Global Climate Change and Regional Wetlands:
Impacts And Response

By Gillian Davies and Patrick Garner

In the last 100 years global climate change has proven to be the most insidious of organic revolutions -- on the one hand, almost invisible in its slow turnings, and on the other, sweeping in its worldwide implications. The majority of the world's scientists no longer debate its reality. Based on current science, how may these changes affect the New England region? And particularly, how may our vast waterways and wetlands be altered?

Quoting Daniel Webster in his opening remarks at the 2001 AMWS Annual Meeting, President William Kuriger said, "There is nothing as powerful as the truth, and often, nothing as strange." Bill also instructed the membership to, "Always seek the truth". Yet the truth, particularly when it reveals itself in incremental steps, is often easily ignored.

As scientists we do seek the truth. But driven by economic concerns, international corporations and other commercial stakeholders commonly resist environmental pressures to revise manufacturing processes and forms of energy consumption. These interests in turn exert tremendous pressure on political decision-making in this country. Regardless, the scientific community has reached a consensus that differs markedly from the voices of the politicians governing our country.

REGIONAL CLIMATIC CHANGES & IMPACTS TO WETLANDS

Graham Giese with the Woods Hole Oceanographic Institution notes that in Massachusetts, 65 acres of upland are lost yearly to rising sea levels, and that these adverse impacts will continue in the future, perhaps at an increased rate (1997, Giese). The EPA warns that many regional cold-water rivers and streams could be significantly affected by climate change. A recent report states, "Warmer air temperatures will lead to warmer stream temperatures eventually making habitat unsuitable for some cold-water fish species whose thermal tolerance is exceeded" (1995, EPA). Paul Epstein, Associate Director of the Harvard Medical School, writes, "Hotter summers increase photosynthesis and metabolism of algae, and also favor the more toxic forms—cyanobacteria and dinoflagellates… the affects can cascade through ecosystems and lead to increased diseases of shore birds, sea mammals, fish and humans" (1997, Epstein).

How will global climate change affect wetlands? David Wolfe, a professor at Cornell University, notes the following concerns for this region's wetlands: loss of habitat; increased toxic contamination; increases in invasive and exotic plants; increased eutrophication; accelerated atmospheric deposition; and increased septic runoff into waterways. He also notes that climate change will "… amplify many current stresses…" (1997, Wolfe).

As wetland scientists, we note that rising temperatures may particularly affect marginal and transitional wetland systems, decreasing their extent and modifying their vegetative types and diversity. Projections for increased volume of storm precipitation, seasonal shifts of storm events and increased peak events may lead to flashier rivers in the spring.

Warmer summer months may decrease river baseflow in many inland areas. Shifting precipitation patterns may dramatically alter the subtle dynamic between perennial and intermittent streams, leading to fewer and fewer perennial stream flows. Flooding events may become far more frequent due to continuing urbanization in combination with increased extreme precipitation, which in turn may create conditions highly conducive to higher erosive impacts throughout our river systems.

Quoting the most recent international assessment of wetland impacts to our region, "Altered precipitation and temperature regimes will affect the seasonal pattern and variability of water levels of wetlands, thereby affecting their functioning--including flood protection, carbon storage, water cleansing, and waterfowl/wildlife habitat" (1998, IPCC). The report goes on to note, "The responses of affected wetlands are expected to vary; they might include migration of the wetland area along river edges or the slope of a receding lake and/or altered species composition. More serious effects would include altered physical characteristics; degradation to a simpler, less diverse form; or complete destruction. There also could be a loss of desired attributes, such as their ability to provide suitable habitat for particular species; their ability to act as a feeding or breeding area in support of an adjacent open-water commercial or recreational fishery; or their ability to buffer occasional flooding (Mitsch and Gosselink, 1986; IPCC 1996, WG II, Chapter 6).

Vernal pools are likely to be particularly vulnerable to changes in precipitation and evaporation. Unlike perennial water features, their water supply is created annually, with no "borrowing" from water stored during a wetter year. Life cycles of vernal pool species tend to be adapted closely to the particular microclimate of a given locale. If a vernal pool holds water for a shorter amount of time, species may not have enough time to complete the aquatic phase of their lifecycle. If vernal pools hold water for longer periods of time, predatory insect populations tend to increase, thus decreasing or eliminating the branchiopods that they typically feed on. Changes in water temperature can effect longevity of the pool, as well as the timing of hatches (1997, Graham).

