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Outside the Fence II–MSN Airport: Follow-up Study on Goose/Aircraft Strike Risk 2010 vs 2012 Before vs After Crop Habitat Modification

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ABSTRACT: Five biweekly dawn-dusk observations of Canada goose movements near Dane County Madison Regional Airport (MSN) were made 10 October–15 December 2012 and results compared with similar 2010 data that had defined goose numbers, origins, and destinations for local goose flights within 10 miles of the airport across fall migration period dates. Following 2010 research suggestions, MSN airport authorities changed crop leases for lands they owned northeast of the airport to require immediate turning of corn crop residue following harvest. The affected area had been identified as a major attraction site leading to high risks of goose/aircraft strikes for Runway 21 ILS traffic in fall 2010. Following 2010 study protocol, geese were again visually tracked to observe origins/destinations for local flights and visual ground checks made to confirm locations attracting geese through airport patterns. In 2010, corn stubble fields northeast of the end of Runway resulted in observation of 696 geese entering that aircraft strike risk zone. This figure was extrapolated (total seen times 15 days for each cycle) to an estimated 10,440 risk geese entering/leaving there for the study duration. In 2012, only 31 geese were observed to fly in/out to feed there, an extrapolated value (465 geese for fall) representing a reduction of 97.1% in goose risk for that airport zone, despite average 6-fold increase in goose numbers observed at Warner Park roost area near the airport in 2012. Results indicated modification of agricultural habitat attracting geese to the airport vicinity can greatly reduce goose strike risk once attraction sites are identified. Needed changes were accomplished at no airport cost by having field leases require immediate disking of crop residue after harvest.

KEY WORDS: aircraft, airport hazards, bird strike risks, *Branta canadensis*, Canada geese, corn residue management

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INTRODUCTION

There were 1,401 Canada goose (*Branta canadensis*) strikes with civil aircraft reported in the U.S., 1990–2012 (Dolbeer et al. 2012), 42% involving multiple birds, as did “Miracle on the Hudson” Flight 1549 (NTSB 2010). That incident focused increased attention on finding ways to reduce goose strike risks to aircraft that may lead to emergency situations and possible loss of human life.

Dane County Regional Airport (MSN) is located 5 nautical miles (8 km) ENE from downtown, Madison, WI. It serves military planes based there, general aviation, and commercial air traffic, serving over 1.5 million passengers, with >100 arrival/departures daily in 2010. After the Flight 1549 incident, media cries “to make the skies safer” drew attention to geese in Warner Park (WP), 3.4 km from MSN. USDA Wildlife Services, Waupun, WI, proposed lethal removal of geese there. Alternatives to lethal removal of urban geese exist (Whitford 2002, 2008, Smith et al. 1999) but were deemed ineffective. Local resident resistance to goose removal from Warner Park stimulated research to determine whether WP geese were a major threat to MSN travelers, and whether area goose flight patterns or feeding sites could be altered to permit geese and planes to coexist more safely (Whitford 2014).

Radar-based studies near Horicon Marsh, WI, had defined fall timing, flight paths, and triggers for Canada goose migration from Horicon Marsh to southern Illinois (LeMarche 1972). This predated extensive transplanting of giant Canada geese (*B. canadensis maxima*), which now reside in the state all year. Radio-tagged geese residing at Horicon Marsh before moving on south evidenced highly predictable movement patterns such that most geese returned annually to the same small roost sites

in the marsh, using them nightly, and followed the same daily flight paths to food while there (Bartelt 1987). Southern Illinois studies found goose movements in late autumn/winter were primarily from night roosts to/from the nearest available corn residue in fields (Raveling 1969, Anderson and Joyner 1985). For spring staging migrants along the Platte River in Central Nebraska, it was reported that “geese usually go to the nearest food (corn residue) from roost sites” (Anteau et al. 2011), and that “tilling (disking) corn stubble reduces residual corn waste available for geese by 92% from a mean of 234.1 kg/ha to 23.7 kg/ha, making such fields far less attractive to geese” (Sherfy et al. 2011).

