COMMITTEE ON THE
STATUS OF ENDANGERED
WILDLIFE IN CANADA

OTTAWA, ONT. K1A 0H3
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COMITÉ SUR LE STATUT
DES ESPÈCES MENACÉES
DE DISPARITION AU
CANADA

OTTAWA (ONT.) K1A 0H3
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STATUS REPORT ON THE SNOWY OWL *NYCTEA SCANDIACA* IN CANADA

BY

DAVID A. KIRK

STATUS ASSIGNED IN 1995
NOT AT RISK

REASON: WIDESPREAD, NO EVIDENCE OF DECLINE, NO OBVIOUS THREATS.

OCCURRENCE: MANITOBA, NEWFOUNDLAND, NORTHWEST TERRITORIES, QUEBEC AND YUKON TERRITORY

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STATUS REPORT ON THE SNOWY OWL
NYCTEA SCANDIACA

IN CANADA

BY

DAVID A. KIRK
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STATUS ASSIGNED IN 1995
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Contents

Executive Summary

Description. Almost as large as a Great Horned Owl *Bubo virginianus*, male Snowy Owls are almost entirely white, with faint narrow, pale grey or brown barring on the head, breast, back, wings and sometimes the tail. Generally, this barring is extensive and much heavier in females (the only parts of the plumage that are pure white are the face, the foreneck and middle part of the breast), and plumage tends to become soiled during breeding so that females are easily distinguished from males. The bill is black while the legs and feet have dense white feathering. The iris is lemon yellow.

Distribution. The Snowy Owl has a circumpolar distribution. In North America it breeds from the Aleutian Islands and northern Alaska through Arctic Canada. In winter the largest concentration of Snowy Owls (mostly adults) occurs in the Great Plains, but irregular southward movements, involving low numbers of mainly immature birds occur in eastern and western North America.

Population size and trends. Assessing the population size of Snowy Owls is extremely difficult because of the vast Arctic breeding area, and nomadic movements of owls. Estimates of numbers of Snowy Owls on Christmas Bird Counts (CBCs) suggest annual fluctuations in numbers. There is no evidence of downward trends but this is difficult to determine because of the cyclic nature in wintering numbers. More sophisticated analyses are needed of CBC data to determine long-term trends from the 'noise' of annual population fluctuations. Also, needed are surveys of Snowy Owls on the breeding grounds to investigate population densities and breeding success in relation to prey abundance.

Habitat. Snowy Owls breed in the Arctic, and prefer rolling tundra with rocky promontories. In the low arctic, dwarf shrub vegetation may be the main habitat. In winter a wide variety of open habitats are used, including coasts, marshes, fields, lake shores and large rivers.

General biology. Generally monogamous (there are some cases of polygamy, perhaps in response to high prey abundance), the Snowy Owls' reproductive success is determined by the availability of its lemming (*Lemmus* and *Dicrostonyx*) prey populations. In areas where they are dependent on lemmings, owls may breed only in good years. Age of first breeding is probably two years or more. Clutch size varies from 7.5-9.2 eggs in Arctic Canada to 5-14 eggs in Finnish Lapland. Snowy Owls depend largely on lemming populations for food, and are a top level predator in the Arctic ecosystem.

Limiting factors. The principal factor limiting populations of Snowy Owls is the adundance of its prey populations. There is evidence in Europe that human persecution has resulted in a decline in Snowy Owls. Collisions with human-made structures is a principal source of mortality among wintering Snowy Owls. Legislation now largely protects Snowy Owls on their wintering grounds, and the small scale hunting of owls by northern native peoples, probably only impacted local populations in the past. Some non-cultural random killing of owls may occur.

Protection. Snowy Owls are protected under the Migratory Birds Convention (1916) in the United States, but in Canada, Snowy Owls are protected under provincial legislation. Nevertheless, they are subject to illegal hunting and accidental death on the wintering grounds.

Special significance of the species. Important theoretical and ecological questions about the relationship between predator populations and their prey have been addressed using the example of the Snowy Owl. This area is still poorly understood and further research is needed to elucidate this relationship. Snowy Owls may be important environmental indicators in the Arctic region. The Snowy Owl is an important symbolic species of the Arctic region; it is represented in the oldest cave art in France when the arctic region extended further south. It is also harvested on a small scale by northern native peoples for food (especially in times of adversity), skins and claws, although this varies from region to region. Hunting of Snowy Owls on passage in the James Bay area is currently widespread.

Conclusions. Because of its widespread distribution and apparent abundance, judging by CBCs, the Snowy Owl may not require any COSEWIC designation.

