A birding perspective and analysis of Hurricane Sandy in Ontario, Autumn 2012

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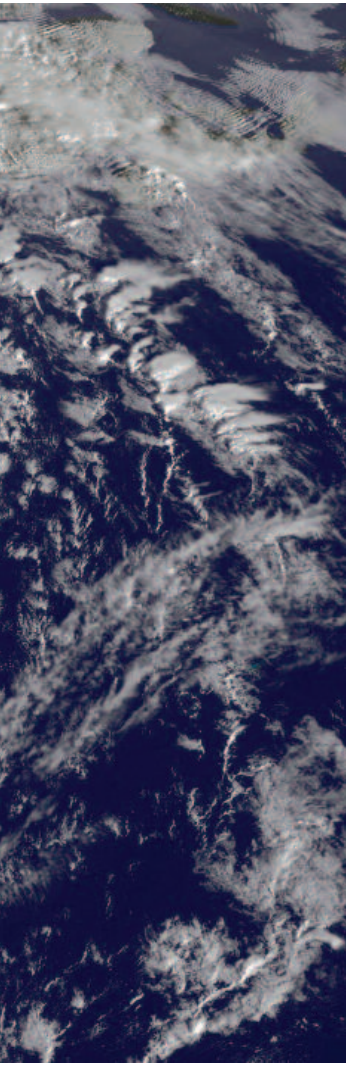

Figure 1. NOAA's GOES-13 satellite captured the visible image of post-tropical Sandy rolling inland Tuesday, 30 October 2012 at 6:02 AM EDT (Blake *et al*. 2013).

Introduction

Hurricane Sandy was the largest Atlantic hurricane on record (since 1988, when reasonably accurate estimates of storm sizes began) to ever move up the eastern seaboard (Fig. 1; Blake 2013, Blake *et al.* 2013), displacing thousands of birds to the lower Great Lakes in the process (eBird 2013), some of which were unprecedented in their rarity.

The Global Forecast System was one of the first models to hint at the remote possibility that a remarkable weather event could affect the mid-Atlantic coast, around 29 October 2012. The prediction on 21 October 2012 of a 954 mb low pressure system seemed beyond reason, as it is well known that forecasting powerful systems far in advance is strewn with error in track and intensity (Leslie *et al.* 1998, Marks and Shay 1998). Eventually, however, the final outcome was one of the most remarkable meteorological and ornithological events in Ontario's history.

The purpose of this paper is to describe the events leading up to Hurricane Sandy (hereafter 'Sandy') and its aftermath as it passed through Ontario, from both meteorological and ornithological viewpoints.

Meteorological History

What would eventually become Sandy was labeled as a tropical depression by the National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center (NHC) at 1200 Coordinated Universal Time (UTC) on 22 October 2012, roughly 305 nautical milles south-southwest of Kingston, Jamaica (Blake 2013, Blake *et al.* 2013). The system organized fairly quickly and was deemed a tropical storm six hours later, receiving the name Sandy as the eighteenth named storm of the 2012 Atlantic hurricane season (Blake 2013, Blake *et al.* 2013).

Development of the system was gradual, progressing steadily. The NHC data indicated that Sandy became a hurricane at 1200 UTC on 24 October and made her initial landfall seven hours later in Jamaica as a 75kt category one hurricane (Blake 2013,

Blake *et al.* 2013). As Sandy emerged over open water north of Jamaica, the storm intensified rapidly, reaching category three intensity just prior to her second landfall in Cuba (Blake 2013, Blake *et al.* 2013) (Fig. 2).

After weakening across Cuba, due to interaction with land, Sandy continued northwards into the Bahamas (Blake 2013, Blake *et al.* 2013). It was during this period, from 25 – 27 October, that a complex series of meteorological events began, setting the stage for the final track of Sandy. The interaction with a trough of cold air arriving from mainland North America provided energy in the form of baroclinic forcing and began processes associated with an extratropical transition, allowing Sandy's wind field to expand dramatically (Blake 2013, Blake *et al.* 2013).

