

Ocean Acidification: The Importance of a Proactive Management Plan for Canadian Fisheries.

Executive Summary:

Ocean Acidification will have widespread effects on ocean ecosystems, affecting many if not all marine organisms that support economically important Canadian fisheries. Canada, through Fisheries and Oceans Canada, must implement a management plan to account for these changes, relieve fishing pressures where necessary, and potentially capitalize on new opportunities to ensure the sustainability of our natural resources.

What is Ocean Acidification?

Increased atmospheric concentrations of Carbon dioxide (CO₂) have caused similarly higher concentrations to dissolve into ocean waters. This upsets the equilibrium of carbonate ions (CO₃²⁻) and CO₂. CO₂ reacts with water (H₂O), producing bicarbonate ions (HCO₃⁻) and releasing protons (H⁺) into the water. Some protons will bind to CO₃²⁻ to create more HCO₃⁻. Therefore, ocean acidification results in two things: *more protons and less CO₃²⁻*.

Protons are the measurable effect of what constitutes ocean acidification – a higher concentration of protons means a higher acidity, or lower pH. Even conservative predictions based on IPCC carbon emission predictions forecast a 0.4 decrease in ocean pH by the end of the century. A change of this scale corresponds to a **150% increase in acidity** from pre-industrial era conditions¹. This change of acidity has many implications for marine organisms.

Less CO₃²⁻ has implications for marine organisms that use CO₃²⁻. This CO₃²⁻ undersaturation will affect shell-building organisms such as mussels and clams because they use CO₃²⁻ to build calcium carbonate (CaCO₃²⁻) structures. Studies have shown that the net effect of ocean acidification on organisms' ability to calcify and grow will be negative².

What Does it Mean for Canadian Fisheries?

Many if not all economically important fish and invertebrates will be affected by ocean acidification. Fisheries in Canada generate upwards of **3 billion dollars in exports alone**³, about 30 million of which is generated by shellfish and invertebrates that are likely to be directly affected by CaCO₃ undersaturation. Fish are likely to be affected indirectly by ocean acidification due to changes in food web dynamics, and acidity may also have direct effects of fish health.

¹ Feely, R.A., Doney, S. C., & Cooley, S. R. (2009). Ocean Acidification. *Oceanography*, 22(4), 36-47.

² Kroeker, K. J., Kordas, R. L., Crim, R. N., & Singh, G. G. (2010). Meta-analysis reveals negative yet variable effects of ocean acidification on marine organisms. *Ecology Letters*, 13(11), 1419-1434

³ Statistics Canada - International Trade Division

Not all effects will be detrimental. It has been shown that certain marine organisms, particularly photosynthetic organisms like non-calcifying seaweeds and photosynthetic plankton will in fact benefit. Some crustaceans, which can be economically important, may not be affected to any significant degree, positively or negatively⁴.

The Way Forward for Canadian Fisheries Management

Management plans for fisheries in Canada must include planning for changes due to ocean acidification. This will include *restricting* fisheries that are known to be vulnerable to acidification, but also encourage exploring new *sustainable options*. Ensuring that we have enough ongoing *monitoring and analysis* of fish and shellfish stocks to anticipate and adapt to changes will be essential. Plans should be in place to *react quickly* to changes in fish stocks noticed through this monitoring.

Knowledge on ocean acidification is largely already available throughout the scholarly community, but it is still an emerging topic and much research remains to be done. Particularly, fishes direct responses to acidification are not yet well understood. Fish represent a huge economic importance to Canada; Government management should include mandating *research* on fish as well as the organisms and habitats they rely on.

Conclusions and Recommendations

Future fisheries management steps must include:

- **Restrictions of fisheries known to be vulnerable to changes from ocean acidification.**
- **Identification and exploration of sustainable fisheries options with respect to ocean acidification.**
- **Ongoing long-term monitoring and analysis of fish stocks.**
- **Action plans that can take immediate effect if changes are noticed.**
- **A priority for ocean acidification research, particularly on fish.**

⁴ Kroeker *et al.* 2010.