COSEWIC
Assessment and Update Status Report

on the

Southern Flying Squirrel
Glaucomys volans

Atlantic (Nova Scotia) population
Great Lakes Plains population

in Canada

NOT AT RISK
2006

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE IN
CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC 2006. COSEWIC assessment and update status report on the southern flying squirrel *Glaucomys volans* (Atlantic (Nova Scotia) population and Great Lakes Plains population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 33 pp.

Previous report:

Stabb, M. 1988. COSEWIC status report on the southern flying squirrel *Glaucomys volans* in Canada. Committee on the Status of Endangered Wildlife in Canada. 1-91 pp.

Production note:
COSEWIC would like to acknowledge Ian Adams and Ewa Bednarczuk for writing the update status report on the southern flying squirrel *Glaucomys volans* (Atlantic (Nova Scotia) and Great Lakes Plains population) in Canada, prepared under contract with Environment Canada, overseen and edited by Marco Festa-Bianchet, Co-chair (Terrestrial Mammals), COSEWIC Terrestrial Mammals Species Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le petit polatouche (*Glaucomys volans*), population de l'Atlantique (Nouvelle-Écosse) et population des plaines des Grands Lacs, au Canada – Mise à jour.

Cover illustration:
Southern flying squirrel — Photograph by ©Philip Myers.

Catalogue No. CW69-14/501-2006E-PDF
ISBN 0-662-43315-7

COSEWIC
Assessment Summary

Assessment Summary – April 2006

Common name
Southern flying squirrel – Atlantic (Nova Scotia) population

Scientific name
Glaucomys volans

Status
Not at Risk

Reason for Designation
Southern flying squirrels are small inconspicuous nocturnal forest-dwelling rodents with impressive gliding ability. They are difficult to distinguish from the northern flying squirrel. In Nova Scotia, the southern species was first detected in 1971, and until 2001, was only known from seven sites. New recent research located southern flying squirrels in 32 locations and over a much wider area in the southern part of the province than expected. Like a number of species in Nova Scotia, it is at the north of its range and disjunct. Habitat loss through deforestation and fragmentation of intact forest may lead to extirpation of some local populations, but does not currently pose a threat to the species' persistence and the population appears stable.

Occurrence
Nova Scotia

Status history
Designated Special Concern in April 1988. Split into two populations in April 2006 and the Atlantic (Nova Scotia) population was designated Not at Risk. Last assessment based on an update status report.

Assessment Summary – April 2006

Common name
Southern flying squirrel – Great Lakes Plains population

Scientific name
Glaucomys volans

Status
Not at Risk

Reason for Designation
Southern flying squirrels are small inconspicuous nocturnal forest-dwelling rodents with impressive gliding ability. They are difficult to distinguish from the northern flying squirrel. Dedicated sampling programs have generally revealed greater abundance and range than previously assumed. Its known area of occupancy has expanded. Habitat loss through deforestation and fragmentation of remaining forest may lead to extirpation of some local populations in the southern part of its range in Ontario, but does not currently pose a threat to the persistence of this population. The overall trend in habitat availability is stable or positive. Recent research in Ontario has revealed a much wider range of suitable habitat and reported a substantial range expansion. There is little information on this squirrel from Quebec as there have been no directed surveys for this species.

Occurrence
Ontario and Quebec

Status history
Designated Special Concern in April 1988. Split into two populations in April 2006 and the Great Lakes Plains population was designated Not at Risk. Last assessment based on an update status report.

COSEWIC
Executive Summary
from the 1998 Status Report

Southern Flying Squirrel
Glaucomys volans

Atlantic (Nova Scotia) population
Great Lakes Plains population

Species information

The southern flying squirrel is a small, arboreal squirrel with soft, greyish-brown fur on the back and sides and pure white belly hairs. They are distinguishable from northern flying squirrels (*Glaucomys sabrinus*) from live specimens in the hand or good photographs. There is no record of interbreeding between the species. There is little evidence of genetic structuring of populations of southern flying squirrels in Ontario. Genetic results from Nova Scotia suggest the isolated population in that province is diverging from central Canadian populations.

Distribution

G. volans occurs from Minnesota in the northwest, New England and Nova Scotia in the northeast and south to the Gulf of Mexico. Isolated populations occur in Nova Scotia, Mexico and Central America as far south as Honduras. In Canada, *G. volans* occurs in south and central Ontario, southwestern Québec and southern Nova Scotia. It is not known to occur in New Brunswick.

In Canada, the Great Lakes population ranges along the northern shore of Lakes Erie and Ontario eastward into southwestern Québec. Northward, the species is found throughout much of central Ontario. Recent work has extended the northern limit from a line roughly between Muskoka and Petawawa to Temagami and Killarney Provincial Park. However, the northern edge of the species' range fluctuates year-to-year; the northern limit in 2004 was over 200 km further south than in 2003. Data from Québec are lacking, but there has been no systematic effort to search for this species. They are known from the Outaouais region and may occur throughout the Eastern Townships, but have not been located there. The Extent of Occurrence of the Great Lakes population is estimated at approximately 160,000 km^2. The Atlantic Population occurs entirely within southern Nova Scotia between Kentville in the northeast and Tobeatic Wilderness Area in the southwest. The population's Extent of Occurrence is estimated at 6,500 km^2.

Habitat

Suitable habitat requirements are primarily mast-bearing trees for food and tree cavities for nesting. Southern flying squirrels select older forest stands, but whether southern flying squirrels depend on old growth is a matter of debate. In the northern part of their range, southern flying squirrels utilize forests dominated by hardwood, mast-bearing trees with some conifer. The southern flying squirrel is a secondary cavity nester, utilizing holes excavated by woodpeckers, or resulting from broken limbs or disease in dead and live trees. There are several protected areas throughout their Canadian range.

Biology

G. volans are polyestrous and may reach sexual maturity after six months (though this is unusual). One annual litter is most common in Canada, occasionally two. Mean litter size is 2.75 in the US and 3.5 in Canada. Limited survival data for *G. volans* suggest survival to three years is rare. Generation time is estimated to approximate 1.5 years. Parturition occurs as early as late April and as late as August.

The diet of southern flying squirrels is varied. The food is hardwood tree mast, particularly hickory (*Carya* spp.), oak (*Quercus* spp.) and beech (*Fagus grandifolia*), though they also readily consume insects, eggs, nestlings and other foods when available. Predators of *G. volans* include domestic cats, owls, elaphid snakes and raccoons. Feral and domestic cats likely contributed to the extirpation of *G. volans* from Point Pelee National Park and may limit flying squirrels in rural areas.

Relatively little is known about the dispersal habits of southern flying squirrels. Adults are capable of covering large distances in short periods of time. Individuals have been recorded to move > 2 km in a night.

Population sizes and trends

There is no abundance estimate for either the Great Lakes or Atlantic population. Estimates of population size for southern flying squirrels are constrained by low capture rates and unequal capture of individuals. *G. volans* also exhibits wide annual variation, rendering any single point-in-time estimate unreliable. In both populations historical declines have likely occurred due to substantial habitat loss, particularly in southern Ontario. Whether populations have declined in recent years is unknown. Neither population has substantive opportunity for rescue from the United States. The Atlantic population is completely isolated, some 500 km by land from the nearest location in Maine. The only land border with the Great Lakes population is in northeast New York, Vermont and possibly New Hampshire. However, status of southern flying squirrels in these border areas is unknown. The Great Lakes and associated rivers effectively isolate Ontario from US populations; flying squirrels are poor swimmers.

Limiting factors and threats

Overwinter survival is likely dictated primarily by availability of stored food, while cold minimum winter temperatures may increase mortality. Other thresholds limiting southern flying squirrel populations are unknown, including minimum density of nesting cavities and woodlot size and connectivity.

Habitat loss is the major threat facing southern flying squirrels. Activities that reduce overall forest cover (e.g. conversion of forested land to urban development) or remove forest structure attributes within a stand (e.g. removal of nesting trees or harvesting of mature mast-producing hardwoods) are key threats to southern flying squirrel survival at both the individual and population levels. Habitat fragmentation can also be disruptive to southern flying squirrel ecology. *G. volans* will use 'greenbelt' corridors between larger habitat fragments, but population densities in Arkansas declined following forest harvesting, while populations in adjacent mature stands increased.

Mortality threats come from trapping and domestic cats. Southern flying squirrels are known to be killed in traps set for other species. Where their range overlaps with registered traplines, they may be at risk. Domestic cats are effective flying squirrel predators and pose a major predation risk to southern flying squirrels throughout their range.