Given the above information, I hoped studying Canada goose daily movements near MSN in fall of 2010 would allow me to: 1) quantify goose risks and sources of geese posing a risks to aircraft; 2) identify origins/destinations of daily feeding flight paths used by geese; 3) identify traits of goose attraction sites near MSN to gain insight into how to reduce goose strike risks; and, 4) define subunits of the Madison fall goose population and their relative contribution to airport risks. That study was done 6 October to 7 December 2010 (Whitford 2014). Key study conclusions included: 1) residual corn in stubble attracted geese near the airport to feed, and 2) disking corn residue on fields north of Runway 21 threshold right after harvest could reduce goose strike risks there by >90%. MSN officials revised 2012 crop field leases to require immediate disking after corn harvest for the field just north of Runway 21 threshold (lands they owned), where 696 risks of goose/aircraft strikes for ILS approach Runway 21 were observed in just two evenings in 2010. This change provided an opportunity to test 2010 study predictions. The second

study (10 October to 15 December 2012) began with goals of: 1) assessing change in goose strike risks observed for the ILS approach path to Runway 21 resulting from new lease requirements, and 2) gathering data on changes in goose and risk numbers and movement patterns between the two study years. Finally, 424 flightless geese/goslings were euthanized in Madison parks in 2011 and 2012 (Madison Parks Dept. pers. comm.), so this study could determine if this action substantially reduced WP goose numbers or aircraft risks observed in autumn of 2012 versus 2010.

METHODS

The same methods were used for 2010 and 2012 studies. Complete details regarding criteria for designating geese as “risk geese” and timing of observations are found in Whitford (2014) and a summary is provided here. Study design used a single observer (the author), and a fixed observation site off the NE corner of MSN airfield that provided 16 km of unobstructed vision to observe goose flights above east, west, south, and northeast horizons, and 10 km to the north. Both studies included 5 full-day (½ hour before dawn to full dark) cycles of observations, with cycles carried out roughly 2 weeks apart. Each observation cycle was extended over multiple days to reduce influence of possible daily variation in area goose numbers. Observation days were opportunistic, as they required 10 statute mile (16 km) visibility to permit maximum visual distance, allowing counting geese in flights and height estimation, and providing uniformity in visual sample area. On such days, I stood outside my car continually scanning the sky in all directions for goose movement for 4-6 hours. I used 7-15× Zoom Bushnell binoculars (Bushnell Outdoor Products, Overland Park, KS) to identify, count, and estimate height of distant geese. I recorded time and number of geese when first seen, probable origin, estimated distance (from airport) height, and direction/path of flight. When origin/destination were uncertain, it was listed as unknown. I tracked each local flight until it landed. Goose numbers observed were graphed versus time, in 2-hour blocks for each observation cycle, to help predict greatest/least risks to aircraft by date and time of day.

Goose flight heights were all estimated by one observer as feet above ground level (AGL) since airport pattern heights, local terrain, and structure heights were used as reference heights (Randall et al. 2011), and 50 years of range/height estimation in goose hunting were based in English yard or foot units. I later converted heights to meters. The person estimating heights had 35+ years as a pilot, and research experience with Canada geese and is able to determine goose size/subspecies (necessary to estimate height and distance more accurately) by neck-to-body length proportions and by call pitch and duration, based on extensive prior Canada goose vocal research (Whitford 1987, Whitford 1999). Height estimates were incremental and recorded in units as follows: <100 ft to nearest 25 ft; 100-500 ft to nearest 50 ft; 500-1,200 ft to nearest 100 ft; and >1,200 to nearest 200 ft.

Observations were conducted 10 October to 15 De-

ember 2012 and were designed to begin before migrant geese arrived and end after most migrants left the area. Using 15-day intervals between cycles permitted evaluating changing goose numbers across the fall and insight into airport risk influences of resident and migrant Canada geese. It also met FAA rules for Airport Wildlife Hazard Assessments: “standardized counts of birds shall be made at least twice monthly” (protocol for the conduct and review of WHA, WHMPs, WHSVs, and Continual Monitoring, FAA Regulations, Advisory and Certalerts AC No: 150/5200 2012).

I listed all goose flights observed as either “risk geese” as defined below, or as “non-risk” for flights moving >3.4 km from the airport. Geese flying at migration heights >1,200 ft (366 m) AGL (Bellrose 1980) and not descending in Madison were recorded as “transient migrants” and not counted among risk/non-risk geese totals for each cycle.