A Abstract

The Snowy Owl *Nyctea scandiaca* is a large (males 1642 g, females 1963 g), white, diurnal owl that breeds in the arctic regions. Distributed throughout the Canadian Arctic, northern Alaska and northern Eurasia, the species prefers rolling Arctic tundra with rocky promontories. The Snowy Owl is a nomadic breeder, following the patchy occurrence of peak microtine vole populations. It is generally monogamous, but polygamy has been recorded and may be a response to peaks in prey abundance. Clutch size and breeding success vary dramatically depending on the abundance of vole prey populations. Migration movements of the species in response to prey populations is not fully understood. Previously, it was believed that Snowy Owl populations fluctuated on a cyclic basis (3-4 years) in synchrony with its prey, but this has recently been questioned. Christmas Bird Count (CBC) data suggest that a majority of Snowy Owls migrate on an annual basis, especially in the Great Plains, and are not irruptive. Also, individuals are often territorial on the breeding grounds and banding indicates that they have high site fidelity. Demography of the eastern and western wintering populations may differ from the main population which winters in the Great Plains. Because the species is large and conspicuous it is vulnerable to persecution by humans. In Europe there is evidence that human persecution has caused declines in Snowy Owl breeding populations. Given its widespread distribution and apparent abundance, the species likely is 'not at risk'.

B Distribution

Breeding in the high arctic tundra, the Snowy Owl *Nyctea scandiaca* has a circumpolar distribution from the tree line to the edge of the polar seas (Parmelee 1992). Irruptive movements of Snowy Owls in some areas mean that breeding distributions are subject to some annual variation.

1) Canada. According to Godfrey (1986) the Snowy Owl *Nyctea Scandiaca* 'breeds from Prince Patrick Island (probably) and northern Ellesmere Island (Cape Sheridan) south through the Arctic Archipelago to northern Yukon (Herschel Island); northern Mackenzie (Baillie Island, Perry River, and probably inland for an undetermined distance); Keewatin; northern Manitoba (Churchill); Southampton Island; Hudson Bay (Belcher Islands; northern Québec (Povungnituk, Kogaluc River, Kuujjuaq); and northern Labrador (south to Okak, possibly to Nain). Winters within parts of breeding range, but probably south of zone of 24-hour winter darkness, and south in irregular numbers to southmost parts of all the provinces. Largest flights to southern localities occur about every four years, these being correlated with periodic low points in numerical fluctuations of small mammals in the Arctic, especially lemmings, which are the staple arctic food.'

In good years, Snowy Owls breed throughout the Canadian Arctic Islands, as well as northern Yukon, northern Mackenzie, southern Keewatin, north-eastern Manitoba (Churchill), northern Québec and northern Labrador (Johnsgard 1988, Parmelee 1992). During winter, Snowy Owls can occupy a huge area, south of their breeding range to southern Canada. Their principal wintering grounds in Canada are the Great Plains (Kerlinger et al. 1985); in south-western Alberta Kerlinger and Lein (1986) recorded wintering owls between early-mid November and late February-mid/late March.

2) United States. Snowy Owls breed in the Aleutian islands, Hall Island in the Bering Sea and northern Alaska. Outside the breeding season, Snowy Owls also occur irregularly as far south as central

California, southern Nevada, Utah, Colorado, Oklahoma, central and south-eastern Texas, states bordering the Gulf of Mexico and Georgia (Johnsgard 1988). In their principal wintering grounds in the Great Plains, Snowy Owls occur in Montana, North Dakota and South Dakota (Kerlinger and Lein 1988b).

3) Worldwide Breeding in the high arctic tundra, the Snowy Owl has a circumpolar distribution from the tree line to the edge of the polar seas (Parmelee 1992).

C Protection

In the United States, Snowy Owls are protected by the Migratory Birds Treaty whereas in Canada their protection is the responsibility of the Provinces. During their winter movements Snowy Owls are vulnerable to illegal shooting (for trophies), collisions with vehicles, power lines or fences (Kerlinger and Lein 1988a). Native people hunt Snowy Owls for food, claws and skins, but the effect of is unknown and may affect only local populations (Parmelee 1992). The use of owls by native peoples varies from region to region; in the James Bay region (Atawapiskat) hunting of Snowy Owls on passage was widespread in the 1980s and probably still occurs (D. McRae pers. comm.). The Snowy Owl is the oldest known species depicted in cave art in France when Arctic climate extended further south (Parmelee 1992).

D Population size and trends

Determining population size and trends of Snowy Owls is extremely difficult because of 1) the remoteness and vastness of their breeding areas; 2) variation in southward movements (due to prey population cycles and weather) resulting in variable numbers of wintering birds and 3) nomadic movements of individual birds over huge areas - perhaps in a circumpolar fashion. There are very few studies from the Arctic breeding grounds and most counts are of wintering birds in southern Canada or the United States. There are four sources of data on Snowy Owl populations: 1) Christmas Bird Counts (CBCs), 2) Breeding Bird Atlases (BBAs), 3) breeding studies and 4) Nature Conservancy rankings.