Existing protection

Nova Scotia lists *G. volans* as "yellow," indicating "sensitive to human activities or natural events". Ontario ranks the southern flying squirrel as "special concern". Québec lists the species as "likely to become threatened or vulnerable". NatureServe conservation rankings in adjacent states are all S5, except for Vermont (S4) and Maine (SU).

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5th 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2006)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

Southern Flying Squirrel
Glaucomys volans

Atlantic (Nova Scotia) population
Great Lakes Plains population

in Canada

2006

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SPECIES INFORMATION

Name and classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Rodentia
Family:	Sciuridae
Genus:	*Glaucomys*
Species:	*volans*
Subspecies:	*volans*
Authority:	Linnaeus (1758)
source:	Dolan and Carter (1977)
Other names:	French: Petit polatouche

Dolan and Carter (1977) identified 10 subspecies. The only subspecies occurring in Canada is *G. v. volans*. The other subspecies occur entirely in the southern United States, Mexico and Central America.

Morphological description

Southern flying squirrels (*Glaucomys volans*) are small, nocturnal arboreal tree squirrels with soft, greyish-brown fur on the back and sides and pure white belly hairs. When gliding, squirrels are supported by a furred patagium extending from the wrists to the ankles. The tail is dorso-ventrally flattened and assists with in-flight steering and landing.

Distinguishing southern flying squirrels from northern flying squirrels (*Glaucomys sabrinus*) is difficult without live specimens in the hand or good photographs. Size (body mass and length of hind foot), colour of ventral fur and tail morphology are the main distinguishing features (Table 1). Tail shape is most noticeable when a flying squirrel has landed on a tree and the lighter-coloured tail is contrasted against the dark trunk of the tree. Petersen (2004) developed a molecular screen that utilized restriction enzyme digestion of the cytochrome-b gene to generate species-specific patterns.

Sightings by non-experts in areas of known or suspected sympatry should be considered “generic”. Despite the closeness in overall physical appearance, northern and southern flying squirrels are distinct species (see Arbogast 1999) and there is no record of their interbreeding (Dolan and Carter 1977; Wells-Gosling and Heaney 1984; Wells-Gosling 1985).

Table 1. Summary of phenotypic differences between northern and southern flying squirrels.

Characteristic	Southern Flying Squirrel	Northern Flying Squirrel
base of ventral fur	white	grey
dorsal and lateral pelage	greyer, less rich than northern flying squirrel	brown
mass	47 – 85 g (pregnant females may approach 100 g (Adams 1995))	70 – 140 g
total length	200 – 260 mm	245 – 370 mm
tail length[1]	93.5 mm	120.7 mm
tail shape	tapers base to tip	no taper, tail sides parallel

[1]Data for Nova Scotia and Ontario flying squirrels only (Lavers 2004)

Genetic description

Arbogast (1999) identified three main mtDNA lineages for *Glaucomys* spp.: two for *G. sabrinus* ("eastern", including all of Canadian and "western"), and one for *G. volans*. *G. volans* was found to have diverged from the eastern *G. sabrinus* lineage some 0.7-1.3 million years ago. Little sequence variation was found across the range of *G. volans* in North America (Arbogast 1999). The evolution of the southern flying squirrel was influenced by glacial successions and coniferous and deciduous forest distribution (Arbogast 1999).

There is little evidence of genetic structuring of populations of southern flying squirrels in Ontario. Bednarczuk (2003) assessed several characteristics using microsatellite DNA markers for three Ontario locations: Point Pelee National Park (PPNP) (reintroduced in 1993 from Norfolk County), Norfolk County and Minden. Bednarczuk (2003) found low genetic differentiation among all three subpopulations (Table 2).

Table 2. Genetic differentiation among three Ontario subpopulations of southern flying squirrel. Source: Bednarczuk (2003).

Subpopulations compared	F_{ST}
Point Pelee National Park vs Minden	0.0539
Point Pelee National Park vs Norfolk	0.0252
Norfolk vs Minden	0.0113

Low subdivision (F_{ST} = 0.0314) was detected across 11 HN woodlots, suggesting a panmictic subpopulation. Estimated mean expected heterozygosity (H_E) and observed heterozygosity (H_O) based on four microsatellite loci were: 0.7934 and 0.7233

respectively for PPNP; 0.8356 and 0.7712 for Norfolk; and 0.7655 and 0.7500 for Minden. Similarly, moderate to high heterozygosities for seven microsatellite loci were reported for a population of southern flying squirrels in South Carolina (Fokidis *et al*. 2003). Bednarczuk (2003) also documented a low average pair-wise sequence divergence of 0.0045 between unique cytochrome-b haplotypes of five Ontario subpopulations (PPNP, Norfolk, Minden, Hamilton and Peterborough).

Petersen (2004) investigated geographic variation and phylogeography in *G. volans* in Nova Scotia using the mtDNA cytochrome-b gene and the control region (CR). Samples from Nova Scotia (NS), Ontario and the United States were undistinguishable displaying a low cytochrome-b sequence divergence of 0 – 2.1%, suggesting rapid post-glacial expansion in the Great Lakes Plains and Atlantic populations.

However, the control region exhibited higher rates of divergence (Petersen 2004). Average pair-wise sequence divergence of NS samples (n= 53) was 0.1±0.3%; 2.5±0.5% in the Ontario samples (n = 13); 2.1±0.5% between NS and Ontario samples; and 6.1±1.4% between NS and the United States samples (n = 1). Thirty-one CR haplotypes were identified in the overall Canadian *G. volans* samples, twenty of which were unique to 53 NS individuals. Two of the NS haplotypes were common occurring in 58.5% of the NS samples, another four haplotypes were identified in more than one individual, and the remaining 14 haplotypes were found in one individual only. Haplotypes were not shared between Ontario and NS. The lack of shared haplotypes between Ontario and NS *G. volans*, and the two common NS haplotypes suggest a significant loss of genetic variability by the NS population. *G. volans* was likely isolated in NS about 8,000 years ago at low population numbers resulting in the significant loss of genetic variability. The population then experienced a range expansion period approximately 2,000 years ago (Petersen 2004). These results may also be indicative of NS *G. volans* population diverging from Ontario populations. However, larger Ontario haplotype samples are required for a more robust analysis.

Designatable units

The two designatable units are based on a major range separation and different ecozones for southern flying squirrels in Canada: Great Lakes Plains and Atlantic populations. The Great Lakes Plains population occurs in southern Ontario and southwestern Québec, primarily within the Carolinian and Great Lakes / St. Lawrence faunal provinces. It accounts for the majority of southern flying squirrels in Canada.

The Atlantic population is limited to southern Nova Scotia, in the Appalachian / Atlantic Coast faunal province. It is isolated from all other *G. volans* population in Canada and the United States. Genetic work by Petersen (2004) suggested that southern flying squirrels are one of a number of species found in southern Nova Scotia isolated from the main part of their species' range (see also Pielou 1991; Davis and Browne 1996). These species spread north following the retreat of the Wisconsin glaciers during an intermittent warming period, then became isolated following

subsequent cooling. The Atlantic and Great Lakes Plains populations differ both genetically (Petersen 2004; see Genetic description) and phenotypically (Lavers 2004).

DISTRIBUTION

Global range

G. volans occurs from central Minnesota to the Gulf of Mexico (Figure 1). The western limit of the range is approximated by the prairie tree line, including eastern Nebraska, Kansas, Oklahoma and Texas (Stabb 1988). Isolated populations occur in Nova Scotia (Figure 1), Mexico and Central America as far south as Honduras (Dolan and Carter 1977; Diersing 1980).

Figure 1. The global distribution of *Glaucomys volans*. Map developed from Bowman *et al*. (unpubl. data), Lavers (2004), NatureServe (2004), Dobbyn (1994) and Dolan and Carter (1977). Question marks indicate uncertain range limits in Canada.

There is a single record of a southern flying squirrel from Eastport, Maine, on the coast near the New Brunswick border (Cameron 1976; Godin 1977 in Stabb 1988). Habitat modelling for southern flying squirrels in Maine (Krohn *et al*. 2001) suggests they may occur only along the state's coast. However, the species is rarely documented there. Cameron (1976) reported only six records of southern flying squirrels for Maine, including the Eastport record. O'Connell *et al*. (2001) captured only northern flying squirrels on Mt. Desert Island (Acadia (US) National Park), despite historical records of southern flying squirrels being present there.

Canadian range

Recent surveys suggest the northern limit of the Great Lakes Plains population occurs as far north as Temagami and Killarney, Ontario (J. Bowman pers. comm. 2004). The Atlantic population is at least 500 km by land from *G. volans* in Maine (Lavers 2004).

