

Egg predation by Great Horned Owls: A significant predator of Black Tern nests in Kawartha Lakes, Ontario

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Introduction

The Black Tern (*Chlidonias niger*) is a Special Concern species in Ontario that has undergone an annual population decline of 10.5% across the Great Lakes basin since 1995 (Tozer 2013). Population recovery has been hampered by low breeding productivity, for example, nest success (% of nests that hatched ≥ 1 chick) averaged 37% across nine studies conducted in Ontario, Minnesota, New York, Iowa and Wisconsin (Heath *et al.* 2009). Predation has been found to limit Black Tern productivity in some areas (Mazzochi *et al.* 1997, Maxon *et al.* 2007, Heath and Servello 2008) but the mechanisms are not well documented. Predator identity has been confirmed with evidence in only the situations of Great Blue Herons (*Ardea herodias*) preying on chicks (Chapman and Forbes 1984) and Great Horned Owls (*Bubo virginianus*) preying on adults (Murphy 1997). All remaining accounts of which

we are aware are comprised of circumstantial evidence and/or inferences from mobbing behaviour by terns (Cuthbert 1954, Bailey 1977, Dunn 1979, Chapman Mosher 1986, Firstencel 1987, Shealer and Haverland 2000, Heath and Servello 2008). We investigated factors affecting nest success, including predation, in Black Tern colonies in the Kawartha Lakes region of Ontario.

Methods

We investigated five Black Tern colonies in the Kawartha Lakes region: Rice Lake, Pigeon Lake, Emily Creek, Osler Marsh and Buckley Lake from 2013-2015. We conducted nest searches and subsequent monitoring once a week at each site for twelve consecutive weeks, beginning the third week of May. We recorded the location of the nest, clutch size, egg flotation stage (Hays and LeCroy 1971) and a suite of habitat variables. We also sampled



Figure 1. Image of HCO Scout GuardR SG560 and Black Tern pair with nest and eggs at Emily Creek.
Photo: Valerie von Zuben.

prey at 15 locations and monitored 60 artificial nest platforms throughout the season. To determine nest fate and identify predators, we deployed motion-sensitive infrared cameras (Figure 1) at 13 nests in 2014 and 17 nests in 2015. Cameras offer the most accurate method of surveillance (Williams and Wood 2002) and disturbance to the terns was minimal. We mounted cameras on hollow metal poles and inserted the poles into mud and vegetation within 2 meters of nests. Birds acclimatized to cameras within a few minutes. We placed most of our cameras at the two sites with the highest rate of nest failure: Emily Creek and Osler Marsh. The majority of cameras were set

up to take still images to conserve card memory, but a sub-set of cameras recorded 10-second video clips. Battery life and card memory usage were monitored weekly. In 2015, plastic bird deterrent spikes were affixed to cameras and mount poles to discourage perching.

Results

Nest success rates we observed were similar to success rates in previous studies in different jurisdictions (Table 1) (Heath *et al.* 2009). In our study, predation was the leading cause of nest failure. We recorded nest fate as depredated for all nests that were found to be empty at an early-to-middle stage of incubation. At nests that

Figure 2. Great Horned Owl consuming Black Tern egg at Osler Marsh. Photo: Valerie von Zuben.

were found to be empty at the latest stage of incubation, we confirmed that we could not detect any chicks and recorded fate as unknown. Of the nests that failed to produce a single chick, predation by Great Horned Owl was confirmed on camera at 6 nests in 2014 and 5 nests in 2015 at Emily Creek and Osler Marsh (Table 2). Surprisingly, most confirmed predation by owls was at the egg stage (Figures 2 and 3). Chick predation was assumed based on owl presence at the nest and subsequent absence of chicks during nest monitoring checks. We also found clumps of feathers on two separate occasions indicating owl predation of adult terns. The Great Horned Owls at our sites left no tracks or feathers at nests



Table 1: Nest fate and success rate of 330 Black Tern nests in the Kawartha Lakes region, 2013-2015. Camera monitoring of nests was not conducted in 2013 and predator identity could not be verified that year.

