Johnston, J.W., Wolfe, B.B., Edwards, T.W.D., and Hall, R.I., 2005, **Bustard Island: archive of Lake Athabasca water level history**, *Cold Regions Research Centre Symposium, Managing Water in the Peace-Athabasca-Slave River Corridor*, Wilfrid Laurier University, Waterloo, Ontario, April 15-16.

Paleoenvironmental research in the central interior of the Peace-Athabasca Delta (PAD) has revealed evidence for widespread inundation of Lake Athabasca in the late 19th century. High levels of Lake Athabasca at this time are portrayed as an expansive western embayment in archival maps compiled by Mollard et al. (2002). A subsequent series of maps from the early part of the 20th century depict eastward recession of Lake Athabasca from the shallow embayment that occupied part of the central interior of the PAD, to a large open-drainage basin that received outflow from Lake Athabasca en route to the Slave River via the Riviere des Rochers, to a large open wetland that is frequently flooded. Paleolimnological analysis of a short sediment core retrieved from PAD 9 (Hall et al. 2003), a closed-drainage basin in the southern part of the Peace sector located near the western margin of the late 19th century Lake Athabasca high-water stand, is strongly consistent with the paleohydrologic changes that characterized this period. Results included a major community shift in the relative abundance of open- to closed-drainage indicator diatom taxa, which provided evidence in support of a several decade-long Lake Athabasca high-water stand and subsequent fall in water level.

Subsequent paleoliminolgical analysis of longer sediment cores retrieved from PAD 9 (Edwards et al. 2004) shows that the high relative abundance of open-drainage indicator diatom taxa persist beyond several decades and extend back to ~AD 1600 with a local maximum occurring at about 1700. A sustained multi-centennial high-water stand of Lake Athabasca (~1600-1900) may be responsible for the diatom stratigraphy during this interval at PAD 9, as well as wet conditions documented in the sediment histories of other basins at this time that are susceptible to a rise in Lake Athabasca water level (incl. Jemis Lake, PAD 37, and Johnny Cabin Pond, PAD 31; see Hall et al. 2003; Edwards et al. 2004). While an increase in river flood frequency could also be invoked to explain these stratigraphic records, this is inconsistent with low flood frequency during the 1700s reconstructed from laminated sediments in PAD 15 (Wolfe et al. in review a) or extremely dry conditions inferred from multi-proxy paleolimnological records from an elevated perched basin in the Peace sector (PAD 5), which is well-beyond the influence of fluctuations in Lake Athabasca water levels but within reach of floodwaters derived from Peace River ice-jams (Wolfe et al. in review b). Independent evidence for Lake Athabasca water level history for the past several centuries, which includes the Little Ice Age (LIA; ~AD 1550-1890) and Medieval Warm Period (MWP; ~1000-1550), is lacking but is essential to reconcile our paleolimnological reconstructions and interpretations in the PAD. Previous Lake Athabasca water level reconstructions by Stockton and Fritts (1973) and subsequent re-analysis by Meko (2002) are limited to the past two centuries.

An island in the southwestern part of Lake Athabasca called Bustard Island is being studied to provide independent evidence for high water levels in Lake Athabasca that may have affecting the PAD beyond the last two centuries. The island comprises several isolated wooded areas, low-lying wetlands, and two shallow ponds. Two northeast-facing embayments on the island contain components of a typical barrier beach complex (modern beach, barrier, and lagoon). The "North Pond" and adjacent wetland are in the lagoonal area and is separated from Lake Athabasca by a 4-m high barrier of sand that parallels the modern coastline. A stratigraphic record of Lake Athabasca water level changes may be stored in the sediment of the "North Pond" as water levels in these basins are probably coupled by groundwater exchange between the water bodies. To explore this possibility, sediment sequences were retrieved from the "North Pond" in mid-July 2004. The upper 40 cm was obtained using a gravity corer and sectioned at 0.5-cm intervals at the field station. Sediments recovered to 2.3-m depth were collected using a Russian peat corer in four overlapping sections. In addition, several tree cores were collected from trees on top of the 4-m high barrier using a hand-held increment borer to indicate a limiting age for the barrier. Preliminary ring counts indicate that trees were established on the barrier at least as early as the 1830s. Sediments from the “North Pond” are mainly organic matter with several distinct sandy laminations and beds. The close proximity of the coring site to a washover fan suggests that the sand was derived from the barrier and transported by waves overtopping the barrier and, thus, may provide direct evidence of former high-water stands of Lake Athabasca. Alternatively, the sand units may have been transported by wind (aeolian) and deposited in the shallow lake that could be associated with low-water stands of Lake Athabasca.

Results from the “North Pond”, integrated with our ongoing paleolimnological and dendroclimatological research program, will play a key role in answering the following research questions:

1. Does the persistence of high abundance of diatom taxa indicating open-drainage conditions from AD 1600-1900 at PAD 9 represent a sustained high-water stand of Lake Athabasca, perhaps maintained by increased snowmelt-enhanced Athabasca River discharge during the LIA?

2. Was the preceding MWP marked by a low-stand of Lake Athabasca due to rainfall-dominated Athabasca River discharge? Are hydrological conditions of the MWP analogous to present and future conditions?

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