North Slope Lakes Project

Water and Environmental Research Center
University of Alaska Fairbanks

Measurements of Hydrologic Gradients and Watershed Boundaries in Low-Relief Tundra Plain Lake Watersheds

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By Michael R. Lilly, Daniel Reichardt, Jeff Derry, and Daniel M. White

The North Slope Lakes project team measures water levels and related hydrologic conditions at a network of study lakes and water reservoirs across the coastal plain on the North Slope, Alaska. Additional chemistry and physical measurement data are also being collected at many of these lakes. Lake L9312 is part of the network of study lakes, and represents a small perched lake with no continuous stream flow into the lake. The lake is recharged through direct rain and snow precipitation on the lake, overland and subsurface flow through the active layer in the adjacent lake watershed, and periodic flooding during spring snowmelt from the adjacent Colville River. This lake is the primary water supply source for the Alpine facility. Water is used on a continuous basis throughout the year.

The measurement of watershed boundaries in low-relief lake watersheds can be challenging due to the uneven nature of the land surface cover. There is also some temporal variability due to impacts of snow drifts and channel icing during spring snowmelt. Flow through the active layer (seasonal thaw layer) is also important during summer months. The natural relief of the tundra surface and cryogenic processes that lead to patterned ground formation, polygons, and related features result in many small depressions that maintain a network of tundra ponds and puddles. These ponds and puddles can be surveyed to obtain the general hydrologic gradients in low relief watersheds and help determine the watershed boundaries for lakes. Surveying water levels in these features in the watershed and to the outside of the watershed can help determine the extent and variability of the watershed boundary. This data, in combination with field observations of flow during spring snowmelt can be used to determine the seasonal variability of watershed boundaries, which is useful in determining the range in potential watershed recharge to the lake on a seasonal basis.

Survey methods, which achieve accuracy levels of 0.2 feet (~3 centimeters) in the horizontal and 0.1 feet (~3 centimeters) in the vertical, are acceptable for mapping out watershed boundaries. When benchmarks with sea-level datum control is available, surveys should be measured to a standard datum. End of summer conditions are most representative of the general watershed boundaries. Field observations during breakup can help verify the potential seasonal variability during the early snowmelt period. One important objective of a lake-watershed survey is to determine the locations and elevations of lake outlets. There are two primary outlets for L9312. One is located in the southeast corner and one located on the northwest corner of the lake. The northwest corner outlet is slightly lower and was observed to have flow leaving the lake during

surveys in mid September, 2006. The outlet elevation is important at determining the conditions of the lake and when it is full, or in an overfull condition.

Figure 1 represents an example of the elevation difference between small ponds and puddles along a transect perpendicular to Lake L9312 western boundary in the area of the facility pumphouse. An example tundra pond is shown in Figure 2, which is located along the transect. This pond shows signs of declining water levels due to a combination of drainage through the tundra and underlying active layer, and evaporation. These processes are offset by summer precipitation in the area. Figure 2 shows the location of the pumphouse, and the lowest outlet for the lake. The end of summer season before snowfall is an optimum time to survey small ponds and puddles to help map low-relief watersheds.

