

ANNUAL REPORT ON VITAL SIGNS MONITORING OF SHALLOW LAKES IN
DENALI NATIONAL PARK & PRESERVE

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Executive Summary

This was the first year of implementation of the shallow lake monitoring plan. During this sampling effort we sampled 30 lakes dispersed across the northwestern corner of Denali National Park and Preserve. We made detailed observations of water quality and physiography. This work will continue for the next two years. These data combined should give us good insight into the general patterns of change occurring in the Minchumina Basin.

Key Words

LAKES – MACROINVERTEBRATES – WATER QUALITY

INTRODUCTION

This report summarizes the data collected for the shallow lake monitoring project taking place in the Central Alaska Network Parklands. Work in 2006 focused on the lakes in the northwestern section of Denali National Park and Preserve (Denali). Shallow lakes were selected for monitoring because they are abundant on the landscape; they are small ecosystems where we can more easily monitor change, and they serve diverse ecological functions. Furthermore these ecosystems appear to be changing. A significant drying trend has been documented for shallow lakes in regions of discontinuous permafrost in Alaska (Riordan et al. 2006) and Russia (Smith et al. 2005). Riordan et al. (2006) related this drying trend to a pacific wide shift in the climate regime from cool and moist to hot and dry (Mantua et al., 1997; Hare et al., 1999; Hare and Mantua, 2000; Dickson, 2000). This climate shift occurred in the mid-1970's and has been observed in both the temperature record and in tree-ring growth patterns (Barber et al. 2004). Smith et al. (2005) documented significant expansion of shallow lakes in regions of continuous permafrost and related changes in lake surface area to the distribution of continuous and discontinuous permafrost.

The northwestern corner of Denali NP&P is situated in the Yukon-Kuskokwim Bottomlands section of Denali NP&P. It consists of a vast complex of wetland ecosystems containing large regions of discontinuous and continuous permafrost (Clark map and estimates). Riordan et al. (2006) estimated a 5% decrease in lake surface area in this general vicinity between 1950 and 2000. Many of the lakes Riordan measured were found on continuous permafrost. Nearby Minto Flats State Game Refuge (Minto) displayed a marked decrease (336%) in lake surface area. Contrary to Denali NP&P Minto has a complex hydrologic cycle and many stream networks which implies there is a larger percentage of discontinuous permafrost however no detailed data exist on permafrost distribution there.

The objectives of the shallow lake monitoring project are to:

1. Detect decadal-scale trends in the area, distribution, and number of shallow lakes and ponds in Central Alaska Network Parks.

2. Detect decadal-scale trends in the water quality of shallow lakes and ponds in Central Alaska Network Parks.
3. Detect decadal-scale trends in the structure and composition of vegetation in shallow lakes and ponds in Central Alaska Network Parks.
4. Detect decadal-scale trends in macroinvertebrate taxa richness and relative abundance in shallow lakes and ponds in Central Alaska Network Parks.

METHODS AND MATERIALS

Thirty lakes were sampled in the northwestern corner of Denali National Park and Preserve in summer 2006 (Figure 1). Sampling followed the standard operating procedures outlined in draft monitoring protocols for shallow lake monitoring (Larsen et al. 2005). Samples were collected for analysis of water and macroinvertebrates. Surveys on lake morphology were also conducted to estimate lake level and bathymetry data that will be used to determine lake volume. Vegetation surveys were not conducted in 2006 but will be completed in 2007. RADARSAT images were collected throughout the ice-free season in both index sites in Denali and Wrangell-St. Elias National Park and Preserve. These images will be used to estimate lake surface area.

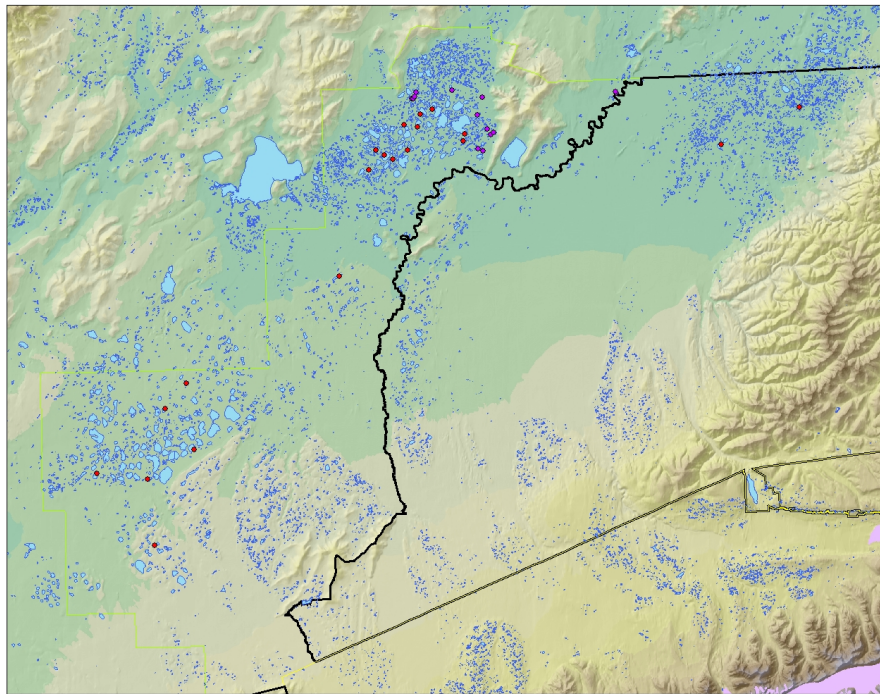


Figure 1. Study sites in northwestern corner of Denali National Park and Preserve. Red dots indicate lakes sampled with float plane in late July and purple dots denote lakes sampled via motorboat in early June.