Christmas Bird Counts. An analysis of Christmas Bird Counts (CBCs) over the whole of North America between 1959-1988 indicated that over the long-term wintering populations were stable (there was a nonsignificant negative trend; -0.4% change per year, n = 540 circles; mean relative abundance/100 party hours 1.58; B. Hoover and J.R. Sauer pers. comm.). Few analyses of trends in CBC data have been conducted on a regional basis, probably partly because Snowy Owls occurred in low numbers and because their numbers fluctuated greatly annually (see Kerlinger et al. 1985, Kerlinger and Lein 1988b). Kerlinger and Lein (1988b) found that the numbers of Snowy Owls counted on CBCs throughout the Great Plains between 1961-1984 did not fluctuate sychronously. There was, however, great variation among different CBCs conducted in the same year. For example,

although the highest count of 24 owls was from Regina, SK, in 1979, other localities in the same count year had below average counts (Kerlinger and Lein 1988b). Now that CBC data are computerized regional analysis by region is a relatively simple operation.

Based on CBC data, Snowy Owl winter mostly in the northern Great Plains (Root 1988). On CBCs in Canada between 1961-1984, an average of > 2.25 owls per count was found (except for Oak Lake, Manitoba) and owls were recorded in 75% of all years (Kerlinger and Lein 1988b). Table 1 shows mean counts of Snowy owls from CBC data analysed by Kerlinger and Lein 1988b). On CBCs in British Columbia, Snowy Owls were recorded in highest numbers on the coast (10 of 18 localities and 15% of all total counts). The highest count, at Ladner on 22 December 1973 was the all-time high for the whole of North America (107 owls). Other peak counts include 27 birds in Vancouver (26 December 1973) and 14 birds at Whiterock on 30 December 1973 (Campbell et al. 1990). Fewer numbers are counted in the interior (the species was recorded at only three of 19 localities and 3% of all count).

In the analysis of Christmas Bird Count data by Root (1988), Snowy Owls were recorded at 235 sites. Green Bay, Wisconsin had the highest numbers of Snowy Owls (0.21 owls/party hour) but this is due to an intensive effort (Operation Snowy Owl) in this area specifically to locate the species, and therefore does not reflect their true distribution (T. Erdman pers. comm.).

Breeding Bird Atlases During Québec's breeding bird atlas Snowy Owls were probable breeders in only two squares, and were observed during the breeding season in only three others. Only one Ontario record of breeding (one of 137, 10 x 10 km blocks) was possible during the atlas years, on the Hudson Bay coast near Fort Seven (Weir 1987). Snowy Owls breed in northeastern Manitoba (Godfrey 1986). In winter, Holland and Curtis (in prep.) describe the Snowy Owl as 'uncommon from the middle of October until the end of April'; it is 'rare during the first week in May, and occasional into the third week of May, late July and early October.' Snowy Owls are uncommon in southwestern Manitoba from mid-November until the end of March. They are rare during April, as well as the last week in October and first two weeks in November (Holland and Curtis in prep.). Taylor (1983) referred to the Snowy Owl as a rare winter visitant of open country in the Pinawa - Lac du Bonnet region.

In Saskatchewan the Snowy Owl is a common winter resident in the plains (Smith in press). Wintering owls have been recorded in 207 squares according to Smith (in press). Spring and fall transients have also been recorded in two and three squares, respectively, and there are two records of summer visitants (Smith in press). Snowy Owls also overwinter in large numbers in Alberta; migrants arrive in mid-November and depart northwards in late March (Semenchuk 1992). There are three records of breeding; one from Ft. McMurray, another from Lake Louise and a third from Lesser Slave Lake (Pinel et al. 1991 in Semenchuk 1992). In British Columbia, Campbell et al. (1990) described the Snowy Owl as a 'rare to fairly common but irregular winter visitant on the coast; rare to uncommon in the interior'. On the extreme southwest mainland coast, the species can be very common in irruptive years. It is also 'fairly common in the northern interior and uncommon in the southern interior' (Campbell et al. 1990). There are a total of 1,886 records of wintering Snowy Owls for British Columbia, with most of these occurring in December followed by January and November and February (Campbell et al. 1990).

Breeding studies Manning et al. (1956) conducted the largest ever breeding census of Snowy Owls on Banks Island in the Canadian Arctic. He estimated 15,000-20,000 owls (0.23-0.31 owls/km^2) during a good breeding season compared to only 2,000 (0.03 owls/km^2) in a poor one. Manning et al. (1956) corrected the number of owls seen per unit time for the conspicuousness of the species and then calculated densities. Taylor (1974 a, b) estimated Snowy Owl numbers on Bracebridge-Goodsir Lowlands on central Bathurst Island in the western Queen Elizabeth Islands between 1968-1971. In his 54 km^2 study area in a good lemming year (1969) he found 15 pairs of owls with 13 clutches completed. However, only one (unsuccessful) breeding pair was found in 1971 and no owls nested in 1968 or 1970. Similarly, Snowy Owl breeding numbers peaked on Southampton Island when the lemming population peaked in 1970 (Parker 1974). Because snow cover was the lowest in 1968-1969 in Taylor's (1974 a, b) study, Miller et al. (1975) suggested that snow cover may affect lemming survival and therefore owl numbers.