The southern flying squirrel is not known from New Brunswick. Studies on northern flying squirrels (e.g. Vernes 2004; Gerrow 1996) in Acadia National Park found no southern flying squirrels despite efforts to do so (D. Sabine pers. comm. 2004; M. Smith pers. comm. 2004). The range map currently available at NatureServe (2004) incorrectly shows *G. volans* occurring in southern New Brunswick and throughout mainland Nova Scotia.

Great Lakes Plains population range

Southern flying squirrels range along the northern shore of Lakes Erie and Ontario eastward into southwestern Québec. Northward, the species is found throughout much of central Ontario, though notably the species is absent or largely absent from that area north and west of Guelph and Orangeville, including the Dundalk Uplands (Ontario Island) and the Niagara Escarpment including the Bruce Peninsula and Manitoulin Island (J. Bowman. pers. comm. 2004; Figure 2).

Across central Ontario, *G. volans* occurs north through Haliburton Co., Muskoka Dist., Renfrew Co., Nipissing and Parry Sound districts, north to eastern Sudbury Dist. (Killarney Provincial Park) and northern Nipissing Dist. (Temagami).

The Great Lakes Plains population appears well connected in the contiguous forests of central Ontario (J. Bowman pers. comm. 2004). There is uncertainty whether there is a gap in southern flying squirrel occurrence between, approximately, Toronto and Hamilton (J. Bowman pers. comm. 2004). If this gap occurs, the Great Lakes Plains population may be effectively split in two between southwestern Ontario and eastern / central Ontario. In southwestern Ontario, southern flying squirrels persist mainly in isolated sub-populations; only in Norfolk County is there good connectivity between large patches of suitable habitat.

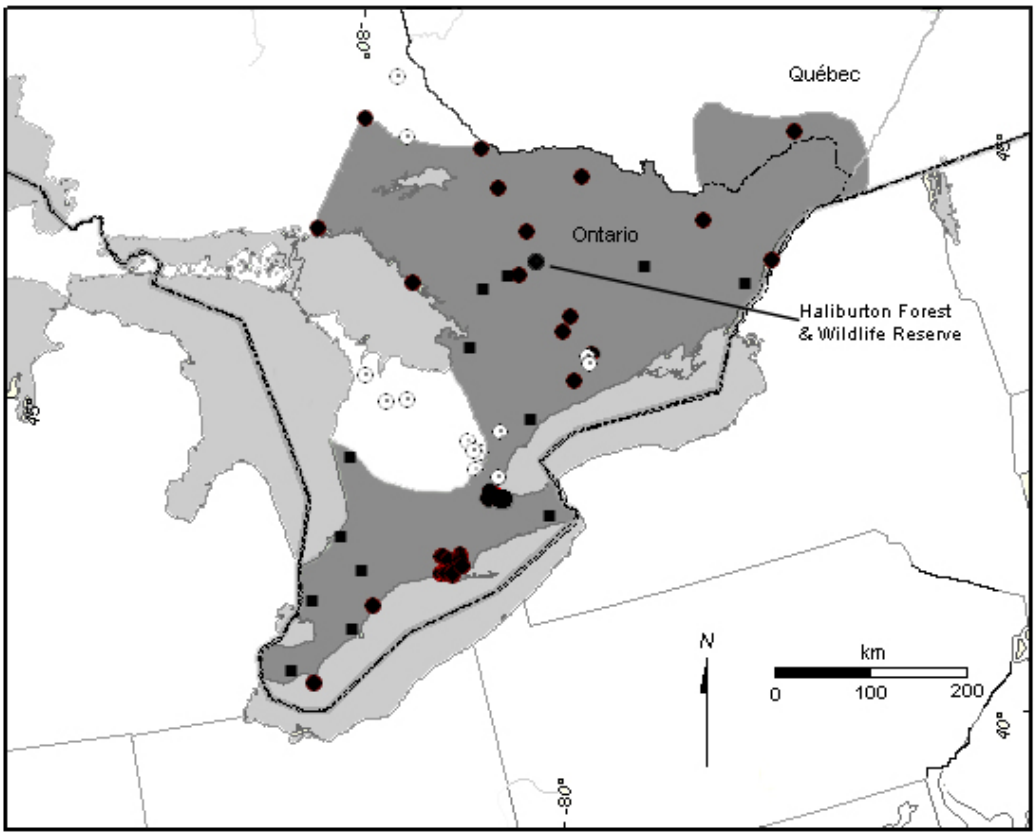

Figure 2. Range of Great Lakes southern flying squirrel population. Black circles indicate sites with documented southern flying squirrel presence by J. Bowman (unpubl. data); G. Holloway (unpubl. data); Bednarczuk 2003; Pasma and Dobbyn 2003; Bednarczuk and Judge, 2002; Adams 1995; St. Lawrence Islands National Park 1985. White circles indicate sites sampled by J. Bowman *et al*. (unpubl. data) during 2002-2004 and Aurora District MNR 2004 where southern flying squirrels were not detected. Black squares are selected historical records from Dobbyn (1994) to document estimated extent of occurrence. The Québec distribution is after Québec MRNFP (2004). The Haliburton Forest and Wildlife Reserve was the northernmost record of southern flying squirrels in central Ontario during 2004 field work.

There has been no systematic effort to search for this species in Québec. In the Outaouais Region, their confirmed distribution is between Pointe-aux-Chènes (east) and Fort-Coulonge (West); the northern-most report is at Sandall Lake (46° 08' N; 76° 28' W) west of the municipality of Lac Cayamant, 50 km north of Gatineau (D. St.-Hilaire pers. comm. 2004). *G. volans* is likely present elsewhere in the southern part of the province where suitable habitat exists including north of the Ottawa River and in the Eastern Townships as far east as Sherbrooke or Mont-Mégantic (Table 3). The species' presence in northern New York, Vermont and New Hampshire is also uncertain (J. Litvaitis pers. comm. 2004). In Maine, sightings and suitable habitat are restricted to coastal regions.

The Extent of Occurrence of the Great Lakes Plains population is estimated at approximately 160,000 km^2. The Area of Occupancy is unknown but likely to be significantly lower.

Table 3. Information on the presence of *Glaucomys* spp. in southwestern Québec protected areas. Number (in parentheses) following protected area name correlates to location on Figure 4.

Protected Area	Species present	Source
Parc National du Mont-Mégantic (13)	*G. sabrinus*; *G. volans* possibly present but unknown.	P. Gaillon pers. comm. 2004
Parc National du Mont-Orford (14)	*Glaucomys* present, but species uncertain.	C. Lascelles pers. comm. 2004
Réserve Faunique de Papineau-Labelle (12)	1 of 36 flying squirrels caught by registered trappers in 1999 was a female *G. volans* captured in the Val-des-Monts area.	C. Genest pers. comm. 2004
Parc National du Mont-Saint-Bruno (15)	*G. sabrinus*	D. Henri pers. comm. 2004
Parc national du Mont-Tremblant (16)	*Glaucomys* present. Species uncertain but thought to be *G. sabrinus*.	L. Cadieux pers. comm. 2004

The northern limit of the Great Lakes Plains Population range appears to fluctuate widely. In 2003, southern flying squirrels were found as far north as Temagami, Ontario. In 2004, with similar trapping effort at the same locations, they were undetected north of the Haliburton Forest and Wildlife Reserve (north of Haliburton, ON) and nearby Leslie Frost Centre (south of Dorset, ON), over 200 km south of the 2003 northern limit (G. Holloway pers. comm. 2004; J. Bowman pers. comm. 2004). The Leslie Frost Centre was the previously accepted range limit (Stabb 1988). Bowman *et al*. (unpubl. data) carried out considerable search effort in 2004 (13,259 trap nights) north of this latitude with no captures.

These data reflect a substantial population crash in 2004, especially at northern part of the range. Bowman *et al*. (pers. comm. 2004) attribute the decline to an energetic bottleneck during winter 2004 brought about by a combination of a cold winter and a documented failed mast crop in autumn 2003. Southern flying squirrels had little food available to hoard for winter 2004 and were likely unable to persist through the cold months. Spring breeding would have failed as well, but this was probably unimportant, since even adults were not detected during 2004 surveys.

Atlantic (Nova Scotia) population range

Southern flying squirrels were not known from Nova Scotia prior to 1971 (Wood and Tessier 1974). Their isolation from other southern flying squirrel populations (Figure 1) precludes the possibility of recent migration explaining their presence in Nova Scotia. Flying squirrels' nocturnal habits allow their presence to be often unnoticed and traps set on the ground or at elevations <1.0 m have very low capture rates for southern flying squirrels (Risch and Brady 1996). Additionally, several other vertebrates were documented only recently from Nova Scotia, including *Microtus chrotorrhinus*, *Lasionycteris noctivagans*, *Pipistrellus subflavus*, *Sorex dispar*, *Sorex gaspensis*. Most

of these over-looked mammals are nocturnal, highly cryptic, geographically isolated and/or require specialized inventory methods to determine presence or absence (M. Elderkin pers. comm. 2004).

