

Effects of Great Horned Owls (*Bubo virginianus*) on a Leach's Storm-Petrel (*Oceanodroma leucorhoa*) population

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ABSTRACT—Populations of Leach's Storm-Petrels (*Oceanodroma leucorhoa*) are in decline globally, but causes of these declines are unclear. One possibility is predation at breeding colonies. To estimate effects of one pair of Great Horned Owls (*Bubo virginianus*) on a Leach's Storm-Petrel colony, we analyzed owl pellets collected from Bon Portage Island, Nova Scotia, Canada, over 5 consecutive breeding seasons (2011–2015). Great Horned Owl diets were mainly Leach's Storm-Petrels by number (79%) and by mass (66%). Muskrats (*Ondatra zibethicus*), meadow voles (*Microtus pennsylvanicus*), and masked shrews (*Sorex cinereus*) completed the diet. This is, to our knowledge, one of the most specialized diets reported for this species of owl. We estimate that this specialized diet reduced by at most 1% annually the population of Leach's Storm-Petrels on this island. Received 18 October 2017. Accepted 14 September 2018.

Key words: Bon Portage Island, *Bubo virginianus*, Great Horned Owl, Leach's Storm-Petrel, *Oceanodroma leucorhoa*, pellet analysis.

Les effets du Grand-duc d'Amérique (*Bubo virginianus*) sur une population d'Océanites cul-blanc (*Oceanodroma leucorhoa*)

RÉSUMÉ (French)—Les populations d'Océanites cul-blanc (*Oceanodroma leucorhoa*) sont en déclin mondialement, mais les causes de ces déclins ne sont pas claires. La prédation de colonies de reproduction est une possibilité. Pour estimer les effets d'une paire de Grands-ducs d'Amérique (*Bubo virginianus*) sur une colonie d'Océanites cul-blanc, nous avons analysé des pelotes de réjection recueillies sur l'île Bon Portage, en Nouvelle-Écosse, au Canada, pendant cinq saisons de reproduction (consécutivement de 2011 à 2015). Le régime alimentaire des Grands-ducs d'Amérique était principalement composé d'Océanites cul-blanc à la fois par nombre (79%) et par masse (66%). Les rats musqués (*Ondatra zibethicus*), les campagnols des prés (*Microtus pennsylvanicus*) et les musaraignes cendrées (*Sorex cinereus*) complétèrent le régime. À notre connaissance, ce régime alimentaire est l'un des régimes les plus spécialisés constatés pour cette espèce de hibou. Nous estimons que ce régime spécialisé a réduit annuellement par 1% (au plus) la population d'Océanites cul-blanc sur cette île.

Mots-clés: analyse des pelotes de réjection, *Bubo virginianus*, Grand-duc d'Amérique, île Bon Portage, Océanite cul-blanc, *Oceanodroma leucorhoa*.

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Most species of seabirds are experiencing population declines, and a variety of causes are to blame including being victims of fisheries bycatch, depletion of food supplies either from fisheries or because of climate change, and breeding habitat loss and disturbance (Croxall et al. 2012, Paleczny et al. 2015). Populations of Leach's Storm-Petrel (*Oceanodroma leucorhoa*) are declining in North Atlantic colonies (Robertson et al. 2006, Newson et al. 2008, Wilhelm et al. 2015) to the extent that the International Union for Conservation of Nature (IUCN) recently up-listed them from "Least Concern" to "Vulnerable" (IUCN 2016). For larger seabird species, causes of declines are often well known (Tuck et al. 2001, Hilton and Cuthbert 2010, Croxall et al. 2012) because it has been easier to track them throughout the year. However, for smaller species such as storm-petrels, causes are less clear, but are likely a result of a combination of the above and other factors.

Bon Portage Island is home to a colony of Leach's Storm-Petrels previously estimated to number approximately 50,000 pairs (Oxley 1999). However, a recent survey estimated a 30% decline in the population size over the last 17 yr (Pollet and Shutler forthcoming), comparable to declines reported for other Atlantic colonies (Robertson et al. 2006, Newson et al. 2008, Wilhelm et al. 2015). Compared to other islands in Atlantic Canada with storm-petrel colonies, Bon Portage uniquely has breeding Great Horned Owls (*Bubo virginianus*). Great Horned Owls generally have opportunistic diets that often reflect prey availability (Rusch et al. 1972). Their diet consists mostly of small mammals, passerines, reptiles, fish, and invertebrates (Errington et al. 1940, Artuso et al. 2013), but on some islands, owls may also feed on seabirds (Crossin 1974, French 1979, Vermeer et al. 1988, Bicknell et al. 2009), which are abundant and can be easy prey items. The aim of this study was to estimate, with pellet content analysis, effects of Great Horned Owls on a Leach's Storm-Petrel population breeding on Bon Portage Island. Pellets contain the least digestible parts of prey (e.g., bones, hair, feathers, scales). Great Horned Owl adults produce on average a single pellet per day during the breeding season (Artuso et al. 2013). Content analysis of regurgitated pellets is a favored noninvasive method to investigate diets of raptors (Marti et al. 2007).