HIGHER SURFACE TEMPERATURES PROJECTED

According to the Intergovernmental Panel on Climate Change's Draft Third Assessment Report (issued 2/19/2001), our globally averaged surface temperatures have increased by about 0.6 degrees Celsius during the 20th century, and are projected to increase 1.4 to 5.8 degrees Celsius by 2100 relative to 1990. Average global sea levels are modeled to rise 0.09 to 0.88 meters by 2100 (0.3 to 2.9 feet). Prior estimates (released three years ago) for climate change projected a less dramatic increase in temperature and sea level rise. Climate change modeling capabilities have increased significantly, resulting in revised estimates. New evidence supports the idea that most observed climate warming over the last 50 years has been caused by humans.

The National Assessment Synthesis Team (2000, US Global Change Research Program), has issued a report titled "Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change". It notes that in the northeast region of the United States, coastal areas have already warmed by up to 4 degrees F during the 20th century. During this period, precipitation in this region has increased by more than 20% in most areas, although some locations have experienced precipitation decreases. These reports are also corroborated by recent hydrological studies from Cornell University and others (1993, Wilkes). In addition, precipitation extremes have increased, while drought now occurs in fewer places in New England. During the last 50 years, the time period between first and last dates of snow cover has decreased by 7 days.

The same report goes on to state that in the Northeast, temperatures are projected to rise 4 degrees to 9 degrees F by 2100. Temperatures would increase the most in coastal areas, and winter minimum temperatures would increase more than maximum temperatures. Projections of precipitation changes range from small regional decreases to as much as 25% increases. Increases in spring flooding are likely, due to increased rapid snowmelt events and heavy rains falling on frozen ground. Hurricane intensity and frequency may change (due to warmer air carrying more water vapor).

Further, research indicates that activity of soil microorganisms will increase with increased temperatures. Climate change is likely to increase water temperatures as well, which will intensify the pressures already placed on water-based ecosystems by urban and agricultural runoff and other forms of water pollution. Coastal salinity could be affected by changes in precipitation and runoff. Saline wedges are expected to be driven further up into our larger streams. Many areas of coastal wetlands are caught between rising sea levels and developed inland areas, which effectively prevent inland migration of wetlands as a response to sea level rise. Less severe winters may allow greater survival of vector-borne diseases and their hosts (such as deer, mice and Lyme-disease transmitting ticks).

ACTIONS, REACTIONS & POLITICS

Although many governments in the world are willing to take steps towards reducing the emission of greenhouse gases, our current federal administration appears increasingly disinterested in substantively addressing the emerging realities about the impacts of climate change.

At this time, the Massachusetts state government is not addressing these issues. What actions can we take on a local or state level? Should the state be planning for impacts from climate change? Is it unrealistic to begin to plan for environmental impacts that may not be completely understood for years to come? Should we modify our resource management strategies? If so, how, and in what ways?

Rather than relying on politicians to take care of this “global” problem for us, we believe that we can and should begin to address these anticipated climate changes on the local, state and regional level. In the words of an old saying, “If the people will lead, the leaders will follow.”

As representatives of the wetland community, what questions do we need to be asking ourselves? What is going to happen to the New England landscape and New England wetlands as climate change proceeds? How should we adjust wetlands regulation and management to account for the effects of climate change in our region of the world? What is the particular role of wetlands in climate change mitigation? What happens to marginal wetlands such as vernal pools, and the species that depend on them, as temperature, precipitation and evaporation increase? With increased soil microorganism activity, how will wetland soils change? What will these effects be on wetland vegetation, and on animals dependant on wetlands? In what ways do we shift our resource protection focus, given what we know about climate change? How do we protect ecosystems that are in an unusually rapid state of flux? Are we protecting resources in a way that maximizes long-term survival of the resource? Are some of our current policies irrelevant in light of projected changes? What can be done at the regional, state and local level, without waiting for the federal government to take a leadership role?

AMWS, as an organization of professional scientists, can play a key leadership role at the state and regional level. We can start by educating ourselves and by actively bringing this topic into the public policy debate. We can join with the many regional universities and non-profit scientific organizations that are currently studying these impacts. For an issue that is going to have such a widespread impact on all of our lives, and as importantly, on the lives of our children and grandchildren, climate change impacts confront a disturbing silence in the arena of public policy. We can change that.

Climate change websites:
Intergovernmental Panel on Climate Change: www.ipcc.ch/
EPA Global Warming Site: www.epa.gov/globalwarming/
Union of Concerned Scientists www.ucsusa.org/
SURVAS www.survas.mdx.ac.uk/
National Assessment Synthesis Team www.gcrio.org/NationalAssessment
[Note: the above sites are a selected listing from 100's of private and government sites available worldwide. Each of these sites has many additional links.]