G. volans occurs in southern Nova Scotia in an area roughly bounded by the South Mountains in the north, the Gaspereau Valley (Kentville) to the west, the New Ross area in north-east Lunenburg County to the south and Kejimkujik National Park in the west.

Prior to 2001, southern flying squirrels were documented from only seven locations in Nova Scotia: five in Kejimkujik National Park and two near Kentville in Kings County (Lavers 2004). *G. volans* in Nova Scotia was previously considered to be two isolated "populations" centred on Kejimkujik National Park and Kentville (Stabb 1988). Lavers (2004) collected records (live or specimen) from 32 new locations in southwestern Nova Scotia representing 60 individuals suggesting a single continuous population (Figure 3). Southern flying squirrels may occur further south (toward Yarmouth and Shelburne) of the current known range limit, including the Tobeatic Wilderness Area. The population's Extent of Occurrence is estimated at 6,500 km^2, based on an analysis of point locations of sighting records.

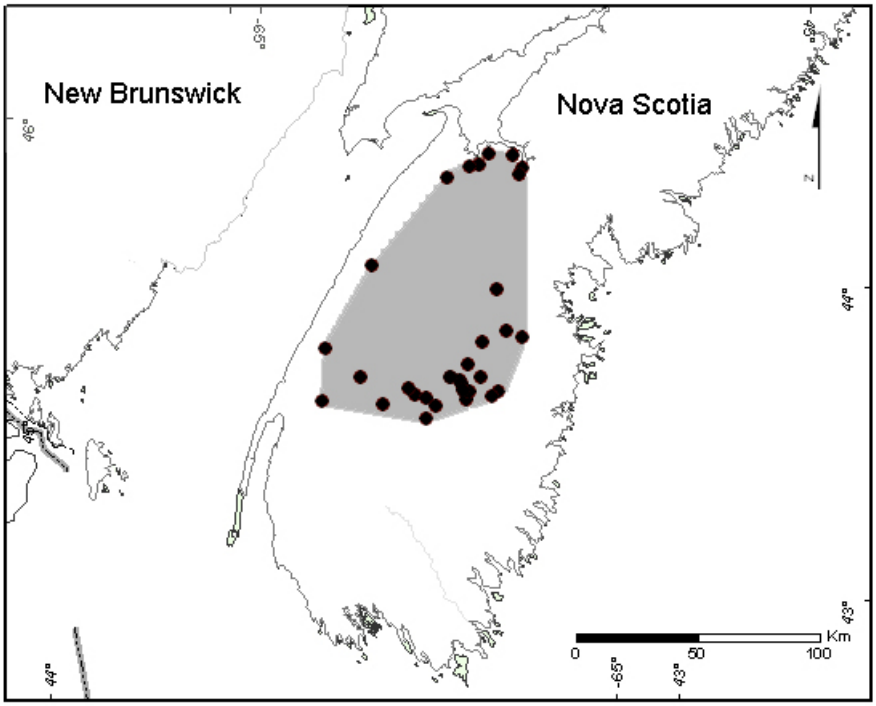

Figure 3. Range of Atlantic population of southern flying squirrel. Black circles indicate record locations.

Genetic evidence (Petersen 2004, see Genetic description above) supports southern flying squirrels being native to Nova Scotia and not recently introduced by humans. Previous records documenting only northern flying squirrels in the province (e.g. Smith 1940; Banfield 1974)

HABITAT

Habitat requirements

Stabb (1988) provided a thorough description of southern flying squirrel habitat requirements. These have been supported by more recent work (Fridell and Litvaitis 1991; Adams 1995; Taulman *et al*. 1998; Taulman 1999; Lavers 2004; Taulman and Smith 2004). Suitable habitat requirements are primarily mature mast-bearing trees for food and tree cavities for nesting.

In the northern part of their range, southern flying squirrels use forests dominated by hardwood, mast-bearing trees with some conifer, generally pine (*Pinus* spp.) (Doby 1984; Gilmore and Gates 1985; Adams 1995; Lavers 2004). In the Atlantic population, *G. volans* selected forests with American beech (*Fagus grandifolia*), eastern hemlock (*species*), red oak, white ash (*Fraxinus americana*) and white pine (*Pinus strobus*). Nest trees (dead or alive) also tend to be larger in diameter than trees without nests (Gilmore and Gates 1985; Adams 1995; Taulman 1999; Lavers 2004).

Recent work has shown that southern flying squirrels select older forest stands (Adams 1995; Taulman 1999; Lavers 2004; Taulman and Smith 2004). In Nova Scotia, stand age around nest trees averaged 87.9 years $\pm$ 27.7 (n = 41), significantly older than random sites (Lavers 2004). In Point Pelee National Park, southern flying squirrels exhibited strong selection for the oldest stands in the park following reintroduction (Adams 1995). Stand age is not so important itself as the attributes found most commonly within those stands. Older hardwood trees produce more mast and older stands tend to have more cavities. Younger stands and those selectively harvested to retain nesting sites and enough mature mast-producing trees may support southern flying squirrels as well (note how many mast-producing trees is “enough” is not known). However, reported high densities from younger stands may include subordinate individuals or juveniles who have been displaced to a lower quality habitat (Goertz *et al*. 1975; I. Adams pers. obs.).

Proximity to water also may be important (Sonenshine *et al*. 1979; Taulman 1999). In Ontario’s Norfolk County woodlots, which were used as the source population for the Point Pelee National Park reintroduction, squirrels were most often captured in vernally flooded swamps dominated by silver maple (*Acer saccharinum*). Following release at Point Pelee, similar habitats were commonly used (Adams 1995). When flooded, these forests may provide protection to flying squirrels by deterring terrestrial predators from accessing the nest tree.

The southern flying squirrel is a secondary cavity nester. Downy (*Picoides pubescens*) and Hairy Woodpeckers (*P. villosus*) are the primary excavators of cavities used by *G. volans* (Sollberger 1940; Muul 1968). They also use cavities formed either from broken limbs or disease. Lavers (2004) found that only 28% of 46 nests were excavated by woodpeckers. Similarly, most cavity nests in Point Pelee, were in knotholes or broken branches of live trees (Adams 1995). Southern flying squirrels will readily use human structures for nesting, including attics, outbuildings and nest-boxes

erected for birds. In the southern part of their range, southern flying squirrels will also build drays (Dolan and Carter 1977).

Cavity entrances are usually 3.5 to 5 cm in diameter (Muul 1968). Stabb (1988) reported nest cavity heights averaging 6.6 m (1.3 to 14.0 m). Cavities at Point Pelee and in Norfolk County tend to be toward the upper end of that range in the tree canopy of mature live trees or large snags (Adams pers. obs.). In Nova Scotia, nest height averaged 5.4 m $\pm$ 3.3 (n = 46; Lavers 2004).

Habitat trends: Great Lakes

Approximately 90% of southern Ontario's original woodlands were eliminated by 1920 (Larson *et al*. 1999). About 13% of that land has since returned to woodland, in large part because they were marginal agricultural lands. Provincial efforts have helped protect other significant woodlots from development (Larson *et al*. 1999). Whether these woodlots are large, well-connected and mature enough, as well as containing required habitat elements, to support southern flying squirrels is not known.

Haldimand-Norfolk Region lost 80% of its forest cover by 1900 (Gartshore *et al*. 1987). Perhaps, southern flying squirrels presently found in the Norfolk township woodlots, which represent 17% of the region's forest cover, recolonized them as habitat became available. A similar pattern of secondary forest use by southern flying squirrels seems to be occurring along the Niagara Escarpment forest in Hamilton, Ontario, which was bare in the 1920s. If reforestation continues, southern flying squirrels may increase in abundance in southern Ontario. However secondary forests will take time to mature and they will be under pressure from anthropogenic effects such as habitat fragmentation and urbanization.

Habitat trends may be positive in the Canadian Shield portion of forests used by southern flying squirrels. Limited agricultural and urban development, along with the practice of selective logging, may help preserve continuous tracts of forest (J. Bowman, pers. comm. 2004). Based on climate change models, mast-producing species are expected to slowly extend their range northward, potentially increasing southern flying squirrel habitat in the long term (J. Bowman, pers. comm. 2004).

