

Status Report  
on  
Bog Elfin  
(*Callophrys lanoraieensis*)

by

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" DRAFT "

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## Executive Summary

Based on current knowledge, Bog Elfin has one of the most restricted distributions of any northeastern North American species of butterfly. In Canada which has 73% of the global populations, it occurs in extreme eastern Ontario, southern Quebec, New Brunswick and southern Nova Scotia. It has a largely wetland (Spruce bog) habitat that is declining in parts of its range, yet the rate of discovery of new populations has recently increased. Its larval foodplant is one of the most dominant and widely distributed plants in North America and its restricted occurrence and ecology require more study. The easternmost, more or less disjunct populations in New York and Ontario are considered endangered. It is clearly a species that presents a number of research and conservation challenges. It is concentrated in three regions: southern Maine, southern and northwestern New Brunswick and the St. Lawrence Lowlands. Never more than a few hundred have been seen in one day at any population, and the majority of sightings are less than 10 in a day. It is ranked as S1 or S3 in all of the jurisdictions in which it occurs and is ranked G3G4 globally. The Association for Biodiversity Information report on Bog Elfin (Schweitzer 1998) appropriately suggests that Bog Elfin is "not in immediate danger at most sites, but is too scarce and local to be called secure."

The current area of occupancy in Canada is very roughly 189 km<sup>2</sup>, and the total Canadian population is unknown. Habitat has been reduced and is considered locally declining. The area of occurrence appears in some way very restricted and is estimated as approximately 128,000 km<sup>2</sup>, with the result that the habitat available is also restricted, despite the fact that it is otherwise a widespread habitat.

A national designation of "Special Concern" is proposed based on a relatively small area of occupancy as well as a lack of essential information. This is based on application of IUCN criteria that account for the definition of COSEWIC risk categories. It is also recommended that the government of Ontario consider designation of the Bog Elfin as threatened or endangered provincially based largely one threat to its specialized habitat. Census of Ontario populations, determination of geographic occurrence and habitat status in Quebec and further analysis of geographic variation are also recommended.

## Technical Summary

**SPECIES NAME** Bog Elfin (*Callophrys lanoraieensis* Sheppard)

### DISTRIBUTION

Extent of occurrence globally: **Approximately 128,000 km<sup>2</sup>**

Area of occupancy: **Unknown but has been very roughly estimated as 189 km<sup>2</sup>.**

### POPULATION INFORMATION

Total number of individuals in the Canadian population: **Unknown. Maximum a few hundred seen at a site in one day, however usually not more than 10 seen.**

Generation time: **1 year.**

Total population trend: **Unknown**

Rate of decline (if appropriate) for total population: **Unknown**

Number of known populations in Canada: **58 (NB- 27, NS-8, ON-3, QC-20)**

Number of known populations in US: **21 (ME-17, MA-1, NH-2, NY-1)**

Is the total population fragmented? **YES**

number of individuals in smallest population: **1**

number of individuals in largest population: **A few hundred**

number of extant sites globally: **77**

number of historic sites from which species has been extirpated: **Possibly 2 in US.**

Does the species undergo fluctuations in numbers? **Yes**

If yes, what is the maximum and minimum number? **Unknown**

### LIMITING FACTORS AND THREATS

- 1) limited habitat (i.e. southern Spruce bogs) for Bog Elfin remaining in North America ;
- 2) loss of habitat due to peat mining activities and conversion of land to other uses;
- 3) ground water table changes on edges of bogs

### RESCUE POTENTIAL

Does the species exist outside Canada? **YES**

Is immigration known or possible? **NO**

Would individuals from the nearest foreign population be adapted to survive in Canada?  
**YES**

Would sufficient suitable habitat be available for immigrants? **YES**

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## INTRODUCTION

Recent and potential wetland losses in Ontario have resulted in a consideration of the conservation status of a number of the species potentially at risk as a result of these wetland losses. One of these is the Bog Elfin Butterfly (*Callophrys lanoraieensis*), the status of which is reviewed here with resulting recommendations. This restricted species has long been a conservation concern, but a number of recent discoveries of new localized populations have resulted in questions as to the extent to which it is a conservation priority and what actions if any are appropriate.

## METHODS

### Information Sources

Entomologists with a knowledge of lepidoptera of the northeast and particularly those with extensive field experience, were contacted for information on occurrence and ecology of Bog Elfin. These and other contacts are listed in section 12 of this report. Other contacts included biologists in conservation data centers, in provincial natural resource departments, at museums and at other research centers.

In order to develop a complete distribution map and accurate information on number of populations, literature searches were done and information was gleaned from a variety of sources (see Literature Cited, section 11). The annual summaries of Lepidoptera observations published by the Toronto Entomological Association and by the Lepidopterists' Society in the "News" were consulted for reports. The summaries of the Lepidopterists' Society checked included those for 1972 to 1999 (excluding 1983). Bog Elfin element occurrences on file with the regional conservation data centers (natural heritage centers) in both the United States and Canada were obtained and information from collections was also obtained in so far as possible. The database used to produce the Butterflies of Canada (Layberry et al. 1998), now maintained by CNC provided a valuable framework for compiling a database including locations.

### Site Definition

Sites or populations are interpreted as locations of occurrence more than 2 km apart.

### Calculation of Area of Occurrence

The outer boundaries of dots on the global distribution map representing major regions (St. Lawrence, Nova Scotia, etc.) were used to calculate the area of occurrence. This resulted in an approximation that is larger than the actual area of occupancy, and represents a maximum in a range of values. Information was insufficient to determine areas of occupancy. There was insufficient information to apply any particular methodology to calculation of population sizes and non-extant populations, although possible population declines are briefly discussed.

## Evaluation of Status

Evaluation of status included: 1) the species at the national level; 2) the Ontario populations at the national level and; 3) the populations in Ontario. The national evaluations were based on recently established criteria of the Committee on the Status of Endangered and Threatened Wildlife in Canada (COSEWIC) (see Appendix 2), while the provincial evaluation is based on general criteria.

# SPECIES INFORMATION

## 1. NAME, CLASSIFICATION AND TAXONOMY

### 1.1 Name

Scientific Name: *Callophrys lanoraieensis* (Sheppard 1934)

Synonym: *Incisalia lanoraieensis* Sheppard 1934

Common Name (English): Bog Elfin (also Spruce-Bog Elfin, see Scott 1986)

Common Name (French): Le Lutin des tourbières (Sheppard 1934)

### 1.2 Classification

The genus *Callophrys* has been treated in either a restricted sense with the Elfins given the name *Incisalia* or in a broader sense where they are treated as *Callophrys* (see discussion in Layberry et al. 1998, p.25). Recently leading authorities have used *Callophrys* (Scott 1986, Layberry et al. 1998) based to some extent on recent work by Warren and Robbins (1993).

