Overview

The McMurdo Dry Valleys (MDV) is a polar desert on the coast of East Antarctica which has not yet experienced climate warming. The MCMILTER project has documented the ecological responses of the glacier, soil, stream and lake ecosystems in the MDV to a cooling trend (1986 to 2000), which was associated with the depletion of atmospheric ozone. Recently, high flows and strong katabatic winds have occurred during three summers and changed the landscape, enhancing ecological connections.

Central Hypothesis

The central hypothesis of current MCMILTER research is: Climate warming in the McMurdo Dry Valley ecosystem will amplify connectivity among landscape units leading to enhanced coupling of nutrient cycles across landscapes, and increased biodiversity and productivity within the ecosystem.

Contemporary patterns in distribution of biota in the MDV are used to understand underlying ecological connectivity. Although the abundance and diversity of the MCM DV biota is low relative to most other ecosystems, recent and ongoing work reveals that representative taxa from most of the major lineages of the Tree of Life are present and functioning. Diatoms in particular serve as excellent indicators of environmental change, and MCM DV diatoms showcase this utility via the Antarctic Freshwater Diatom Database.

Biota, Abundance, and Diversity

High flows were found to suppress invertebrate abundance in algal mats despite similar chlorophyll-a content.

Response to Change

Changes in connectivity are hypothesized to be mediated by geographic variation among valleys.

Fig. 1. Map of Taylor Valley (showing Ronny, Horace, and Fryxell Basins) and Wright Valley indicating the distribution of monitoring and experiment locations.

Fig. 2. Schematic diagram of Dry Valleys contrasting cold to sunny summers.

Fig. 3. Lake Fryxell, Taylor Valley.

Fig. 4. Conceptual model of climate-driven processes and pulses in the MDV ecosystem.

Eventual warming in the MDV with the amelioration of the ozone hole is hypothesized to act as a slowly developing, long-term press of warmer summers, interrupted by transient pulse events of high summer flows and strong katabatic winds.

Fig. 5. (A) Ground-based and satellite measurements of ozone concentration over Antarctica. (B) Taylor Valley lake level change inversely with ozone concentration from 1970 to 1990. (C) Total annual flow of Owyx’s River from 1970 to 2000.

Fig. 6. Diatom changes in lake volume, heat content, ice thickness, and volume-weighted mean temperature for (A) Lake Fryxell and (B) East Lobe of Lake Bonney.

Fig. 7. Abundance and diversity of (A) major taxa and (B) endrocytes in MCM Dry Valley lakes.

Fig. 8. Flow frequency variability in Lake Fryxell stream: (High – flows every season, for most of the season) and diatom abundance response.

Fig. 9. Changes in invertebrates and microbial mats in the Edel Channel Radiolysis Experiment. (A) Habitat preferences of invertebrates in MDV streams (B) Variation in abundance of invertebrates with distance from stream centre. (C) Site map; site 1 is just below diversion. (D) Changes in invertebrate abundance in streamside mat and submarine bottom low flow and high flow summers.

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Fig. 10. (A) 1. anokie (gray arrow) and freshwater fluxes interact with flow-through lake, 2. anokie and freshwater fluxes from fluvial sources carried by a large stream, 3. anokie and freshwater fluxes from near-coast sources with closed basin lakes, and 4. pavement glacier blocks all but anokie sources (B) Location map of MDV.

Fig. 11. Thermokarst occurrence of Garwood Valley after a warm/summer hydrological pulse event.