RI's Climate Challenge
Waves of Change

Changes to Marine Fish?

Changes Can Have Economic Impact

Because of constant changes in the region's environment, many species found at the edge of those geographical boundaries are more stressed, and as environmental conditions change their distribution can shift quickly and with environmental and economic consequences, especially for commercial fisheries.

There has been an increase in winter sea surface temperature, which is correlated with the decline of various species that reside in Rhode Island waters during the cold winter months (e.g., winter flounder). These cold-water species may be in the process of being replaced by seasonal, southern migrants (e.g., butterfish and scup) that are increasingly abundant during summer months.

This change has direct repercussions on commercial fishing in regard to the areas fished, the target fisheries, and the fact that bottom-dwelling (demersal) fish such as winter flounder fetch more on the open market than water-column (pelagic) butterfish.

Predators Flourishing

It is possible that warming waters are a significant cause of the decline of commercially important winter flounder by changing the spring timing of when the sand shrimp, which prey on juvenile flounder, become active during the year. The loss of the young fish naturally translates into fewer larger, catchable and saleable adult fish of the species. The reduction in winter flounder, which has essentially vanished as a viable target fishery in Narragansett Bay in the past two decades, is an economic blow to fishermen as well as local fish wholesalers, running down the indirect revenue ladder to restaurants and retailers.

In addition, it has been observed that in recent years, populations of the comb jellyfish (ctenophores), have grown in size, and the timing of their annual arrival in local waters has shifted from late summer to early summer due to warming waters. This has caused a significant decline of a common type of zooplankton, (copepods), once abundant in Narragansett Bay, due to predation by the comb jellies. Cancer crab, lobster, and some fish populations could also be affected by their larvae being consumed in larger quantities.

Lobsters Affected

Although lobster populations were found to have increased from the 1960s to 2000s, rising seawater temperature is expected to adversely affect lobster populations in the region.

Shifts of the lobster population northward and potential stresses such as increased incidence of disease have changed their population in the Rhode Island region. Temperature affects lobster health and behavior at all life stages, including molting, the settlement of post-larval lobsters, growth rates, and movement and seasonal migration. (Anyone who has seen the "Migration of the Lobsters" documentary on TV knows that the iconic New England delicacy can get around a bit on their own.)

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Currently, the southern limit of lobster along the Northeast coast is located near Long Island and northern New Jersey. As waters warm, this southern limit will move northward, possibly north of Rhode Island waters, causing a severe decline in the local fishery and an increase in the northern Gulf of Maine fishery. According to a comparison of lobster distribution between the relatively colder period from 1965 to 1969 and the warmer period from 2000 to 2004, the center of lobster geographical density has already shifted north. This is not good news to the Rhode Island lobstering fleet.

Widespread Major Shifts in Species

A further major shift in the Rhode Island Sound coastal fish community is from bottom-dwelling fish

species to smaller water-column southern fish species and large invertebrates (e.g., squid, crabs, lobster), with the resulting economic impacts to the fishing industry.

A significant decline (75 percent from 1980 to 2000) in winter populations of bottom-dwelling fish has been observed in Narragansett Bay while species that dominate the water column have increased (though less dramatically), which could be attributed to the effects of warming waters. That change is not unique to Rhode Island and the Northeast U.S. Similar climate-induced changes affecting bottom-dwelling communities have been observed in areas like the Bering Sea and North Sea.

The shift from bottom to water column species is consistent with similar shifts in other more southern estuaries, such as Chesapeake Bay. This change has been attributed primarily to increasing sea surface temperatures and, secondarily, to fishing pressures, with changes in food availability as another potential factor. So blame a gradually heating planet, not overzealous fishermen.

The North Atlantic Oscillation – It Matters

An increase of the winter North Atlantic Oscillation (NAO) that results in warmer ocean temperatures and the decrease of phytoplankton, is associated with the rapid alteration in the predominant species since the 1980s, and are strongly correlated to changes in the water column food web. Fish will go where what they want for dinner goes. Easy enough to understand.

During the NAO "positive phase," ocean water and climate is warmer in the eastern U.S, to the south of Cape Cod, and in Europe. It is projected that a positive NAO will dominate or have a strong presence during the next 50 to 100 years, especially in winter and if there remains a scenario where emissions of carbon dioxide are high. This means in all likelihood, the trends being observed now will likely continue at regional scales.

The ability of the commercial fishing industry to adapt to these changes will ripple across the economic and social spectrum of life in Rhode Island. Facing rising gas prices for boats to pursue the fish where they migrate, everyday family household needs, and a lower value for their type of catch, all ancillary industries from fish wholesalers to the local Stop & Shop and Walmart to the tourists waiting to tuck on their lobster bibs can expect to see a literal sea change.

Plankton And Bottom Dwellers

Plankton—The Unseen Impacts of the Food Chain

Time to put on your science hat in earnest. This stuff get tricky when one talks about things very few of us can see.