Criteria for designating geese as an “airstrike risk” in this study were 1) any goose flight passing over/within 3.4 km (2 nautical miles) of the airfield’s outer margins below 800 ft AGL (approx. 243.8 m), standard airport pattern altitude and 2) any geese flying through or within 0.5 km of any ILS (Instrument Landing System) approach/departure glide slope corridor at any height below 800 ft AGL to a distance of 3.4 km from the ILS inner marker, which is set 1,000 ft (340 m) from the runway threshold. The rationale for “risk” designation criteria was that FAA guidelines call for ILS glideslopes to establish a 3-degree-slope glide path where, by definition, planes should: 1) cross the runway threshold at 50 ft (15.2 m) AGL, and 2) be at 600 feet (182.8 m) AGL when 2 nautical miles (3.4 km) from the runway threshold (see: <http://flightsimulation.com/aviationtheory.25.ILSNAVIGATIONpart2.TheGlideSlope>).

MSN is a class C airspace airport, requiring all landing planes to use ILS approaches, so all planes landing there should be above 600 ft (180.2 m) AGL when >2 nautical miles from the airport perimeter. Results of 2010 MSN study flight height data for 100 randomly chosen goose flights (2,324 geese total) indicated average flight height was 291.3 ft (88.78 m) (Whitford 2014), and only 22 of these geese (0.95%) were estimated to be >500 ft AG. Since 99.05% of these geese were below 500 ft (152.6 m) AGL within airport airspace and to 10-16 km beyond (Whitford unpubl.), aircraft were not expected to experience significant goose strike risk until below 500 ft (152.6 m) AGL in final approach and during departure until climbing above 500 ft AGL. Given slower flight speeds and low descent rates of final approach flight versus take off and full throttle climb angles, aircraft exposure time to goose risks on approach is 3-4 times greater than departure exposure risk. Over 30% of North American Canada goose strikes reported involved planes on the ground during landing, take off, or taxi operations (Dolbeer et al. 2012). However, MSN grass, water, and wildlife management are excellent and probability of such strikes here appear extremely low.

The percentage of total geese moving near the airport to/from each identified origin and destination was calculated for all observation cycles in 2010 (Whitford