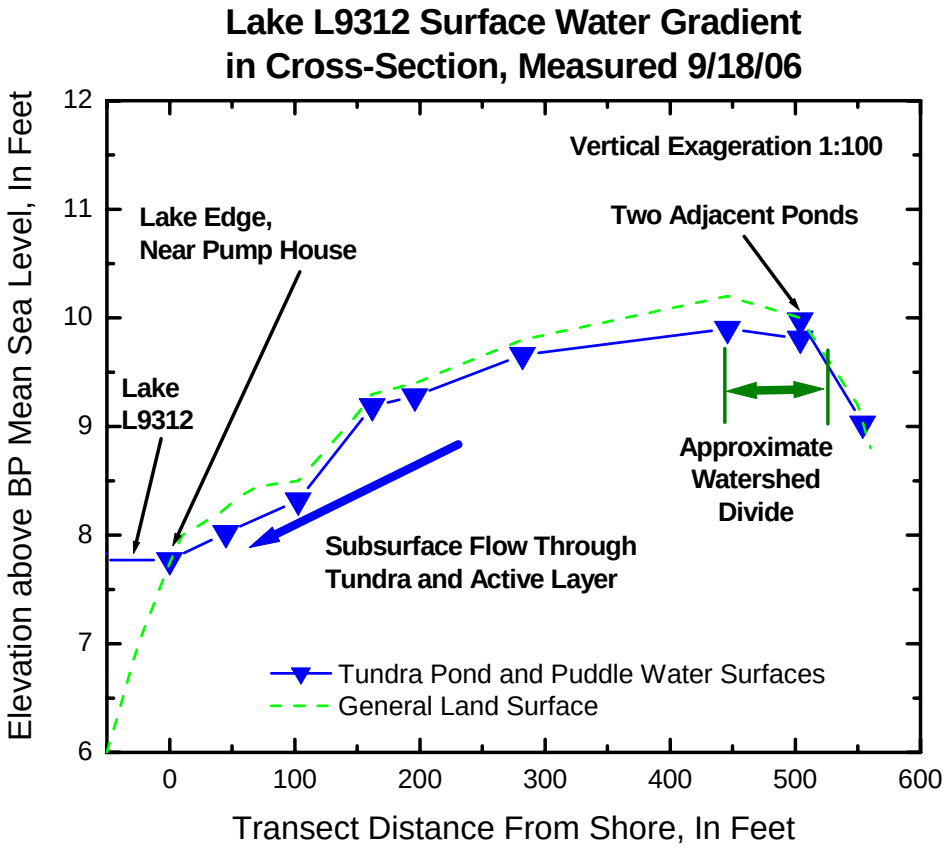

Figure 1. Water-surface elevation in Lake L9312 and adjacent tundra ponds and puddles along a transect parallel to the lake edge near the facility pump house and water pipelines to the lake.

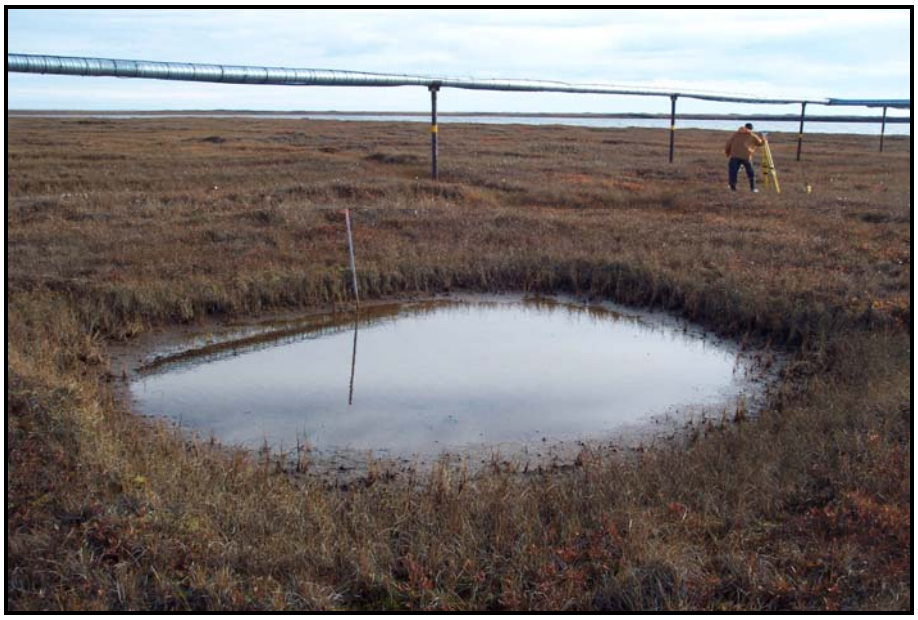

Figure 2. Example tundra pond (puddle) near Lake L9312. Photo taken 9/18/06 by M. Lilly.

Figure 2. Northern end of L9312, with L9311 and L9310 in the background. Outlet of L9312 is visible in the northwest corner of the lake. Photo taken 9/18/06 by M. Lilly.

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