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By

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Subject:
Global warming and wildlife impacts in the Commonwealth of Virginia.

Global Warming and Wildlife.
Summary of testimony

I examine the magnitude of predicted global warming events, and discuss wildlife impacts using examples from the Commonwealth of Virginia.

Worldwide projections of temperature rise over the next century vary between 1.5^{o}C and 5.5^{o}C. Current models do a better job of predicting temperature than they do of predicting rainfall at the regional level. The scenarios for Virginia in the coming century predict temperature increases from 3.5^{o}C to as high as 6.5^{o}C clustered in the summer months, but the accompanying overall rainfall patterns vary between drier and wetter in total amount, sometimes with a wetter spring but drier fall months, and often with more extreme rainfall events. Fresh water supply dominates much of what we see in wildlife biology.

Virginia is an excellent example of a natural laboratory in which to study the impacts of global warming. It sits at a number of important biogeographic boundaries where animal and plant species, both terrestrial and aquatic, change in north-south and east-west directions. Climate, and particularly temperature, is a causative agent in determining these boundaries.

A transect from west to east across the landscape of Virginia includes the forested foothills of the Appalachians, the coastal plains, freshwater wetlands, tidal salty estuaries feeding the Chesapeake Bay, coastal barrier islands and the inner continental shelf. Remarkable diversity exists both along the transect and within each habitat type. The plant and animal communities that occupy these habitats have evolved over geological time. Destabilizing the relationships between just a few of these contributing species can have a domino like effect resulting in large and deleterious impacts on the entire community. Examples of projected global warming impact include higher prevalence of forest fires, increased impact of insects on forest resources, increased displacement of native plants by invasive species in forests, freshwater wetlands and managed agriculture, change in river flow and water quality impacts on freshwater fishes, increasing low dissolved oxygen dead zones in the Chesapeake Bay, increased incidence and intensity of diseases of both fish and oysters, loss of critical submerged aquatic vegetation habitat, reduced feeding opportunities for migratory bird populations on the Atlantic flyway, and the changing distribution of ecologically and commercially important species on the inner continental shelf.

Global Warming and Wildlife.
Testimony text

Mr. Chairman, Members of the Committee, it is a pleasure to be here today in response to your invitation to provide testimony on Global Warming and Wildlife.

My name is Roger Mann. I am a Professor of Marine Science and Director for Research and Advisory Services at the School of Marine Science, Virginia Institute of Marine Science, College of William and Mary. I have been a researcher examining natural ecosystems and their management for both ecological services and sustained harvest of commercially valuable products for over thirty years. While my primary focus has been on estuarine and coastal systems it is impossible to examine such systems without an appreciation of the biology of the complex watersheds that are the source of the rivers that feed these estuarine and coastal systems. Today I focus my remarks on the magnitude of predicted global warming events, and discuss wildlife impacts using examples from my adopted home state, the Commonwealth of Virginia.

Global warming is a real phenomenon. Worldwide projections of temperature rise over the next century vary between 1.5^{o}C and 5.5^{o}C. A current scientific challenge is to refine models that were designed to make predictions at the global level and make them amenable to predictions at the regional level. There are roughly twenty different global models operating on about 14 supercomputers around the world that are focusing on these problems. At the regional level the models do a better job of predicting temperature than they do of predicting rainfall. The scenarios for Virginia in the coming century predict temperature increases from 3.5^{o}C to as high as 6.5^{o}C clustered in the summer months, but the accompanying overall rainfall patterns vary between drier and wetter in total amount, sometimes with a wetter spring but drier fall months, and often with more extreme rainfall events. Fresh water supply dominates much of what we see in wildlife biology. These warm and wet, or warm and dry scenarios have clear implications for change in natural populations in Virginia and elsewhere.

I argue that Virginia is an excellent example of a natural laboratory in which to study the impacts of global warming, that impacts are becoming evident in all natural systems within the state, and that they are cause for concern. Virginia sits at a number of important biogeographic boundaries where animal and plant species, both terrestrial and aquatic, change in north-south and east-west directions. Climate, and particularly temperature, is a causative agent in determining these boundaries. A simple viewing of a weather map on the evening news illustrates the role of climate. In the winter the jet stream can dip in a southerly direction and cold air moves in from the mid west and southern Canada. As the jet stream moves north warmer air displaces the cold air. By contrast summer weather is dominated by warm, humid air masses from the Gulf of Mexico. Gradual changes in the duration and extensions of these respective air masses in a north to south direction translates into shorter and warmer winters and/or or longer and wetter summers. Again, both have implications for the natural populations.