## 2. DESCRIPTION [to be completed through reference to Clench 1944]

### 2.1 Adult

This small elfin has a wingspan of 16-19 mm and looks like a diminutive Eastern Pine Elfin (*C. niphon*) (Layberry et al. 1998). It is tailless and dull brown above, brown below with distinctive irregular dark brown and white lines (Figure 1), which suggest the checkered lower surface of the hindwing of *C. niphon*, but much less contrasting, more smudged and without the chevron markings seen in *C. niphon* and with the edges much less scalloped. The Pine Elfin (*C. niphon*) and the Western Pine Elfin (*C. eryphon*) generally have a wingspan of 22-28 mm (Layberry et al. 1998). Other species of *Callophrys* differ in having the basal half of the hindwing much darker than the outer half.

### 2.2 Egg

## 2.3 Larva

The tiny larva is green with a wide white stripe along the sides (Layberry et al. 1998). In early instars it burrows in the needles of its food plant, Black Spruce (*Picea mariana*). McGugan (1958) reports that larva are present from early July to early August, but predominantly during mid-July in the Maritimes.

## 2.4 Pupa

McGugan (1958) reports a single pupa collected during late July. Bog Elfin overwinter in the pupal stage in the litter below the host Spruce trees.

# 3. DISTRIBUTION

## 3.1 North American Range

The Bog Elfin (*Callophrys lanoraieensis*) has a very restricted total range extending from New Brunswick and southern Nova Scotia to coastal Maine and eastern New Hampshire with isolated occurrences further to the west in southern Quebec, eastern Ontario and eastern New York (Opler & Malikul 1992, Scott 1986). Although its range is more extensive than suggested by recent maps including Opler and Mal (1992), Opler and Krizek (1984) and Layberry et al. (1998), the Bog Elfin is still very restricted (Figure 2), and based on present knowledge, Bog Elfin has one of the most restricted ranges of any eastern North American butterfly. Schweitzer (1998) referred to it as a "narrow endemic" and referred to a "global range" of less than 100 square miles. Our calculation (see methods) of the general area of occurrence based on the distribution map is 128,000 km<sup>2</sup> but this represents a broad region within which it is confined to habitat patches which would approximate the area noted by Schweitzer (1998) i.e. 259 km<sup>2</sup>. Since 73% of the populations are in Canada, this would result in a roughly 189 km<sup>2</sup> Canadian area of occurrence.

## 3.2 Canadian Distribution

### 3.2.1 Ontario

The history of occurrence of Bog Elfin in Ontario was recently outlined in detail by Catling et al. (1998) and this provides the basis for the following notes (see Figure 3). Bog Elfin were first discovered in Ontario on 22 May 1982 when seven were seen during a 35 man-hour search in Alfred Bog (44°30'00"N, 74°49'00"W), 8 km SE of Alfred (Layberry et al. 1983, Hess 1984, see also Cuddy 1983). The search was initiated by Don Lafontaine and Jim Troubridge. The party also included Henri Goulet, Ian Jones and Ross Layberry. Henri Goulet netted the first specimen and 7 were captured and closely examined. The species was seen again in Alfred Bog on several occasions (Hall 1983, Hall et al. 1984), although not consistently (Hall 1987). Layberry recorded it there on 29 May 1983. On 27 May 1986, no

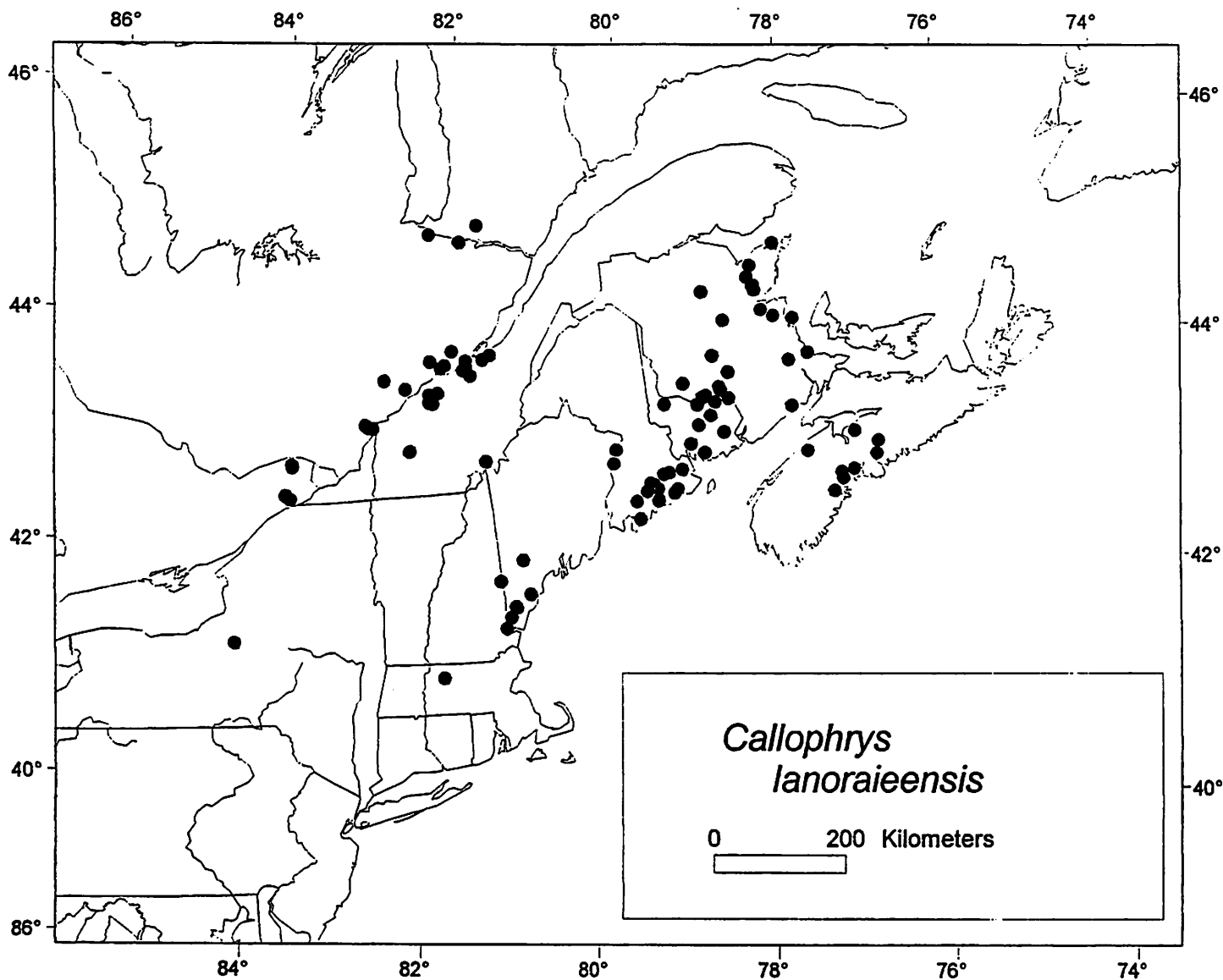


Figure 2. Map of northeastern North America showing distribution of *Callophrys lanoraieensis*