Climate changes such as warmer waters, increased cloudiness caused by an increase in storminess, and altered circulation patterns at both vertical and horizontal scales affect microscopic phytoplankton, which are a key to life in a marine ecosystem. The Northeast U.S. Continental Shelf ecosystem is affected significantly by climate change, which means phytoplankton feel the effects. And everyone else in the game, for that matter.

Phytoplankton form the foundation of marine food webs, and therefore changes in phytoplankton dynamics can have significant impacts on organisms throughout the food chain.

Warmer waters allow for higher rates of grazing of phytoplankton by zooplankton. (Think animal eats plant.) However, specific processes that result in changes in zooplankton community structure remain unclear and the implications for the remainder of the ecosystem are not fully known. But to be sure, any change results in more change, good or bad.

The Essential "Plankton Bloom"

Narragansett Bay has experienced a decline in the consistency of the winter-spring bloom of phytoplankton. The timing of the annual cycle of phytoplankton has shifted from a prolonged, bay-wide, large winter-spring bloom to a less consistent, less intense, shorter, winter bloom with brief intense blooms in the spring, summer, or fall.

Why does this matter?

Decreasing plankton blooms are projected to decrease food availability to juvenile bottom-dwelling fish (like the profitable winter flounder) due to declines in the bottom filter- and deposit-feeders that readily consume dead phytoplankton. Like children, undernourished young fish have a higher rate of not making it to adulthood.

Data show that at least since the 1970s, the amount of phytoplankton has decreased significantly in Narragansett Bay. It has been hypothesized that

these changes have been induced by climate change, specifically warming waters and an increase in cloudy days. Increased cloudiness limits phytoplankton growth because the photosynthesis upon which their lives rely is light-dependent.

Because the bloom now occurs later in the year, warmer waters allow for higher rates of grazing by zooplankton (animal eats plant, remember?). Increased grazing depletes the supply of phytoplankton that sinks to the bottom and provides food to the bottom-dwellers.

It has also been shown that sinking phytoplankton blooms in warmer weather have less nutritional value than cold weather blooms, which would further diminish the food supply of the bottom community.

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This decrease in organic matter reaching the bottom (resulting from the diminished phytoplankton bloom) can drastically alter fluxes of nutrients between the sediment and water column, with important implications for the ecosystem functions of Narragansett Bay.

Stratification and Mixing

Here comes the really hard part. If you start thinking oil and water, or for those of you who spend too much time in elegant bars, a pousse caffé, you get the image. Or maybe just conjure up one of those Dairy Queen sundaes where they layer the chocolate syrup with the ice cream in a see-through tall plastic cup.

The Need to Mix

Stratification of the water column means that oxygen-rich water at the surface does not mix down to the oxygen-poor bottom layer, causing a lack of oxygen to support life. This environmental scenario is known as a hypoxic condition, with a low level of oxygen in the water to let creatures and plants "breathe." You will hear great deal of talk among the professionals about "low DO" (a lack of dissolved oxygen) the next time a major fish kill occurs. It will essentially mean the fish suffocated.

Seasonal stratification in the waters of the outer Continental Shelf and continental slope have shown strong stratification – the division between the chocolate syrup and ice cream - of the water column during the spring and summer, and weakly stratified or mixed waters during the fall and winter.

Wind power increases the top-to-bottom (vertical) mixing. If wind speed declines in the area, as historical evidence suggests from the Rhode Island mainland, this would reduce the wind-mixing potential of the water column. Stronger storms, as projected, would increase the wind-mixing potential of the water column in Rhode Island waters.

A decrease in water column mixing could be a result of warmer surface water temperatures and increased inputs of freshwater from rivers into an estuary such as Narragansett Bay. Higher water temperatures decrease the amount of oxygen that the water can hold, and increase stratification, which could contribute to the occurrence and/or severity of low oxygen levels. And as water temperatures rise, the breathing rates of organisms in the water increase, thus increasing the demand on oxygen supply; in a watery sense, they suck the air out of the room.

The impacts of changes in river flow, solar heating, wind strength, and storminess due to climate change upon stratification patterns cannot yet be predicted, but we know it exists and has a harmful impact on life in those waters.

Harmful Algae Blooms

Warming waters due to changing climate have been reported as at least partially responsible for the increasing occurrence of harmful algal blooms (HABs) that can stress or kill aquatic organisms.

HABs are a rapid rise of phytoplankton to levels that pose threats to ecosystem and/or human health. Harmful effects upon ecosystems can result from a massive die-off of phytoplankton and can lead to depleted oxygen in the water column, caused by microbes associated with the HAB, creating very little oxygen or no oxygen (anoxic) conditions

HABs are now frequently occurring along the coast of Maine and are becoming more common in Massachusetts waters; however, HABs have not been documented in Rhode Island waters to date.

That doesn't mean they are not on their way. Anyone who remembers the Greenwich Bay fish kill of 2003, a seminal moment in Rhode Island environmental lore that led to a multi-million dollar investment by the state in the prevention of the nutrients/nitrogen that can trigger low oxygen conditions, needs to be reminded of the potential impact.