A transect from west to east across the landscape of Virginia includes the forested foothills of the Appalachians, the coastal plains that support a mixture of forestry and agriculture, freshwater wetlands whose values as filters of water have only recently been fully appreciated, tidal salty estuaries feeding the Chesapeake Bay with its fringing marshes, coastal barrier islands and the inner continental shelf. Remarkable diversity exists both along the transect and within each habitat type. Indeed, it is the rich biodiversity within local habitats that contribute to their stability. The plant and animal communities that occupy these habitats have evolved over geological time. The complex interactions between these community members is all important, and if there is a single message that I leave with you today it is that destabilizing the relationships between just a few of these contributing species can have a domino like effect resulting in large and deleterious impacts on the entire community. Consider as an analogy a spider's web, all parts contributing to stability in function. But break a limited number of strands and the web is weakened. Just a few more strands and the web collapses. A universal concern among biologists throughout the Commonwealth of Virginia is that global warming will unravel just a few of those strands with cascading impacts.

Let me walk you from the Appalachians to the ocean shelf and provide just a few examples of our concern.

- As summer temperatures increases there is expectation that forest species typical of the Appalachian foothills will move both north and to higher altitude. Warmer temperatures alone in combination with lower rainfall favor conditions that promote fires and increase the probability that stressed trees will eventually succumb to insect and disease problems – especially so when insect species can migrate faster than trees.

- All plants respond on a seasonal basis to both temperature and day length in their annual cycles of growth and reproduction. Changing the synchrony of these events by elevating temperature in a fixed sequence of day lengths can be expected to disrupt the equilibrium in forest communities. Insects play important roles in forest ecosystems as both food for higher trophic levels, such as birds and small mammals, and as destructive agents of trees. Warmer temperatures will both increase the range of destructive insects and alter insect life cycles, for example reducing two -year life cycles to one year with obvious doubling of the impact on the host trees. Such situations have already been documented in western states where warming has allowed the pine borer beetle to move to higher latitudes and attack stands of lodgepole and ponderosa pines. Pine beetles now attack white bark pines, essential habitat for grizzly bears.

- Changes in physical forest structure by the death of trees creates fragmentation of the footprints of forest growth on larger spatial scales. Disturbance at the edge of forested areas provides opportunity for invasive species, usually non-native to the Commonwealth but introduced over time either intentionally or by accident, to establish a foothold and eventually expand their range with displacement of native species. Non-native plant species often remain green through warmer periods that

stress native forest plants, compounding their advantage in warmer conditions. Indeed, invasive species such as the Tree of Heaven (*Ailanthus altissima*), Japanese Honeysuckle (*Lonicera japonica*) and the Multiflora Rose (*Rosa multiflora*) have been documented to make up one half of the biomass in some stressed and invaded forest communities in Virginia. Changes in forest composition may pose grave problems for the many migratory birds that pass through the region. Virginia's Department of Forestry closely monitors this situation.

- Managed agricultural land in Virginia is richly used by wildlife. It is possible that climate and water conditions will help some commercial crops in the short run, but it is also likely that climate changes will lead to lower yields and many important food crops would be less nutritious. Maintenance of productivity on Virginia farms lands is a constant adaptive response to rainfall, temperature, and the vagaries of pests, parasites and weed species, many of which are invasive. A general increase in temperature will drive out native animals and encourage the spread of potentially destructive tropical plant and insect invasive species, such as, tropical soda apple (*Solanum viarum*), cogongrass (*Imperata cylindrical*), water hyacinth (*Eichhornia crassipes*), and pink hibiscus mealybug (*Maconellicoccus hirsutus*). The vigilance of Virginia's Department of Agriculture and Consumer Services insures rapid response to local threats.