During aerial surveys for caribou *Rangifer tarandus pearyi* and musk oxen *Ovibos moschatus* in the Queen Elizabeth group (Melville, Eglinton and Bryam Martin Island) in 1972, 1973 and 1974, Miller et al. (1975) found that Snowy Owl distribution and nesting densities differed regionally due to variation in lemming abundance. On Sandy Point (1974), Snowy Owls were 5.2 $\pm$ 0.9 km apart (n=22), while on Eglinton (1973) they were 5.5 $\pm$ 0.7 km apart (n=30) (Miller et al. 1975). On Eglinton there was a higher density of owls in 1974, since intersite distances were smaller (mean 3.9 $\pm$ 1.4 km, n=8). There has been no recent research on the breeding grounds of Snowy Owls and this could provide very useful information on their population biology and movements.

Nature Conservancy Rankings Nature Conservancy rankings for the Snowy Owl are SZ for Ontario, Saskatchewan and British Columbia (i.e. regularly occurring, migratory, non-breeding species for which no effective habitat conservation measures can be taken) (D. Sutherland, J. Duncan, and S. Cannings, respectively, pers. comm.). In Québec the species is ranked S3S4 (i.e. intermediate between rare or uncommon with 21-100 occurrences, and widespread, abundant and apparently secure with many occurrences, but of long term concern; M. Huot pers. comm.).

There have been suggestions that Snowy Owls have declined in Eurasia (Portenko 1972), but there is little evidence for this is North America. There are reports that the magnitude of 'flights' during irruptions is less than previously. For example, in Ohio, invasions of 20-30 statewide sightings occurred in 1953-54, 1960-61, 1974-75 and 1980-81 (Peterjohn 1989), but nowadays owls occur in small numbers (2-3 sightings along Lake Erie in some years, 5-7 lakefront reports and 2-3 inland in others) annually (Peterjohn 1991). Large flights (CBCs recording a total of 20-25 owls and these were probably underestimates) also occurred in Wisconsin in 1964, 1967, 1977 and 1981 (Robbins 1991). Robbins did not report any large flights since 1981 and this may also indicate a decrease in the numbers of birds wintering in the state.

An unusual phenomenon occurred during the late summer and early fall of 1993, when many young, emaciated Snowy Owls were found in Saskatchewan, Minnesota and Montana, apparently the result of a mid-summer crash in the lemming population (C. Shank pers. comm.). For example, 11 dead Snowy Owls were washed up dead at Whitefish Point in Minnesota (T. Erdman pers. comm.). Mostly juvenile Snowy Owls were involved and these were very vulnerable to mortality from highway traffic, probably because of their poor body condition.

E Habitat

On the breeding grounds, Snowy Owls inhabit arctic tundra from near sea level to slopes generally less than 300 m elevation (Parmelee 1992). In both Norway (Watson 1957) and Sweden (Wiklund and Stigh 1986), higher elevations (600-1500 m) are used because lemmings (the chief prey of Snowy Owls) only occur there. Snowy Owls prefer rolling tundra with knolls which can be used as look-outs (Snowy Owls are 'sit and wait' predators) or nest sites (Cramp 1985). In North America, vegetation in low arctic regions comprises dwarf shrub meadows, in the high arctic it is willow, saxifrage, heather and lichens (Parmelee 1992). Habitat use is determined most by prey adundance, although in Europe owls seem to avoid damp hollows (Cramp 1985). Snowy Owls winter in a wide range of open habitats - coasts, marshes, prairies, fields, lake shores and large rivers in Canada (Godfrey 1986). Wintering owls use a wide variety of prominent structures erected by humans (Parmelee 1992). Adults of both sexes, and juveniles, defend territories in parts of their wintering range and dominant birds select habitats with high prey densities (e.g., Boxall and Lein 1982).

F General Biology

1) Reproductive

Generally monogamous (there are some cases of polygyny and one of polyandry), Snowy Owls may form pairs on the wintering grounds (Boxall and Lein 1982). Age of first breeding is unknown, but it is probably at least two years or older (Parmelee 1992). In areas where they are dependent on lemmings *Lemmus* spp. Snowy Owls can breed every year (e.g., Robinson and Becker 1986). However, owls usually fail to breed in poor lemming years, and may possibly breed only every 3-5 years (Parmelee 1992). Nests are selected on high ground, lacking snow cover and not liable to flooding. The female forms a shallow scrape in which to lay the white or cream coloured eggs. Clutch size varies greatly depending on prey abundance; in Watson's (1957) study on Baffin Island, the mean clutch was 7.5-9.2, while in Finland the mean clutch in 66 nests was 7.7 (range 5-14; Mikkola 1983). Incubation begins with the first egg, thus eggs hatch aysnchronously (in a clutch of seven with a two day hatching interval, the first hatched owlet may be 2-3 weeks older than the last hatched owlet; Johnsgard 1988). Hatching success can be extremely high in favourable conditions; Parmelee et al. (1967) documented a clutch of 11 eggs where all young survived. Also, of 32 eggs examined by Watson (1957), 31 young survived to fledging. Owlets can grow very quickly, perhaps partly because parent owls can hunt for food during 24 hours of daylight. They can leave the nest at 14 days old and scatter over a wide area (Sutton and Parmelee 1956).