Extratropical transition was incomplete and Sandy was able to maintain full tropical storm status (Blake *et al.* 2013). The complex series of events caused frontal structures to form within the

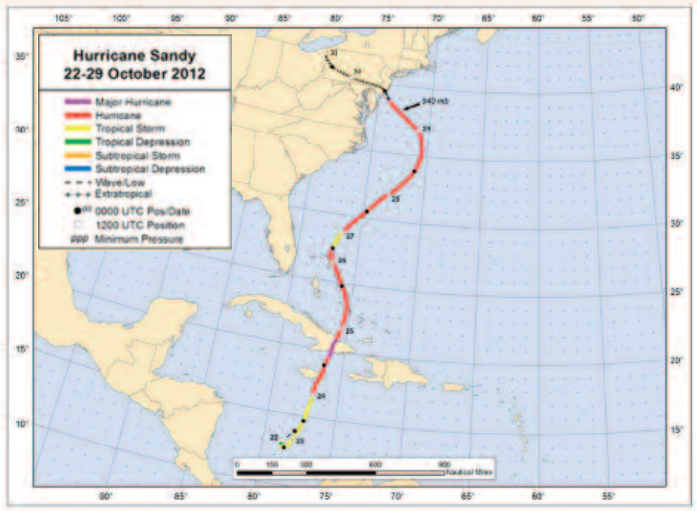

Figure 2. The official storm track of Hurricane Sandy (Blake *et al.* 2013).

Ontario Meteorology Perspective

The remarkable events which took place over the Atlantic Ocean involving the movement and intensity of Sandy were well documented by meteorological experts around the world (Blake *et al.* 2013). The story in Ontario was easier to monitor by the authors as they examined data from stationary weather stations and provided personal field observations. A day by day breakdown is examined below:

26 October 2012 – A warm southerly flow is pushing into Lake Ontario in the morning. To the west, an approaching trough (cold front) will provide the future fuel to turn Sandy into the powerful and devastating system it will become over the next few days.

27 October 2012 – The cold front brings north or northwest winds from James and Hudson bays.

28 October 2012 – The inversion of the trough, due to the anomalous blocking pattern over Atlantic Canada, coupled with the remarkable wind field of Sandy, are impacting Ontario.

29 October 2012 – North-northwest to north-northeast winds intensify and the origin of the wind curves more to the northeast in the morning. The remarkably large wind field of Sandy is pushing east and northeast winds down the St. Lawrence Seaway and into southern Ontario (primarily Lake Ontario).

It is just after sundown on the 29th that Sandy is close to landfall near Atlantic City, New Jersey. It is around this time that Sandy loses her tropical characteristics. The NHC

cyclone away from the centre (Blake 2013, Blake *et al.* 2013). Hurricanes typically do not show these features, giving Sandy the appearance of a hybrid system (Blake 2013, Blake *et al.* 2013).

Sandy continued to grow in size as the cyclone moved northwards from Bermuda to North Carolina (Blake 2013, Blake *et al.* 2013). On 29 October, Sandy reached an anomalous blocking pattern (high pressure) in the North Atlantic (Blake 2013, Blake *et al.* 2013); perhaps the defining moment from an Ontario birding standpoint, causing a highly unusual change in wind direction to the north and then northwest as Sandy began her final course towards the coast of New Jersey. This blockage allowed a second trough over the southeast US to provide a notable boost to the baroclonic forcing of energy into the cyclone (Blake 2013, Blake *et al.* 2013). This change in direction moved Sandy again over warm Gulf Stream waters allowing her to intensify to her secondary peak of an 85kt category two hurricane on 1200 UTC 29 October 2012 (Blake 2013, Blake *et al.* 2013).

Over the next several hours, Sandy began to transition to an extratropical cyclone once again. This time the process was accelerated by the additional injection of cold air and cooler water near the coast of New Jersey (*i.e.* to the west of the Gulf Stream; Blake 2013, Blake *et al.* 2013). When only 45 nautical miles northeast of Atlantic City, New Jersey, the NHC declared Sandy a fully extratropical system at 2100 UTC on 29 October (Blake 2013, Blake *et al.* 2013). Post-tropical cyclone Sandy made her final landfall at 2330 UTC in New Jersey with an estimated intensity of 75kt winds (Blake 2013, Blake *et al.* 2013).