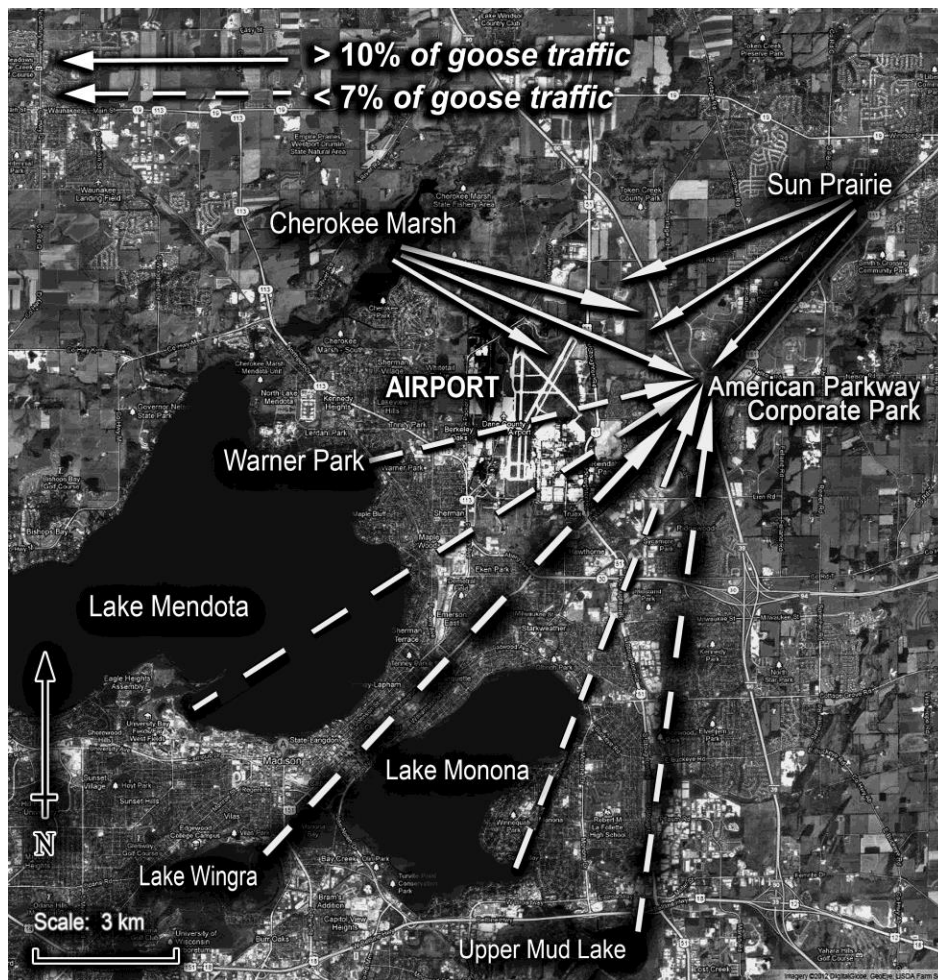


Figure 1. Feeding flight paths from roost and resting sites to feeding locations near MSN airport 2010. Three solid arrows from upper left are from Cherokee Marsh; three solid arrows from right are from Sun Prairie ponds. Dashed arrows from middle left is from Warner Park, other dashed arrows from sites on south shores of Lake Mendota. Each solid arrow indicates >10% of all geese observed used those flight paths. Dashed arrows indicate <6.5% of all flights observed. Geese using three most easterly paths never enter the airport risk zones and do not fly high enough to be a problem to aircraft approaching the airport.

2014). All regularly used feeding flight paths indicated by those data were overlaid on a satellite photo of MSN and its surrounding environs (Figure 1) to provide a visual reference for discussions of risk areas, flight paths, roost areas, and goose attraction sites.

Before and/or after observation periods, I drove to suspected landing/departing sites to confirm them and identify attraction sources. Counts of geese at WP and ponds near Rieder Road and Hwy 151 south of Sun Prairie (SPPs), 7 km northeast of MSN, were recorded at least twice for each cycle in 2012 as in 2010. The largest number observed on a single count for each site/cycle was recorded to track changes in local goose numbers across the fall migration, and for comparison with goose numbers observed in each study year. Wisconsin Society for Ornithology’s published Annual Christmas Bird Count records were compared with my counts to help verify local 2012 goose estimates.

RESULTS

In 2012, 3,148 total flying geese, of which 877 were considered risks, were seen in 4 observation cycles. Dates, times of day, and numbers of risk versus non-risk geese seen are shown in Figure 2 A-D. Snow, fog, and mist during Cycle 5 prevented observations, and it is not included in results. Number of geese and risk geese/observation cycle in 2012 are shown in Table 1.

A striking study result was the extremely low goose numbers observed Cycle 2, 2012 (Table 1, Figure 2B). Compared to Figures 2A, 2C, and 2D, the 39 geese (14 risk) seen in Cycle 2 represents only 0.66% of total geese and 0.77% of total risk observed in all the other 8 observation cycles of 2010 and 2012 combined, or a 99.33% risk reduction versus total 2010 and 2012 strike risk.

Only 14 geese (all risks) were observed to land on the focal study site where the corn stubble had been disked