Methods

Bon Portage Island (Outer Island on some maps; 43°28'N, 65°44'W) is at the southern end of Nova Scotia, Canada, and is designated an Important Bird Area (BirdLife International 2017). The island has a maximum elevation of 10 m above sea level and hosts a research station with limited human activities between May and October. The island has several breeding seabird and songbird species. In addition, muskrats (*Ondatra zibethicus*), meadow voles (*Microtus pennsylvanicus*), masked shrews (*Sorex cinereus*), and snowshoe hares (*Lepus americanus*) are at densities far exceeding those on the mainland that is ~2 km away (Stewart et al. 1989).

As part of a larger storm-petrel research program during the 2011–2015 field seasons (Pollet 2017), we collected owl pellets at known roosting sites every 2 weeks from early May until the end of September. We kept each pellet in an individual bag and dissected the pellets in the lab following standard procedures (Marti et al. 2007), keeping all skulls or jaw bones. For each prey species, skull, lower jaw, or upper jaw bones were identified using species descriptions (Willner et al. 1980, Reich 1981, Huntington et al. 1996, and Whitaker 2004 for muskrat, meadow vole, Leach's Storm-Petrel, and masked shrew, respectively). Relevant bones were counted assuming a minimum number of individuals were eaten to account for contents of pellets. To determine relative importance of each prey species, numbers of individuals of each species, calculated from bones in pellets, were multiplied by species-specific average masses provided in the preceding citations.

Results

We collected 181 pellets from 3 roosting sites. In those pellets, we identified 255 prey items. No muskrat skulls or jaw bones were found; 4 of 5 pellets that contained muskrat bones were found at the same location over a 2 d period and there was no overlap in bone types among those pellets. Therefore, we assumed that those bones should be counted as a single prey item. In terms of individual prey items, Leach's Storm-Petrel was the dominant species, followed by meadow vole, muskrat, and masked shrew (Table 1). In terms of biomass, Leach's Storm-Petrel was again the

Table 1. Summary of prey items (binomials in text) found in 181 pellets of Great Horned Owls on Bon Portage Island 2011–2015.

	Leach's Storm-Petrel	Muskrat	Meadow vole	Masked shrew
2011	48	1	8	0
2012	30	0	13	1
2013	40	1	16	0
2014	45	0	7	0
2015	38	0	6	1
Total	201	2	50	2
% individuals	78.8	0.8	19.6	0.8
% biomass	65.5	18.8	15.6	0.1

dominant species, followed by muskrat, meadow vole, and masked shrew (Table 1). Leach's Storm-Petrel skulls were present in 134 pellets, and those pellets contained, on average, 1.5 (SD 0.7) Leach's Storm-Petrel skulls (range 1–5). Including pellets without petrels, the average was 1.1 (SD 0.9).

Discussion

Great Horned Owls are considered generalist predators, with any one species typically making up no more than 50% of their diets (Maser et al. 1970, Marti and Kochert 1996, Zimmerman et al. 1996). Based on pellets we collected on Bon Portage Island, Leach's Storm-Petrels made up >65% of diets of Great Horned Owls, and only 4 species comprised the entire diet. Previous Great Horned Owl diet studies suggest a diverse diet of 15 or more species at any one location (Maser et al. 1970, Marti and Kochert 1996), even when there is a single dominant prey species (Zimmerman et al. 1996). The large Leach's Storm-Petrel colony on Bon Portage Island, combined with their nocturnal lifestyle, make them ideal prey for owls. With an average of 1.1 storm-petrels per pellet and one pellet per day per owl for the 5 month period during which storm-petrels are present on the island, we estimate that a minimum of $1.1 \times 150 \text{ d} \times 2 \text{ adults} = 330$ Leach's Storm-Petrel adults are being eaten by a pair of Great Horned Owls on Bon Portage Island every year, which is ~0.4% of the ~78,000 adult petrels (Pollet and Shutler forthcoming). This estimate does not include petrels fed to owl nestlings on the island each summer (ILP and DS, pers. observ.) because we did not know where their egesta was deposited. It

is possible that a second pair of Great Horned Owls was breeding on the northern part of the island, but we neither had pellets to analyze their diets, nor can we be certain that owls observed here were not the pair we knew were from the southern part of the island. Assuming 2 pairs of owls and accounting for nestlings' diets, we estimate that <1% of the Leach's Storm-Petrel population of Bon Portage Island may be preyed upon by Great Horned Owls each year. This is likely only a minor contribution to the decline of the storm-petrel population on Bon Portage Island.

Leach's Storm-Petrels are nocturnal around the colony but their movement is greatly diminished during full moons to avoid avian predators such as gulls and skuas (Watanuki 1986, Votier et al. 2006). On land, Leach's Storm-Petrels are clumsy, making them easy prey for owls; they have been found in diets of Burrowing Owls (*Athene cunicularia*; Mills 2016), Snowy Owls (*Nyctea scandiaca*; Williams and Frank 1979, Bicknell et al. 2009), and Short-Eared Owls (*Asio flammeus*; Holt 1987), but never approaching the high proportions we documented for Great Horned Owls in our study. In addition, Leach's Storm-Petrels are migratory and come to the island only to breed (Huntington et al. 1996). Thus, a seasonal shift in Great Horned Owl diets must occur once the seabirds migrate away from the island in fall (Pollet et al. 2014) because the species does not undergo significant migrations and moreover does not forage at sea (Artuso et al. 2013). However, we have yet to find pellets on the island early in the spring, before the storm-petrels return. This suggests that owls either choose different roosting sites outside the storm-petrel breeding season or leave the island when storm-petrels are absent.

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