Sandy weakened steadily and moved slowly west-northwest to north before losing a defined centre over northeast Ohio around 1200 UTC on 31 October (Blake 2013, Blake *et al.* 2013). Following this event, the remnants of Sandy moved northwest to northeast over Ontario in the days before eventually merging with a low pressure system over eastern Canada (Fig. 2; Blake 2013, Blake *et al.* 2013).

declares Sandy a post-tropical cyclone, though still remarkable in terms of her size and strength.

30 October 2012 – As the core of the system continues to move closer to Ontario, winds intensify throughout the night and a remarkable north-northwest to northeast wind greets observers at various lake watching sites around southern Ontario. Now that Sandy is post tropical, she is weakening steadily. A frontal boundary that formed days ago over the Atlantic Ocean inside Sandy is at the far reaches of eastern Lake Ontario early in the morning. By late morning, the boundary has pushed across Lake Ontario to Hamilton. The shift is marked by an increase in precipitation and a shift in winds to the east-northeast noted by observers at Van Wagners Beach. Winds are now blowing to all of Lake Ontario directly from the Atlantic Ocean in an area roughly from Massachusetts to Long Island, NY (Fig. 3, Blake *et al.* 2013, *see page 16*).

31 October 2012 – The weak remnant core of post tropical Sandy slowly passes over eastern Lake Erie and western Lake Ontario throughout the day. Winds are light and variable.

1 November 2012 – The remnants of Sandy have pushed north through southern Ontario, and the back of the storm produces powerful west-northwest winds, squalls and cooler temperatures.

2 November 2012 and onwards – Northwest winds persisted for days following the passage of the system.

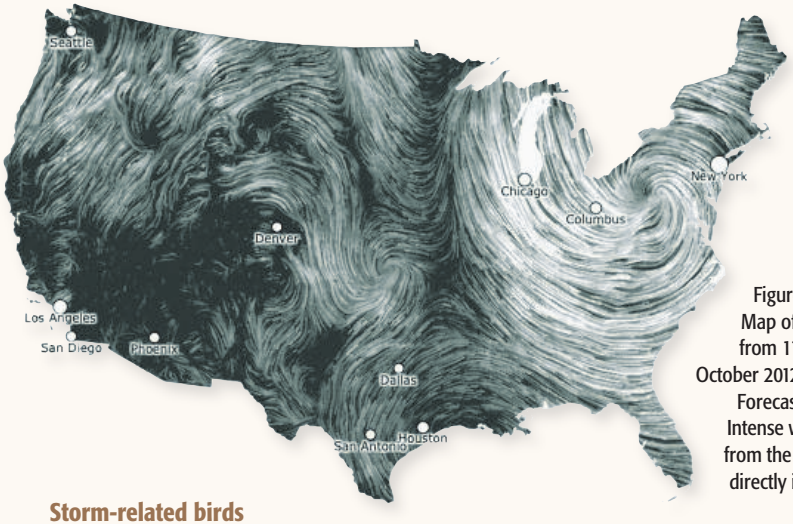

Figure 3. CONUS Wind Map of Hurricane Sandy from 11:59am EST on 30 October 2012 (National Digital Forecast Database 2012). Intense winds are blowing from the eastern seaboard directly into Lake Ontario.

Storm-related birds

Sandy displaced thousands of birds from the Atlantic Ocean as well as birds from the Arctic (eBird 2013). A summary of select notable species observed throughout Sandy's displacement are provided below, as per OntBirds, eBird (2013), Cranford (2013) and Mackenzie (2013).

Brant *(Branta bernicla)*

Exceptional numbers were found on lakes Huron, Erie and Ontario, with places like Sarnia and Long Point recording local record high counts.

A record high count of 220 was recorded at Long Point on 30 October.

Wilson's *Storm-Petrel* *(Oceanites oceanicus)*

- one, 30 October, Van Wagners Beach (Robert Z. Dobos *et al.*)

Leach's Storm-Petrel *(Oceanodroma leucorhoa)*

- one, 30 October, Thickson Point (Glenn Coady)
- one, 30 October, Van Wagners Beach (Fig. 4, David R. Don *et al.*)

Storm-Petrel sp. *(Hydrobatidae sp.)*

- one, 30 October, Van Wagners Beach (Brandon R. Holden *et al.*)

Black-legged Kittiwake *(Rissa tridactyla)*

Impressive numbers were observed throughout southern Ontario at multiple locations on lakes Huron, Erie and Ontario, with minimum high counts listed below:

- 88, including two second basic (the rest first basic/first winter), 30 October, Van Wagners Beach (Fig. 5, m. obs.)
- 16 (all first basic/first winter), 1 November, Fort Erie (Waverly Beach, m. obs.)