Habitat trends: Atlantic

The Atlantic population of southern flying squirrels appears to be closely tied to the distribution of red oak in Nova Scotia (Lavers 2004). Red oak is a common tree species in southwestern Nova Scotia, although another preferred species, American Beech, has suffered from disease and its distribution and individual tree size has been reduced (M. Elderkin pers. comm. 2004). Overall, rate of forest loss increased in southwestern Nova Scotia during 1997 – 2002, with forest loss exceeding forest gain (Rozalska and Colville 2003). Freedman *et al*. (1996) noted that a substantial reduction in standing live trees (snags), hollow live trees and coarse woody debris has accompanied conversion of original Acadian forests to earlier seral stages and agricultural fields.

Habitat protection / Ownership

Habitat is protected by various national and provincial parks and wildlife reserves throughout their range (Table 4). In addition to these, Ontario has a system of Conservation Areas (e.g. Backus Woods in Norfolk County) which provide some protection to southern flying squirrel habitat. The parks in Table 4 represent areas capable of supporting an isolated *G. volans* population. There are numerous other protected areas throughout the species' range where southern flying squirrels occur, most of which are small and isolated habitat fragments. Such smaller protected areas may help sustain southern flying squirrels in the highly developed and fragmented habitat mosaic of southern Ontario, SW Québec and Nova Scotia's Annapolis Valley.

Table 4. Selected large protected areas by province, their area and whether southern flying squirrels are known to be present. Areas given are for the entire protected area and do not necessarily represent total habitat area available to southern flying squirrels. (§ indicates recent range expansion documented by J. Bowman *et al*. (unpubl. data)).

Map[1]	Protected Area	Total Area (km^2)[2]	*G. volans* present?
	Ontario		
1	Point Pelee National Park	16	yes
2	Georgian Bay Islands National Park	~25	yes
3	St. Lawrence Islands National Park	~9	yes
4	Algonquin Provincial Park	7653	yes §
5	Bon Echo Provincial Park	66	unconfirmed, probable
6	Frontenac Provincial Park	52	unconfirmed, probable
7	Kilarney Provincial Park	485	yes §
8	Killbear Provincial Park	18	unconfirmed, probable §
9	Pinery Provincial Park	25	yes
10	Rondeau Provincial Park	32	yes
	Québec		
11	Gatineau Park (National Capital Commission)	363	yes
12	Réserve faunique de Papineau-Labelle	1628	yes
13	Parc national du Mont-Mégantic	55	unconfirmed, possible
14	Parc national du Mont-Orford	58	unconfirmed, possible
15	Parc national du Mont-Saint-Bruno	6	unconfirmed, probable
16	Parc national du Mont-Tremblant	1510	unconfirmed, possible
	Nova Scotia		
18	Kejimkujik National Park	381	yes
19	Tobeatic Wilderness Area	1038	unconfirmed, probable

[1]Corresponding location on Figure 4.

[2]Note: habitat suitable to southern flying squirrels may be substantially less.

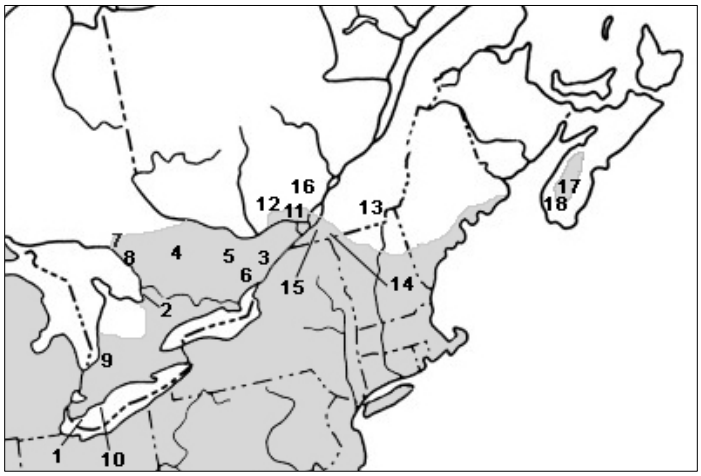

Figure 4. Locations of protected areas identified in Table 5. Shaded area is current known distribution of southern flying squirrels.

Table 5. Site locations of southern flying squirrel trapping effort in Ontario, 2002 – 2004. Source for all data: J. Bowman, P.J. Wilson, G.L. Holloway and J.R. Malcolm (unpubl. data.), except Clear Creek Forest: Pasma and Dobbyn (2003).

Site	2002		2003		2004		New Record
	G. volans detected	Trap Nights	*G. volans* detected	Trap Nights	*G. volans* detected	Trap Nights	
Clear Creek Forest			yes	1500	yes	120	
Krug Forest (FON Tract)			no	128			No
Sites in Grey County			no	<50			
Sites in Bruce County			no	130			
Ganaraska Forest			no	266	yes	400	Yes
Henderson Line Woodlot (Peterborough)					yes	75	Yes
Keene Road Woodlot (Peterborough)					no	75	No
Mark S. Burnham Provincial Park					no	75	No
Oliver Property (Trent Research Station, Pigeon Lake)	yes	68	yes	87	yes	84	
Kawartha Highlands Signature Site	yes	183	yes	120	yes	60	Yes
Leslie M. Frost Centre	yes	154	yes	440	yes	400	Yes
Crown land adjacent to Killbear Provincial Park			yes	30			Yes
Haliburton Forest & Wildlife Reserve					yes	2685	yes
Crown land adjacent to Killbear Provincial Park			yes	30			yes
Algonquin Provincial Park - Hwy 60	yes	5043	yes	9499	no	11295	yes
Algonquin Provincial Park - Achray	yes	3094	yes	2286	no	900	yes
Algonquin Provincial Park - Kiosk			yes	930	no	128	yes
Killarney Provincial Park			yes	367	no	180	yes
Nipissing Crown Game Preserve			no	140			
North of Mattawa (Olrig and Antoine Townships)			yes	315	no	400	yes
Emerald Lake (Afton Township)			yes	345			yes
Highway 11 corridor between Temagami North and Latchford					no	420	

BIOLOGY

Life cycle and reproduction

G. volans may reach sexual maturity after six months (Wells-Gosling 1985), although females producing a litter in their first year is unusual (Giacalone-Madden 1976). *G. volans* are polyestrous (Banfield 1974) and may produce two litters in a season (Dolan and Carter 1977). Although this is more likely to occur in the southern parts of the species' range, females have been observed to rear two litters at Point Pelee National Park (Adams 1995). Mean litter size from American studies is 2.75 (sd= 0.59, n=11 studies, range= 1-6; source: Stabb 1988). Canadian litter size data are limited to Point Pelee (3.45 ± 0.66 SD, n = 11; Adams 1995) and Norfolk County (3.66, n = 3; Stabb 1988).

Survival data for *G. volans* are scarce. Giacalone-Madden (1976) reported a mean "annual disappearance rate" of ~50% with wide variance for southern flying squirrels on Long Island, NY. Doby (1984) found a substantial drop in nest box recaptures after three years of age in North Carolina. At Point Pelee National Park, the oldest captured squirrel was four years, representing <1% of the population (Bednarczuk 2003). Two of 42 (4.8%) squirrels captured there in 1997 were ≥3 years old (Adams 1997) and 10 of 58 (17.2%) squirrels captured in 2003 were originally tagged in 2001 (Bednarczuk and Stephens 2004).

Generation time is estimated to be 1.5 years: most females rear their first litter at age one and few survive to three years of age.

Parturition starts as early as late April and as late as August. Parturition dates appear linked to food availability and weather conditions. For example, unusually cold winter temperatures and a potential lack of mast crop food resources due to a drought the preceding year likely resulted in a delayed onset of reproduction and an omission of the second litter at PPNP in 2003 compared to 2001 (Bednarczuk and Stephens, 2004).

Interspecific interactions

G. volans aggressively outcompetes the larger *G. sabrinus* for nesting sites (Weigl 1978; Muul 1968). *G. volans* also carries a strongilid nematode that is lethal to *G. sabrinus*. Competitive exclusion of *G. sabrinus* has been suggested to be at least partially mediated by this parasite (Wetzel and Weigl 1994; Weigl *et al*. 1999 in Lavers 2004). Previously thought to be only marginally sympatric because of behaviour, parasites and habitat selection differences (Weigl 1978), the two species are now known to have substantial range overlap throughout much of *G. volans'* Canadian distribution, with the exception of southwestern Ontario (J. Bowman unpubl. data; Lavers 2004). The two species have also been found to occur in the same winter aggregations (Lavers 2004).

