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Wood Buffalo National Park Flood Report, Spring 2014

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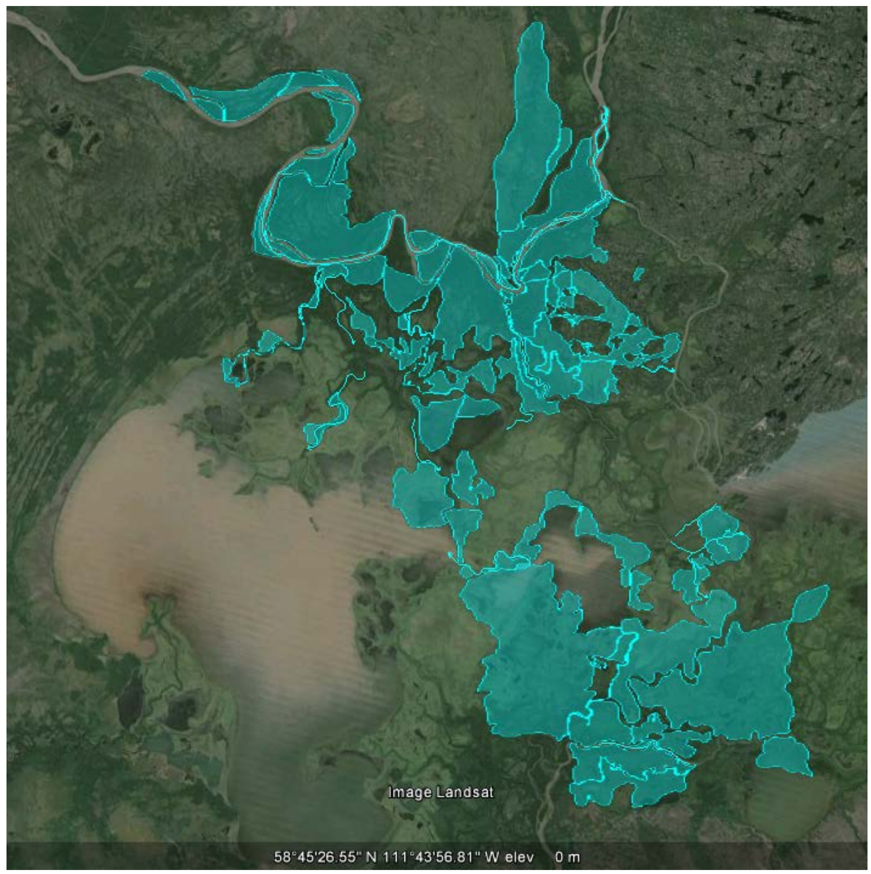

Figure 1 - Overview of the extent of flooding discernible during aerial monitoring in Wood Buffalo National Park (May 2014)

During May 2014, Parks Canada staff monitored breakup and ice jam flooding on the Peace and Athabasca Rivers in Wood Buffalo National Park. Members of the resource conservation team flew in a fixed-wing aircraft on May 3-5 to document the locations of ice jams and extent of subsequent flooding in the Peace-Athabasca Delta (PAD). We conducted more extensive surveys by helicopter on May 6-8 and 13-16, to improve our documentation of the extent of flooding and to determine potential danger to people and cabins in the park. We could not fly on May 9-10 due to bad weather, and the jam on the Slave River released by May 11.

An overview of the extent of flooding discernible during aerial monitoring in May 2014 is shown in Figure 1, right (see Appendix I, and accompanying interactive Google Earth layer). There was widespread flooding on both the Peace and Athabasca rivers, though flooding did not reach the extent of other spring flood events in recent memory, such as the flood of 1997. The 2014 flooding of Egg Lake (58.8963°N, -111.4228°W) is notable, as this site is covered by several long-term monitoring programs. Egg Lake had previously been identified as a perched basin that might have been experiencing reduced frequency of flooding and rapidly-changing vegetation in recent years.

Limitations of aerial monitoring

The extent of flooding described below, and presented in the interactive Google Map accompanying this document, is based on aerial observations made from helicopters and fixed-wing aircraft. The maps were drawn from photos, video, detailed notes referring to GPS points and track-logs taken while flying, and local geographical knowledge (e.g. providing names of flooded basins or channels, and recommending areas to observe closely for flow direction).