Ross's Gull (*Rhodostethia rosea)*

- one adult, 1 November, Waverly Beach (Kenneth G.D. Burrell *et al.*)

Laughing Gull *(Leucophaeus atricilla)*

- one adult, 30 October, Thickson Point (Glenn Coady)

Figure 5. Black-legged Kittiwakes (*Rissa tridactyla*) at Van Wagners Beach on 30 October 2012.
Photo: Brandon R. Holden.

Pomarine Jaeger *(Stercorarius pomarinus)*

Similar to Black-legged Kittiwakes, impressive numbers were observed throughout southern Ontario at multiple locations on lakes Huron, Erie and Ontario, with minimum high counts listed below:

- ten, 30 October, Van Wagners Beach (m. obs.)
- seven, 1 November, Waverly Beach (m. obs.)

Long-tailed Jaeger *(Stercorarius longicaudus)*

- one, 30 October, Van Wagners Beach (m. obs.)
- one sub-adult, 1 November, Long Point Tip (Stuart A. Mackenzie and Adam Timpf)

Razorbill *(Alca torda)*

- one, 30 October, Thickson Point (Glenn Coady)

While the above species list identifies exceptional or record high numbers of interesting species observed during Sandy, numerous other interesting species or record counts were recorded throughout this event. Gyrfalcon (*Falco rusticolus*), Sabine's Gull (*Xema sabini*), Forster's Tern (*Sterna forsteri*) and many other species, most notably waterbirds, were recorded in higher than normal numbers, most likely attributed to Sandy (eBird 2013).

Numerous Cave Swallows (*Petrochelidon fulva)* were recorded throughout southern Ontario and upstate New York (eBird 2013); however, a previous system occurring just prior to Sandy was the most likely culprit in pushing birds north into the region. Several other interesting and unusual species were noted for which documentation by the Ontario Bird Records Committee has yet to review; these birds are not listed above.

Discussion

Prior to the arrival of the storm, Holden postulated the potential impacts Sandy could have on avian migration and vagrants into southern Ontario. The basic premise was that migrants and vagrants would occur from the direction of origin of the wind field impacting an area. As the storm progressed, the impacts would compound as new and stronger winds directed birds to southern Ontario from different locations. They were informally dubbed Phases 1, 2, 3 and 4. A brief overview is presented below:

Phase 1: Initially strong north winds associated with a trough of cold air would draw migrants and potential vagrants southwards (*i.e.* from James Bay) into the southern Great Lakes region.

Phase 2: As the centre of the storm approached, the counter clockwise motion of the cyclonic storm would then bring northeast winds into southern Ontario and potentially birds from the St. Lawrence Seaway and nearby areas.

Phase 3: An unusual frontal boundary-like feature was present within Sandy. As the remnants of Sandy pushed closer to Ontario, somewhat resembling a "back door warm front", winds came directly from the east coast of the US into southern Ontario (specifically Lake Ontario).

Phase 4: If any birds were trapped within the eye (or remnant core), the passage of this portion of the storm (and any accompanying southerly winds) could displace them.

Beyond the predicted Phases, it was also noted that storm conditions at any time led observers to detect noteworthy birds that were already present in a given area which were now simply concentrated or reshuffled allowing for them to be recorded. An analysis of vantage points, weather and bird observations are presented below. An attempt was made to compare popular vantage points for lake watching among the three Great Lakes directly affected by the winds of Sandy in southern Ontario. The locations used are:

- Lake Ontario – Van Wagners Beach and Niagara-on-the-Lake.
- Lake Huron – Point Edward Lighthouse.
- Lake Erie – the tip of Long Point and Waverly Beach (Fort Erie).

28 October: Holden spends several hours lake watching at Van Wagners Beach, with notable sightings being single flocks of Brant and Sanderling (*Calidris alba*) (Fig. 6). These sightings correlate to the effects of Phase 1.