Bog Elfins could be found in Alfred Bog, but other expected species of butterflies were present. It was reported in annual summaries of the Toronto Entomologists' Association as seen in Alfred Bog on 19 May 1991 (group led by Layberry including Sid Daniels, Kirk Zufelt and Bob Curry, see Layberry 1992 and Hanks and Hess 1992) and 5 June 1994 (Jeff Crolla, Ross Layberry and Tim Sabo, see Hanks 1995). On 19 May 1991 it was abundant and many were seen along the Horse Creek Drain survey line through Black Spruce forest that provides access to the sedge lenses where the butterflies are usually found (Hanks & Hess 1992). The Alfred Bog location was a significant westward extension of the known range. It was 130 km WSW of the type locality at Lanoraie, Quebec.

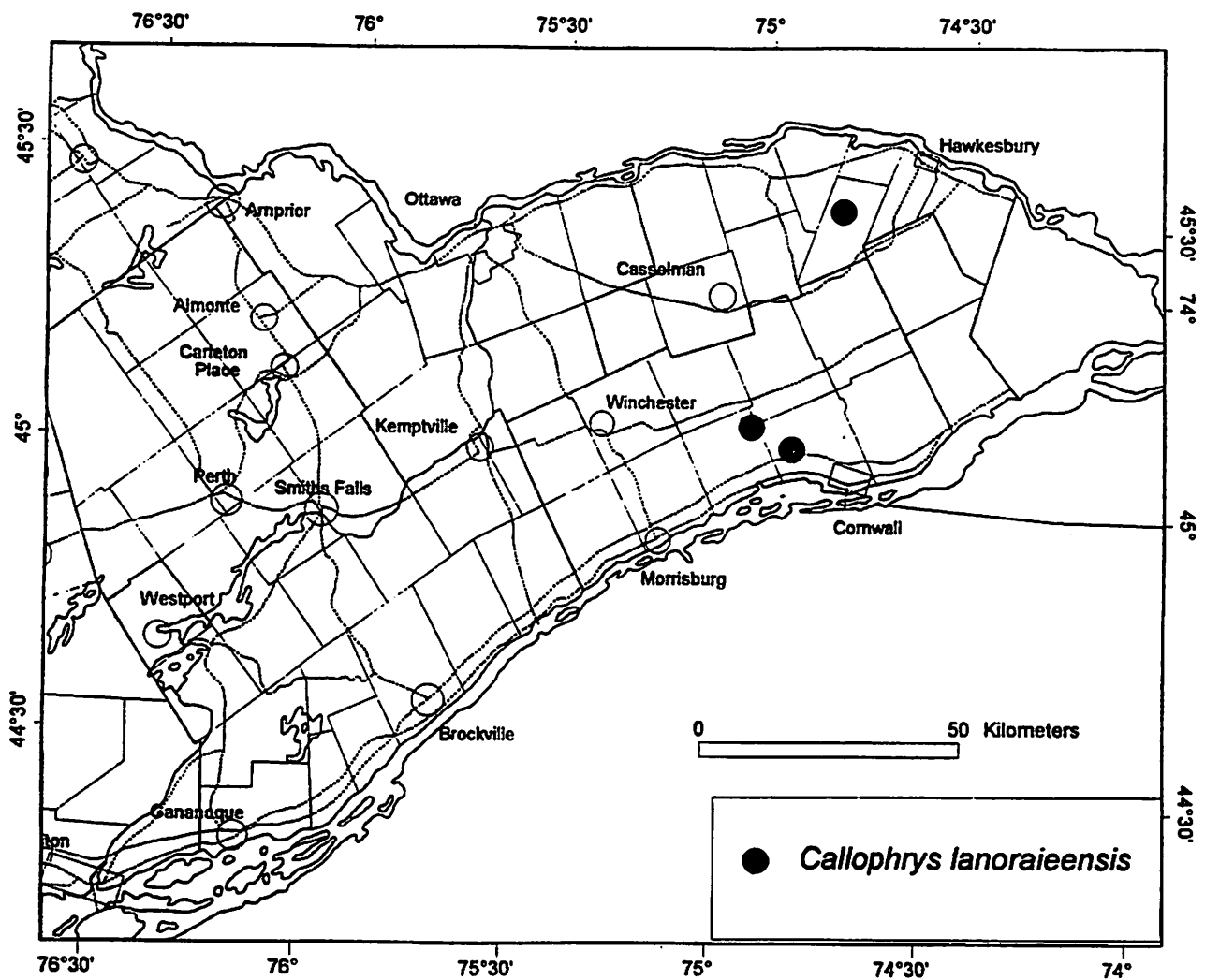


Figure 3. Map of eastern Ontario showing locations of *Callophrys lanoraieensis*

Attempts to locate this butterfly in Mer Bleue Bog near Ottawa, another large bog further to the west in eastern Ontario, have so far been unsuccessful (JPC pers. obs., see also Hall 1983, Hall et al. 1984), but this bog is lacking a number of the eastern elements associated with Bog Elfin (see under Limiting Habitat, section 8.1). The absence of any new discoveries in Ontario over a period of 14 years made it seem unlikely that any more colonies would be found, but on 19 May 1996 Catling observed 10 Bog Elfins on the west side of Newington Bog ( 45°06'50"N, 74°59'00"W ), an extensive peatland 45.6 km SSW of the Alfred Bog site (Layberry 1997).

On 28 May 1996, Crolla and Lafontaine found a Bog Elfin on the outskirts of Newington Bog (Layberry 1997), approximately 1 km southwest of the site found by Catling. Interestingly, the situation here was one that could be readily matched in many parts of eastern Ontario. On 27 May 1997 Catling and Layberry visited Newington Bog and observed Bog Elfins. The occurrence of the Bog Elfin in Newington Bog might have been predicted on the

basis of both its nearness to Alfred Bog and its floristic similarity to Alfred Bog, including shared eastern elements such as Rhodora (*Rhododendron canadense*) and Atlantic Sedge (*Carex atlantica* ssp. *capillacea*). Both of these plants are characteristic of the Quebec and New England bogs where *lanoraieensis* is found. Notably, neither of these plants has been found in Mer Bleue Bog.

