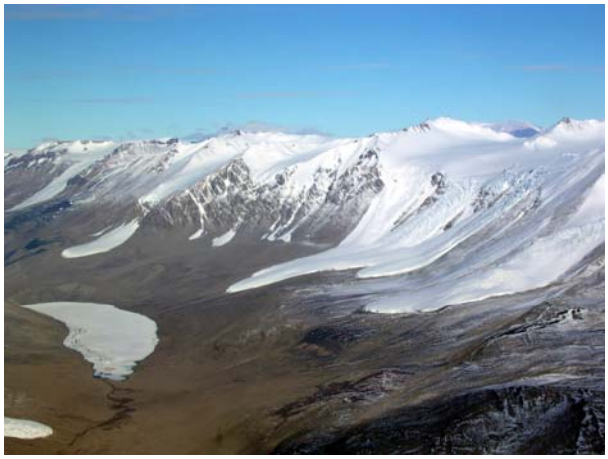
McMurdo Dry Valleys (MCM)

The McMurdo Dry Valleys (MCM) Long Term Ecological Research Program is an interdisciplinary and multidisciplinary study of the aquatic and terrestrial ecosystems in an ice-free region of Antarctica. MCM joined the National Science Foundation's LTER Network in 1993.



Long-term ecosystem research in the MCM is of particular importance for a number of reasons. Firstly, climate change is essentially the ecological driver within the MCM because the system is poised near a significant hydrologic threshold; a small climate warming releases vast quantities of water from the frozen glacier reservoirs leading to major ecosystem responses. Liquid water is critical to the existence of life within the valleys. Therefore, understanding the production, transport, and accumulation of water is the key to the overall understanding of how this ecosystem works. The amplified responses in the MCM allow us to more easily examine how the ecosystem responds to physical controls. Secondly, the biological diversity of organisms in the MCM is extremely low, which means that we can characterize biodiversity and potentially the linkages to ecosystem function more readily than is possible in more diverse ecosystems. Consequently, the potential for understanding the relationship between biodiversity and ecosystem function is great. These relationships are fundamental to ecosystem ecology, and understanding gained at the MCM will advance our insight into all ecosystems.

The overall objectives of the McMurdo Dry Valleys LTER are to understand the influence of climate legacies on the overall structure and function of the MCM ecosystem and to determine the role that contemporary material transport has in structuring the ecosystem. The primary goals of the current funding period are to document biodiversity and the ratios of C:N:P in particulate organic matter and inorganic N and P across the major landscape units within the MCM.

Site Characteristics

The McMurdo Dry Valleys (77°30'S 163°00'E), adjacent to McMurdo Sound, are 2,200 miles (3,500 km) due south of New Zealand. They form the largest relatively ice-free area (approximately 4,800 km^2) on the Antarctic continent. These ice-free areas of Antarctica display a sharp contrast to most other ecosystems in the world, which exist under far more moderate environmental conditions. The dry valleys receive less than 10cm of precipitation per year, and the average temperature is -19ºC (maximum: 11.8ºC, minimum: –65ºC). The area is characterized by a strong solar cycle with continuous sunlight persisting for about half the year followed by the 24 hour darkness of polar night.

The dry valleys are a mosaic of perennially ice-covered closed-basin lakes, ephemeral streams, soils and glaciers. It is one of the driest and coldest ecosystems on earth and harbors a distinctive biota capable of surviving in the diverse and often inhospitable habitats of the dry valleys. Microorganisms dominate the MCM with the most complex life forms being small invertebrates.

A hydrological continuum exists in the dry valleys, beginning with glaciers and ending in the closed-basin lakes. Glaciers cover about one third of dry valleys. These large reservoirs of water

can be released through melting, and as the only significant source of water to the streams and lakes, they are fundamental to the hydrology and biology of the dry valleys. Numerous ephemeral streams link the glaciers and lakes within the dry valleys for four to ten weeks during the austral summer. These streams recharge the dry valley lakes and are important sources of nutrients. The lakes, being the terminus of the hydrological continuum in the dry valleys, are reservoirs of history and are the only environments within the study site that contain liquid water and support metabolic activity throughout the year.

Soils account for the majority of the valley surface area and are generally poorly developed, coarsely textured, high in soluble salts and support low rates of biological activity. Antarctic soils have a high degree of spatial and temporal heterogeneity in soil properties, moisture regimes, and biological composition. The majority of soils sampled across the valleys support up to three invertebrate taxa (tardigrades, rotifers, nematodes), but there are regions, in contrast to lower latitude ecosystems, that completely lack soil invertebrates. Aeolian transport is thought to have an important role in the dispersion of soil organisms in the dry valleys.

Research Focus

The first six years of MCM (1993-1999) demonstrated that physical constraints and modification by material transport control the structure and function of this polar desert ecosystem. We discovered that subtle changes in temperature, precipitation, and albedo have a major influence on the hydrologic cycle, biogeochemistry and biological productivity within the valleys. Biological activities are affected by the transport of water, nutrients and organic carbon between landscape units (glaciers, streams, lakes and soils). Within the context of an extreme sensitivity to variations in climate and significant linkages among landscape units, it also became clear that "legacies" of past events influence the structure and function of the modern ecosystem.

During the second six-year funding period (1999-2005) we evaluated of the role of “legacy” (carry-over or ecosystem “memory” of past events) on function and structure of the ecosystem. For example, we showed that the presence of Lake Washburn, which inundated Taylor Valley between 24,000-6,000 yr BP, followed by a subsequent cold, dry period ending about 1000 yrs BP, created old pools of organic carbon and nutrients in the soils and lakes that drive many of the ecosystem processes we now observe.

The current funding period (2005-2011) emphasizes the relationship between C:N:P stoichiometry and biodiversity in the context of the “legacy” left by past climate events. A major goal is to understand both how the environment controls the diversity of organisms and how diversity itself controls the functioning of the MCM ecosystem.