2) Movements

Snowy Owls are nomadic on the breeding grounds, the breeding population shifting to areas of maximum prey abundance (Kerlinger in pers. comm. to Parmelee 1992). Snowy Owls migrate southward each year from the high arctic zone with 24 hours winter darkness. Most individuals remain north of 55° N but in irruption years owls are found to the south of this latitude. Kerlinger and Lein (1986) demonstrated that there were sex and age differences in migration movements, with adult

females wintering in the north and immature males wintering in the southern range. This led them to conclude that winter distribution was caused by social dominance.

There is some controversy over the factors influencing the magnitude of southward movements by Snowy Owls and thus the number of wintering birds. It has been suggested by numerous authors that the erratic southern movements of Snowy Owls to the wintering grounds reflect the cyclic (3-5 year) fluctuations of microtine vole populations (e.g., Snyder 1943, Gross 1947, Chitty 1950). The invasions recorded in various regions support some kind of cyclic fluctuations, but the length of the cycles may vary. For example, in British Columbia, irruptions occurred in the winters of 1889-90, 1896-97, 1908-09, 1916-17, 1917-18, 1945-46, 1950-51, 1953-54, 1957-58, 1963-64, 1966-67, 1973-74, 1977-78 and 1984-85 (references in Campbell et al. 1990).

Recently Kerlinger et al. (1985) challenged the view that irruptions of Snowy Owls were cyclic, at least for the main wintering area of the Great Plains. They believe that several factors argue against Snowy Owl irruptions or movements being related solely to prey abundance. First, many Snowy Owls migrate to the Great Plains regularly each winter and populations are not apparently irruptive (Kerlinger et al. 1985), second, many birds are territorial (Keith 1964, Boxall and Lein 1982) and third, banding returns demonstrate winter site fidelity (e.g., Oeming 1957, 1964, Follen and Leupke 1980). Lastly, the fact that thousands of Snowy Owls winter in the Great Plains implies that the breeding catchment area for these birds must be huge (thousands of km^2). There is no evidence that lemming populations fluctuate at this scale (Maher 1970), although lemming numbers can crash over very large areas according to Watson (1957). Kerlinger et al. (1985) suggest that snow cover and temperature are more likely explanations of Snowy Owl movements in the Great Plains.

However, there are several data sources that conflict with the interpretations of Kerlinger et al. (1985). For example, banding data from Green Bay in Wisconsin indicate that there are indeed four year cycles in wintering Snowy Owls (T. Erdman in pers. comm. to Robbins 1991). Peak numbers occur for two years; in the first year most individuals are juveniles, while in the second year most owls are adult. Few birds are recorded for the following two years.

In eastern and western North America, numbers of wintering Snowy Owls fluctuate widely from year to year, but relatively few birds are involved, and these are mostly immature birds, whereas those in the Great Plains are predominantly adults (Kerlinger and Lein 1986). In an analysis of Christmas Bird Count data from 1951-1982, Kerlinger et al. (1985) found that the periods between successive peaks of owl abundance ranged from 2-7 years, and only 50% (n=26) of lags occurred at intervals of 3-4 years (Fig. 2), as predicted by the 'cyclic' population hypothesis. Peaks of approximately equal amplitude did, however, occur in the eastern region in every 3-4 years (Kerlinger et al. 1985). This is therefore not inconsistent with irruptions of Snowy Owls being related to prey abundance.

3) Behaviour/Adaptability

The nomadic breeding habits of the Snowy Owl, and its ability to alter clutch size according to prey populations demonstrate that its reproductive strategy is adapted to fluctuating prey populations.

Two species of lemming are the main prey of Snowy Owls in Arctic North America during the breeding season, the varying lemming *Dicrostonyx groenlandicus* and brown lemming *Lemmus trimucronatus* (Sutton and Parmelee 1956, Watson 1957, Gabrielson and Lincoln 1959). Where

lemmings are absent, a range of prey may be taken (e.g., rabbits *Oryctolagus cuniculus* or shorebirds in Shetland; Robinson and Becker 1986).

Outside the breeding season a wide variety of prey is also taken (e.g., grebes and ducks in southwestern British Columbia; Campbell and MacColl 1978; deer mice *Peromyscus maniculatus* and meadow voles *Microtus pennsylvanicus* in southern Alberta; Boxall and Lein 1982). Of 87 Snowy Owls killed in Maine, stomach contents of 35% contained rats and mice, 20% snowshoe hares *Lepus americanus* and 10% passerine birds (Mendall 1944). Marti et al. (1993) have recently summarized data on Snowy Owl diet, and showed that the number of prey species was similar among the regions where data were available, being 26 in Canada and Alaska (Parker 1974, Williams and Frank 1979, Lein and Boxall 1979, Boxall and Lein 1982) 22 in western North America (Campbell 1978) and 28 in east central North America (Gross 1944, Catling 1973, Chamberlin 1980). However, there was a striking difference among the regions in the mean weight of prey taken by Snowy Owls (Canada and Alaska 49.1 g, western North America 506.0 g, and east-central North America 59.7 g) reflecting the ducks and grebe prey taken in western British Columbia.

