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THE IMPACT OF OCEAN ACIDIFICATION ON LOBSTERS AND OYSTERS

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Lobsters and oysters are vital to marine ecosystems. Lobsters play a crucial role in the food chain by regulating populations of smaller organisms such as crabs and sea urchins, helping maintain the balance within coral reef ecosystems. Their role as prey for larger predators also supports biodiversity and the stability of the food web. Oysters are equally important, contributing to habitat formation and regulating oxygen levels in the water. However, these vital creatures are threatened by ocean acidification, which is increased acidity levels in ocean waters, primarily due to the absorption of excess atmospheric carbon dioxide. Acidification is more present in colder waters as carbon dioxide dissolves faster. This alteration in ocean chemistry has profound implications for lobster habitats and physiology, leading to various health issues and a decline in their populations. This paper explores how the change in ocean acidity harms lobsters and oysters, which are integral to the health and balance of marine environments.

Habitat Damage to Lobsters

The changes in the ocean's chemistry can profoundly impact lobster habitats. Acidification can decrease the populations of organisms that lobsters typically prey on, resulting

in a decline in available food. Lobsters struggle to maintain their health and reproductive capabilities without adequate food sources. Also, the altered ocean conditions can lead to decreased lobster populations. As their habitats become less hospitable and food sources scarcer, lobsters face increased challenges in sustaining their numbers. The adverse effects of ocean acidification extend beyond lobster habitats, significantly harming lobsters' physiology, particularly in their juvenile stages. Juvenile lobsters face difficulty in growing and forming strong shells in acidic waters. These shells are crucial for survival, protecting against predators and harsh environmental conditions. In their early stages of development, lobsters are thus increasingly vulnerable, not just to predation but also to the harsh realities of their changing environment. Additionally, the stress from acidic waters, often coupled with warming temperatures, further strains their physiological development.

Physiological Damage to Lobsters

The susceptibility of lobsters to diseases is another serious concern. Acidic conditions weaken their immune systems, making them more prone to infections and diseases like shell disease. Specific diseases have been observed more frequently in lobsters living in acidic waters. For instance, a study in the *Nature Journal* (Tai, 2021) highlighted the heightened health risks lobsters face in such environments. “Shell-forming organisms… crustaceans- appear particularly sensitive to changes in ocean chemistry linked to OA (Ocean Acidification) severely impacted by high dissolution rates and increased energy costs linked to the need to increase the effort for homeostasis and mineralization to form and maintain calcium carbonate shell components.” Furthermore, the MIT Sea Grant has raised concerns about the structural integrity of lobster shells in acidic conditions, which not only makes them more susceptible to diseases but also affects their overall growth and survival prospects. One of the researchers states: “Increased

stress due to warming and acidification, we hypothesize, will compromise the structural integrity of the shell, leading to deformation and potential increased incidence of epizootic shell disease" (ntmadmin, 2017). These physiological impacts threaten the lobster population and have broader implications for the marine ecosystem, given their crucial role in maintaining ecological balance.

Economic Damage of Lobster Population Decline

The economic implications of ocean acidification on the lobster population are far-reaching, particularly for the lobster fishing industry and Atlantic Ocean coastal communities, particularly in New England. Weakened shells and increased susceptibility to diseases reduce the quality and marketability of lobsters and make it challenging to maintain sustainable lobster fisheries. The impact on coastal communities, especially in regions heavily dependent on lobster fishing, like Maine, will be significant in the future. Lobster sales form the backbone of the local economy in these areas, and a decline in lobster populations directly translates to reduced catch and income. This situation could lead to job losses and economic strain for these communities. The ripple effects of such a downturn will be extensive, affecting not just the fishermen but also the whole supply chain, including the processing, transportation, and retail sectors. The potential negative impact on fisheries due to ocean acidification underscores the need for immediate action to address environmental changes, as the livelihoods of many in coastal regions hinge on the health and sustainability of lobster populations.

Oysters and Ocean Acidification

The implications of ocean acidification will most likely lead to negative impacts on oysters as well. As explained by Arcgis (2022), “Adult lobsters are less vulnerable to ocean acidification than shellfish like oysters. That’s because oysters build their shells out of calcium carbonate, and acidic water dissolves the calcium carbonate and weakens the oysters’ shells.