We systematically covered the area surveyed by flying the main channels of the Athabasca and Peace Rivers to mark locations of ice jams. We then followed flood waters from where they breached banks or ran through main channels to their maximum extent. Finally, we flew over locations of special interest for local land-users, and basins covered by long-term monitoring programs run by Parks Canada, Environment Canada, and BC Hydro. Flood water could typically be spotted from several kilometres by its reflection, and then closely investigated from several hundred metres. Flood water could be differentiated from melt water by colour; melt water tends to be clear, while flood water is sediment-laden, and brown. The direction of flow could often be discerned by observing plumes where flood water meets melt water, watching movement of floating debris in relation to fixed points, and by examining on-the-ground evidence post-flood (e.g. the direction willows were bent at the high-water mark, or the location of ice-scarring on trunks of trees).

Aerial monitoring does have limitations. It can be difficult to determine the source of flood-waters in some basins (flooding through very small channels, slow seepage over banks, infiltration through the water table, or flooding under ice cover). Late in a flood event, it can become difficult to determine directions of flow as all water (including melt water) becomes silty. Flow direction in channels can reverse over a matter of hours as ice jams release and basins begin to drain. It can be difficult to gauge the quantity of flood water received in certain basins (i.e. depth), the amount of water that is retained in basins post-flood, and the relative contributions of different channels to major lakes (e.g. Lake Claire, which received water from the Peace and Athabasca).

Finally, the area that can be monitored is limited by range (fuel capacity and efficiency) and availability of aircraft, weather, and availability of experienced personnel. Our 2014 flood monitoring was thus limited to areas heavily influenced by the Athabasca and Peace Rivers. Little is known about the extent of flooding to the west and south sides of Lake Claire, specifically the Birch, Buckton, and McIvor Rivers.

Peace River

Extent of flooding on the Peace River:

The water level rose an estimated 6 metres on parts of the Peace downstream of Garden River, in the areas around Peace Point (59.1237°N, -112.4479°W) and Sweetgrass Landing (58.9280°N, -111.9265°W). Maximum water levels probably occurred around May 5-6, while a large ice jam was in place between Burnt Thumb (59.005486°N, -112.062549°W) on the Peace, and 30th Baseline (59.075086°N, -111.419856°W) on the Slave. Many islands were inundated, as were low-lying areas within the floodplain (Figure 2).

Figure 2 – Overbank flooding on north side of the Peace River (58.943158°N, -111.896172°W) near Sweetgrass Landing (May 6, 2014).

Cabins at Peace Point, Carlson's Landing, and Moose Island were not flooded, but water came within about 1 m of breaching the bank at Rocky Point (Figure 3), and reached some cabins downstream of Rocky Point.

Figure 3 - Water level approaching bank at Rocky Point (58.916183°N, -111.594057°W) on the Peace River (16:00 on May 6th, 2014).

Water breached the north and south banks of the Peace River in several areas – particularly around Sweetgrass Landing (Figures 4-5).

Figure 4 – Ice and sediment deposited by overbank flooding at Sweetgrass Landing (photo taken post-flood: May 14, 2014).


Figure 5 - Overbank flooding at Sweetgrass Landing (May 6, 2014)

When the flood was at its peak, most of the major channels south of the Peace (Sweetgrass River, Claire River/Pine Channel, Baril River) began flowing rapidly, eventually carrying flood water as far as the north end of Lake Claire, Lake Mamawi, and Baril Lake (Figure 6).

Figure 6 - Flood waters from Peace River flowing into north end of Baril Lake (58.800464°N, -111.688498°W) via Baril River (May 6, 2014)

Minor ice jams on small channels caused some overbank flooding north of Lake Mamawi and Lake Claire, but flooding in the area between Peace River, Lake Claire, and Lake Mamawi was mostly restricted to the main channels.

Quatre Fourches Channel:

From about May 7-10 there was an ice jam on the Quatre Fourches channel, in the area west of Pushup Lake (see map - Appendix I. Head: 58.8424°N, -111.5761°W; Toe: 58.7925°N, -111.5314°W). This caused flooding of channels that feed a number of basins in the vicinity of Pushup Lake, and eventually Egg Lake (Figure 7).

Figure 7 – Flood water in Egg Lake (58.8963°N, -111.4228°W). Photo taken soon after flood (May 15, 2014).

During post-flood observation, flood waters from the Quatre Fourches could be seen draining into Rocher Channel via Chilloney's Creek.

Observations by date:

May 3, 2014 – A large ice jam was seen from Burnt Thumb on the Peace River to about 30th Baseline on the Slave River. Upstream of the head of the jam the Peace River was open, and downstream of the toe the Slave River was still sheet ice. As a result, low-lying areas were flooded. Some muddy water from the Peace was evident in Pine Channel of the Claire River about 11km south of the Peace River, but not as far as Baril Lake.