Diet

The diet of southern flying squirrels is varied. The main food is hardwood tree mast, particularly hickory (*Carya* spp.), oak (*Quercus* spp.) and American beech

(Harlow and Doyle 1990; Sawyer and Rose 1985) although they also readily consume insects, eggs, nestlings and other foods when available (Dolan and Carter 1977; Wells-Gosling 1985; Stabb *et al*. 1989). Southern flying squirrels rely on stored mast crop for over winter food. Lavers (pers. comm. 2004) reports that in sympatric populations of *G. volans* and *G. sabrinus* in Nova Scotia, both species consume fungi year round. Mycophagy is well-known for northern flying squirrels (Maser *et al*. 1985; Maser *et al*. 1986) but is otherwise unknown for southern flying squirrels.

Predation

Predators of *G. volans* include owls, elaphid snakes, raccoon (*Procyon lotor*), opossum (*Didelphus virginianus*), weasels (*Mustela* spp.), mink (*Mustela vison*), marten (*Martes americana*), as well as red fox (*Vulpes vulpes*), domestic cat (*Felis domesticus*) and bobcat (*Lynx rufus*; see Stabb 1988). Flying squirrels may avoid predators such as owls which may watch them as they glide, by immediately running around to the back of the tree trunk following landing (Adams and Bednarczuk pers. obs.). Domestic and feral cats are common predators and may present a serious conservation challenge for southern flying squirrel. Cats likely contributed to the extirpation of *G. volans* from Point Pelee National Park (and other habitat fragments) in the early 1900s (Adams and Nudds 1992) and probably continue to limit isolated populations in forest fragments in rural southwestern Ontario and elsewhere. In Nova Scotia, 42% of 129 collected southern flying squirrel specimens were killed by domestic cats (Lavers 2004).

Physiology

G. volans do not hibernate during winter but become much less active, and may form aggregations to reduce the costs of thermoregulation. Most aggregations are <10 individuals and consist of primarily family units, but as many as 50 individuals have been observed in one tree cavity (see Stabb 1988). The optimal group size for southern flying squirrels may be six individuals at which point energy expenditures are reduced by 50% at 0-9°C (Stapp *et al*. 1991).

Dispersal/migration

Relatively little is known about the dispersal habits of southern flying squirrels. Juveniles appear to remain together throughout the winter with their mother and other conspecifics (Lavers 2004; Giacalone-Madden 1976; Muul 1968). Prior to winter, movements are limited compared to the breeding season.

Adults are capable of covering large distances in short periods of time. Mean male and female home ranges for Arkansas *G. volans* were 9.0 ± 2.5 ha (n = 7) and 3.9 ± 0.6ha (n = 7) respectively (Stone *et al*. 1996). Adams (unpubl. data) observed radio-collared males moving >2 km in a single night following translocation to Point Pelee National Park. In similar linear forest habitat near Hamilton, ON, an adult male moved of 2.4 km in a single night (mean movement estimates not available) (Bednarczuk and Judge 2002).

POPULATION SIZES AND TRENDS: GREAT LAKES POPULATION

Search effort

Very little systematic trapping for southern flying squirrels has occurred in the Great Lakes Plains Population. Population data are available for Point Pelee National Park (Bednarczuk and Stephens 2004; Bednarczuk 2003; Adams 1997) and Algonquin Provincial Park (G. Holloway unpubl. data). From 2002 through 2004, J. Bowman, P.J. Wilson, G.L. Holloway and J.R. Malcolm (unpubl. data.) completed 42,971 trap nights at 26 different sites throughout south and central Ontario (see Table 5) capturing 500 southern flying squirrel individuals 748 times. Their annual catch per unit effort was 1.36 captures per 100 trap nights in 2002 (8,542 trap nights), 3.57 captures per 100 trap nights in 2003 (16,597 trap nights), and 0.22 captures per 100 trap nights in 2004 (17,832 trap nights). Catch per unit effort data derived from other locations in Ontario are reported in Table 6.

Table 6. Live-trapping data from various southern flying squirrel field projects in Ontario, 1993 to 2003. * denotes catch per unit effort corrected for closed but empty traps or non-target species.

Location	Year	n (indiv)	Catch per Unit Effort	Source
Point Pelee National Park	2001	155	44%*	Bednarczuk 2003
	2003	68	22%*	Bednarzcuk and Stephens 2004
Clear Creek Forest	2003	38	6.0%*	Pasma and Dobbyn 2003
Norfolk Township	1993/94	114	0.84%	Adams 1995
	2000	396	45.8%	Bednarczuk 2003
Hamilton	1999 – 2001	200+	20-50%	Bednarczuk and Judge 2002
Minden	2001	21	21.6%	Bednarczuk 2003
Trent University Research Station	2001	25	5%	L. Bridges pers. comm. 2004
Trent University Research Station	2002	4	6%	P. Wilson pers. comm. 2004
OMNR provincial study (Table 5)	2002	8542 TN*	1.36%	Bowman *et al*. unpubl. data
OMNR provincial study (Table 5)	2003	16,597 TN*	3.57%	Bowman *et al*. unpubl. data
OMNR provincial study (Table 5)	2004	17,832 TN*	0.22%	Bowman *et al*. unpubl. data

*denotes number of Trap Nights

Abundance

There is no abundance estimate for the Great Lakes Plains Population. Multiplying even a conservative density estimate by the area of Extent of Occurrence would provide a vast over-estimate of population size because the Area of Occupancy (unknown) is a small fraction of the Extent of Occurrence.

Estimates of population size for southern flying squirrels are constrained by low capture rates and unequal capture of individuals. *G. volans* also exhibits wide annual variation, rendering any point-in-time estimate unreliable. Published densities vary widely (Table 7). Raised trap height can increase trapping success (Risch and Brady 1996), but catch per unit effort is usually quite low (Table 6).

The total number of individuals of all ages in the Great Lakes Plains population may number in the several thousands to tens of thousands, the majority of which are mature individuals capable of reproducing. Roughly half of the marked population at Point Pelee National Park was composed of mature individuals in 2001, and 75% of captured individuals in 2003 were mature (Bednarczuk and Stephens, 2004). During trapping in Hamilton in 2001, 2.5 times more adults than juveniles were captured (Bednarczuk and Judge 2002).

Table 7. Southern flying squirrel density estimates.

Location	Density (per ha)	Forest type	Source
Point Pelee National Park, Ontario	1.7 – 2.3 (2001) 0.3 – 0.4 (2003)	hackberry, maple, oak	Bednarczuk and Stephens, 2004
Algonquin Prov. Park, Ontario	2.9 (2003) 2.6 (2003) 0.6 (2003) no captures in 2004	beech – maple sugar maple mixed maple - conifer	G. Holloway unpubl. data
Nova Scotia	0.9 – 8.4*	mixedwood	Lavers 2004
Michigan	2.82	oak – hickory	Jordan 1948
Michigan	5		Baker 1983 (in Stabb 1988)
Maryland	6.2	hardwood - conifer	Gilmore and Gates 1985
Virginia	34.0 – 38.0	hardwood – pine	Sawyer and Rose 1985
Virginia	3.7 – 13.8	oak – hickory - beech	Sonenshine *et al*. 1979
Arkansas	0.2 – 0.9	pine – hardwood	Taulman 1999
Alabama	1.8 – 3.5	pine – oak	Hatten 1992

*Lavers (pers comm 2004) advised caution when using these population data as they are based on few captures.

Fluctuations and trends

There are few data on population fluctuations for the Great Lakes Plains population, due to a lack of long-term monitoring studies and no historical data. However, results from northern and central Ontario and Point Pelee National Park suggest that southern flying squirrels undergo wide population fluctuations throughout the Great Lakes range.

Given widespread habitat loss throughout southern Ontario (see Habitat trends: Great Lakes), a decline from historical levels has probably occurred. Observed range extensions in central Ontario appear subject to fluctuation and may not offset declines in the southern part of *G. volans*' Great Lakes Plains population range.

Rescue effect

There is limited possible rescue effect for the Great Lakes Plains population. Immigration to Ontario is restricted by the Great Lakes and their associated rivers. Flying squirrels are poor swimmers because the patagium restricts leg movement. They therefore can cross water bodies no wider than “one glide”; maximum 50 m.

The only land border between the United States and Canada is in southwestern Québec. There is little known about southern flying squirrel distribution in this area of Québec or adjacent states New York, Vermont and New Hampshire.

POPULATION SIZES AND TRENDS: ATLANTIC POPULATION

Search effort

Lavers (2004) used a campaign (March 2001 to March 2003) of media coverage, posters and presentations to targeted groups to solicit sightings of either species of flying squirrel. Specific target audiences were cat owners, fur trappers and naturalists as those most likely to encounter and/or recognize flying squirrels. Sightings >2 km apart were considered independent. Systematic live-trapping was only conducted at 5 sites: near Kentville, South Brookfield (southeast of Kejimkujik National Park) and 3 sites within Kejimkujik.