Year	2013	2014	2015
No. Nests Monitored	91	95	144
No. Successful	25	43	41
No. Depredated	36	29	54
No. Abandoned/infertile	11	2	16
No. Flooded	3	2	10
No. Other	0	1	2
No. Unknown Fate	16	18	21
Nest Success %	27	45	28



Table 2: Details of 11 predation events on Black Tern nests by Great Horned Owls in the Kawartha Lakes region, 2014-2015, based on camera recordings.

Site	Year	Day	Time	Egg or Chick	Consumption or Presence*
Emily Creek	2014	July 16	22:43	Chick	Presence
Emily Creek	2015	July 2	00:28	Egg	Consumption
Osler Marsh	2014	June 21	23:39	Chick	Presence
Osler Marsh	2014	June 21	23:49	Chick	Presence
Osler Marsh	2014	July 10	1:46	Egg	Consumption
Osler Marsh	2014	July 10	2:18	Chick	Presence
Osler Marsh	2014	July 10	4:00	Egg	Consumption
Osler Marsh	2015	June 13	2:25	Egg	Presence
Osler Marsh	2015	June 16	3:45	Egg	Consumption
Osler Marsh	2015	June 24	23:14	Egg	Consumption
Osler Marsh	2015	June 25	23:57	Egg	Consumption

*"Consumption" confirms predation event; "Presence" indicates a probable predation event in which eggs or chicks were missing in a subsequent nest check.



Figure 3. Great Horned Owl consuming Black Tern egg at Emily Creek.
Screen capture of video by Valerie von Zuben.

and there was very little evidence of broken eggs or nest disturbance. The majority of nests deemed depredated simply had missing eggs between weekly checks. American Mink (*Neovison vison*) sign was found at depredated nests at Pigeon Lake and an American Crow (*Corvus brachyrhynchos*) was recorded on camera eating two abandoned eggs. Predator identity was not confirmed at any nests at Buckley Lake. Eggs in two different nests were crushed by a Wood Duck (*Aix sponsa*) and a Great Blue Heron crushed eggs at a third nest. Other wetland species recorded on camera, which induced alarm responses by terns and were thus

perceived as a threat, with the potential to damage a nest, include Mallard (*Anas platyrhynchos*), Common Gallinule (*Gallinula galeata*), Snapping Turtle (*Chelydra serpentina*) and Midland Painted Turtle (*Chrysemys picta*).

Discussion

Great Horned Owls are generalist predators with a broad dietary niche (Martí and Kochert 1996). Range-wide, their diet is comprised of 90% mammals, 10% birds and trace amounts of amphibians, reptiles and invertebrates (Artuso *et al.* 2014). In North America, the proportion of avian prey in the diet of Great Horned

Owls ranges from 5 to 65% (Tomazzoni *et al.* 2004). Owls in the prairie pothole region of North Dakota rely heavily (65%) on wetland-dependent avian prey, with 2.7% classified as shorebirds (including Black Tern) and the rest comprising mostly ducks and rails (Murphy 1997). Great Horned Owls were responsible for 68% of documented mortality of Piping Plover (*Charadrius melodus*) and Least Tern (*Sternula antillarum*) chicks in South Dakota (Kruse *et al.* 2001), the majority of Gull-billed Tern (*Gelochelidon nilotica*) predation in coastal Virginia (Eyler *et al.* 1999) and direct and indirect mortality of Common Terns (*Sterna hirundo*) in the Monomoy Refuge of Massachusetts (Nisbet 1975, Nisbet and Welton 1984). Tomazzoni *et al.* (2004) also emphasized the importance of wetlands to foraging Great Horned Owls in Brazil, with the majority of prey items coming from wetland habitat.