G Limiting factors

The main factor limiting populations of Snowy Owls is prey abundance, particularly lemming populations on the breeding grounds. Lack of food also contributes to overwinter mortality, as in the Duluth-Superior area of Minnesota (D. Evans in pers. comm. to Smith and Ellis 1989). Weather may also affect overwinter survival. Smith and Ellis (1989) also believe that preferred overwinter habitat is subject to development in areas with high human populations, and thus potentially limiting. Numerous human influences result in direct mortality of Snowy Owls on the wintering grounds. Because Snowy Owl are large conspicuous birds that perch on exposed telephone poles, fence posts, trees and snow banks they are susceptible to shooting by humans. In some states shooting is still a major factor contributing to overwinter mortality (e.g. Wisconsin; Robbins 1991; T. Erdman pers. comm.). Snowy Owls often overwinter at airports so they are vulnerable to strikes by aircraft; for example at Kennedy International Airport, New York, Chevalier (1988) reported seven cases of Snowy Owls being killed and one injured between 1964-1987. A new factor is the possible effect of physiological stress on Snowy Owls attributed to disturbance by birders and photographers (Smith and Ellis 1989). There is little direct evidence for stress effects but this cannot be ruled out according to Smith and Ellis (1989). Human activity in the vicinity of wintering owls has also resulted in deaths by shooting (Walker 1978). Shooting of owls on migration by native people occurred annually in the early 1980s in the Hudson Bay Lowlands (e.g. Attawapiskat, Winisk; Thompson and Hutchison 1987) and continues today (K. Abraham pers. comm.). Small scale harvesting of Snowy Owls on the breeding grounds during times of adversity by some northern native peoples probably only impacted local populations and is now negligible, and therefore not a potential limiting factor for populations (Parmalee 1992). For example, owls trapped incidentally in traps set for foxes on Oman Island in the western Arctic over 30 years ago, were eaten (J. McDonald pers. comm.), probably because of lack of other food.

H Special significance of the species

Owing to its Arctic distribution, the Snowy Owl is largely diurnal, unlike most other owl species which are nocturnal. What is most interesting about this species is its ability to breed in areas of high prey abundance, and refrain from breeding in years of food shortage. However, this is not fully understood and there is a lack of research on Snowy Owls on their breeding grounds. This is particularly important because of the possibility that global climatic factors may be affecting prey populations and thus indirectly, Snowy Owls. Although never considered an important food item, Snowy Owls have been killed in the Arctic for food in the past, but not indiscriminately (J. McDonald pers. comm.). Judging by their use in mythology by humans over thousands of years, the Snowy Owl is an important symbol of the Arctic region.

I Evaluation and proposed status

The Snowy Owl is a very widespread species, having a circumpolar distribution and as such is not threatened. There are no convincing data to suggest that populations of Snowy Owls have shown any long-term changes, although reductions in the magnitude of invasions have occurred in some states. Whether the latter is evidence for declines or simply changes in wintering distribution is not known. However, more analyses are needed of regional Christmas Bird Count data for Snowy Owls and more research is needed on the periodicity or otherwise of irruptive movements in eastern and western North America. Given that Snowy Owl populations in Europe have been reduced through human persecution, and that Snowy Owls are vulnerable to both hunting and trapping, careful monitoring of these activities should be conducted in the North American Arctic region. Also, large scale climatic changes might be affecting populations of Snowy Owls and this requires increased research. In conclusion, no COSEWIC designation is recommended for this species.

J References

Boxall, P.C. and Lein, M.R. 1982. Territoriality and habitat selection of female snowy owls (*Nyctea scandiaca*) in winter. Can. J. Zool. 60:2344-2350.

Campbell, R.W. and MacColl, M.D. 1978. Winter foods of Snowy Owls in southwestern British Columbia. J. Wildl. Manage. 42:190-192.

Campbell, R.W., Dawe, N.K., McTaggart-Cowan, I., Cooper, J.M., Kaiser, G.W. and McNall, M.C.E. 1990. The birds of British Columbia. Vol. 2: Nonpasserines. Royal British Columbia Museum, ictoria.

Catling, P.M. 1973. Food of Snowy Owls wintering in southern Ontario, with particular reference to the Snowy Owl hazard to aircraft. Ont. Field Biol. 26:1-15.

Chamberlin, M.L. 1980. Winter hunting behavior of the Snowy Owl in Michigan. Wilson Bull. 92:116-120.

Chevalier, S. 1988. Snowy Owl populations at Kennedy International Airport, New York: a twenty-three year study. North Am. Bird Bander 12: 102.