Southern flying squirrels do not occur in New Brunswick; the nearest record is from Eastport, Maine, near the NB border (Godin 1977 in Stabb 1988). Most records from Maine are in the southern part of the state, which lists the southern flying squirrel as “special concern” (Maine Audubon Society 2000).

LIMITING FACTORS AND THREATS

J. Bowman (pers. comm. 2005) suggested that overwinter survival is dictated primarily by availability of stored food, finding a numerical response to changes in oak and beech mast with an approximately 1-year lag. They proposed that winter temperatures affect the amplitude of year-to-year fluctuations.

Doby (1984) concluded that food played a critical role in the species’ winter ecology and population levels fluctuated with food availability in North Carolina. Similarly at Point Pelee National Park, the reintroduced southern flying squirrel population dropped from at least 100 individuals in fall of 1994 to only 43 individuals captured in a 1997 census following a reported mast crop failure in 1995 (Adams 1997).

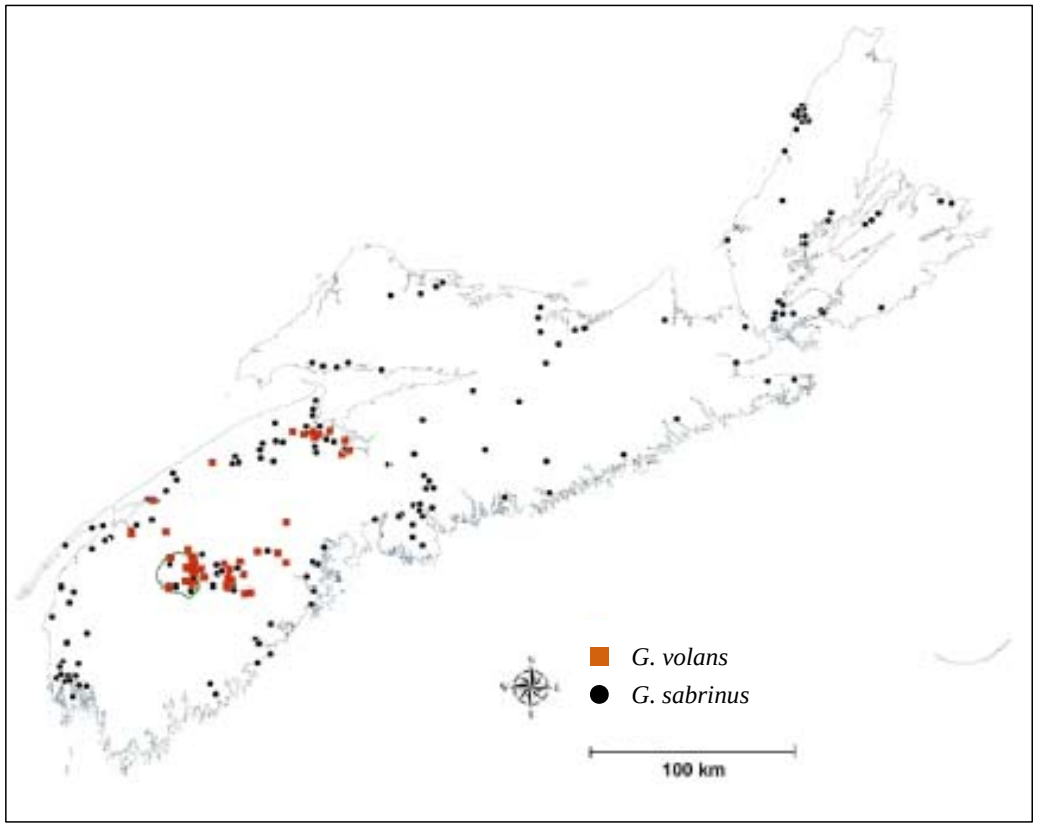

Figure 5. Distribution of southern flying squirrel (red squares) and northern flying squirrel (black circles) observations during Nova Scotia campaign, March 2001 to March 2003 (Lavers (2004). This figure shows locations of reported observations, not results of a systematic trapping effort to document flying squirrel presence / absence.

Others have proposed that climate dictates the species' northern range limit, either mean January isotherm (Muul 1968) or a minimum daily temperature of -15°C (Stapp *et al*. 1991). The southern flying squirrel has high energetic demands as they are nocturnally active year-round (the coldest time of day) with a gliding locomotion that increases heat loss. Over-wintering aggregations and torpor are adaptations which help minimize energy expenditures (Stapp *et al*. 1991; Stapp 1992; Merritt *et al*. 2001).

At what point nesting cavity availability becomes limiting to southern flying squirrel is unclear. In Point Pelee National Park, availability of nesting cavities was not a limiting factor to reintroduced southern flying squirrels (Adams 1995). Work in South Carolina also found that nest sites were not limiting to southern flying squirrel (Brady *et al*. 2000). Widespread removal of mature trees and snags can be expected to be detrimental to flying squirrels; they are obligate cavity nesters in Canada.

Habitat loss is the major threat facing southern flying squirrels. Activities that reduce overall forest cover (e.g. conversion of forested land to urban development) or remove forest structure attributes within a stand (e.g. removal of nesting trees or

harvesting of mature mast-producing hardwoods) are key threats to southern flying squirrel survival at both the individual and population levels.

Reduction of forest cover, particularly in southern Ontario, likely reduced *G. volans* abundance in the core of its Great Lakes population. The loss of habitat in southern Ontario has been documented (see Habitat trends: Great Lakes); however, there are no population data (historical or current) to support whether this reduced southern flying squirrel numbers.

Other flying squirrel species are at risk due to habitat loss. Northern flying squirrel subspecies, *G. sabrinus coloratus and G. s. fuscus*, found in the Appalachian Mountains are listed as Endangered in the USA (US Fish & Wildlife Service 2004). The European flying squirrel (*Pteromys volans*) is declining in Finland (Hanski 1998).

A minimum woodlot size and distance from other occupied habitat required to maintain southern flying squirrels is not known. They are found in small woodlots (<10 ha) in Norfolk County, but many of these areas are proximal to, and well-connected with, much larger forested tracts.

Nupp and Swihart (2000) found southern flying squirrels present only in forest tracts >6 ha and in close proximity to other woodlots in Indiana. Woodworth *et al*. (2001) found southern flying squirrels in 28 of 30 “forest fragments” in southern Illinois. However, the sites were within a “primarily forested landscape” where maximum distance between fragments was 643 m and the two patches not inhabited by flying squirrels were the most isolated.

Habitat fragmentation is known to disrupt southern flying squirrel ecology. Taulman *et al*. (1998) reported that population densities in Arkansas declined following forest harvesting, while populations in adjacent mature stands increased. In the same study, nest box use in “greenbelt” corridors (primarily unharvested riparian buffer strips) also increased. Squirrels used these “greenbelts” as corridors for travel between fragmented mature stands (Taulman and Smith 2004).

Industrial forestry that converts mixedwood hardwoods to conifer plantations in Nova Scotia has been identified as a threat to the Atlantic population (Lavers pers. comm. 2004). *G. volans* strongly selected for mixedwood sites in Nova Scotia and avoided conifer-dominated stands (Lavers 2004).

Mortality threats facing flying squirrels are primarily fur trapping by-catch and domestic cats. There is no commercial trapping for either species of flying squirrel and by-catch data are not kept. However, large numbers of northern flying squirrels are known to be caught in traps set for other species (primarily marten) across much of the species’ range (I. Adams pers. obs.). Limited records exist for southern flying squirrel killed by trappers in Québec (C. Genest pers. comm. 2004) and Nova Scotia (Lavers 2004).

SPECIAL SIGNIFICANCE OF THE SPECIES

G. volans is not a species of public or socio-economic importance. It is not well known mainly due to its nocturnal habits. Most public sightings occur at home or cottage backyard bird feeders or in attics where *G. volans* may nest. Throughout much of its range in the United States, *G. volans* may be regarded as a common arboreal sciurid often perceived as a pest species.

Southern flying squirrels are regularly sold as pets in the U.S. and seem to be successfully reared in captivity. In Canada it is illegal to possess southern flying squirrels as pets but there is no information on any illegal pet trade.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Glaucomys volans is "yellow listed" by Nova Scotia, indicating it is "sensitive to human activities or natural events" (Nova Scotia DNR 2002). Ontario ranks the southern flying squirrel as "special concern" (Ontario MNR 2004). Québec lists the species as "likely to become threatened or vulnerable" (M. Lepage pers comm. 2004; Québec MRNFP 2004). *G. volans* was designated Special Concern by COSEWIC in 1988. Conservation rankings provided by NatureServe (2004) are given in Table 8.

