Snow Ecology: A Report on a New Initiative
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tion, Plants/vegetation, Ecology, Animals/wildlife, Anthropology, Climate/paleoclimate, Archaeology, Geology, Education, Soil, or Other), and the geographic location and community type.

Papers summarizing existing research data/information on plants or animals of a savanna/barren type are encouraged. Savanna/barren types include but are not limited to the following: redcedar barrens; jack pine barrens; spruce barrens; New Jersey pine barrens; foxtail pine barrens; sand pine scrub; California or midwest oak savanna; longleaf pine savanna; ponderosa pine savanna; aspen parkland, etc.

Authors of papers or posters accepted for presentation will be notified by 15 May. At that time, authors will be mailed instructions for developing and formatting an expanded abstract of not more than 3 single-spaced pages with total length not to exceed 5 pages. Expanded abstracts will be compiled into a conference proceedings that will be distributed at the conference.

6th International Symposium on the Microbiology of Aerial Plant Surfaces

The symposium will be held 11-15 September 1995 on the Island of Bendor, Bandol, France.

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Meeting Reviews

Snow Ecology: A Report on a New Initiative

Snow plays a key role in the ecology of much of Earth's surface, especially in circumpolar and high-altitude regions where ecosystems are under increasing stress from global changes in climate and local human development. Until recently, our knowledge of snow has been restricted to areas of study associated with specific physical, chemical, and biological disciplines. Although this research has resulted in a significant progress in understanding snowpack dynamics, there has been no concerted attempt to integrate the results of these studies to further our knowledge of snow as a life-support milieu and as a component of larger terrestrial ecosystems. In order to develop a better understanding of snow ecology through interdisciplinary studies, a nucleus of research workers from both the physical and biological sciences recently formed the Snow Ecology Working Group (SEWG). The SEWG was approved as a contribution of the International Commission on Snow and Ice (ICSI) to the International Geosphere-Biosphere Program (IGBP) at the ICSI Bureau Meeting in Vienna in August 1991. ICSI is a commission of the International Association of Hydrological Sciences (IAHS).

The objectives of the Working Group are to:

1) facilitate exchange of knowledge and expertise on snow and snow-covered systems between researchers in the physical, chemical, and biological sciences;

2) develop a conceptual framework for snow ecology as a science and an experimental methodology for the study of snow and snow-covered systems;

3) develop conceptual and applied comprehensive models for the processes, states, evolution, and stability of snow ecosystems;

4) produce documents that outline the conceptual framework of snow ecology, the state of science, and appropriate experimental methods;

5) organize an international conference with emphasis on the methodology and application of the conceptual framework to the development of models that explain the evolution of snow and snow-related ecosystems.

To achieve these objectives, a Snow Ecology Workshop was convened by SEWG in Québec City, 3-7 June 1993. The Workshop was sponsored by the Natural Sciences and Engineering Research Council of Canada, Hydro-Québec, the Canadian Polar Commission, The Institut national de al recherche scientifique (Université de Québec) and the Department of the Environment of the Government of Québec (Environnement Québec). The Workshop was attended by university and government researchers and graduate students; the 20 participants included climatologists, physicists, chemists, microbiologists, plant ecologists, and invertebrate and large-mammal ecologists.

The format of the Workshop consisted of state-of-the-science reviews followed by in-depth discussions on the linkages and feedback mechanisms between the physical, chemical, and biological phenomena in snow. The reviews on the first day traced the physical progression of snow from snowfall and snowcover formation on a global scale to snow metamorphism on the ground, snow redistribution and sublimation in forested and open environments, the melt of snow and chemicals contained in the snow, to the interaction between the snow chemistry and the biological components of snow (microbes, invertebrates, and mammals).

The second day considered the life cycles and habitats of snow microbes such as bacteria, algae, fungi, and small invertebrates; the accumulation of organic debris; and the relationship of larger life forms such as spiders, collembola, and large plants to snow in alpine and arctic ecosystems. The reviews of the third day were devoted to the larger mammals that live in and on snow, with special emphasis on the caribou.