May 5, 2014 – The ice jam was still present on the Peace River, though the head had moved downstream several kilometres. The toe was still at 30th Baseline and sheet ice still covered the Slave River downstream. Some flood water from the Peace was entering Baril Lake but was only evident at the mouth of Baril River. Flood water reached the northern bays of Lake Claire through Claire River (Pine Channel).

May 6, 2014 – The ice jam was showing movement. The head had again moved downstream a few kilometres to Point Providence. Though the toe was stable, flow was evident in the upstream sections and some open leads were present. The extent of flooding had increased, especially to the south. Flooding was evident between Pine Channel and Baril River, extending in to Baril Lake and Claire River. There was some flooding west of the Quatre Fourches Channel, via Rosebush Creek.

May 7-8, 2014 – The head of the ice jam continued flowing downstream on the Peace. It did not appear to jam again at Rocky Point (an area that has been known to jam in the past).

May 9-10, 2014 – Parks staff could not do extensive flying due to poor weather, but observed that the toe of the jam at 30th Baseline had released. No further ice jamming was observed and water levels began to recede.

Athabasca River

Extent of flooding on the lower Athabasca River:

Overbank flooding covered much of the area between the Athabasca and Embarras. There was also flooding of channels and basins north of the Embarras, in the area around Otter Lake (58.545520°N, -111.563680W) and Pair Lakes, as far as Lake Mamawi. Notably, the flooding in this area seemed to stop just west of Otter Lake, and did not include Hilda Lake. An interesting new feature on the lower Athabasca is a cut-through channel gradually forming towards the Embarras River at Embarras Portage (58.448960°N, -111.485963°W), a few kilometres downstream of where an aversion prevention channel was dug in the 1970s.

Flooding was observed south of the Athabasca River as far as Limon Lake (58.420934°N, -111.351317°W) and Blanche Lake (58.389088°N, -111.302747°W) (Figure 8).

Figure 8 – Flooding at Limon Lake, looking south from the Athabasca River (May 4, 2014).

Observations by date:

May 3, 2014 – There was an ice jam between the stretch of the Athabasca north of Limon Lake (58.445782°N, -111.431038° W) and west of Richardson Lake (58.451686°N, -111.200182°W). Water levels were high, though possibly already receding on the Athabasca and Embarras.

May 5, 2014 – The Athabasca River was clear of ice, and the earlier jam had broken up over the last 36 hours. The extent of flooding from the Athabasca had not changed. A small jam was observed at the winter road crossing downstream of the Dog Camp portion of the Quatre Fourches, but cabins were not flooded.

Embarras River and Mamawi Creek

Water levels were high on the Embarras, and Mamawi Creek, perhaps rising as much as 3-4m. There was extensive erosion of the bank near the cut-off to Mamawi Creek and overbank flooding (Figure 9). A large amount of woody debris was carried to the mouth of Mamawi Creek at Lake Mamawi, which was the first area of the lake to have open water. Water levels were high along Mamawi Creek, causing flooding of channels and some overbank flooding and deposition of sediment into Johnny's Cabin Pond and Mamawi Creek Pond.

Figure 9 – Severe ice-scarring on mature spruce at the cutoff of Mamawi Creek from the Embarras. There was also extensive erosion and deposition of fresh sediment over this bank (east bank of Mamawi Creek)

Slave River:

The main action on the Slave River was related to the toe of the large ice jam at 30th Baseline, and extending up the Peace (Figure 10).

Figure 10 - Toe of ice jam on Slave River (May 6, 2014). Sheet ice visible on either side of island.

Where the Slave meets the Rocher, water levels rose about 4 m at times, with one maximum around May 1, and a second around May 5. Though water was high, we did not observe extensive overbank flooding along the Slave, and most of the flooding occurred further upstream on the Peace.

Rocher Channel

Breakup occurred fairly gradually along the length of the Rocher. Water levels rose several metres at times, but we did not observe any ice jamming, except at the major jam where the Rocher meets the Slave. While much of the Rocher broke up without jamming, the mouth of the Rocher at Lake Athabasca remained frozen fairly late (until about May 10), causing a large volume of water and woody debris to flow east from the Quatre Fourches channel into Lake Athabasca. This occurred for several days (May 7-10), and ended around May 10-11 as the jam at 30th Baseline released and the mouth of the Rocher became ice-free and began flowing north. This restored northward flow from the Athabasca River, Lake Athabasca, and the Quatre Fourches Channel and precluded major overbank flooding along the Rocher.