Chitty, H. 1950. Canadian arctic wildlife enquiry, 1943-1949: with a summary of results since 1933. J. Anim. Ecol. 19:180-193.

Cramp, S. (ed.). 1985. Handbook of the birds of Europe, the Middle East and North Africa: the birds of the western Palearctic. Vol. 4. Terns to Woodpeckers. Oxford Univ. Press, Oxford.

Follen, D and Luepke, K. 1980. Snowy Owl recaptures. Inland Bird Banding 52:60.

Gabrielson, I.N. and Lincoln, F.C. 1959. Birds of Alaska. Stackpole Co., Harrisburg, P.A., and Wildl. Manage. Inst., Washington, D.C.

Godfrey, W.E. 1986. The birds of Canada. Revised Edition. National Museum of Canada.

Gross, A.O. 1944. Food of the Snowy Owl. Auk 61:1-18.

Gross, A.O. 1947. Cyclic fluctuations of the Snowy Owl and the migration of 1945-1946. Auk 64:584-601.

Holland, G. and Curtis, in prep. The birds of Manitoba.

Johnsgard, P.A. 1988. Snowy Owl. Pp. 136-143 *in* North American owls. Smithsonian Instit. Press, Washington, D.C.

Keith, L.B. 1964. Territoriality among wintering Snowy Owls. Can. Field Nat. 78:17-24.

Kerlinger, P. and Lein, M.R. 1986. Differences in winter range among age -sex classes of Snowy Owls *Nyctea scandiaca* in North America. Ornis Scand. 17:1-7.

Kerlinger, P. and Lein, M.R. 1988a. Causes of mortality, fat condition, and weights of wintering Snowy Owls. J. Field Ornithol. 59:7-12.

Kerlinger, P. and Lein, M.R. 1988b. Population ecology of Snowy Owls during winter on the Great Plains of North America. Condor 90:866-874.

Kerlinger, P., Lein, R.M. and Sevick, B.J. 1985. Distribution and population fluctuations of wintering Snowy Owls (*Nyctea scandiaca*) in North America. Can. J. Zool. 63:1829-1834.

Lein, M.R. and Boxall, P.C. 1979. Interactions between Snowy and Short-eared Owls in winter. Can. Field-Nat. 93:411-414.

Maher, W.J. 1970. The Pomarine Jaeger as a brown lemming predator in northern Alaska. Wilson Bull. 82:130-157.

Manning, T.H., Hohn, E.O. and Macpherson, A.H. 1956. The birds of Banks Island. Natl. Mus. Canada Bull. 143:1-144.

Marti, C.D., Korpimäki, E. and Jaksic, F.M. 1993. Trophic structure of raptor communities: a three continent comparison and synthesis. Current Ornithol. 10:47-137.

Mendall, H.L. 1944. Food of hawks and owls in Maine. J. Wildl. Manage. 8:198-208.

Mikkola, H. 1983. Owls of Europe. T. and A.D. Poyser, Berkhamsted, London.

Miller, F.L., Russell, R.H. and Gunn, A. 1975. Distribution and numbers of Snowy Owls on Melville, Eglinton, and Byam Martin Islands, Northwest Territories, Canada. Raptor Research 9:60-64.9

Oeming, A.F. 1957. Notes on the Barred Owl and the Snowy Owl in Alberta. Blue Jay 15:153-156.

Oeming, A.F. 1964. Banding recovery of Great Gray Owl. Blue Jay 22:10.

Parker, G.R. 1974. A population peak and crash of lemmings and Snowy Owls on Southampton Island, Northwest Territories. Can. Field-Nat. 88:151-156.

Parmelee, D.F., Stephens, H.A. and Schmidt, R.H. 1967. The birds of southeastern Victoria Island and adjacent small islands. Natl. Mus. Canada Bull. 222:1-229.

Parmelee, D.F. 1992. Snowy Owl *in* The Birds of North America, No. 10 (A. Poole, P. Stettenheim, and F.B. Gill, eds.). The Academy of Natural Sciences, Washington, D.C., The American Ornithologists' Union.

Peterjohn, B.G. 1991. The birds of Ohio. Indiana University Press, Bloomington.

Portenko, L.A. 1972. Die Schnee-Eule. A. Ziemsen Verlag. Wittenberg Lutherstadt.

Robbins, S.D., Jr. 1991. Wisconsin birdlife, population and distribution - past and present. Univ. Wisconsin, Madison. 720 pp.

Robinson, M. and Becker, C.D. 1986. Snowy Owls on Fetlar. Brit. Birds 78:228-242.

Root, T. 1988. Atlas of wintering North American birds. An analysis of Christmas bird count data. Univ. Chicago, Chicago.

Semenchuk, G.P. 1992. The atlas of breeding birds of Alberta. Fed. Alberta Natur., Edmonton.

Smith, A.R. in press. Atlas of the birds of Saskatchewan.

Smith, D.G. and Ellis, D.H. 1989. Snowy Owl Pp. 97-105 *in* Proc. Northeast Raptor Management Symposium and Workshop. (B. Giron Pendleton, ed.). National Wildlife Federation Scientific and Technical Series No. 12.