- Invasive plants such as the common reed *Phragmites australis* threaten stressed freshwater marsh habitat resulting in significant change in community structure and opportunities for native wildlife.

- Temperature and rainfall both drive in-stream river flow and water quality parameters that are central to successful growth and reproduction of freshwater fishes in Virginia rivers.

- Divergence of long-term temperature and day length synchrony could impact food chains supporting resident fishes in rivers and streams. Studies in Seattle's Lake Washington have demonstrated an advance in the timing of the spring plankton bloom with warming temperature; however, key zooplankton species, on which fish feed, that typically graze on the bloom have not changed their seasonal activity and now miss the optimal grazing period. Fish go hungry.

- Estuaries are enormously complicated ecosystems, changing over time and across spatial scales. The Chesapeake Bay is the largest estuary in the nation, with a watershed covering 8500 square kilometers, 60 % of which are forested, and a resident population of over 15 million people. This water body is a national treasure in terms of its recreational, commercial and societal value. Oxygen solubility in seawater decreases as temperature increases creating an increasingly stressful environment for resident species living in shallow waters, but it can and does get worse in deeper water. Each summer part of the main stem of the Bay stratifies as warmer, fresher water layers above denser, saltier water. The deep

layers do not mix and their oxygen content is depleted – hypoxia (low oxygen) and eventually anoxia (no oxygen) dominate. Such deep regions have been described as dead zones. We know the dead zone is getting bigger each year and all the projections associated with global warming scenarios predict an increase in its size.

- Dead zones force species that typically seek refuge in deeper, colder water into warmer shallower water where they suffer physiological stress. A prime example is the striped bass (*Morone saxatilis*). Ecologically important, recreationally and commercially valuable - a magnificent fish. We know that 80% of the striped bass in the Bay are infected with a disease called *Mycobacteriois*, but this is manifested predominantly in stressed fish. Warmer waters, we suspect, bring increases in the numbers of fish characterized by large skin lesions.

- Submerged aquatic vegetation (SAV) in the shallow waters of the bay form complex shallow water habitats that are critical for small crabs and fish. Bay SAV populations are under stress. The single dominant native SAV species, eelgrass (*Zostera marina*), is already at the southern end of its range and increased temperature contributes to its local instability. Indeed, a significant die off in eelgrass in 2005 has been related to local high water temperature. The prospect for displacement of the native eel grass by the more temperature tolerant widgeon grass (*Ruppia maritima*) is not comforting in that widgeon grass is more ephemeral in nature.

- Oyster (*Crassostrea virginica*) populations in the bay have been ravaged over the past 4 decades by two diseases, commonly termed MSX (*Haplosporidium nelsoni*) and Dermo (*Perkinsus marinus*), whose activity is temperature dependent. Indeed increasing water temperature has been identified as the primary agent allowing the range extension of Dermo, with its deleterious impacts, from the Chesapeake Bay northwards to the Delaware Bay and Long Island Sound over the past two decades. Very large investments have and are being made to restore the bays oyster resource and the industry that it supports. The added challenge of increased disease prevalence and intensity makes this task yet more difficult.

- The Eastern Shore of Virginia is a critical feeding station on the Atlantic flight path for migratory birds. As food species are stressed, consider for example the value of horseshoe crab (*Limulus polyphemus*) eggs during breeding events between the tide lines, these bird populations face literal life and death situations.

- On the inner continental shelf the bottom dwelling dominant species, the surf clam (*Spisula solidissima*, also a notable fishery resource) is changing in distribution. Forty years ago this species was abundant between the Virginia Capes and Cape Hatteras in North Carolina. Now, they are virtually absent south of the mouth of the Chesapeake Bay. The populations are increasingly being limited to more northerly and deeper waters by increasing summer water

temperatures. We suspect this offshore migration describes the distribution of many Mid Atlantic species.

The addition of climate change to the mix of stressors already affecting valued habitats and endangered species will present a major challenge to future conservation of U.S. ecological resources. Across Virginia, from the Appalachians to the inner continental shelf, we are observing changes in natural populations of endemic plants and animals that can arguably be linked to global warming, and we expect trends to continue. As biologists we are concerned. As custodians of this rich natural resource we should all be concerned.