Our study is the first to visually confirm and document consumption of bird eggs by Great Horned Owl. To the best of our knowledge, the only literature that alludes to this phenomenon describes mostly circumstantial evidence of owl predation on eggs of Least Tern (McMillian 1998) and Swallow-tailed Kite (*Elanoides forficatus*) (Coulson *et al.* 2008). Nisbet and Welton (1984) suggest that direct predation of eggs or nestlings by owls is less important to bird nest success than indirect mortality such as nocturnal nest abandonment as a result of owl presence. In their study of Common Terns (*Sterna hirundo*), Great Horned Owl presence led to egg and chick loss from exposure, ant attack,

hatch failure, egg breakage and predation by additional predators. Heath (2004) found nocturnal nest desertion to be a common occurrence in Black Tern colonies in Maine.

Great Horned Owls generally prefer fragmented habitats of open second growth forests, swamps and agricultural areas (Artuso *et al.* 2014), which are abundant in the Kawartha Lakes region and much of southern Ontario. Given that Great Horned Owls are distributed continent-wide, this predator could pose a large overall threat to Black Tern productivity across their range. Effective and ethical solutions remain elusive; Smith *et al.* (2010) found that predator removal (by culling or translocation) can produce significant increases in breeding bird populations but Catlin *et al.* (2011) had mixed success removing owls from areas near Piping Plover nest sites. The ethical and practical issues of lethal forms of predator control have to be evaluated in conjunction with alternative non-lethal solutions. Predator exclusion using nest cages and fencing are widely used and effective management tools but are invasive, expensive, and labour intensive (Smith *et al.* 2011). Heath and Servello (2008) found that predator enclosures were readily accepted by adult Black Terns, which protected chicks until fledging at 70% of nests. With any predator management strategy, it is essential to have evidence-based confirmation of predator identity before evaluating options. It is also important to test the efficacy of the chosen strategy before prescribing it widely. The protection of remaining breeding colonies is one of the key priorities for Black Tern population

recovery (Matteson *et al.* 2012) but to do this, the mechanisms driving productivity at the local level need to be better identified. We will continue to study predation dynamics at our Kawartha Lakes colonies with a focus on developing and evaluating simple, cost effective and minimally invasive techniques to prevent Great Horned Owl predation of eggs and chicks.

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Influence of bottom-up trophic dynamics on Northern Saw-whet Owl irruptions revealed by small-scale banding data in Central Ontario

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Introduction

The Northern Saw-whet Owl (*Aegolius acadicus*) is one of the most common of eastern North America's owl species, but also one of the smallest and most elusive, making it a difficult species to study (Beckett and Proudfoot 2011). Despite its nocturnal nature the Northern Saw-whet Owl can be lured into mist nets and banded every fall during its southerly movements away from breeding ranges. Large-scale analysis of Northern Saw-whet Owl movement has indicated that there are significant differences in the proportions of adult and juveniles migrating between years (Beckett and Proudfoot 2011) and that these differences relate to regional differences in the yearly fluctuations of prey (Confer *et al.* 2014). Years where there are high proportions of juveniles are termed irruption years.

Most avian predators are thought to show high breeding success in relation to higher prey populations in the breeding range, and this may be the cause of Northern Saw-whet Owl irruptions (Côté *et al.* 2007). Some evidence suggests that Northern Saw-whet Owls return to the same breeding ranges annually, and also display migration route fidelity (Beckett and Proudfoot 2011). By contrast, Northern Saw-whet Owls are thought by others to be nomadic, tracking their prey across the landscape and choosing breeding habitat based on high local prey availability (Bowman *et al.* 2010). Both hypotheses support the notion that owl irruptions are caused by particularly high breeding success within the breeding range rather than synchronous movements of particularly successful cohorts.



