AQUACULTURE AND CLIMATE CHANGE:

Ocean Warming

Gulf of Maine Research Institute

Overview

Sea surface temperatures (SST) in the Gulf of Maine are rising three times faster than the global average of 0.27 °F per decade since the 1980s. One of the climate-related challenges for aquaculturists lies in matching the species they farm with its habitable zone. As water temperatures increase above habitable tolerances, farmed species are increasingly susceptible to diseases, predators and pests, and organ stress. Changing season length (i.e., longer, hotter summers and shorter, warmer winters) can also affect industry operations both positively and negatively. Warmer water contains less oxygen and nutrients which, with other impacts, can lead to more hypoxic events (periods of low oxygen that can be fatal to marine animals). These are major risk for most marine species including farmed marine species.

Common Impacts

- **Decreased Production:** Farmed species that live at the edge of their habitable temperature zone have been documented to consume less food, grow slower, and produce lower-quality meat, each impacting the final price a producer can get for their product.
- **Marine Heat Waves:** Marine heatwaves, or prolonged periods of warm water, are increasing in prevalence and duration. If a marine heat wave is extreme enough, it can kill aquaculture species, but more likely it will contribute to an environment of stress that decrease yields.

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(Common impacts continued)

- **Hypoxia:** Heat reduces the amount of oxygen that can be dissolved in ocean water, contributing to hypoxia that can suppress feeding and growth rates.
- **Growing Season:** With warmer waters comes a longer growing season. On average, aquaculture farms can anticipate 3-4 extra weeks in the growing season. The downside to this impact is that pests, diseases, and harmful algal blooms also benefit from this extended growing season.

Risk Mitigation Strategies

- **Site management:** Select deeper or cooler sites to buffer against surface warming. While this mitigates some risk, this also introduces operational complexity, regulatory challenges, and complex interactions with established fisheries and a growing interest in offshore wind energy.
- **Real-time monitoring:** Track temperature and dissolved oxygen, with responsive harvest or feeding adjustments.
- **Selective breeding:** Develop or adopt strains of kelp and finfish that tolerate warmer conditions.
- **Diversification:** Incorporate species adapted to warmer conditions (e.g., alternative shellfish or seaweed species).
- **IMTA systems:** Pair species like kelp, shellfish, and finfish to stabilize water quality and distribute risk.

Case Studies

At **Muddy River Farm**, they are developing portable growing systems specifically designed to enable shellfish to easily be transferred between open ocean and terrestrial growing sites. This technology can be used to support the full life cycle of shellfish, or it can be used on an as-needed basis to protect them from environmental stressors. Post-harvest, startups are working on mobile refrigeration units, such as **Shred Electric's** Shred Cubes, that can be used in remote areas in lieu, or in addition to, ice to keep product cold on its way to market.

These resource sheets were created in collaboration with the USDA Northeast Climate Hub to improve understanding of the likely impacts of climate change on the region's aquaculture industry. If you have questions, or would like to learn more, you can reach out to jwildwistle@gmri.org, cmaurin@gmri.org, or scan the QR Code to see a list of resources used in the creation of these materials.