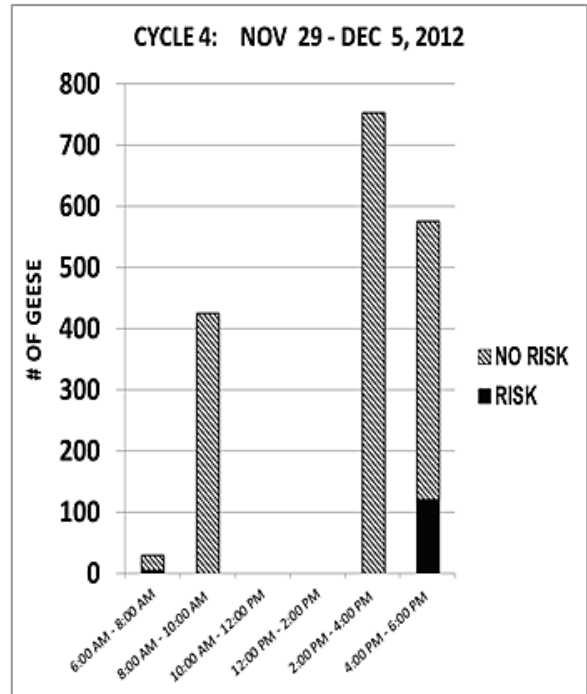
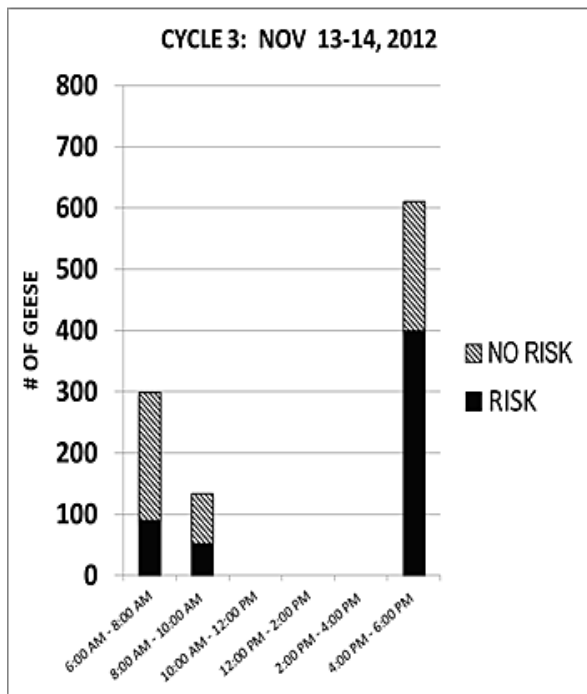
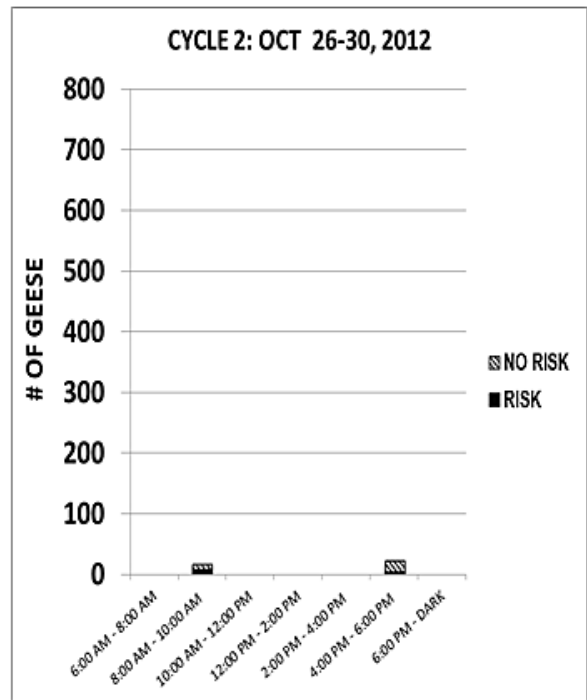
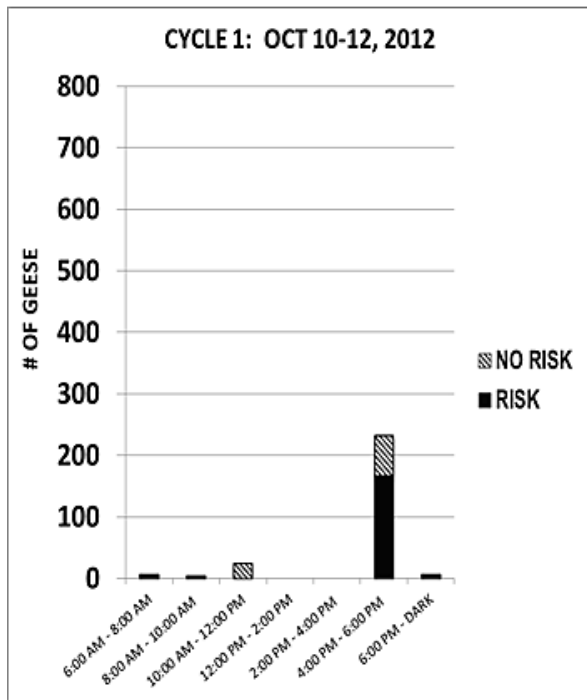


Figure 2. Graphs of observation dates, daily total goose numbers and risk goose numbers relative to times of day on 2-hour blocks for each Cycle 1- 4 as Figures A-D, respectively, for 2012 fall goose observations at MSN.

Table 1. Number of geese and risk geese/observation cycle in 2012.

Cycle	Total Geese	Risk Geese
1	273	184
2	39	14
3	1,044	542
4	1,555	129

immediately after harvest, as per new lease terms. This was a 97.99% risk reduction from 696 risk geese seen there in 2010, when corn stubble was returned.

