

American Water Resources Association
2009 SPRING SPECIALTY CONFERENCE
Managing Water Resources Development in a Changing Climate
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Tuesday, May 5
10:30 AM – 12:00 Noon
Session 17: Aquatic Ecosystem Impacts II

1. Linking North Slope Climate, Hydrology, and Fish and Wildlife Management - Erica Betts,
University of Alaska Fairbanks, Fairbanks, AK (co-authors: Amy Tidwell, Jeff Adams, Philip Martin)

The North Slope of Alaska provides critical habitat for a large number of fish and wildlife populations. Climate change is affecting the Arctic in profound ways through changes in sea ice levels, snow fall, precipitation and temperature. Changes in these parameters create stresses which fish and wildlife populations must adapt to if possible. A key challenge for many agencies on the North Slope, such as the U.S. Fish and Wildlife Service is to try and determine how the present and future effects of climate change will trigger responses in the fish and wildlife populations which they manage. One method currently being developed, in response to this challenge, is to characterize the hydrology of the North Slope and connect those hydrologic factors to landscape processes and ultimately to patterns of fish and wildlife populations. This study will begin by assessing the current state of knowledge about the relationship between hydrology and fish and wildlife habitats. This will provide a foundation for identifying fresh water provinces across the North Slope. These provinces will be determined based on characteristics of climate, hydrology, fish and wildlife distributions, and habitats. This will require a multi-disciplinary approach involving experts in climatology, hydrology, and remote sensing as well as fish and wildlife biologists. The North Slope of Alaska is an expansive, remote landscape facing both the pressures of climate change as well as the potential for increased oil and gas development. The fact that the North Slope is both large and remote has allowed it to maintain large populations of fish and wildlife as well as provide a challenge to scientists seeking to understand and characterize the physical and biological systems. This study is an effort to bring together current understanding of the biological and physical systems on the North Slope and use hydrologic characteristics to link the climate system to the biological system. The ultimate goal is to provide a tool by which ecosystem and wildlife managers can assess possible future changes in fish and wildlife populations resulting from climate change forecasts.

2. Vulnerability and Adaptation in British Columbia's Freshwater Ecosystems - Katherine Wieckowski, ESSA Technologies Ltd., Vancouver, BC, Canada (co-authors: Marc Neltiz, Marc Porter, Katrina Bennett, Todd Hatfield, Katy Bryan, Dave Marmorek)

In the Pacific Region, it is expected that climate change and variability will lead to a variety of measurable changes in freshwater environments. Changes in air temperatures and in the amount, form, and timing of precipitation, snow pack (melt), and stream flow are expected. The biological implications of these physical changes on freshwater ecosystems and species are significant as changes in timing / magnitude of water flows and thermal regimes are fundamentally linked to behavioural and physiological responses of aquatic species. The effects of human activities (stressors and restoration actions) on freshwater ecosystems are overlaid on these biophysical responses. Stressors can magnify adverse effects by reducing water availability and quality in freshwater habitats. Alternatively, restoration actions may buffer the effects of climate change by managing freshwater supplies during low summer flow periods when migration, spawning, and rearing occur. It is therefore important to develop adaptation strategies (i.e., reducing stressors or implementing restoration actions) that benefit freshwater ecosystems affected by climate change and variability. Adaptation strategies should be designed on the basis of a credible assessment of vulnerabilities. This presentation briefly describes methods to assess vulnerabilities of freshwater ecosystems. A first method identifies streams that are "temperature sensitive", defined as having temperatures high enough to cause negative effects, reduced capacity for regulating stream temperature due to altered/degraded ecosystem function from land use, or are sensitive to the effects of climate change. A second method focuses on identifying instream-flow needs for fish using (a) a meta-analysis of instream-flow studies; and (b) calculations of minimum in-stream flow requirements based on historic variability in

daily naturalised flow data. A third method identifies the effects of changes to stream flow on habitat capacity and fish abundance using habitat-based intrinsic potential and juvenile production models. We present a case study of a northern area in the Fraser Basin to illustrate how different methods for assessing flow and temperature vulnerabilities can be integrated into a common framework to see how freshwater ecosystems respond under several climate change scenarios. Last, we present alternative adaptation strategies available to managers to cope with identified freshwater ecosystem vulnerabilities.

3. Temporal and Spatial Variability in North Carolina Piedmont Stream Temperature - Johnny Boggs, USDA Forest Service, Raleigh, NC (co-authors: G. Sun, S.G. McNulty, W. Swartley, E. Treasure, W. Summer)

Future climate change affects aquatic ecosystem by degrading water quality through elevating its temperature. Understanding temporal and spatial patterns of in-stream temperature can provide useful information to managing future impacts of climate change on these systems. This study will compare temporal and spatial patterns of headwater in-stream temperature in six catchments in the piedmont of North Carolina (NC) and examine if streamside management zones can moderate the effects of increases in air temperature. The NC Neuse River Buffer Rules were established in the 1990s to protect nutrient sensitive waters through maintaining and protecting existing buffers. These buffers can provide additional benefits including moderating daily diurnal fluctuations and stream temperature maximums. In October 2007 six catchments ranging from 12 to 46 hectares (i.e., four on Hill Forest and two on Umstead Research Farm) with perennial stream channels were outfitted with water temperature probes. The monthly maximum stream temperatures ranged from 10.6 – 16.2 oC and 12.6 to 17.9 oC in the Hill Forest paired catchments and 13.7 – 20.3 oC and 12.3 – 18.5 oC in the two larger catchments during the winter. The monthly maximum temperature in the summer range from 19.1 – 20.2 oC and 20.4 – 21.4 oC in the Hill Forest paired catchments and 25.8 – 25.8 oC and 22.6 – 22.9 oC in the two larger catchments. Monthly maximum stream temperature in one of the streams at Umstead was 10.7 – 17.8 oC in the winter and 24.4 – 24.8 oC in the summer. The diurnal fluctuations were relatively small averaging 1.5 oC during the summer, but higher in the winter in each stream. Air and monthly maximum stream temperatures were linearly related ($p < 0.05$) with the highest correlation occurring in the winter when compared to the summer. This suggests that the trees along the buffers are moderating the affects of air temperature on water temperature by reducing wide fluctuations in temperature. Using the water-air temperature linear model, a 1 oC increase in monthly maximum air temperature will increase surface water temperature by 0.4 and 0.5 oC in the summer and winter, respectively.