In this manner we developed specific hypotheses on how the physical, chemical, and biological components interact and modify each other in order to produce the multi-phase, multi-life-form milieu we know as the snowcover. It is now evident that the snowcover is an ecosystem evolving in response to meteorological and biological inputs and, in return, fundamentally changing these factors.

Certain considerations may be drawn from information presented at the Workshop. One is that as an ecosystem, snow may be considered analogous to a lake, and as an interdisciplinary science, snow ecology may be considered analogous to limnology. The snow ecosystem functions at three critical levels that are defined by boundaries at the snow–air and snow–soil interfaces:

1) Supra-nival—above snow, including large plants and animals and the atmosphere;

2) Intra-nival—within snow, including small plants, microbes, invertebrates, small mammals and snowpack properties; and

3) Sub-nival—below snow, including small plants and animals, microbes, invertebrates, and the soil.

A further consideration of this concept of snow as an ecosystem, is that the snowcover is the mediator between micro-organisms, plants, animals, chemicals, atmosphere, and soil. Snow mediates because it functions as:

1) An Energy Bank—snow stores and releases energy. It stores latent heat of fusion and sublimation and crystal bonding forces. The bonding forces are applied by atmospheric shear stress, drifting snow-particle impact, and the impact of animals walking over the snowcover. The intake and release of energy at various times of the year thus makes snow a variable habitat for intranivean organisms and is a cause of their migration within the snow environment.

2) A Radiation Shield—cold snow reflects most shortwave radiation, and absorbs and re-emits most thermal infrared radiation. Its reflectance of shortwave is a critical characteristic of the global climate system. As snowmelt progresses, the snowcover reflects less shortwave radiation due to a change in its physical properties. This reflectance can be additionally reduced on the order of 10% by in situ life forms such as populations of red snow algae.

3) An Insulator—as a porous medium with a large air content, snow has a high insulation capacity and plays an important role in protecting microorganisms, plants, and animals from wind and severe winter temperatures. Its insulation can result in strong temperature gradients that fundamentally restructure the snow composition and provide opportunities and constraints for organisms that live in the snowcover. In windswept areas specific organisms take advantage of enhanced snowcover insulation where vegetation is relatively dense; however, their further interaction with this vegetation is presently unknown.

4) A Reservoir—snow is a reservoir for water, chemicals, and organic debris that provides habitat and food sources for various life stages of microbes, invertebrates, and small mammals. The physical and chemical properties of snow, especially radiation penetration, gas content, temperature, wetness, porosity, pH, inorganic chemistry, and organic debris content, control intra-nivean biological activity and in turn are influenced by the behavior of nivean organisms.

5) A Transport Medium—snow moves as a particulate flux as it is relocated by the wind in open environments or intercepted by vegetation in forests. It moves as a vapor flux because of sublimation, resulting in transport to colder surfaces or to the atmosphere. During melt, snow moves as meltwater in preferential pathways within the snowpack to the soil or directly to streams and lakes. These transport phenomenon are taken advantage of by certain snow organisms but can also cause limitations to the success and survival of their populations.

6) A Host for a Food Web—a food web that occurs both within the snowcover and at the snow–atmosphere and snow–soil interfaces involves many families and species of organisms. Within the snowcover, snow algae are primary producers, grazed upon by primary consumers including protozoa and small invertebrates. Smaller forms such as the fungi and bacteria are decomposers and some invertebrates are probable detritivores. The invertebrates are in turn preyed upon by other invertebrates and small mammals. Small mammals become the prey to larger mammals, which either hunt them on the surface or dig into the snowcover to retrieve them. Large and small mammals also graze upon plants that protrude into the snowcover or are buried by it. Leachates from organic substrates are an important feature in this food web, particularly in the effect of plant residues and animal wastes upon microbial activity.