Since that field was not a feeding site in 2012, flight paths used in 2010 from WP and SPPs and Cherokee Marsh (CM) to that field were unused in 2012. Feeding flight paths identified in 2010 from CM and WP to fields within/near American Family Corporate Park (AFCP)

were unused in Cycles 1 and 2, 2012. After corn at AFCP was harvested 29-30 October, and stubble left unturned, these same flight paths became major risk zones in Cycles 3 and 4, totaling 2,826 geese (716 risk geese), or 75.83%, of all risk geese for 2012.

One new high-risk feeding site appeared in Cycle 1, just beyond the north end of Runway 18. A narrow, unturned harvested corn field <5 ha, it attracted 166 risk geese through the Runway 18 ILS at <150-foot heights (18.9% of total 2012 risk geese). They landed, fed, and flew up to circle and land again as commercial jets landed on Runway 18 in the final 40 minutes of daylight. Total geese seen in Cycle 1 2012 was 273, or 8.81 times more than seen in Cycle 1 2010, probably indicating some migrants had arrived earlier than in 2010. Before Cycle 2 began, the company owning the field stripped it of soil to expand gravel mining. No geese were seen there again. Further risks to aircraft from geese feeding there appear to have been permanently eliminated.

The average number of geese counted per observation cycle at WP rose from 87.5 (n = 5, range 0-200) in 2010 to 531.25 (n = 4, range 100-750) in 2012, a >6-fold increase in geese versus fall 2010. Geese counted at SPPs decreased in 2012 to a daily average of 266.25 (n = 4, range 0-800) from 950 (n = 4, range 0-1,800) in 2010, roughly a 70% decline in geese counted for 2012. I think it likely that this decline resulted from drought-induced pond surface area reduction, and geese roosting there in 2010 shifting roosts to WP or CM in 2012. A major increase in geese roosting west of the airport in 2012 was noted when it created high goose risk numbers seen in Cycles 3 and 4, once corn fields at AFCP were harvested. These counts suggest goose numbers near the airport were at least 30-40% greater in 2012 than 2010 and contributed to higher total flying goose numbers (3,148) observed in 2012, versus 2,772 in 2010.

DISCUSSION

The 2012 study was done primarily to assess aircraft/goose strike risk reduction gained by requiring turning corn residue within 24 hours of harvest on the field north of Runway 21 threshold. This site was associated with 696 risk goose observations (74.1% of all 2010 risk goose observations) in 2 days of the 2010 study (extrapolated to 10,440 expected total risk geese for the 30-day period of Cycles 4 and 5 combined). Risk in 2012 with corn residue at that location having been turned under was 14 risk geese observed for all the cycles, a 98% risk reduction. There were no Cycle 5 data in 2012, due to bad weather. In 2010, Cycles 4 and 5 were the times when observed risk goose numbers were highest there. Yet, I think it safe to say no risk geese would have been seen at this site if 2012 Cycle 5 had been completed. Cycles 3 and 4, 2012, evidenced 1,044 total geese, with 542 risks; and 1,784 total geese with 129 risks, respectively, yet none were seen in the field north of off Runway 21 threshold in these cycles. Absence of geese there strongly supports research results that claim tilling/disking corn residue makes fields unattractive to foraging geese (Sherfy et al. 2011). However, Anteau et al. (2011) reported that geese staging along the Central Platte River in spring preferred the tilled corn fields to

grazed and mulched stubble. These would be primarily small-bodied white geese and smallest of arctic-breeding Canada goose subspecies, both with short necks and short bills and known to work arctic mudflats for invertebrates and tubers, and unable to see over taller stubble to detect predators. In the present study, Wisconsin's large Canada goose subspecies unequivocally preferred untilled versus tilled corn residue as feeding sites.

Only 39 geese were observed flying near MSN in Cycle 2, 2012, (despite 700+ geese being counted at WP and 250 at SPPs in that cycle). This was lowest number of geese seen flying near the airport in all cycles of 2010 and 2012, except Cycle 1, 2010 when 31 geese were observed; but low post-observation count numbers at WP (28) and SPPs (15) indicate Cycle 1, 2010 preceded migrant arrival in 2010. In contrast, in 2012 Cycle 1, 273 total geese were observed flying near the airport, 8.8 times more than 2010 Cycle 1, and 750 geese were counted at WP and 450 at SPPs, indicating that many migrants were present. By Cycle 3, 2012, 1,044 geese were seen, showing that the increase in migrant geese had continued.