Northern Saw-whet Owl
Photo: Tianna Burke



Northern Saw-whet Owl
Photo: Laura Koloski

Small mammals of the boreal forest appear to show population fluctuations that follow a 4-year cycle (Cheveau *et al.* 2004). While food supply plays an important role in the reproduction of small mammals, Korpimäki *et al.* (2004) argued that predation is the main cause of mortality among these populations, creating fluctuations from year-to-year. By contrast, Falls *et al.* (2007) studied fluctuations of deer mice (*Peromyscus maniculatus*) over a 36-year period and concluded population fluctuations were highly influenced by forest seed crop in the autumn and that overwinter deaths were greatly reduced in years with high seed production. These two contrasting views correspond, respectively, to top down (predator mediated) and bottom-up (primary production mediated) trophic interactions (Powers 1992).

A meta-analysis of 102 field experiments (Shurin *et al.* 2002) indicates that top-down forces are stronger in aquatic ecosystems than in terrestrial ecosystems. The hypothesis of nomadism (Bowman *et al.* 2010) in Northern Saw-whet Owls would support a top-down system, where owls may have an effect on the fluctuations of small mammal populations by depleting a local population and moving to find areas with higher abundance of prey. In contrast, a bottom-up system would be implicated if Northern Saw-whet Owl populations fluctuated as a function of primary production (coniferous seed production), through the influence of the food abundance on yearly small-mammal population fluctuations via enhanced reproduction and survival.

The southern region of the Canadian boreal forest is breeding habitat for Northern Saw-whet Owls that migrate through the Peterborough, Ontario, region (Badzinski 2007). Data from boreal forest seed production may therefore provide insight into broad-scale primary production and whether Northern Saw-whet Owl populations are regulated by top-down or bottom-up processes. Capture and banding at the James McLean Oliver Ecological Centre of Trent University provides 15 years of data on the age structure of migrating Northern Saw-whet Owls. We test the hypothesis that small scale fluctuations in the proportion of hatching year owls coming through a single banding station can be explained by qualitative measures of forest seed production from the presumed breeding grounds of the banded owls. Support for our hypothesis would indicate that bottom-up processes help to explain Northern Saw-whet Owl demography.

Coniferous seeds are the preferred forage of Northern Saw-whet Owl prey such as red-backed voles (*Myodes gapperi*), deer mice (*Peromyscus* spp.) and other small rodents (Lobo 2014). If bottom-up interactions are taking place, a year with high seed production in the autumn will produce more fallen nuts and seeds for small mammals on the forest floor, allowing for higher survival rates over winter and higher reproductive success in the spring, ultimately leading to a more successful breeding and fledging season for Northern Saw-whet Owls. We predict that high boreal seed production two summers before

our fall captures (i.e., not the current summer) would result in high seed availability in the winter immediately preceding the March to May owl breeding season and would lead to higher proportions of hatching year owls in our subsequent fall banding. We also predict that the proportion of second-year birds captured in any one year would be positively related to the seed production indices from two years previously.

Methods

Banding Data

Northern Saw-whet Owls have been banded near Nogies Creek, Ontario (44.57° N, 78.5° W), at the James McLean Oliver Ecological Centre, Trent University, since 1999. Three standard passerine mist nets (36 mm mesh), 12 meters in length and 2.5 meters high, were set up yearly for the month of October (plus or minus the last few days of September and the first few days of November), in a forested portion of the property. The nets were arranged in a triangular pattern with a speaker between the nets playing repetitive Northern Saw-whet Owl calls as an audio lure. During inclement weather (high winds, below 0°C or raining) or when predators were present (e.g., Barred Owls, *Strix varia*) the nets were not opened and the audio lure remained off. When conditions were acceptable the nets were opened and the audio lure was turned on for a minimum of 4 hours each night starting about 19:30 hrs. Nets were then checked every 20 minutes for owls. Each owl caught was removed from the net and banded with an aluminum uniquely numbered

