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Rachel L. Valenziano

*University of Nebraska State Museum, rvalenziano1@gmail.com*

Thomas E. Labeledz

*University of Nebraska State Museum, tlabeledz1@unl.edu*

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Stomach Content Analysis of Recent Snowy Owl (*Bubo scandiacus*)  
Specimens from Nebraska

Rachel L. Valenziano<sup>1</sup> and Thomas E. Labeledz<sup>2</sup>

University of Nebraska State Museum, Division of Zoology  
W-436 Nebraska Hall, University of Nebraska-Lincoln  
Lincoln, Nebraska 68588-0514  
<sup>1</sup>rvalenziano10@gmail.com  
<sup>2</sup>tlabeledz1@unl.edu (corresponding author)

Introduction

The Snowy Owl (*Bubo scandiacus*) is a circumpolar bird of prey that breeds in extreme northern latitudes, including Canadian and Alaskan tundra. During winter months, some immature and non-breeding birds disperse south. North American birds may travel to southern Canada and northern parts of the United States, and in some extreme cases as far south as Oklahoma and Texas (Parmelee 1992). Although not fully understood, these irruptive events may be caused by the abundance of prey in northern Canada and Alaska (Parmelee 1992).

Prey typical of Snowy Owls are small mammals (e.g. lemmings and hares) of their home range and an occasional bird from a variety of species including waterfowl (Parmelee, 1992). Research on prey items selected by birds outside of breeding range in North America primarily includes ducks and grebes in southwest British Columbia (Campbell and MacColl 1978), voles in Montana (Detienne et al. 2008), and mice and voles in southern Alberta and Michigan (Boxall and Lein 1982, Chamberlin 1980, respectively).

Over the past century, several irruptions of Snowy Owls have been recorded in Nebraska, most notably during the winters of 1917-18, 1954-55, and 2011-12 (Jorgensen et al., 2012). The most recent of these irruptions, during the winter of 2011-12, produced the largest number of confirmed Snowy Owl sightings in Kansas and Missouri, possibly explained by the increased ease of communication through the use of mobile technology in the general public (Robbins and Otte 2013).

Once reaching areas as far south as Nebraska, Snowy Owls typically suffer high rates of mortality, possibly due to lack of prey species, disease, or anthropogenic factors (Kerlinger and Lein 1988, Meade 1942). During the 2011-12 irruption, several carcasses were donated to the University of Nebraska State Museum (UNSM) and provided a source for examination of body condition and diet. Also included was one carcass donated to UNSM during the following winter, 2012-13.

In Nebraska, Missouri, and Kansas, 379 Snowy Owl sightings were confirmed by researchers at the Nebraska Game and Parks Commission, University of Kansas Biodiversity Institute, and the Kansas State Research Extension (Jorgensen et al. 2012, Robbins and Otte 2013). However, sex, age class, and diet information was only recorded for Missouri and Kansas birds. The University of Nebraska State Museum prepared seven specimens salvaged during this time and recorded external measurements. Several more specimens were salvaged but location and other data were not recorded and not included in this analysis. The primary objective of this study was to examine evidence of diet in Snowy Owl fatalities in Nebraska in the winters of 2011-12 and 2012-13.

### Methods

All Snowy Owl specimens were salvaged via NGPC personnel, except one that was salvaged by Labeledz under the UNSM salvage permit. All data resulted from consistent protocol of study skin preparation in the Zoology Division at UNSM. Careful observation of body condition, including fat level (Winker 2000), condition of muscle mass, and signs of disease were also recorded (Table 1). Additional determination of age was accomplished using Pyle (1997) and Seidensticker et al. (2011). Where possible, cause of death of each individual was determined and noted. A permanent museum catalog number was assigned to each finished specimen.

Gut contents were saved from individuals (2) where food items were present. The bolus of food material was carefully removed and weighed. The bolus was placed in a 95% ethyl alcohol solution for preservation. At a later date the bolus was removed from alcohol and sorted into identifiable part groupings (i.e., bony material, fur/feathers, etc.) and further retained in alcohol. The bony materials were later soaked in water and cleaned of extraneous tissue by use of dermestid beetles (*Dermestes maculatus*).

Bones from the stomach contents were considered the primary source identification of the prey items. Bones were identified by direct comparison to the extensive collection of vertebrate skeletal remains at UNSM. Bone and bone fragments were identified to bone element (e.g., cervical vertebrae) and to animal Class (e.g., Aves) by general comparison. Once Class was determined, specimens of similar size were examined until a match was found. Once a match was found, all similar species within that group were compared and often multiple individuals within a species were compared to separate individual variation from species variation.

Non-bony material from the bolus was retained in alcohol. Subsets of feathers and other soft materials were removed from alcohol, washed in water, and dried. The dried material could then be used for comparison to soft parts of possible prey species.

## Results

Of the seven owls prepared during this study, one was too badly damaged to record any internal information. Of the six remaining specimens, four had no gut contents and exhibited a range of degraded muscle mass and emaciation. The remaining two had identifiable remains in their digestive system and seemingly healthy body conditions (Table 1).

The first of these two birds (ZM-18695, male) was found dead on 22 Feb 2012 in Harlan County, Nebraska. This bird had very heavy subcutaneous and visceral fat content. It appeared to be very healthy and had a full stomach (bolus weight: 42.72g).

Whole and fragmented bones found within the bolus of ZM-18695 include: seven whole/partial cervical vertebrae, five distal pieces of scapula, one fragment of the posterior area of keel from sternum, six rib fragments, and about ten miscellaneous bone fragments. The bones were determined to be avian, and narrowed to waterfowl (Anseriformes) by structural anatomy and size comparisons. Further comparisons eliminated all waterfowl except Mallard (*Anas platyrhynchos*) and Northern Pintail (*Anas acuta*) but a confident identification could not be made. However, large numbers of vermiculated feathers were also found in the bolus. These feathers compared favorably to Northern Pintail and did not compare favorably to Mallard. Thus we determined this prey item to be a male Northern Pintail.