So, what can explain such low numbers of geese and risk geese observed in Cycle 2? Perplexed by the low numbers, I searched for geese and an answer after the cycle. What I discovered was that there were no unturned harvested corn fields at any site identified as goose attractions in 2010, nor could I find any north or east of the airport until reaching Sun Prairie. So, no attractive feeding sites existed close to and east of the airport during this period, and absence of geese in that area provides further support for concluding that tilling corn residue harvest greatly reduces field attraction for geese. During this cycle, geese from WP and CM were observed flying northwest to feed. Absence of geese near the airport in Cycle 2, 2012 strongly supports my 2010 conclusion that reducing corn residue at all sites identified in 2010 could reduce MSN airport goose risks >95%. Data from Cycle 2, 2012 suggest a 99% risk reduction can be attained. Patterns of increase/decrease in goose numbers for 2010 and 2012 were similar but differed in timing and were higher overall in 2012 versus 2010. Total migrant/resident goose numbers peaked earlier in 2010, reaching 1,263 geese for Cycle 3 (9-11 November 2010) and declining to 511 for Cycle 4 (16-18 November 2010). In 2012, total geese observed/cycle peaked at 1,784 for Cycle 4 (29 November to 2 December), roughly 3 weeks later than in 2010, and was nearly 50% greater than highest goose numbers of any cycle of 2010. This supports claims that total MSN area goose numbers were far greater in fall 2012, and that that most of the increase in observed risks to aircraft are related to increase in migrant geese present rather than resident geese.

Fall 2012 continued summer droughts, and wetlands in Dane County were reduced in number and surface area. This may have triggered rural resident geese to move to Madison area lakes and marshes, as night roost sites leading to the increase in WP geese in October 2011. Another explanation might be related to a hunting regulation change made in 2011. Early goose season 1-15 September in 2010 was followed by a closure of hunting in the exterior goose zone. As of 2011, the exterior zone

goose season began September 16, the day after early goose season ended, and remained open (except for the morning of opening of statewide duck hunting). So, extended 2012 early goose hunting efforts may have driven geese into protected urban areas.

Fewer geese used shrinking ponds at SPPs as a roost in 2012 versus 2010. Yet, fall airport area observed goose numbers were 12% higher overall in 2012 than in 2010, despite extremely low numbers seen in Cycle 2. Many displaced geese apparently moved to roosts at WP and CM, thus moving geese from roosts east of the airport to roosts west of it. Corn stubble within/bordering AFCP attracted >1,000 geese/day following crop harvests 30 October to 4 November 2012. Daily flights of geese roosting west of the airport crossed near the airport to feed at AFCP fields once they were harvested, as evidenced by greatly elevated goose and risk numbers in Cycles 3 and 4, 2012. Geese roosting at SPPs in 2010 were outside the airport "risk area" when they flew to feed on corn residue at AFCP. Shifting roost locations to CM and WP in 2012 increased both total geese and "risk geese" observed for Cycles 3 and 4 (2012) and largely masked the major risk reductions made by turning corn stubble after harvest on the field near Runway 21.

Without goose count data from Cycle 5 (2012) it is difficult determine whether area goose numbers remained higher than in that period 2010. Comparing weather conditions and other goose count information October to December of 2010 and 2012 might provide an answer. A 20-in snowfall 9 December 2012 (Keyel and Kavanagh 2013) buried corn residue on Madison area fields, prompting many geese to leave. Fall 2010 weather patterns were similar with deep snows December 16 near Madison (Kavanagh 2011). Wisconsin Christmas Bird Counts done by Wisconsin Society for Ornithology (15 December to 5 January) for multiple assigned Madison count areas reported 13,897 Canada geese in 2012 (Domagalski 2013). Count data indicate goose numbers fluctuated annually from 2,290 to 14,710 with no trend toward overall increase from 1998 to present, and 3,516 geese reported in 2010 counts. A nearly 4-fold increase in Christmas Count goose numbers in 2012 versus 2010, coupled with my 6-fold increase in geese counted at WP, make it likely Madison Airport area fall 2012 goose numbers were at least 2-3 times greater than in 2010. If correct, that would explain why overall goose number/risk geese observed did not decline to lower levels, given that 696 risk geese in 2010 were reduced to 14 in 2012 by tilling corn residue of the field north of Runway 21.