Inspired by the increasing evidence for a less exacting habitat than was previously conceived, Catling and Layberry surveyed Black River Bog on 27 May 1997 and observed approx. 10 Bog Elfins. This bog (45°04'00" N, 74°52'40" W) is in a wetland 9.1 km SE of the Newington location, and 4 km NNE of Long Sault. On 31 May 1997, Ross Layberry with Nancy and Michael Van der Poorten saw a few Bog Elfins at Newington Bog and one at Black River Bog.

Its status in Ontario was indicated as "not yet determined" in the Ontario Butterfly Atlas (Holmes et al. 1991), but it is currently assigned the rank of S1. Specimens from Alfred Bog, Newington Bog and Black Creek Bog are preserved in the Canadian National Collection at Agriculture Canada (CNC).

### 3.2.2 Quebec

Although originally described from Quebec in 1934 (Sheppard 1934), *Callophrys lanoraieensis* was known in Quebec only from the type locality for over 50 years (Le Blanc 1985). It has been more recently found in a number of bogs (Dion 1995) and has a much broader distribution in Quebec than was initially suspected. Dion (1995) indicated 8 locations and he evidently found it in 3 of several bogs he visited and noted that it was common and seen abundantly. He further noted that since the habitat is very common throughout the southern part of Quebec, lepidopterists have many opportunities to discover this butterfly, thus suggesting that it is probably more common than the few records indicate. Handfield (1999) listed 24 localities in Quebec, but some of these are close and we have not seen vouchers for the northernmost records (e.g. Maniwaki), which are important in suggesting a much wider distribution. An Srank has not been assigned for this species in Quebec, but with approximately 20 locations and likely at least a few undiscovered an appropriate rank would be S3.

### 3.2.3 New Brunswick

The earliest reports from New Brunswick are from the Canadian Forest Insect Survey in 1939 and during the 1940's. McGugan (1958) showed approximately 12 localities in New Brunswick including the southwestern part of the province as well as the north coast and southern Baie de Chaleur region. The preliminary atlas of the butterflies of New Brunswick showed 3 sites in the southwest (Thomas 1996). Layberry et al. (1998) showed 6 localities. Canada Trust Bog project yielded more locations during the summer of 2000. There are now 27 localities in New Brunswick, and it is ranked S3. Regional experts suggest that it will likely be found in more locations and is not subject to immediate threat (T. Thomas, R. Webster pers. comm.).

### **3.2.4 Nova Scotia**

Ferguson (1954) noted that *C. lanoraieensis* appeared to be absent from Nova Scotia. The first report for Nova Scotia was that of McGugan (1958) who mapped it near the Lunenburg-Queens county boundary 10 km from the coast. In 1969 it was found by Barry Wright, a biologist at the Nova Scotia provincial Museum. Subsequently B. Wright and Ken Neil found additional colonies. It appears to be most frequent on the sandy barrens near the coast between Gold River and Shelburne. The populations are not considered threatened nor have any declines been documented and populations appear stable (K. Neil, pers. comm.). It has now been reported from at least 8 locations in Nova Scotia. A lack of observations from certain parts of the province (e.g. Cape Breton) despite visits at the appropriate time of the year has led to the conclusion that it is probably actually restricted in the province (K. Neil pers. comm.). The relatively recent discovery of a number of colonies is believed to be a consequence of the species being overlooked rather than a recent invader.

The official provincial colour rank of red has been assigned by the Nova Scotia Department of Natural Resources, and they indicate no presently known threats to habitats or populations (K. Bredin pers. comm.). A rank of S2 is appropriate, although no Srank has been officially assigned.

## **3.3 Distribution in the United States**

### **3.3.1 Maine**

Brower (1974) reported 11 localities in Maine where it was evidently first discovered in the Lincoln area in the 1920s by W.J. Clayton who, according to Brower, recognized it as distinct. In an 1934 article noting the high diversity of Lepidoptera in the Passadumkeag bogs, Grey (1934) did not mention any species of *Callophrys*, but the Bog Elfin was not named or described until that year based on material from Quebec. It has been reported from 17 localities in Maine and is ranked S3 - SC (Special Concern).

### **3.3.2 Massachusetts**

Bog Elfin was first discovered in Massachusetts near Petersham on 24 May 1997 by David Wagner. Specimens were sent to the Smithsonian and confirmed by Bob Robins and also by Don Lafontaine during the meetings of the Lepidopterists' Society in Connecticut. The Massachusetts Butterfly Club reported it from the same location on one visit since 1997, but there has not yet been a survey of the entire habitat that would provide any useful information on population size (M. Nelson pers. comm.).

### **3.3.3 New Hampshire**

Bog Elfin was first collected in New Hampshire during the early 1900's, and there is at

least one literature report for this site (Brower 1974) which reports “a male taken by Weed and Fiske about 1900 in Spruce Hole southwest of Durham”. There appear to be no sightings for over 100 years (Nichols and Sperduto 1997, W. Kiel pers. comm.) at the historic Spruce Hole locality, but recent searches are considered inadequate due to poor weather conditions and timing (D. Chandler pers. comm.). Despite a very early collection for the state, it has only ever been known from two localities and is currently ranked SH. There is a 1994 report, however from Effingham suggesting that its status should be S1 in New Hampshire.

### **3.3.4 New York**

On 9 May 1986 a colony was discovered by Don G. Miller in Cicero Swamp State Wildlife Management Area near Syracuse in Onondaga Co., New York. This was the first New York State record (Miller 1995). Four males and one female were collected and the identification was confirmed by Don Lafontaine, Ross Layberry, Reginald Webster and others during the subsequent Lepidopterists’ Society meetings in Ottawa. Robert Dirig deposited one male from the Miller collection in the Cornell University Insect Collection (CUIC). Bog Elfins have not been seen in new York since 1988 despite a few searches in the Cicero Swamp in the early 1990s by R. Dirig (pers. comm.), nor have they been located in apparently suitable Black Spruce, Red Spruce, Tamarack bog in Chenango Co. during an early May survey (R. Dirig, pers. comm.).

Entomologists in New York state have been concerned that the population of Bog Elfins in Cicero Swamp may have been reduced or even extirpated as a result of spraying broadly lethal insecticides such as Dibrome as part of a mosquito abatement program to reduce the threat of equine encephalitis (Miller 1995, Schneider 2000, Schweitzer 2000, R. Dirig pers. comm. 2000).

