Northern coastal marshes more vulnerable to nutrient pollution

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Salt marshes at higher latitudes, including those in densely populated coastal regions of New England and Europe, are more susceptible to nutrient loading and overgrazing by herbivorous critters such as this crab than their counterparts in the tropics. Credit: Brian Silliman

Salt marshes at higher latitudes, such as those in densely populated coastal regions of New England and northern Europe, are more vulnerable to the effects of nutrient pollution, a new Duke University study finds.

"The heavy flow of nitrogen and phosphorus into these marshes from upstream cities and farms can trigger a chain reaction that can lead to intense overgrazing by marsh herbivores," said Brian R. Silliman, Rachel Carson Associate Professor of Marine Conservation Biology at Duke's Nicholas School of the Environment.

"Left unchecked, this overgrazing can undermine the marshes' stability and reduce their ability to protect shorelines from erosion and coastal flooding," Silliman said.

The new study, published today in the peer-reviewed journal *Ecology Letters*, integrates the findings of 80 previous field experiments.

These findings buck a widely held theory that overgrazing by herbivores is more intense in tropical coastal wetlands than temperate ones, said Qiang He, a postdoctoral research associate in Silliman's lab.

"Our analysis clearly shows that when you add similar levels of nutrients into coastal wetlands, marshes at higher latitudes experience a much heavier increase in grazing pressures than their southern counterparts," He said. "It's the first study to demonstrate that these latitudinal differences exist."

As nutrient-laden runoff from cities and farms flows into temperate salt marshes, it causes eutrophication—increased plant growth and reduced oxygen levels in the water—which kills many species of fish and other aquatic animals. As marsh populations of fish and other carnivores drop, populations of snails, crabs, insects and other herbivores or omnivores

grow. These animals begin overgrazing the marsh grasses. As the grasses die off, the marsh becomes destabilized and, over time, may no longer be able to function as it once did.

"In addition to protecting shorelines from erosion and coastal flooding, salt marshes enhance fishery production by providing nursery habitat for fish and shellfish. They absorb river pollution and keep nutrients and toxins from entering our estuaries and oceans. And they store huge amounts of carbon," Silliman said.

"Eutrophication-induced overgrazing can reduce their ability to do all of this," Silliman said.

According to Silliman, plants in temperate coastal marshes are more susceptible to this domino effect in part because they are located at latitudes where pollution is heaviest, and in part because they have probably evolved differently than coastal wetland plants from tropical latitudes.

Plants from tropical mangroves are better equipped, evolutionarily speaking, to defend themselves against overgrazing, he explained. Their new growth often has thicker leaves and more fibrous stems or other natural chemical-based defenses that make it less tasty.

Temperate marsh plants, on the other hand, respond to increased nitrogen by putting forth a tasty flush of soft new leaves and stems, like a recently fertilized lawn in spring. This new growth is much more palatable to herbivores because it's not as tough to chew and doesn't carry as many defensive chemical compounds.

"Marsh grazers such as insects and snails can recognize plant tissues that have more nitrogen than others, and they will key in on those," said He. "By pinpointing this underlying mechanism and shedding light on the

role latitude plays in mediating the impact of nutrient loading, we hope our study will help local environmental managers determine how best to prevent or reduce problems facing wetlands in their areas."

More information: "Biogeographic Consequences of Nutrient Enrichment for Plant-Herbivore Interactions in Coastal Wetlands," Qiang He and Brian R. Silliman; *Ecology Letters*, April 6, 2015. DOI: 10.1111/ele.12429

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