**Table 1:** Measurement details of *Bubo scandiacus* within this study. Average weights of Snowy Owls with moderate fat deposits are  $1806 \pm 30$  g for males and  $2279 \pm 57$  g for females (Parmelee, 1992). Imm = immature, Ad = adult, HY = hatching year, SY = second year, TY = third year.

UNSM Catalog Number	ZM-18463	ZM-18464	ZM-18471	ZM-18693	ZM-18695	ZM-18696	ZM-18697
Date Salvaged	7 Jan 2012	11 Jan 2012	4 Jan 2012	Jan 2012	22 Feb 2012	12 Dec 2012	5 Mar 2012
County	Hall	Buffalo	Adams	Dodge	Harlan	Saunders	Adams
Sex	Male by plumage	Male by plumage	Male	Male	Male	Female	Male
Weight (g)	N/A	1304.4	1020.6	951.5	1779.5	1431.3	810.0
Total Length (mm)	N/A	574	565	525	560	607	505
Wing Chord (mm)	N/A	379	385	405	390	440	380
Bolus weight (g)	None	None	None	None	42.72	36.21	None
Age	Imm/SY	Imm/SY	Imm/SY	Ad/TY	Imm/SY	Imm/HY	Imm/SY
Body Condition	No Fat	No Fat	No Fat	No Fat	Heavy Fat	No Fat	Emaciated

The second specimen (ZM-18696, female) was found dead in Saunders County, Nebraska, on 12 Dec 2012. This bird appeared less healthy, with no visible fat, but was not emaciated (bolus weight: 36.21g). Whole and fragmented bone pieces found include: one atlas (1st cervical vertebrae), odontoid process of axis (2nd cervical vertebrae), three other cervical vertebrae, one rib, numerous tracheal rings, and two miscellaneous bone fragments. Visual comparison confidently determined bone remains having the closest similarity to those of Snow Goose (*Chen caerulescens*). Further comparison of large numbers of feathers from the stomach found all to be white, with several having rusty-colored tips. These rusty colored feathers closely resembled soil-stained breast feathers of UNSM snow goose skin specimens.

#### Discussion

The findings of this study illustrate the variable diet of Snowy Owls when dispersed to southern locations. Interestingly, former research showed the primary food source of wintering Snowy Owls in Montana (Detienne et al. 2008) to be voles (*Microtus montanus*, *M. pennsylvanicus*), which are similar in size to the lemmings of their breeding grounds. This is intriguing because many small mammals, including the same species of vole (*M. pennsylvanicus*), inhabit much of Nebraska (Genoways et al. 2008). However, the only study specifying food items of irruptive owls in this region found an American Coot (*Fulica americana*) and Ring-billed Gulls (*Larus delawarensis*) (Robbins and Otte 2013). In our study as well, the only stomach contents discovered were bird species. One study found that Snowy Owls are capable of existing solely on avian prey, but only where no small mammals are known to be present (Williams and Frank 1979).

This discovery raises questions regarding diet preference of irruptive Snowy Owls in Nebraska. While small mammals are the primary food source of Snowy Owls, there are instances of larger prey items being taken to meet energy requirements (Boxall and Lein 1989). It is not uncommon for these owls to take large birds, like ptarmigan and ducks, in their arctic breeding range (Parmelee 1992). Within their wintering range in Canada, they have been known to take sea ducks (e.g., Common Eider, *Somateria mollissima* and Long-tailed Ducks, *Clangula hyemalis*) (Robertson and Gilchrist 2003). Chevalier (1988) reports Snowy Owls taking avian prey up to the size of American Black Ducks (*Anas rubripes*). However, little work has been done to find diet preference of birds involved in irruptive movements.

In this study the food item (Snow Goose) of sample ZM-18696 was larger than any other prey item reported in North American wintering or irruptive Snowy Owls. In fact, of the literature listed above, no prey items reported were larger than 1300 grams. The mean weight of ten Nebraska Snow Goose samples from UNSM is 2365 grams, making this potentially the largest reported food item for wintering or irruptive Snowy Owls in North America.

It is unknown in this instance if the consumption of waterfowl was opportunistic or targeted. Both samples were salvaged near large bodies of water known to harbor great numbers of waterfowl: Harlan County Reservoir (ZM-18695) and Lake Wanahoo (ZM-18696). Snowy Owl specimens that are salvaged in this state are often starving or diseased, so it is possible that the birds were in such great need of food that they resorted to a more energetically expensive option. However, it is curious that no bird studied in Nebraska, Kansas, or Missouri during the 2011-12 irruption showed evidence of small mammal consumption. It is also possible that the two individuals in this study could have scavenged instead of hunting the Northern Pintail and Snow Goose. Scavenging is rare in Snowy Owls but has been witnessed in British Columbia (Patterson, 2007).

Possible confounds in this study could have arisen due to the small sample size available. Furthermore, bias could be present in the sample because the specimens donated to UNSM were found dead, and not actively collected by researchers. This leads to the possibility that only the owls that were already weakened had died and were consequently found. Healthier birds could be present in the state, but have managed to find sufficient prey and avoid lethal anthropogenic forces.

Further research avenues in this topic could include a more specific study of the diet preference of a larger sample of irruptive Snowy Owls in the Great Plains, based on field collections and observation. Furthermore, geographic tracking of the movements of Snowy Owls throughout the year might reveal more accurate clues to the motivation of southward movement and consequential adjustment in prey selection, or variation in Snowy Owl movements as a result of global climate change.

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