## **3.4 Rejected Reports**

### **3.4.1 Connecticut**

Reported for Connecticut by Layberry et al. (1998), but this was a mistake based on an identification by D. Lafontaine of a specimen submitted as a “new state record” by an entomologist working on the Connecticut fauna, but it was later discovered that the specimen was from Massachusetts and the new state record actually referred to that state.

### **3.4.2 Vermont**

Grehan *et al.* (1995) do not list *C. lanoraieensis* for Vermont. The status of “SR” (reported without persuasive documentation) was apparently assigned in 1999, and it was entered into the heritage program database. The details of the Vermont report are unknown to the Vermont Department of Fish and Wildlife (M. Ferguson pers. comm.) or to the Association of Biodiversity Information (D. Schweitzer pers. comm.). Donald H. Miller, one of the leading authorities on the Lepidoptera of Vermont was also unaware of any Vermont record (pers.

comm.). The record for Vermont could only be traced to the Association for Biodiversity Information report (ABI) report on Bog Elfin by Schweitzer (1998). Since there is no definite evidence for a report, it is best treated as unknown in the state at the present time.

## **4. HABITAT**

### **4.1 General Habitat**

The habitat of the Bog Elfin is universally reported as "Spruce bog", "Black Spruce-Tamarack bog", or "Sphagnum bog", but recently it has also been found in New Brunswick in drier areas of open white pine forest where Black Spruce exists only as clumps (Layberry et al. 1998, Reginald Webster pers. comm.) and occurs in the mostly sandy barrens (graminoid and shrub heathland) of southern Nova Scotia where the spruce trees are scattered. Within that region, it may have been seen more often in the barrens than in the bogs (K. Neil pers. comm.). For additional general information see section 8.1 on habitat limitation.

### **4.2 Habitat in Ontario**

#### **4.2.1 Alfred Bog**

The habitat in Alfred Bog includes wet pathways and wet openings in spruce-tamarack woods. On 19 May 1991 it was abundant and many were seen along the Horse Creek Drain survey line through Black Spruce forest that provides access to the sedge lenses bounded by stunted Black Spruce where the butterflies are usually found (Hanks & Hess 1992). The butterflies have been most often observed perching on low spruce and Mountain Holly, and two were seen nectaring on Bog Laurel (*Kalmia polifolia*). The 4000 ha Alfred Bog which is partly protected is the best known of the Ontario sites and is the only one of the Ontario sites for which any detailed information is available (Cuddy 1983, Mosquin 1991), but it is still understudied not only with respect to composition and general ecology, but also with regard to specific effects on drainage around the edges.

#### **4.2.2 Newington Bog**

At Newington Bog, the butterflies were flying around Black Spruce (*Picea mariana*), and alighting on spruce branches 7-20' above the ground in mixed spruce (5-20' tall) and low heath (less than 1 m high) It is estimated that at least 10 were seen in an area of a few acres, but they were generally difficult to observe. One was also seen in an open cut area within taller closed spruce forest (30-40' tall) about 100 m to the west. The Brown Elfin (*C. augustinus*) was also present, but unlike the Bog Elfin it flew less than 1.5 m above the heath which was mostly Leather-leaf (*Chamaedaphne calyculata*) and which was flowering at the time. Bog Elfin were exclusively associated with the spruce and were not observed on the heath at this location.

In another part of Newington Bog, the butterfly was found in an area of closed canopy Black Spruce-Tamarack (*Larix laricina*) forest within Red Maple (*Acer rubrum*) forest, bordered to the north by an alder-willow thicket. The spruce forest was very dense but there were small sunlit openings with shorter (2 - 4 m) spruce trees and Mountain Holly (*Nemopanthus mucronatus*) shrubs. A single Bog Elfin was collected at midday on the north edge of the spruce-tamarack forest where it abruptly gave way to Red Maple forest (the understory opened up considerably along the edge of the spruce). It flew down from the surrounding 30-40' tall spruce (probably in search of nectar sources) and perched about 2 m above the ground on leaves of Mountain Holly in a small sunlit area.

On 27 May 1997 Catling and Layberry visited Newington Bog and observed Bog Elfins along the railway bed through Black Spruce dominated woodland only a few steps from the car. Here the old railway is surrounded by alder and heath beyond which is closed spruce forest 10-20 m tall. One butterfly landed on the railway bed, but most were seen around young spruce trees 3-6 m tall on the edge of the open bog.

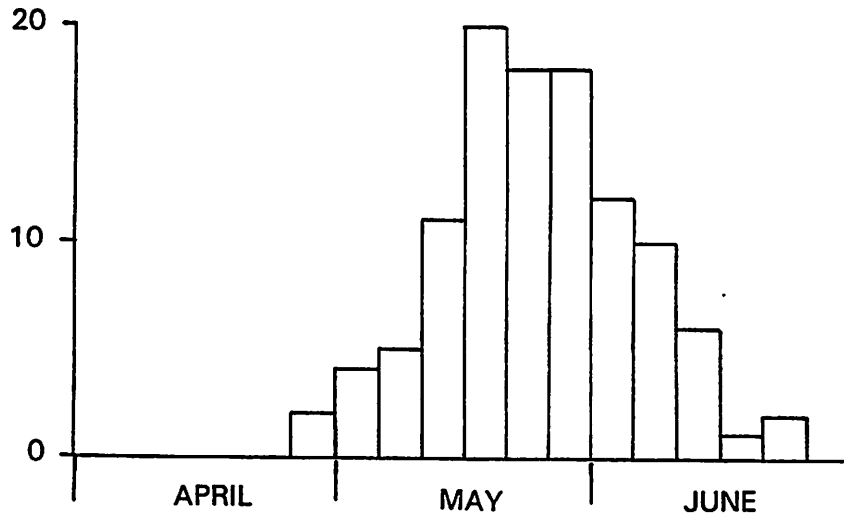
#### 4.2.3 Black River Bog

At Black River Bog, the first Bog Elfin was seen in a small opening in the dense spruce woods and was perching on spruce branches 4 m above ground. Most of the Bog Elfins were located along a wide hydro line on spruce and on shrubs of Leather-leaf. Brown Elfins (*C. augustinus*) were much more common on the low shrubs in the open area. Henry's Elfin (*C. henrici*) was seen in the surrounding Red Maple woods and one Pine Elfin (*C. niphon*) was found on the low heath.

#### 4.3 Habitat in the Maritimes and New England

In New Brunswick and Maine, Bog Elfin occurs mostly in open grown, black spruce 6-13 m tall at the edge of bogs, but has also been observed in a forest dominated by Jack Pine (*Pinus banksiana*) in the northern part of the province (Webster and deMaynadier 1999). It has also been seen occasionally in relatively dry and relatively old Red Spruce forest in New Brunswick (T. Thomas pers. comm.). The most frequently visited nectar sources in Maine, New Brunswick and Quebec are leatherleaf (*Chamaedaphne calyculata*) and rhodora (*Rhododendron canadense*) (Webster and deMaynadier 1999).