RESULTS

This was our first year using the general randomized tessellation stratified (GRTS) sample as a means to identify our sampling sites. The GRTS sampling effort was generally a success however we did encounter four occasions when sampling the GRTS lake was not feasible. We planned to sample GRTS lake 53 however it was nearly filled in with vegetation (Figure 2) so GRTS 89, the next GRTS lake in the area, was sampled instead. We intended to sample GRTS 50 however the 1.5 km walk from our access lake traversed a large bog and made walking too difficult so we sampled the adjacent lake (GRTS 3023) as the next available GRTS lake was not within flying range. We sampled GRTS 2494 in lieu of GRTS 19 for the same reason. We were unable to sample GRTS lake 7 as weather conditions precluded us from landing on the lake. Since we were already weathered in on GRTS lake 1476 we sampled it. Our final difficulty was encountered at GRTS lake 182, this lake had dried significantly since the 2002 base imagery and we were only able to locate small remnants of the original lake. As such we selected one of the remnant water bodies to sample.



Figure 3. GRTS lake 58 had largely paludified in the time since 2002 when lakes were identified.

Water quality varied significantly among lakes (Table 1). All of the lakes sampled were extremely nutrient poor based on estimates of TN and TP. According to Vollenweider's (1979) trophic classification they are classified as ultraoligotrophic to oligotrophic. These data are supported by the extremely low concentrations of Chl_a we found (Table 1). We also observed large populations of *Drosera* growing adjacent to the open water zones of many of the lakes (Figure 4). *Drosera* are small carnivorous plants that trap small insects in a sticky substance on the modified leaf. The plants secrete enzymes into the insects and extract nutrients that are then used for growth and reproduction. Carnivorous plants are frequently found in nutrient poor ecosystems.

Table 1. Summary of chemical characteristics for the Denali shallow lakes study (all measures are mg/L unless otherwise specified.)

	Minimum	Maximum	Mean	SE
Alkalinity	5	139	35	3.3
Total N	0.43	1.29	0.74	0.01
Total P	0.007	0.041	0.021	0.009
Orthophosphate	0.002	0.005	0.003	0.0008
Nitrate	0.002	0.015	0.004	0.0007
Ammonia	0.003	0.080	0.014	0.001
Silica	0.16	3.93	0.96	0.13
Sodium	0.85	4.65	2.18	0.10
Potassium	0.21	2.80	0.86	0.06
Calcium	0.81	34.58	6.79	0.65
Magnesium	0.42	14.77	3.14	0.30
Sulfate	0.02	1.04	0.16	0.02
Chla (mg/m ³)	0.64	6.52	2.15	0.14
Chloride	0.17	1.30	.056	0.24
Dissolved organic carbon	9.91	27.97	17.14	0.46
pH	5.11	9.37	7.22	0.10
Specific conductance (μS/cm)	13	870	95	17

The vast majority of lakes had uniform lake depths. Average lake depth was 1.1m and maximum lake depth was 5.3m. Twelve of the lakes had evidence of recent thermokarsting and 90% of the lakes evidence of older karst activity. Four of the lakes had evidence of fire. Two lakes fell within the 2005 Highpower fire, one in 2002 and another in 1986. There did not appear to be any obvious differences between the burnt and non-burnt lakes in regards to nutrients or any of the other chemical parameters.



Figure 4. *Drosera Anglia* flowers and leaves showing the sticky leaves that trap small unsuspecting insects that are digested by the plants.

DISCUSSION

The problems we encountered in sampling the GRTS lakes are indicative of the landscape scale change that has occurred in Denali in the past few years. This environment is changing rapidly. To determine the amount of change that has occurred here we are proposing to conduct a retrospective analysis of the Minchumina basin using remote sensed imagery. This comparison would allow us to identify regions of change. Furthermore in FY07 we will be conducting an analysis of the RADARSAT imagery collected in 2005 to identify hydrologically stable and unstable areas.

Data analysis reported here only discusses the chemical data in very general terms. A more detailed analysis and review of the macroinvertebrate data will begin in April. A complete analysis and reporting of the Denali data will occur following the 2008 summer field season. At this time we will make comparisons between the two sampling years as well as complete a lake classification scheme based on all three years of sampling.

PLANS FOR 2007

In 2007 we will resample the 30 lakes sampled in Denali in 2006. This will allow us to estimate interannual variation and increase our ability to detect change over time. In 2008 we plan to conduct water quality sampling on 90 additional lakes in Denali. This information will be used to develop a lake classification system that will hopefully be applicable to the other two network parks.

ACKNOWLEDGEMENTS

The shallow lake monitoring project has always relied heavily on cooperation of park staff to collect field data. In 2006 we had several cooperators from Yukon-Charley Rivers National Preserve assist with data collection including John Burch, Wildlife Biologist; Fred Andersen, Fisheries Subsistence Manager; and Melanie Wike, Biological Technician. Margaret MacCluskie, Central Alaska Network Inventory and Monitoring Coordinator also helped collect field data. Our pilot, Ken Barnes the NPS regional aviation officer was gracious enough to not only pilot our Super Cub on floats but he slogged through bogs and assisted in field collection of data as well. Penny Green, Lake Minchumina resident, was also very helpful in planning the complex field logistics required to work in this remote region of Alaska.