29 October: powerful north-northwest to north-northeast winds occur throughout Ontario. Observers stationed at the tip of Long Point had few notable sightings; observers stationed at Van Wagners Beach, including Holden, remarked at the general lack of interesting observations before 10 Black-legged Kittiwakes were recorded from mid-afternoon to dusk (pers. obs.). This is contrasted by observers at the Point Edward Lighthouse who had a notable day with sightings of Brant, Black-legged Kittiwake, Red Phalarope (*Phalaropus fulicarius*), Parasitic Jaeger (*S. parasiticus*) and Franklin's

Gull (*L. pipixcan*). These observations indicate that the effects of Phase 1 were being felt at all locations around southern Ontario; and that the effects of Phase 2 were likely beginning to be felt on Lake Ontario by mid- to late-afternoon.

30 October: powerful north-northwest to north-northeast winds continued in the morning; however, they eventually shift northeast by mid-morning. The remnant core of Sandy was much closer to Ontario than the previous day and many observers around southern Ontario reported remarkable numbers and exciting vagrants; including record high counts of Black-legged Kittiwakes. This was likely attributed to the continuing and compounding effects of Phases 1 and 2 at all vantage points. Perhaps the most notable observations of Sandy occurred on this day, as multiple Leach's Storm-Petrels were reported on Lake Ontario as well as a single Wilson's Storm-Petrel (Cranford 2013). The observations of storm-petrels strongly correlate with the passage of an abnormal frontal-boundary feature within Sandy — bearing some resemblance of a "back door warm front". The passage of this feature came with a change in wind direction from north-northeast to east-northeast at Van Wagners Beach, less than an hour prior to the first sighting of a Leach's Storm-Petrel. This is strongly linked to the beginning of Phase 3 and also indicates why these species were not recorded at stations on lakes Erie or Huron this day (which stayed within the effects of Phase 2).

31 October: the enlarged and weakening core of the system occurred over a large area of southern Ontario. Large numbers of observers took to the field in hopes of relocating the remarkable birds recorded on 30 October, yet few were successful. Sightings such as Brant at Point Edward and the tip of Long Point would have been quite notable in any given year, but paled in comparison to numbers recorded the previous day. If any birds were to occur in Ontario under the effects of Phase 4, the passage of this feature over lakes Erie and Ontario would have made it the ideal location to drop any noteworthy individuals.

1 November: the core of the system was pulling away from Ontario, and powerful west-northwest winds pushed through southern Ontario. This dramatic change in direction meant that locations previously watched vigorously (*i.e.* Van Wagners Beach and the Point Edward Lighthouse) were either unmanned or did not produce sightings of note. The authors moved to Waverly Beach in Fort Erie believing it would be the best location to record birds associated with Phase 4. While no species were recorded that would be associated with displacement in this manner, a number of remarkable birds were recorded, the most notable being an adult Ross's Gull (Cranford 2013). The lingering effects of Phases 1 through 3 were well recorded with continued sightings of Brant, Black-legged Kittiwake and Pomarine Jaeger among other species both at Waverly Beach and by observers stationed on Lake Ontario at Niagara-on-the-Lake (Fig. 5, eBird 2013).

Conclusion

Sandy had the largest wind field ever recorded (since 1988, when reasonably accurate estimates of storm size began) for a hurricane in the Atlantic Basin (Blake *et al.* 2013). The abnormal northwest turn in Sandy's track brought her ashore and provided a remarkable learning experience for amateur ornithologists, demonstrating how large storm systems can displace various bird species. The predictions made by Holden prior to the storm's arrival and the observations made by dozens of individuals throughout southern Ontario have increased our understanding of how to detect storm driven waifs and migrants alike. Many climate scientists believe that human-influenced global warming will lead to increased size and intensity of storms felt in North America, including hurricanes (Emanuel 2005, Anthes *et al.* 2006, Bender *et al.* 2010). If these predictions are realized, continued study of the effects these storms can have on avifauna will be a significant focal point for amateur ornithologists in Ontario and beyond.

Figure 6. Sanderling (*Calidris alba*) at Van Wagners Beach on 28 October 2012, attributed to the effects of Phase 1. *Photo: Brandon R. Holden.*

Acknowledgements

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