Lobster shells contain some calcium carbonate, but it is mixed in with other components like chitin.” Oysters and other shellfish construct their shells primarily out of calcium carbonate, which is more susceptible to dissolution in acidic waters. This is the leading cause of shell weakness, making them highly vulnerable to environmental changes and predators. In contrast, lobster shells, though containing calcium carbonate, are composed of a mix of components, including chitin, which offers them a bit more resilience.

As oysters build their shells primarily from calcium carbonate, the increased acidity in ocean waters makes it more difficult to form and maintain these protective shells. This vulnerability leads to higher mortality rates and reduced growth among oyster populations. The consequences are particularly severe for leading oyster producers, such as those in the United States, France, Japan, and China, where oyster farming is a crucial part of the coastal economy. A decline in oyster health and numbers due to acidification can lead to substantial economic losses in these regions. This affects not only the livelihoods of those directly involved in oyster farming but also indirectly affects the entire supply chain, including processing, distribution, and retail.

Moreover, oysters are vital in maintaining the health of marine ecosystems by filtering water. Sargent (2023) states, "...other shellfish help remove excess nitrogen from waters by incorporating it into their shells and tissue as they grow. Oysters also filter these pollutants by consuming them or shaping them into small packets, which are deposited on the bottom of the sea where they are not harmful." This threat alone sheds light on how devastating this could be.

Ecosystem Disruption

The potential cascading effects on the marine ecosystem are a significant concern. The decline in shellfish populations like oysters and lobsters can alter the food web dynamics,

affecting many species, from small fish to large marine mammals. It can also lead to changes in the sea life's many habitats. This imbalance can lead to further ecological changes, some of which may be irreversible. Hence, it is imperative to study and understand the responses of different shellfish species to ocean acidification, as these insights are vital for developing strategies to mitigate the impacts and preserve marine biodiversity.

Declining Population

Recently, Maine's lobster population has declined, although it has not been directly caused by climate change. According to Ogrysko (2023), "Recent assessments show that the population of young lobsters in the Gulf of Maine has dropped, on average, by nearly 40 percent over a three-year period." However, although the decline is attributed to overfishing, it could also result from climate change. The same could be said in 2020, with the Chesapeake Bay Foundation (2020) informing, "Maryland's Department of Natural Resources has updated their assessments…the number of market-size oysters (larger than three inches) in 2020 was about 400 million, compared to approximately 300 million in 2018."

Fortunately, in recent years, oyster populations have been rising. Chesapeake Bay Foundation (2023) states, "Oysters saw a five-point improvement in the recently released *2022 State of the Bay* report… Both 2020 and 2021 were record years for oyster reproduction, with Maryland and Virginia reporting some of their highest numbers of juvenile oysters in the past 30 years." However, as OA increases, this problem will likely rise again.

Addressing the Problem

Addressing ocean acidification is crucial due to its wide-ranging and interconnected effects. This issue is not just about the health of marine creatures like lobsters and oysters but also has broader environmental, economic, and community impacts. The problem is complex and needs well-rounded strategies that consider all these aspects. Ocean acidification is closely linked to climate change since both are mainly caused by increased carbon dioxide in the air. Solving one without the other is not enough. Plans are needed to cut carbon emissions, support sustainable fishing, and protect our oceans.

The issue needs to be tackled from many angles. Governments, environmental groups, scientists, and the fishing industry must work together. Policies should focus on reducing carbon emissions, funding ocean acidification research, and helping communities that depend on fishing. Various studies and reports show how complicated ocean acidification is. They point out the direct harm to sea life and the more significant effects on food supply, jobs, and the diversity of life in our oceans. This information is a wake-up call, showing why we need to act now to lessen the impact of ocean acidification. Keeping our oceans healthy is vital for the well-being of our planet, so we must act quickly.

Conclusion

The changing ocean acidity is causing significant harm to lobster and oyster habitats, their physical well-being, and, by extension, the broader marine ecosystem and coastal economies. This essay has highlighted the critical roles lobsters and oysters play in aquatic ecosystems, the threats posed by ocean acidification to their habitats and physiology, and the broader implications for other shellfish species and coastal communities.

There is a clear need for further research in several areas. More studies are needed on how different marine species are uniquely affected by ocean acidification and on developing effective strategies to mitigate these impacts. Research should also focus on exploring more sustainable fishing practices and ways to reduce carbon emissions, critical drivers of ocean acidification. It's important to understand that the problem of ocean acidification is crucial not only to the environment but also to people's livelihoods. But quick and concerted action is necessary to keep our oceans safe.

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