In Maine, Bog Elfins occur in dwarf shrub bogs with black spruce, dwarf shrub bogs with black spruce, red pine and white pine, and forested black spruce bogs (Webster and deMaynadier 1999). The bog in Maine with the highest population (32.6 adults/hr) was a relatively dry site with no saturated sphagnum, but with scattered large, open grown spruce and white pine within a dwarf shrub community of Labrador tea, rhodora and sheep laurel. Following the recent Maine survey, it was concluded that survey effort for Bog Elfin should be concentrated in sections of the bog with large open grown black spruce trees, this being the primary habitat, which yielded adults within 5 minutes if the species was present at all.



**Figure 4. Flight period based on dates when observed at various sites**

Note: Since number of individuals depends on intensity of search and skill of the field biologist, the number of individuals was not taken into account. If 100 were at a site, this still counted as only one observation at that site on that day.

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## 5. GENERAL BIOLOGY (see Clench 1944)

### 5.1 Adult

The flight period based on all available Ontario records extends from 19 May to 4 June, with most late May and June specimens being worn. Since 10 were seen on 19 May 1996 at Newington Bog and 20 were seen on 19 May 1991 at Alfred Bog (Hanks & Hess 1992), the flight period probably begins earlier in May with 19-22 May being the early peak. Observations in Nova Scotia extend from 27 April to 22 June (K. Neil, pers. comm.). Opler and Krizek (1984) give a flight period extending from 18 May to 9 June for the US range. The flight period based on all available records is shown in Figure 4.

The small size (imagine something a little larger than a housefly) and canopy dwelling habits of the Bog Elfin may make the species easily overlooked, like the Early Hairstreak (*Erora laeta*). Even at known localities, a concerted effort is often required to locate these elfins, until one becomes familiar with the particular habitat (see under section 4). Sometimes up to 10 Bog Elfins will gather on one isolated spruce tree (to 3 m high) and be scarce elsewhere over an extensive bog (P. Catling pers. obs., T. Thomas pers. comm.). They are

apparently most often seen in openings and at the edges of Black Spruce forest, where they may be found perching on smaller spruce trees and associated shrubs such as Mountain Holly. Particular attention should be paid to any available nectar sources, including Leatherleaf, Blueberry, and Bog Laurel, all of which are known to attract species of Elfins. Most of the observations on lower vegetation have been made between mid-morning and noon, but the sample is relatively small. In taller spruce forest (above 10 m) at Newington Bog, the Bog Elfins were observed in small openings created by cutting at about 10-11 am. When disturbed, they flew directly up into the canopy. At least 10 behaved this way on one sunny morning and there are other reports of Bog Elfins coming down from the treetops to feed in the morning.

## **5.2 Egg**

## **5.3 Larva**

Black Spruce has been widely reported as the foodplant. It has been reared on Black Spruce by T. Thomas, K. Neil and others (pers. comm.). There is a possibility of association with other species of Spruce based on forest insect survey data (McGugan 1958) which allude to use of White Spruce and Red Spruce as larval hosts in the Maritimes. This possibility deserves some exploration, but it should be noted that this host data was not collected in a sufficiently conscientious manner to enable its acceptance without question. Sampling errors are possible since shaking and beating of trees sometimes dislodges species on adjacent trees that are not recorded as sampled. Furthermore the identification of spruces requires qualitative assessment and experience, quite unlike the identification of other conifers. Experience varied within the large group involved in data collection for the forest insect survey. Furthermore there is no indication that the larvae were reared on the reported White and Red Spruce hosts.

## **5.4 Pupa**

Bog Elfin hibernates as pupae.

## **6. SPECIAL SIGNIFICANCE OF THE SPECIES**

One of the most restricted butterflies in eastern North America, but one which has a widespread and commercially important foodplant (i.e. Black Spruce used in lumber) with the result that some of the very limited biological information has originated from scientists studying forest insect pests.

## **7. POPULATION SIZE AND TREND**

### **7.1 Changes in Global Population Size**

There has been no organized monitoring of population size nor have there been sufficient observations to develop any idea of trend. The number of known localities, however, has increased, and the species has either been recently observed or is presumed to be present in most of the historic localities. The recent increase in number of known populations is a result of a few

entomologists learning how to find this insect and passing the information on to others, and to a few recent surveys directed specifically at this butterfly (e.g. Webster and Maynadier 1999).

In general the sightings are of less than 10 butterflies at a time with the notable exception of the report by R. Webster of a few hundred in a bog, 20 km SW of Villeroy in Quebec on 20 May 1988. "Bog Elfin is usually considered rare even in its chosen habitat." (Layberry et al. 1998). A number of biologists have suggested that the species fluctuates in numbers from year to year with phrases like "more than usual" and "over a much broader area" or "up in numbers from last year" and this is probably true, however it remains speculation in the absence of a concerted effort to document populations and fluctuations more accurately.

A population trend can only be determined with at least two reference points involving some fairly accurate data for the past. Since this is not available for Bog Elfin, trend information is not available. One may readily fall into the trap of counting the number of locations and noting an increase since its description in 1934, but this is only a trend in knowledge of an obscure insect and has nothing to do with a population trend. The graph reflects a state of knowledge (see discussion under global rank).

## **7.2 Changes in Canadian Population Size**

No information.

## **7.3 Declining Populations**

Although it has been speculated that there has been extirpation at the Cicero Swamp (New York) and Spruce Hole (New Hampshire) sites, there is no conclusive evidence. The impacts on three Ontario bogs where this species occurs including reductions in size of the bog area imply decline, but no satisfactory evidence is available.

# **8. LIMITING FACTORS**

## **8.1 Limited Habitat**

Bog Elfin is restricted to a specialized habitat. An important consideration is that the specialized bog habitat is not one that is easily re-established once destroyed. The Southern Ontario Wetland Evaluation manual (OMNR 1994) states "Destruction of a bog ecosystem (including removal of its accumulated deposits of peat) would leave many bog species without habitat to sustain them. Since the replacement of peat in a bog can take many thousands of years, these species could be locally extirpated." As a result, bogs are given the highest score under ecosystem age in the Ontario wetland evaluation system.