These snow ecosystem functions occur over time scales that are diurnal, seasonal, and decadal. Furthermore the functions have important spatial interactions at three scales:

1) Micro Scale—variation from

centimetres to metres both vertically through the pack and horizontally across the snowcover, correlated strongly to individual plants, meltwater flow paths, terrain discontinuities, soil properties, food webs, and local populations of intranivean inhabitants;

2) Landscape/Meso Scale—variation from tens of metres to kilometres, correlated strongly to the communities of the largest vegetation forms, elevation, slope, aspect, orography, and exposure to the wind;

3) Macro Scale—variation from tens to thousands of kilometres, correlated strongly with persistent synoptic weather patterns, continental wind flows, location with respect to the poles, oceans, lakes, and continental-scale biomes.

After consideration of the critical issues in separate fields of snow investigation, and identification of the major linkages between living things and the physical and chemical properties of snow, the participants raised the following questions regarding snow as an ecosystem:

1) Can we devise tests of hypotheses regarding the structure and function of snow ecosystems?

2) Do snow ecosystems have a series of quasi-stable states?

3) What scales of states and processes are important from micro to macroscale?

4) Do snow ecosystem variables and states cycle over time? Are these cycles correlated and do they enhance or dampen each other?

5) How may we scale snow ecosystem variables over space and time? How do we go from micro scale to macro scale, diurnal to seasonal and decadal?

The SEWG intends to answer these questions as part of multidisciplinary studies occurring in various snow biomes. For more information regarding participation in these working group activities please contact Professor H. Gerald Jones, Institut national de la recherche scientifique-eau, Université du Québec, Ste-Foy, Québec, Canada, G1V 4C7. Fax: (418) 654-2562.

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Report on MINFORS II

MINFORSII, Minority Participation in Forestry & Natural Resource Sciences. 24-26 October 1993; Corvallis, Oregon.

There has been some discussion in this *Bulletin* over the last year on the need to bring under-represented groups into the ecological sciences (Lawrence et al. 1993, Morrin et al. 1993). While much of the in-depth discussion has been devoted to problems women have in advancing and remaining in the field, it could be argued that the most serious problem we have as an organization is in attracting and retaining ethnic minorities in general and African-Americans in particular. While African-Americans make up 12% of the US population, they are only 0.3% of the ESA's membership, making them, by an order of magnitude, the least represented of any group in the ESA survey. I have been asked in the past what could be done to ameliorate this situation. Last October there was a conference held at Oregon State University in Corvallis, Oregon that showed what could be done. MINFORSII, which stands for Minority Participation in Forestry & Natural Resource Sciences, was held 24-26 October 1993. The purpose of the meeting was to encourage high school and college students of African-American, American Indian/Alaskan Native, Asian-American/Pacific Islander, or Hispanic/Latino descent to pursue careers in the Natural Resources Sciences.

The conference consisted of speeches, panel discussions, graduate student talks on their current research in natural resource sciences, tours, workshops, and exhibits by employers and graduate programs, all designed to aid and encourage minority students to pursue careers in natural resource sciences. Space does not permit me to name all the sponsors and participants but I will list a few in each category to give an idea of the breadth and depth of support this conference had.

Sponsors included:
The Bureau of Land Management
The US Forest Service
Oregon State University
The Intertribal Timber Council
Other federal, state, and Indian agencies
Private corporations and consulting agencies involved in resource management

Speakers and Panelists included:
Denise Meridith, Deputy Director, BLM, Washington, D.C.
Jerry Sesco, Deputy Chief, Research, USDA Forest Service, Washington, D.C.
Jaime Pinkham, Manager, Department of Natural Resources, Nez Perce Tribe, Lapawai, Idaho
Robert Lewis, Director, USDA Forest Service, NE Forest Experiment Station, Radnor, Pennsylvania
Jane Difley, President, Society of American Foresters, Bethesda, Maryland

Exhibitors included:
Job Corps
Florida A&M/University of Florida
Washington State Department of Natural Resources
Universities of Michigan and Idaho, and Purdue University
Soil Conservation Service
Weyerhaeuser Company
Haskell Indian Nations University