Snyder, L.L. 1943. The Snowy Owl migration of 1941-42. Wilson Bull. 55:8-10.

Sutton, G.M. and Parmelee, D.F. 1956. Breeding of the Snowy Owl in southeastern Baffin Island. Condor 58:273-282.

Taylor, P.S. 1974 a. Breeding behavior of the Snowy Owl. Living Bird 12:137-154.

Taylor, P.S. 1974 b. Summer populations and food ecology of jaegers and Snowy Owls on Bathurst Island, NWT, emphasizing the Long-tailed Jaeger. M.S. Thesis, University of Alberta. 167 pp.

Taylor, P. 1983. Wings along the Winnipeg: the birds of the Pinawa-Lac du Bonnet region, Manitoba. Manitoba Naturalists Society Eco Series No. 2, Winnipeg, Manitoba.

Thompson, J.E. and Hutchison, W.A. 1987. Resource use by native and non-native hunters of the Ontario Hudson Bay Lowland. Technical Report, P.O. Box 190, Ontario Ministry of Natural Resources, Moosonee, Ontario POL 1YO.

Walker, L.W. 1978. The book of owls. Alfred A. Knopf Co., New York. 255 pp.

Watson, A. 1957. The behavior, breeding, and food-ecology of the Snowy Owl (*Nyctea scandiaca*). Ibis 99:419-462.

Weir, R.D. 1987. Snowy Owl *Nyctea scandiaca*. Pp. 541 *in* Atlas of the birds of Ontario (M.D. Cadman, P.F.J. Eagles and F.M. Helleiner, eds.). Univ. Waterloo Press.

Wiklund, C.G. and Stigh, J. 1986. Breeding density of Snowy Owls *Nyctea scandiaca* in relation to food, nest sites and weather. Ornis Scand. 17:268-274.

Williams, P.L. and Frank, L.G. 1979. Diet of the Snowy Owl in the absence of small mammals. Condor 81:213-214.

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Table 1 Summary of abundance of Snowy Owls at CBC localities in the northern Great Plains from 1961 to 1984 (from Kerlinger and Lein 1988b).

Locality	Number of years with counts	Number of years with owls (%)	Number of owls reported mean ± SE
Calgary, AB	24	22 (91.7)	4.58 ± 0.99
Edmonton, AB	24	22 (91.7)	3.04 ± 0.76
Regina, SK	23	23 (100.0)	7.35 ± 1.04
Saskatoon, SK	24	19 (79.2)	2.38 ± 0.52
Delta, MB	9	7 (77.8)	4.56 ± 1.56
Oak Lake, MB	22	13 (59.1)	0.82 ± 0.18
Winnipeg, MB	23	18 (78.3)	3.87 ± 1.02
Arrowwood NWR, ND	19	7 (36.8)	0.37 ± 0.11
Bismarck, ND	24	4 (16.7)	0.17 ± 0.08
Des Lacs NWR, ND	22	20 (90.9)	1.41 ± 0.22
Fargo-Moorhead, ND-MN	24	17 (70.8)	1.29 ± 0.26
Grand Forks, ND	22	16 (72.7)	1.23 ± 0.27
Jamestown, ND	21	10 (47.6)	0.95 ± 0.27
Leeds, ND	15	12 (80.0)	0.87 ± 0.13
J. Clark Salyer, NWR,ND	24	13 (54.2)	0.67 ± 0.18
Sullys Hill NGP, ND	16	4 (25.0)	0.25 ± 0.11
Tewaukton NWR, ND	12	2 (16.7)	0.17 ± 0.11
Upper Souris NWR, ND	11	4 (36.4)	0.64 ± 0.31
Valley City, ND	13	7 (53.8)	0.85 ± 0.27
Billings, MT	24	0	
Chester, MT	9	9 (100.0)	1.22 ± 0.15
Fort Peck, MT	9	4 (44.4)	0.67 ± 0.29
Aberdeen, SD	16	9 (56.3)	1.06 ± 0.32
Brookings, SD	24	1 (4.2)	0.04 ± 0.04
Huron, SD	11	2 (18.2)	0.27 ± 0.20
Lake Andes, SD	17	3 (17.6)	1.06 ± 0.69
Madison, SD	23	3 (13.0)	0.17 ± 0.10
Pierre, SD	14	1 (7.1)	0.14 ± 0.14
Sand Lake NWR, SD	9	7 (77.8)	1.22 ± 0.32
Sioux Falls, SD	23	0	
Waubay, SD	24	4 (16.7)	0.21 ± 0.10
Wilmot, SD	18	4 (22.2)	0.22 ± 0.10
Yankton, SD	22	3 (13.6)	0.18 ± 0.11

Figure 1. Distribution of Snowy Owls in North America (taken from Johnsgard 1988). The long dashes indicate usual southern wintering limits; the short dashes indicate limits sometimes reached by wintering vagrants. Extralimital distribution shown in inset.