Since Black Spruce and Red Spruce, the food plants of Bog Elfin, are largely associated with bogs, the amount of wetland habitat is another important consideration. In Maine and the Maritimes, there is abundant habitat. In eastern Ontario and New Hampshire however, suitable habitat is quite limited. Wetlands occupy 12-25% of the state of Maine, however they are much less than 5% of Vermont and New Hampshire and less than 5-12% of other New England states

(Dahl 1990). The extent of continuous habitat required by the Bog Elfin has not been determined, but each of the three currently known Ontario sites are relatively large. In general there are very few bogs in southern Ontario outside the Canadian Shield region within the general area of occurrence of Bog Elfin. Riley (1989) documents only 12 bogs greater than 75 hectares of which only five are located in eastern Ontario.

Spruce is actually absent from a number of extensive peatlands that exist in the southern Quebec region (e.g. Jean and Bouchard 1987), so caution has to be applied in estimates of habitat derived from wetland maps.

A very interesting aspect of potential habitat limitation involves the fact that Bog Elfin has not been found in a number of apparently suitable bogs and the fact that its general habitat and food plant are widespread in Canada, but its still appears to have a very restricted range. Apparent absence from the famous Mer Bleue Bog in the Ottawa valley only 60 km to the west of easternmost colonies (see above under Ontario distribution and Hall 1983) emphasizes this point. It is to be noted that some of the eastern elements associated with Bog Elfin at Alfred Bog, such as *Carex atlantica* and *Rhodora canadense*, also appear to be absent from Mer Bleue, and this general loss of eastern elements may provide a clue. Schweitzer (1998) noted that it "appears to be absent from most suitable bogs", and this may be true outside of a few areas of concentration such as southern Maine, New Brunswick and part of the St. Lawrence lowland region. Layberry (1980) noted absence from apparently suitable bogs near Montague on Prince Edward Island.

In many cases, Bog Elfin may be confined to only a small portion of the bog. The Alfred bog site in Ontario is 400 ha in extent, but Bog Elfin habitat may be restricted to much less than half of this area.

## **8.2 Successional Changes**

Since it may lack spruce, at least the earliest stages of succession in peat bogs following vacuum mining (Berubé and Lavoie 2000) are not appropriate habitat (see below). The habitat (spruce woodland and saturated black spruce around bog edges) is long lasting so that rapid succession is generally not a limitation.

## **8.3 Human Impacts (Habitat Loss)**

Although poorly documented, loss of habitat may be a factor in the potential decline of this species. Commercial harvesting of peat has heightened in Canada since the 1970's with almost 400,000 tons being extracted annually from Quebec and New Brunswick in the early 1980's (National Wetlands Working Group 1988) and quite possibly even greater amounts now. Plant succession occurring in peatlands disturbed by peat mining activities such as vacuum-mining for the production of horticultural mediums may be very different from that which occurs on undisturbed sites (Bérubé and Lavoie 2000). The natural revegetation of peatlands mined with tractor-drawn vacuum machines is slow and dominated by non-bog species such as birches (Lavoie and Rochefort 1996, Lavoie and Saint-Louis 1999, Robert et al. 1999). Spruce and sphagnum may be entirely absent, partly due to the periodic dryness of the peat due to drainage. The reduction or loss of food plants suggests a negative impact on Bog Elfin. Active bog

restoration including filling of drainage ditches may be necessary not only to restore a functional and sustainable peatland ecosystem, but also to restore or maintain optimal Bog Elfin habitat.

Bog Elfin occurs in a region of Ontario where in general wetland losses have been in the order of 60-100% regionally (Environment Canada 1987). Snell (1989) documents a 79.7% loss of original wetland in Prescott County and a 61.9% loss in Stormont County. Since the original land survey 160 years ago, the Alfred Bog wetland has been reduced to half of its original extent (Cuddy 1983), mostly by drainage for production of crops (hay and grass sod) and loss of habitat around the edges has continued until very recently.

There is substantial evidence for loss of habitat in the eastern portion of the Mixedwood Plains Ecozone which is a major zone of occurrence. Bog habitats in this region have been reduced in size and number (e.g. Jean and Bouchard 1987).

Although it may seem remarkable to people living in some parts of New Brunswick or Maine that have an abundance of spruce bogs, bogs are considered by many experts to be seriously threatened (e.g. Larsen 1982, Worley and Klein 1980). The potential for exploitation of peatlands for fuel production vastly increases the potential threat of destruction (Johnson 1985, p. 203). Less than 0.6% of northeastern US peatlands have deliberate protection through ownership by a public agency or by deed restrictions and less than 2% are fortuitously protected as part of publically-owned parks, forests or wildlife refuges. Of course, only some of these and some parts of them are suitable habitat of Bog Elfin.

A fully comprehensive review of the protection status of spruce bogs in parts of northeastern North America encompassing the range of Bog Elfin is beyond the scope of the present report, but indications are that the habitat is not secure and is declining. This provides an interesting and to some extent problematic contrast with the steadily increasing number of known populations.

#### **8.4 Hybridization**

The only reference to a possible hybrid of Bog Elfin is that of Forbes (1960) who referred to "an occasional intermediate specimen" with the colouring of *C. lanoraieensis* but with the black lunate subterminal line more continuous (presumably as in *C. niphon*). Possible hybrids involving *Callophrys niphon* and *C. eryphon* are occasionally alluded to (J. Scott pers. comm.).

