Coastal Socio-Ecological System Dynamics under an array of Environmental Challenges including the 2011 Tohoku Earthquake and Tsunami

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Abstract

A catastrophic earthquake and subsequent tsunami hit the Pacific coast of northern Japan on 11 March 2011, devastating many of the towns, villages and coastal ecosystems located along the shore. To measure the extent of damage caused by the disaster and monitor the change in the state of the marine ecosystem, we started conducting a systematic survey to investigate spatio-temporal dynamics of various marine community structures in relation to changes in a range of physical, biological and anthropogenic variables between 2012 and 2020 in Onagawa Bay in Miyagi Prefecture.
Temporal dynamics of both phytoplankton and zooplankton communities, who occupied the pelagic zone, demonstrated significant seasonal variation along with changes in large-scale environmental conditions such as temperature and nutrient concentrations. However, the observed post-disaster changes in benthic macrofaunal communities, who occupied benthic zone, showed significant relationships with anthropogenic components such as reduction in fishing pressure and the recovery of aquaculture operations.
The pelagic and benthic components of Onagawa Bay appeared to have responded to the 2011 disaster very differently, and this study suggests the post-disaster recovery and dynamics of the coastal ecosystems may be regulated by how human societies respond to the impacts of the catastrophe through their influences on benthic habitat, rather than by the immediate physical force of the earthquake and the subsequent tsunami. This has an important implication because, in coastal ecosystems, recent climate change and other human-induced stressors may have more vigorous effects on the processes operating along benthic-pelagic gradients with clear consequences for ecosystem functioning.

Keywords: coastal ecosystem, environmental change, natural disaster, benthic, pelagic coupling, anthropogenic stressor, community ecology

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