Canadian Wildlife Service band (size 4). The date, time of capture, age, sex, wing chord length and weight of each owl were recorded. Owls were sexed using a discriminant function (Paxton and Watts 2008) and then aged by observing primary and secondary molt patterns. Primary and secondary feathers were observed under a UV light to assess flight feather molt. Hatch-year (HY) owls have uniform wear and rachis vascularization of the primary and secondary flight feathers. Under UV light the ventral surface of all flight feathers and underwing coverts of HY owls appears pink. Under normal lighting these flight feathers in HY owls appear uniform dark brown (Pyle 1997, Project OwlNet 2015). Second-year (SY) owls have a new-old-new pattern in their primaries and secondaries. Under UV light SY flight feathers appear in a pattern of pink-beige-pink. After-second-year birds (ASY) exhibit three generations of primaries and secondaries which appear dark brown, lighter brown and dark brown under normal light and with alternating patterns of pink and beige under UV light (Pyle 1997, Project OwlNet 2015). Owls aged as after-hatch-year (AHY) were not distinguished as SY or ASY, but determined to be older than hatch-year based on the molt pattern of their flight feathers. The owls were released after banding. All procedures used to capture and band owls were done under Animal Care permits from Trent University.

Banding data from all years (1999-2014) were entered into spreadsheets. The data were divided into year-class (HY-birds capable of flight and hatched



Northern Saw-whet Owl. Photo: Tianna Burke

the present year and SY-hatched the year before banding) and sex. Proportions of HY, SY, ASY and AHY birds were calculated out of the total number of owls banded.

Primary Production Indices

To obtain an index of forest primary productivity, data were compiled from the Winter Finch Forecasts produced by naturalist Ron Pittaway for each year since 1999/2000 (Jean Iron 2015, NeilyWorld 2015). His forecasts are compiled from a number of sources including staff from the Ministry of Natural Resources and Forestry in Ontario, biologists, birders and naturalists from across North America. For the purpose of this research, we considered the area of central Ontario and western Quebec as potential breeding areas. In most cases the cone crop predictions were the same for both provinces. Where the predictions differed

slightly, we then used the score from the Ontario region, because of its larger geographic extent north of our banding station. We focused on the qualitative seed production descriptors provided in these reports rather than the winter finch numbers. Lobo (2014) determined from feeding experiments that red-backed voles, deer mice and other common rodents prefer conifer seeds with an overall preference of lodgepole pine (*Pinus contorta*), eastern white pine (*P. strobus*), and occasionally white spruce (*Picea glauca*) seeds. Therefore, focus was placed on mention of native conifer species in the reports (eastern white pine, red pine (*P. resinosa*), white spruce and black spruce (*P. mariana*)). We used the reports to produce a quantitative scale from 1 to 5 using descriptive words and phrases about coniferous cone crops in central Ontario and western Quebec. Years where “very poor”, “failure” and “very low” were used were

ranked as a 1 on the scale. Years where “poor”, “few” (and occasionally with “spotty”) were used were ranked as a 2. Years where “moderate”, “fair” (and occasionally also with “spotty”) were used were ranked as a 3. Years where “very good” and “above-average” were used were ranked as a 4 and where “heavy”, “bumper”, “excellent” were used were ranked as a 5.

Statistical Analysis

The proportion of hatch-year owls was regressed against the seed crop (scale 1-5) from the previous fall reports, whereas the proportion of second year owls was regressed against seed crop from two years prior to banding. These temporal lags were used because seed crops relevant to small mammal production in an owl breeding year are produced a year before the fall that owls are banded at the field station. We first analyzed the relationship between owl age distributions and seed crop by including the covariate: number of fall banding days. As inclusion of this variable did not improve fit, we removed it for subsequent analyses. The proportion of SY owls from the year 2003 was eliminated from our analysis because it appeared that banders in that year, were unable to reliably differentiate between HY and older age classes. The proportion of AHY in that year fell outside of a 95% confidence interval ($\mu=0.22$, $SD = 0.16$, $n = 15$, $CI: 0.14$ to 0.30) of the total sample. Owls aged as third year or after-third-year were combined into the after-second-year category because these older age classes are not reliably determined (ProjectOwlNet 2015). We assessed significance using an $\alpha=0.05$. We conducted all analyses using Program R (CRAN Project 2015).

