Contaminant Biogeochemistry in Terrestial and Freshwater Ecosystems

Jesse Ford (Fisheries and Wildlife) uses a diversity of techniques to examine the sources, status, and significance of anthropogenic contaminants, including semivolatile organic compounds, elemental particulates (e.g., lead, copper), and mercury, in terrestrial and freshwater landscapes. One aspect of this work is determining relative contributions of long-range atmospheric transport, local point sources, and biotransport by anadromous fish from marine to freshwater environments.

In work funded by the U.S. Environmental Protection Agency, the moss monitoring technique was used to delineate spatial patterns of contaminant deposition in the U.S. Arctic and selected regions of the Russian Arctic. This work demonstrated that both arctic Alaska and the Taimyr Peninsula north of Norilsk have surprisingly low concentrations of particulates related to arcric haze, leaving the ultimate depositional fate of contaminants

continued on page 6

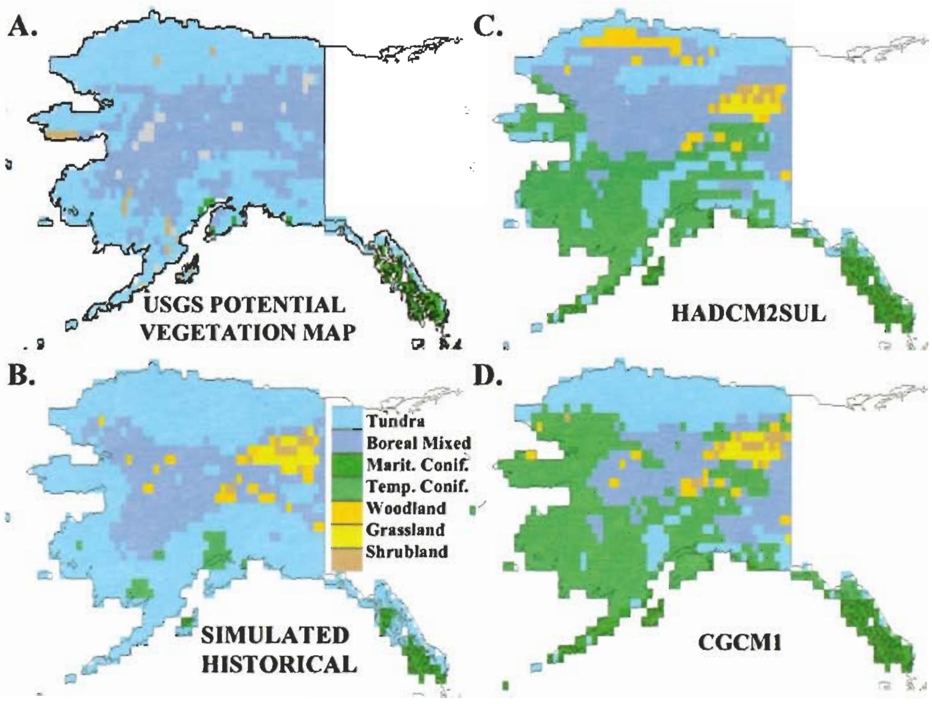
Iñupiat and western scientists plan collaborative research on contaminants in freshwater environments in northern Alaska. During an early planning meeting in Barrow, elder Joshua Nashaknik (far left) discusses good places for whitefish at several subsistence fish camps with (left to right) Jesse Ford (OSU), elder Warren Matumeak, elder James "Jake" Kignak, and translator Maasak Akpik. Not pictured: Joeb Woods, Sr. Photo by Susan Allen-Gil, Ithaca College.

from Eurasian pollution centers unknown. Against this spare background, the influence of local point sources of particulate elements can be seen easily. In contrast to particulates, semivolatile organochlorine compounds show distinctly different signatures in Alaska versus the Taimyr. These results are consistent with the global distillation model in which contaminants that volatilize in warm low latitudes later condense and are deposited in cold higher latitudes, resulting in a net poleward movement of the lighter PCB congeners.

The recent discovery of sockeye salmon *(Oncorhynchus nerka)* as an important vector of PCBs to inland lakes in southcentral Alaska brought the relative role of atmospheric deposition to aquatic foodwebs into question. It also raised the issue of whether similar processes might be influencing arctic freshwater habitats further north, where atmospheric inputs might be expected to be higher (due to lower temperatures) and biotransport by fish lower (due to differences in species composition). On the western Alaska Coastal Plain, salmon are relatively rare, but a substantial subsistence fishery targets several species of whitefish that use both marine and freshwater habitats. Funded by NSF, collaborative work with Ithaca College and local Iñupiat whitefish experts has demonstrated that differences between freshwater resident versus seagoing least cisco *(Coregonus sardinella)* and broad whitefish *(C. nasus)* are minor and that, again, contaminant burdens are relatively low. Associated work by OSU graduate student John Seigle used otolith microchemistry to investigate contemporary life histories of least cisco. Contrary to conventional wisdom that least cisco feed in brackish water during the summer, less than 10% had ever used marine habitat, although use of marine habitat was found to be common in broad whitefish.

Climate Change Modeling

Dominique Bachelet (Bioengineering) and colleagues at OSU and the U.S. Forest Service (USFS) have developed the Dynamic Global Vegetation Model (DGVM) MC1 to predict what climate change scenarios will mean in terms of vegetation growth, plant and soil processes, carbon storage or emissions, forest fire, and other important ecological effects. Funded by USFS, the model's preliminary results point toward significant changes to Alaskan ecosystems. Under a climate scenario that projects significant warming (CGCM1), the model suggests that 90% of the tundra present in Alaska in 1920 could be gone by 2100, with the only large area remaining near the north coast. Under a more conservative scenario (HADCM2SUL), the DGVM indicates that 77% of the tundra could disappear during that time. Interior boreal mixed forests could migrate towards the northeast, yielding to maritime and temperate conifer forests much like those of southeast Alaska (figure below). Because of an increase in statewide biomass with the northward advance of the temperate coniferous forest, the area burned by wildfires increases across the entire state. Insects and pathogens may also cause massive epidemics of plant disease and insect attack—in some cases causing large forest die-offs that could then lead to even more fires.



Under two scenarios of future climate, the Dynamic Global Vegetation Model (DGVM) predicts a loss of total area of tundra and a significant expansion of temperate coniferous forest in Alaska by 2100. A) Potential vegetation map (re-sampled digital map of the Major Ecosystems of Alaska, U.S. Geological Survey, approx. 1991) and simulated vegetation distribution under B) historical climate conditions 1922–1996, and under two climate change scenarios C) HADCM2SUL and D) CGCM1 for the decade 2090–2100. Figure by D. Bachelet.