Working from 1990 to 2012 Bird Strike report Excel tables (Sandra Wright, Manager, FAA Bird Strike Database, USDA APHIS Wildlife Services, Sandusky, OH), using only reports with complete strike data, I was able to calculate figures for Canada goose strikes below 1,500 feet AGL, altitudes deemed most likely for goose strikes at Madison based on observed heights of goose flights there (Whitford 2014). Percentage for all height-reported strikes were: 30.28% on ground-taxi, take-off, or landing roll; 25.17% below 200 feet AGL; 6.21% at 200-500 ft AGL; 2.9% at 500-800 ft AGL; 1.64% at 800-1,100 ft AGL; and 3.07% at 1,100-1,500 ft AGL. Of

those strikes reported above, 59.3% of those below 200 ft AGL and 66.6% of those 200-800 ft AGL were reported to occur during approach phase of flight and 40.7% and 33.4% were reported during climb, respectively. Looking at Excel data on distribution of reported Canada goose airstrikes by month of year 1990 to 2012, I calculated 14.12% , 12.84%, and 10.26% of all reported strikes occurred in September, August, and October, respectively and 7.63% in November. My data for 2010 and 2012 indicated that observed goose strike risks were 40 times higher in November than in September for both years, and almost all were associated with feeding flights by geese attracted to untilled corn stubble fields.

Data regarding goose risks on the ground probably do not reflect MSN observations, for superb grounds management has all but eliminated geese from the airfield. MSN goose strike risk is greatest during approach as calculated from excel database figures and stated in Whitford (2014), but elimination of feeding attractions nearest the airport by turning of corn residue right after harvest can substantially reduce this risk.

Brood rearing/molt sites provide high protein foods needed for gosling growth, and feather regrowth of adult geese, plus they provide access to water to escape land predators while flightless (White and Combs 2004, Whitford 2008). Geese/goslings may come from >14 km away, stay 4-6 weeks, and disperse to other feeding areas once they can fly (White and Combs 2004, Whitford 2008). As such, culling of adults and goslings on brood rearing sites may have limited impact on goose presence there in fall (Whitford 2008). Resident goose roundup/euthanasia were done in 2011 and 2012 in northeastern Madison parks. Despite cost and effort for removal of 424 geese, goose numbers in Warner Park were 6 times higher in fall 2012 than in 2010.

One limitation in study methods used was inability to conduct visual observations at night. Geese make local feeding flights after dark when the moon is near full and cloud cover limited, and may begin migration flights after sunset on moonless, clear nights (La Marche 1972). I have no data on the airstrike risk potential of these movements. A 2005 test of WSR-88d Doppler weather radar to time evening foraging flights of ducks from Lacassine NWR, LA (Randall et al. 2011) showed increased radar echoes leaving the roost 4-14 minutes after sunset, indicating that technology could monitor nocturnal goose movements near MSN in the future.

CONCLUSIONS

The majority of 2012 risk geese (75.83%) were risks only when moving to corn residue attractions on <250 ha of crop land at AFCP, and another 18.9% at the new Runway 18 corn stubble area that is now gone. Area counts indicate that goose numbers at WP and SPPs were >900 total for all cycles 2012, but goose risks stayed low except when fields of unturned corn residue drew geese near or across the airport. These results indicate that if MSN can get owners/farmers of fields at AFCP to turn them right after corn harvest, it should be possible to maintain extremely low goose risk levels all fall, similar to those observed when no harvested unturned corn fields were present NE of the airfield in Cycle 2 in 2012.

Additionally, turning corn stubble immediately after harvest on fields near Runway 21 threshold resulted in a 97.99% reduction in observed goose risks to aircraft there 2012 versus 2010, as predicted. This means having resident Canada geese that attract migrants, extensive corn agriculture, and busy airport activities in close proximity to one another need not be mutually exclusive. Disking or plowing soon after corn harvest greatly reduced corn residue and eliminated attraction of those fields for geese such that goose risk to aircraft was minimal. This option proved far more effective at reducing goose strike risk at MSN than culling local geese, which had little visible impact on fall goose numbers at Warner Park and MSN.

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