Results

The number of Northern Saw-whet Owls captured at the James McLean Oliver Ecological Centre banding station showed substantial annual variation (Figure 1). The proportion of hatch-year birds and second-year birds banded each year appeared to track the forest primary production scale used to rank seed crop abundance in the central Ontario region (Figure 2). On average twice as many HY birds were captured as SY birds (Table 1).

Table 1. Comparison of proportions of hatch-year (HY), second-year (SY), after-hatch-year (AHY), after-second-year (ASY) and unknown (U) age Northern Saw-whet Owls banded at the James McLean Ecological Centre from 2000 to 2014.

Year	HY	SY	AHY	ASY	U
2000	0.19	0.33	0.10	0.32	0.06
2001	0.44	0.12	0.09	0.32	0.03
2002	0.48	0.29	0.02	0.13	0.09
2003	0.56	0.03	0.25	0.12	0.04
2004	0.59	0.02	0.00	0.31	0.08
2005	0.36	0.19	0.04	0.41	0.00
2006	0.46	0.25	0.02	0.27	0.00
2007	0.57	0.23	0.04	0.16	0.01
2008	0.25	0.44	0.06	0.26	0.00
2009	0.47	0.11	0.00	0.42	0.00
2010	0.50	0.25	0.03	0.23	0.00
2011	0.40	0.35	0.00	0.26	0.00
2012	0.48	0.18	0.02	0.32	0.00
2013	0.19	0.57	0.00	0.25	0.00
2014	0.77	0.08	0.01	0.14	0.01

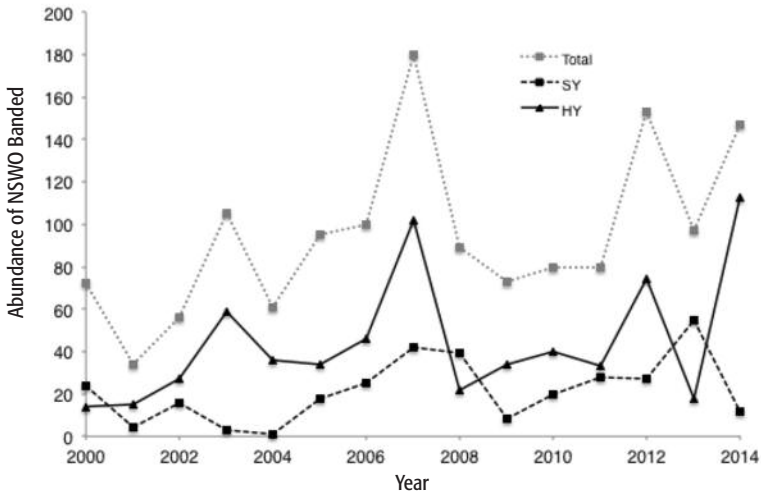


Figure 1. Abundance of hatch-year (HY), second-year (SY), and total abundance of Northern Saw-whet Owls banded at the James McLean Oliver Ecological Centre during autumn migration from 2000 to 2014.

