphical tools that highlight fundamental concepts and the types of connections between concepts within complex systems.
- Educators can use concept maps to assess how students develop understanding. For example, students and educators can modify maps to reflect changes in the scope and depth of their understanding.
- The concept map in the next panel was created using the COSEE-OS Concept Map Builder <http://cosee.umaine.edu/cfuser/cmb/index.cfml>.
- Content from this map will eventually be integrated into the COSEE-OS Ocean Climate Interactive (OCI) <http://cosee.umaine.edu/cfuser/index.cfm>. Currently the live version of this map is on the COSEE-OS website as a stand-alone model.

Concept Map: Ecology of Marine Infaunal Injury & Regeneration



The interactive version of this map, available online, contains more in-depth information visible when users click on map concepts -- including images, videos, news items, and resources. Examples of attached image assets associated with two pathways from this concept map are shown below.



APPLICATIONS

- Scientists, educators and students at all levels and stages of the learning process can use existing concept maps to guide inquiry.
- A tool for graduate students… Use a concept map to guide new graduate students to organize understanding of specific research topics prior to planning independent research.
- Concept maps are useful for evaluating initial understanding and misconceptions about a topic. Educators can use this information to tailor instruction and guide student inquiry. Assignments could include developing and refining concept maps for a given topic within a course
- Free concept map builders, including the COSEE-OS Concept Map Builder, are available online. The COSEE-OS interface encourages collaboration – participants can easily share and modify concept maps they are building.
- This concept map or others like it can help students investigate a variety of questions about regeneration:
  - Why do some organisms regenerate, while others do not?
  - What evolutionary patterns exist among organisms based on regeneration?
  - What are the genetic and physiological differences in organisms that may lead to different responses to injury?
  - What is the role of stem cells in response to injury?
  - How can we effectively induce regeneration in currently non-regenerating tissue?
  - How does the environment affect regeneration ability?
  - Do injury and regeneration play the same role in all habitats?

TAKE A CONCEPT MAP CHALLENGE: HOW DO INJURY AND REGENERATION APPLY TO YOUR RESEARCH?

Use the space below to explore how injury and regeneration influence your study organism/ system. If you would like to share your concept map, please include your name on your map and take a picture with the provided camera. Feel free to modify or erase any existing maps on this board.

TO VIEW THE LIVE VERSION OF THIS MAP PLEASE VISIT:
<http://cosee.umaine.edu/coseeos/gradstudents/grad-bcampbell.htm>

Lindsay SM, Woolley DS, Woodin SA. 1996. Modeling interactions of browsing predation, infaunal activity, and recruitment in marine soft-sediment habitats. Am. Nat. 148: 614-633.

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