Table 8. NatureServe (2004) conservation rankings for southern flying squirrel by jurisdiction. Only US states that border Canada within southern flying squirrel range are included.

Jurisdiction	Ranking
Global	G5 (Nov 1996)
Canada	N3 (Jan 2000)
Ontario	S31
Québec	S3
Nova Scotia	S1
USA	N5 (Nov 1996)
Michigan	S5
New York	S5
Vermont	S4
New Hampshire	S5
Maine	SU

[1]Ontario is expected to change sub-national status to S4 in the near future.

TECHNICAL SUMMARY

Glaucomys volans
southern flying squirrel - Great Lakes Plains population petit polatouche
Range of Occurrence in Canada: Ontario and Quebec

Extent and Area Information	
• *Extent of occurrence (EO)(km²)* **Calculated as Minimum Convex Polygon of known locations in Great Lakes (Ontario / Québec) population**	**Ontario / Québec**: ~160,000 km²
• *Specify trend in EO*	**ON**: medium term (decades) – probably increasing; year-to-year – prone to fluctuations at northern range limit **QC**: unknown
• *Are there extreme fluctuations in EO?*	Possible at northern range limit
• *Area of occupancy (AO) (km²)*	unknown
• *Specify trend in AO*	unknown
• *Are there extreme fluctuations in AO?*	Possible at northern range limit
• *Number of known or inferred current locations*	unknown
• *Specify trend in #*	overall, probably stable,
• *Are there extreme fluctuations in number of locations?*	Possible at northern range limit
• *Specify trend in area, extent or quality of habitat*	Variable but overall probably stable
Population Information	
• *Generation time (average age of parents in the population)*	1.5 years
• *Number of mature individuals*	unknown
• *Total population trend:*	unknown
• *% decline over the last/next 10 years or 3 generations.*	unknown
• *Are there extreme fluctuations in number of mature individuals?*	No, but range in Ontario may vary widely according to winter weather
• *Is the total population severely fragmented?*	Southwestern ON: yes (except Norfolk Co) Central / Eastern ON: probably not QC: unknown.
• *Specify trend in number of populations*	stable
• *Are there extreme fluctuations in number of populations?*	no
• *List populations with number of mature individuals in each*	

Threats (actual or imminent threats to populations or habitats)	
• **habitat loss. Specifically,** o **removal of mature hardwood mast trees (particularly oak, beech and hickory)** o **removal of cavity trees** • **predation by domestic cats**	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* **USA: Secure (N5)** Michigan: S5 New York: S5 Vermont: S4 New Hampshire: S5	
• *Is immigration known or possible?*	Very limited. Only across Québec – USA border south of St. Lawrence R., where their presence is unknown on both sides of border.
• *Would immigrants be adapted to survive in Canada?*	yes
• *Is there sufficient habitat for immigrants in Canada?*	yes
• *Is rescue from outside populations likely?*	no
Quantitative Analysis	not conducted
Current Status COSEWIC: Special Concern, 1988 Not at Risk, 2006	

Status and Reasons for Designation

Status: Not at Risk	**Alpha-numeric code**: n/a

Reasons for Designation:

Southern flying squirrels are small inconspicuous nocturnal forest-dwelling rodents with impressive gliding ability. They are difficult to distinguish from the northern flying squirrel. Dedicated sampling programs have generally revealed greater abundance and range than previously assumed. Its known area of occupancy has expanded. Habitat loss through deforestation and fragmentation of remaining forest may lead to extirpation of some local populations in the southern part of its range in Ontario, but does not currently pose a threat to the persistence of this population. The overall trend in habitat availability is stable or positive. Recent research in Ontario has revealed a much wider range of suitable habitat and reported a substantial range expansion. There is little information on this squirrel from Quebec as there have been no directed surveys for this species.

Applicability of Criteria

Criterion A: There is no evidence of a declining trend, although numbers and range can decrease substantially following harsh winters.

Criterion B: Extent of occurrence is over 150,000 km² and there is no clear evidence of decline. The exact extent of fluctuations due to harsh winters is unknown, but recolonization following local extirpation appears rapid.

Criterion C: Total population size is unknown but likely in the thousands. No evidence of decline, range of suitable habitat appears greater than previously thought.

Criterion D: Total population size is unknown but likely in the thousands.

Criterion E: Not available.

TECHNICAL SUMMARY

Glaucomys volans
southern flying squirrel - Atlantic (Nova Scotia) population petit polatouche
Range of Occurrence in Canada: Nova Scotia

Extent and Area Information	
• *Extent of occurrence (EO)(km²)* **Calculated as Minimum Convex Polygon of known locations**	6300 km^2
• *Specify trend in EO*	probably stable
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)*	unknown
• *Specify trend in AO*	probably stable
• *Are there extreme fluctuations in AO?*	unknown
• *Number of known or inferred current locations*	unknown
• *Specify trend in #*	Probably stable
• *Are there extreme fluctuations in number of locations?*	unknown
• *Specify trend in area, extent or quality of habitat*	decreasing
Population Information	
• *Generation time (average age of parents in the population)*	1.5 years
• *Number of mature individuals*	unknown
• *Total population trend:*	unknown
• *% decline over the last/next 10 years or 3 generations.*	unknown
• *Are there extreme fluctuations in number of mature individuals?*	unknown
• *Is the total population severely fragmented?*	unlikely
• *Specify trend in number of populations*	probably stable
• *Are there extreme fluctuations in number of populations?*	unlikely
• *List populations with number of mature individuals in each*	
Threats (actual or imminent threats to populations or habitats)	
• **habitat loss. Specifically,** o **conversion of mature hardwood and mixedwood forests to conifer stands** o **removal of mature hardwood mast trees (particularly oak, beech and hickory)** o **removal of cavity trees** • **predation by domestic cats**	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* **USA: Secure (N5)** Maine: SU	
• *Is immigration known or possible?*	no
• *Would immigrants be adapted to survive in Canada?*	yes
• *Is there sufficient habitat for immigrants in Canada?*	yes
• *Is rescue from outside populations likely?*	no
Quantitative Analysis	not conducted
Current Status COSEWIC: Special Concern, 1988 Not at Risk, 2006	

Status and Reasons for Designation

Status: Not at Risk	**Alpha-numeric code**: n/a

Reasons for Designation:

Southern flying squirrels are small inconspicuous nocturnal forest-dwelling rodents with impressive gliding ability. They are difficult to distinguish from the northern flying squirrel. In Nova Scotia, the southern species was first detected in 1971, and until 2001, was only known from seven sites. New recent research located southern flying squirrels in 32 locations and over a much wider area in the southern part of the province than expected. Like a number of species in Nova Scotia, it is at the north of its range and disjunct. Habitat loss through deforestation and fragmentation of intact forest may lead to extirpation of some local populations, but does not currently pose a threat to the species' persistence and the population appears stable.

Aplicability of Criteria

Criterion A: There is no evidence of a declining trend, although numbers and range can decrease substantially following harsh winters.

Criterion B: Extent of occurrence is 6,500 km² and there is no clear evidence of decline.

Criterion C: Total population size is unknown but likely in the thousands. No evidence of decline, range of suitable habitat appears greater than previously thought.

Criterion D: Total population size is unknown but likely in the thousands.

Criterion E: Not available.

ACKNOWLEDGEMENTS

We thank the many individuals who provided information, data and background for the preparation of this report. Marco Festa-Bianchet was extremely helpful and answered our questions immediately and informatively. Jeff Bowman (Ontario Ministry of Natural Resources, Peterborough) and Gillian Holloway (University of Toronto) generously provided us with new data and results as they came available. Amanda Lavers provided invaluable assistance with information and data on southern flying squirrels in Nova Scotia. Lisa Bridges (formerly Trent University), E. Followes (OMNR, Aurora District), Jeff Leggo (St. Lawrence Islands National Park) also provided valuable information on southern flying squirrels in Ontario. Daniel St.-Hillaire (Québec Ministère des Ressources naturelles, de la Faune et des Parcs, Gatineau) provided knowledge and insight into *G. volans* in the Outaouais. Previous versions of this report benefited greatly from reviews by (alphabetically) D. Berteaux, J. Bowman, M. Brigham, A. Dextrase, J. Eger, B. Fenton, M. Festa-Bianchet, E. Followes, E. Gagnon, A. Lavers, J. Murie, D. Nagorsen, D. Sutherland, M. Toner, P. Wilson and A. Woodliffe. Funding was provided by the Canadian Wildlife Service, Environment Canada.

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