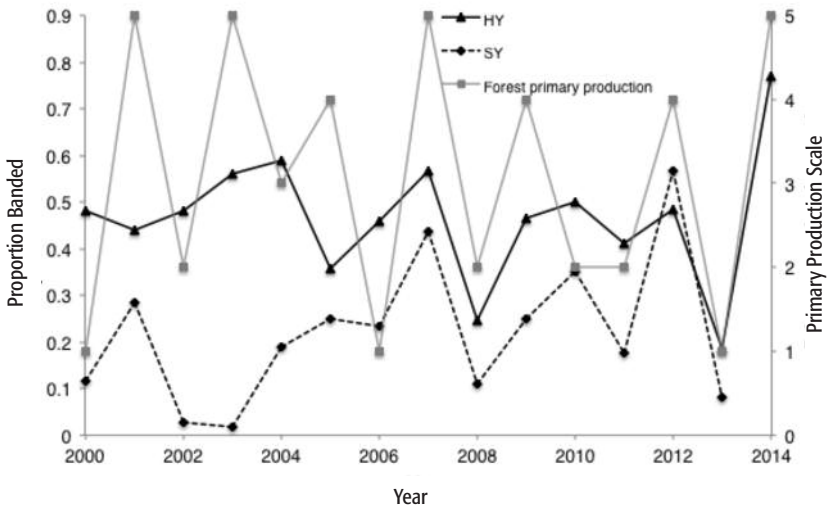


Figure 2. Proportion of hatch-year (HY) and second-year (SY) Northern Saw-whet Owls banded at the James McLean Ecological Centre during autumn migration from 2000 to 2014 compared to an index of primary productivity in Central Ontario forests based on winter coniferous seed crops from 1999 to 2013. A lag of 1-year for HY and a lag of 2-years for SY is incorporated.

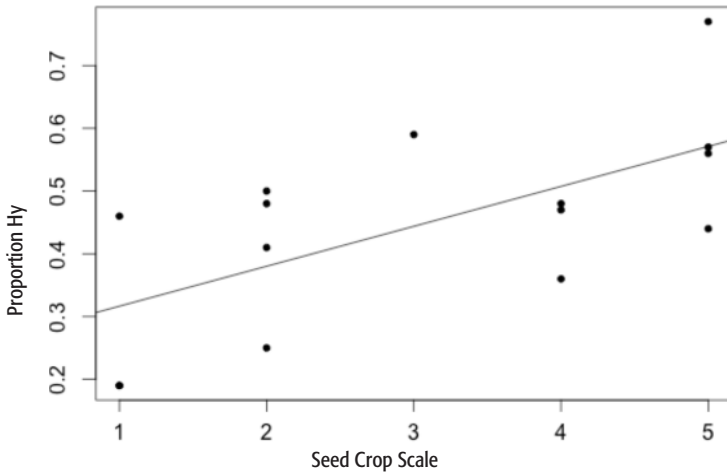


Figure 3. Linear relationship between proportion of Northern Saw-whet Owls banded at the James McLean Ecological Centre during autumn migration that were hatch-year birds, with a lag of one year between seed mast and banding accounted for, and an index of forest primary productivity in Central Ontario based on winter coniferous seed crops.

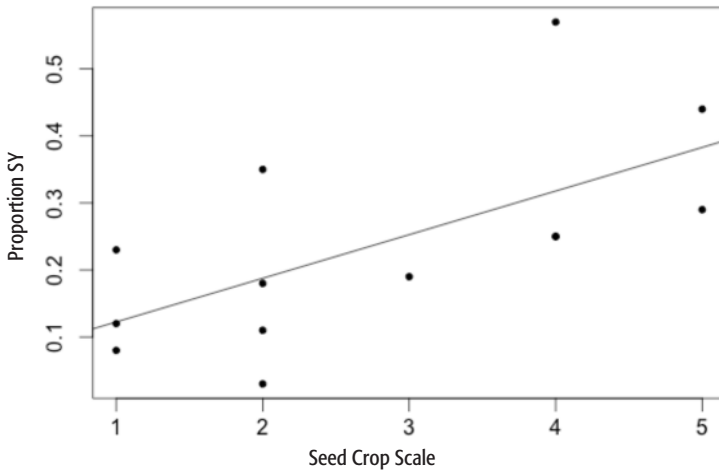


Figure 4. Linear relationship between proportion of Northern Saw-whet Owls banded at the James McLean Ecological Centre during autumn migration that were second-year birds, with a lag of two-years between seed mast and banding accounted for, and an index of forest primary productivity in Central Ontario based on winter coniferous seed crops.