Complementary flood-monitoring efforts in the PAD

Ice Jams on the Peace River (Spyros Beltaos, National Water Research Institute)

Spyros Beltaos has studied the process of ice-jamming for many decades, and much of his work has focused on the mechanics of breakup on the Peace and Athabasca Rivers. He develops and tests models for the process of ice-jamming, and how it affects size and duration of jamming, flood height, and ultimately which basins are flooded.

His most recent work looks at separating effects of climate change from effects of flow-regulation on the process of ice-jam flooding in the PAD. His models are based on flow rates and water levels (from existing water gauges), measurements of ice-thickness (provided by Parks Canada), and climate (e.g. timing of freeze-up).

Discharge and water levels, relative to basin height (Daniel Peters/Parks Canada)

Daniel Peters (UVic Geography/EC Water Science and Technology Directorate) is using data available from the PAD to develop and improve hydrological models for the PAD – models that explain where water goes under a variety of flow conditions. Peters is using data from existing water level gauges previously maintained by Alberta Environment, as well as additional water-level loggers installed by Environment Canada in basins throughout the PAD. This fall, Daniel Peters and Parks Canada are overseeing the collection of LIDAR data for basins around the Quatre Fourches River in the PAD (Egg Lake). This information will provide excellent measurements of relative height of channels and basins to better predict how water will flow in certain flood scenarios.

Water retention in Egg Lake (Charlene Mortensen, University of Victoria)

Water depth in basins (and perhaps concentrations of sediments, isotopes, nutrients, and contaminants) varies depending on how basins are connected to channels, and the substrate of the basin, both of which vary among basins in the PAD. Charlene Mortensen focuses on what happens immediately after a flood – specifically how water is retained in basins such as Jemis Lake and Egg Lake. Her work involves improving hydrological models for particular basins, measuring permeability of materials that make up basins.

Flood height (high and low water marks) (Tom Carter, Environment Canada)

Tom Carter uses traditional and cutting-edge surveying techniques to take on-the-ground measurements related to flooding in the PAD. These include shear-wall measurements (used to estimate ice thickness at time of jam), and high and low water marks on the Peace, Slave, and Embarras. With assistance from Parks Canada, Carter deployed and collected water-level loggers that can be used to improve hydrological models for the delta by relating water levels in channels to water levels in basins at the same time. Tom also assisted with collection of water samples for isotope analysis, and video documentation of flood conditions immediately after the flood while water levels were still high.

Isotope sampling of basins and channels (BC Hydro, Johan Wiklund, Brent Wolfe, Roland Hall)

In spring 2014, a field crew from BC Hydro collected water samples from rivers and basins in the PAD. These were measured for hydrogen and oxygen isotope concentration (Δ18O, Δ2H). Concentrations of isotopes are known to increase (become "enriched") as water evaporates from basins that are not flooded. In contrast, isotopes are "depleted" in flood water. The relative concentration of isotopes in channels (the source of flood water) versus basins (filled with previous years' water *or* recent flood water) was used as an indicator of basins that had received flood water versus basins that had not. Most lakes sampled by the crew (13 of 16) seemed to have received flood water. The lakes that were not flooded were Greenstar Lake (aka Lake 10, or PAD18), Hilda Lake (PAD47), and Sonny's Lake (PAD61). The results seem to correspond closely with observations from aerial surveys.

Ice condition and flooding from remote-sensing (LANDSAT) (Joost van der Sanden)

Joost van der Sanden at the Canada Centre for Remote Sensing works with RADARSAT-2 images. His research group interprets this RADAR information for timing, locations, and conditions of ice cover and flooding on the Athabasca River and in the PAD. This is another way of testing and improving models for water flow, and transport of sediments and contaminants throughout the PAD. The information was mapped and distributed every few days throughout the months of April and May. RADAR information can be difficult to interpret, but extremely useful for comparison with information from observations on the ground or through aerial photos (e.g. rough ice versus smooth ice; flooded vegetation versus dry vegetation; flood-water versus meltwater).

Next steps

Parks Canada has been working to determine the extent of flooding (surface area, and volume/water depth) at a number of sites in the PAD, and how water is retained in certain areas, which might affect the influence of flooding on vegetation patterns in the delta. Not all aspects of spring flooding can be measured from the air, and the work on the ground will focus on filling these gaps, and validating some of the remote-sensing data.

Parks Canada will be working with Environment Canada to collect and examine stable isotopes to determine the source of flood water in different basins. We will also be refining the estimates of flood height using information from depth-loggers, and combining surveys of high water marks with data from hydrometric stations that were functioning during the flood.