Selected References

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IPCC Working Group I. 2001. (Draft) Intergovernmental Panel on Climate Change Working Group I Third Assessment Report.
IPCC Working Group II. 2001. (Draft) Intergovernmental Panel on Climate Change Working Group II Third Assessment Report. Summary for Policymakers: Climate Change 2001: Impacts, Adaptation, and Vulnerability.
New England Regional Climate Change Impacts Workshop. September 1997. Institute for the Study of Earth, Oceans, and Space. University of New Hampshire. Speaker papers by: Paul R. Epstein; Graham S. Giese; Barry D. Keim; and Daniel Wolfe. Report of the Natural Resources Sector and report entitled, "Seasons of Change: Global Warming and New England's White Mountains."
Wilks and Cember. 1993. Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada. Cornell University.

ADDENDUM:
SELECTED SECTIONS FROM "THE REGIONAL IMPACTS OF CLIMATE CHANGE—AN ASSESSMENT OF VULNERABILITY (1998, IPCC)

"Seasonal patterns in the hydrology of mid- and high-latitude regions could be altered substantially, with runoff and streamflows generally increasing in winter and declining in summer…

"Higher air temperatures could strongly influence the processes of evapotranspiration, precipitation as rain or snow, snow and ice accumulation, and melt-which, in turn, could affect soil moisture and groundwater conditions and the amount and timing of runoff in the mid- and high-latitude regions of North America. Higher winter temperatures in snow-covered regions of North America could shorten the duration of the snow-cover season…Warmer winters could lead to less winter precipitation as snowfall and more as rainfall, although increases in winter precipitation also could lead to greater snowfall and snow accumulation, particularly at the higher latitudes. Warmer winter and spring temperatures could lead to earlier and more rapid snowmelt and earlier ice break-up, as well as more rain-on-snow events that produce severe flooding, such as occurred in 1996-97 (Yarnal et al., 1997)…

"… climate change will have its greatest effect through alterations in hydrological regimes-in terms of the nature and variability of the hydroperiod (the seasonal pattern of water level) and the number and severity of extreme events (Gorham, 1991; Poiani and Johnson, 1993). However, other variables related to changing climate may drive a site-specific response. Such variables include increased temperature and altered evapotranspiration, altered amounts and patterns of suspended sediment loadings, fire, oxidation of organic sediments, and the physical effects of wave energy (Mitsch and Gosselink, 1986; IPCC 1996, WG II, Chapter 6)…

"Altering climate and acid depositions can cause declining levels of dissolved organic carbon (DOC) in wetlands-thus increasing the water volumes, sediment areas, and associated organisms exposed to harmful ultraviolet-B (UV-B) irradiation. Potential effects include changes in aquatic communities and photoinhibition of phytoplankton (Schindler et al., 1996; Yan et al., 1996)…

"In many regions, projected increases in hydrological variability would result in greater impacts on water resources than changes in mean hydrological conditions (IPCC 1996, WG II). Increases in the frequency or magnitude of extreme rainfall events would likely have their greatest impacts on water resources in the winter and spring, when the ground is frozen or soil moisture levels are high; severe flooding may be more likely. More severe or frequent floods could result in increased erosion of the land surface, as well as stream channels and banks; higher sediment loads and increased sedimentation of rivers and reservoirs; and increased loadings of nutrients and contaminants from agricultural and urban areas (IPCC 1996, WG II, Section 10.5.5). Longer dry spells would likely have their greatest impact in the summer, when streamflows generally are low. Increases in the severity of summer droughts could result in reduced water quality (e.g., lower dissolved oxygen concentrations, reduced dilution of effluents) and impaired biological habitat (e.g., drying of streams, expansion of zones with low dissolved oxygen concentrations, water temperatures exceeding thermal tolerances) (IPCC 1996, WG II, Sections 10.5.3 and 10.5.4)…

"Projected increases in hydrological variability (e.g., more frequent or larger floods) could lead to increased expenditures for flood management and disaster assistance (IPCC 1996, WG II, Section 14.4.3). Flood-control structures might require modifications to accommodate larger probable maximum-flow events. Alternatives to structural flood-control measures can be instituted to reduce risk at a lower cost to society, but these strategies require significant political will. Even with the high frequency of extreme events that have occurred recently (and their attendant costs), changes to less-costly and more effective nonstructural methods of risk reduction are slow in gaining acceptance… More severe summer droughts also could increase agricultural irrigation demands (IPCC 1996, WG II, Section 14.3.1)

"In general, water-quality problems (particularly low dissolved oxygen levels and high contaminant concentrations) associated with human impacts on water resources (e.g., wastewater effluents) will be exacerbated more by reductions in annual runoff than by other changes in hydrological regimes (IPCC 1996, WG II, Section 14.2.4)…"