There was a significant positive relationship between forest seed crop abundance in the winter before breeding and the number of HY owls banded in the following fall ($F=5.11$, $df=1,13$, $P < 0.05$, $R^2 = 0.23$) (Figure 3). A positive linear relationship was also observed between forest seed crop and the number of SY birds banded two years later, ($F=7.70$, $df=1,11$, $P < 0.05$, $R^2= 0.36$) (Figure 4).



Northern Saw-whet Owl

Photo: Tianna Burke

Discussion

The proportion of hatch-year Northern Saw-whet Owls banded at the James McLean Oliver Ecological Centre varied greatly between 2000 and 2014, with higher proportions occurring every 3-5 years. These irruption years are similar to patterns seen in red-backed vole abundance, the main breeding ground prey species of Northern Saw-whet Owls (Swengel and Swengel 1995, Evans 1997, Duncan *et al.* 2009). Similar fluctuations were also seen within primary production indices from central Ontario. However, fluctuations in Northern Saw-whet Owl populations have never been compared to the primary production occurring within the breeding range relating back to red-backed vole abundance (Cheveau *et al.* 2004, Bowman *et al.* 2010). We found a positive linear relationship between primary production in central Ontario and the number of HY and SY birds banded in autumn. These findings indicate a two step correlation (1) that fluctuations of red-backed vole populations appear to relate to conifer seed crops (Lobo 2014),

(2) vole production appears to relate to the number of HY owls banded the breeding year following a vole population high. Previous research has examined the response of accipiters to fluctuations in mast seed production in forest ecosystems and results indicated that these pulses have bottom-up effects on the entire system (Schmidt and Ostfeld 2003, Schmidt and Ostfeld 2008). Our results suggest a similar relationship for Northern Saw-whet Owls. The outlier year (2003) in the proportions of SY and AHY birds reduced the strength of the relationship between the primary production scale.

Top-down trophic interactions are thought to be the controlling factor when predators and prey exhibit fluctuations or cycles. The well documented trophic interactions between Canada lynx (*Lynx canadensis*) and snowshoe hare (*Lepus americanus*) cycles, where predation by lynx has the ability to lower hare populations during years when hare populations are high is support for a top-down view (Krebs *et al.* 2001). In central Ontario, red-backed vole populations are not considered cyclical; instead they fluctuate irregularly in response to cone crops (Bowman *et al.* 2010). Such pseudo-cyclical patterns in the biomass of seed production by fruiting plants are not uncommon; they are highly dependent on environmental conditions such as temperature, weather and pollination during the growing season (Howe *et al.* 2012).

While most research examining trophic cascades focuses on top-down interactions, it is important to consider the reverse. Research focusing on the Boreal Owl (*Aegolius funereus*), a close relative of the Northern Saw-whet Owl, concluded that owls do not likely cause small mammal population fluctuations, as the owls' behavioural response to scarce prey is immediate, indicating nomadism (Marks and Doremus 2000, Cheveau *et al.* 2004, Bowman *et al.* 2010). Both top-down and bottom-up interactions are likely to play equally important roles in the function of ecosystems (Ritchie and Johnson 2009). Research on trophic cascades shows that primary production has the potential to affect the abundance of populations at all levels, cascading through the ecosystem to higher trophic levels (Power 1992, Dyer and Letourneau 2003, Ritchie and Johnson 2009, Howe *et al.* 2012)

This research contributes to the existing body of research on Northern Saw-whet Owl ecology. The data from a single banding station examined in the present study are an underutilized source of raw ecological information as are the broad-scale primary production indices retrieved from a descriptive online public resource. Using the Winter Finch Forecast presented some challenges, as it was presented descriptively with variation in which species of tree were examined between years and the level of description given. While we were able to develop a useful quantitative scale with these descriptions, it would increase the value of the winter bird forecasts if there were standardized estimates of the annual seed resources,

and if the scale was compared to finch movements or small mammal abundance.

Future research could be conducted across a larger geographic scale and longer time frame using the same method with banding data compiled from several stations to determine whether similar relationship can be seen.

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