The long-term goal of our monitoring is to link the extent, frequency, and type of flooding (e.g. over-bank versus channel) to changes observed in patterns of biodiversity throughout the PAD. This information can then be used to inform and envision management scenarios for the PAD, giving careful consideration to the influence of flow regulation and climate change on ecological integrity in the delta.

Acknowledgements

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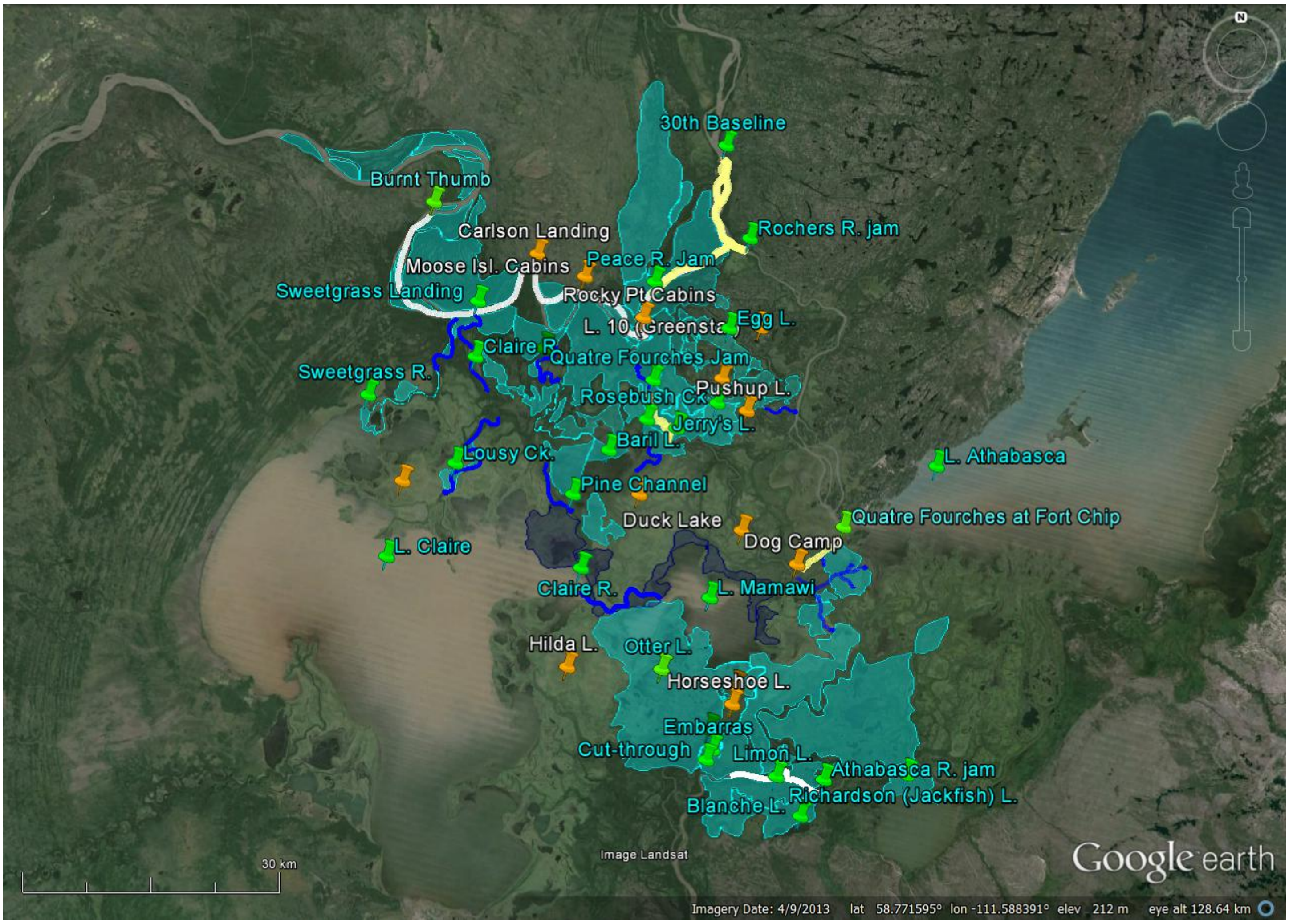
Appendix I – Flood Map



Map of locations of ice jams and total observed extent of flooding along the Peace, Slave, and Athabasca Rivers (May 3-14, 2014). This map is based on photos, videos, and geo-referenced notes taken from aircraft. This is a screencap from an interactive Google Earth layer being prepared for the PAD.