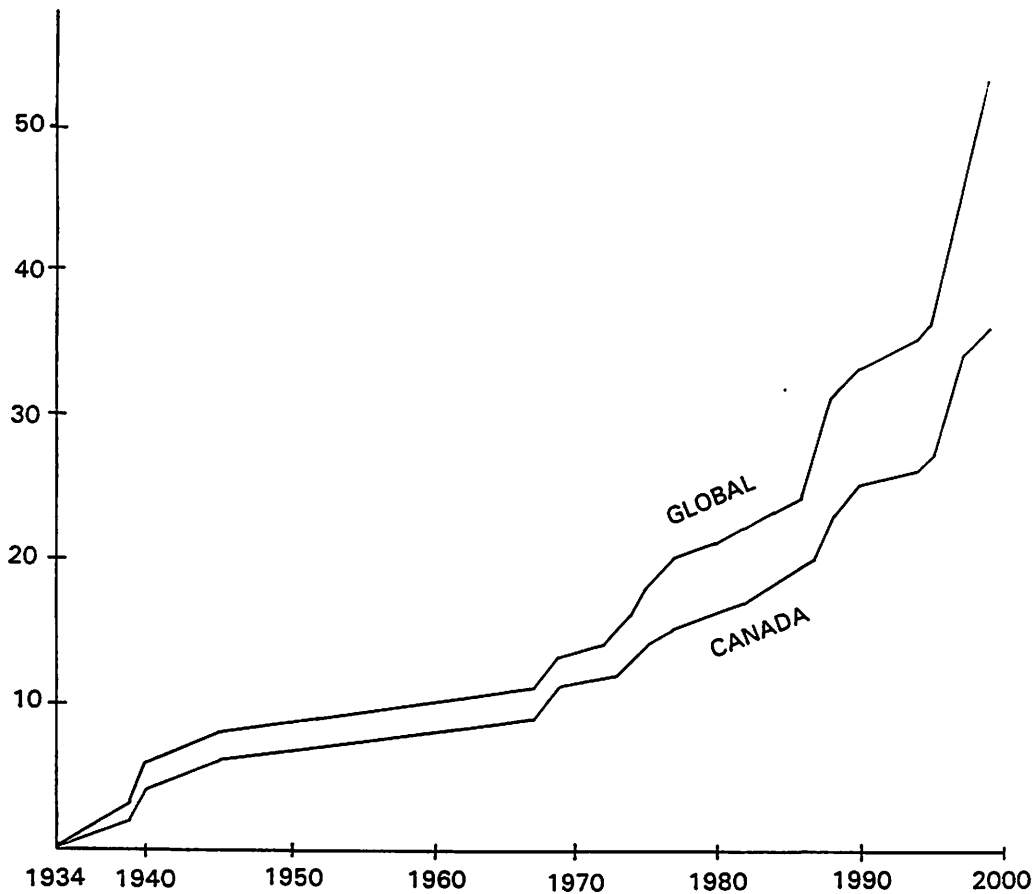
## **ASSESSMENT OF STATUS**

### **9. EXISTING PROTECTION OR OTHER STATUS**

#### **9.1 Status Designations and Ranking**

Global Rank -G3G4 (Schweitzer 1998). Rounded rank - G3.

The Bog Elfin is a challenging species for the assignment of global rank because the real number of populations can only be surmised. Since most populations have not been extirpated as far as is known, the minimum number of populations is approximately 77.



**Figure 5. A very conservative plot of number of localities of Bog Elfin known since its description in 1934 plotted against year**

Note: For the purposes of this graph, locations that were within 5 km were regarded as the same site.

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Remarkably few additional sites for Bog Elfin were discovered between its description as a new species in 1934 and 1967 when only 11 colonies were known. Between 1966 and 1995 there was a substantial increase in the rate of discovery (Figure 5). That was followed by another increase in the rate from 1995 to the present when more discoveries were made in the state of Maine in connection with a study of Bog Elfin. Since the graph is still rising and has not shown signs of levelling off, it suggests that more populations will be discovered. This has also been suggested by many entomologists. The question of how many more is not easy to answer, but the global rank assigned by Schweitzer (1998) of G3G4, meaning 20-100 locations and possibly more, does not seem unreasonable.

**Table 1: Subnational ranks for Bog Elfin (*C. lanoraieensis*) in various states and provinces**

<b>State/Prov.</b>	<b>Rank</b>
<b>CANADA</b>	
Atlantic Region	S3
New Brunswick	S3
Nova Scotia	(has not been assigned; should be S2)
Ontario	S1
Quebec	(has not been assigned; should be S3)
<b>UNITED STATES</b>	
Connecticut	SRF
Maine	S3 - SC (Special Concern)
Massachusetts	S1
New Hampshire	(SH in error; should be S1)
New York	S1
Vermont	(SR in error; should be absent)

**Subnational Ranks**

Subnational ranks are discussed under distribution and summarized in Table 1.

**9.2 Regulatory**

None.

**9.3 Rehabilitation Efforts**

None.

**9.4 Research Programs**

The only research on Bog Elfin presently underway involves an intended survey of geographic variation (P.M. Catling) and surveys in the state of Maine (Webster and deMaynadier 1999).

**Table 2. COSEWIC Definitions of Risk Categories (COSEWIC 2000)**

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**Endangered:** A species facing imminent extirpation or extinction.

**Threatened:** A species likely to become endangered if limiting factors are not reversed.

**Special Concern:** A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

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## 10. ASSESSMENT OF STATUS AND AUTHORS RECOMMENDATIONS

### 10.1 Application of IUCN criteria

The application of IUCN criteria with respect to Bog Elfin is outlined in Appendix 2. With regard to criteria A, with roughly 189 km<sup>2</sup> in area of occupancy since the species is largely restricted to patches of bog habitat, it seems appropriate for a risk designation, but the number of locations exceeds 10 and there is no evidence for decline, and fluctuations, although noted, are not well documented.

With regard to criteria C, although the population sizes reported have generally been small and within the critically endangered category of less than 250, there has been no attempt to accurately determine population sizes. If they are relatively small, however, there is still a need for evidence of decline to apply risk status in this category.

Under criteria D, the small numbers of individuals generally encountered and the relatively small area of occupancy and the fact that Ontario populations and undoubtedly some other populations are suspect, suggest Special Concern.

### 10.2 A Special Case ?

With a partial fulfilment of criteria that would lead to "at risk" status (see above), but an inability to apply these criteria fully due to lack of information, this may be regarded as a special case requiring some flexibility. Another difficulty relates to the fact that population numbers critical to status, are less readily assessed in insects than in birds and mammals.

### 10.3 National Status Recommendation

Based on the forgoing considerations, we recommend Special Concern status in Canada. In an ABI report on Bog Elfin, Schweitzer (1998) stated that the species is "not in immediate danger at most sites, but is too scarce and local to be called secure." Characteristics supporting this designation include relatively small area of occupancy, poorly documented population size, specialized habitat, and localized habitat loss (Table 2).

## **10.4 Additional Recommendations**

### **10.4.1 Designation of Risk Category for Ontario Populations**

Since the habitat supporting each of the three Ontario populations is threatened with further decline (see section 8.3), it is recommended that the Ontario Ministry of Natural Resources consider designation of Bog Elfin as provincially endangered or threatened. On a national scale, the Ontario populations of this species could be designated as endangered by habitat loss and considering that they are at the western range limit, possibly genetically distinct due to stronger selection at range limit, more or less isolated due to landscape characteristics, and disjunct by 200 miles from the nearest Quebec population.

### **10.4.2 Occurrence and Status of Habitat in Quebec**

Evidence for decline of habitat and its potential effect in the Mixedwood Plains ecozone region of Quebec needs to be collected through fieldwork and on site assessments. A more rigorous determination of range in Quebec would help a great deal to establish the national significance. The records for the Saguenay and Maniwaki region are currently being reviewed but the actual determination of number of sites in the Mixedwood Plains ecozone is possible.

### **10.4.3 Ontario Population Census**

Since there is very little information on population sizes with which to determine trends, a method of population censusing needs to be developed. This could have particular value to conservation in Ontario, but would also provide a basis for evaluation population trends elsewhere in the range.

### **10.4.4 Geographic Variation Analysis**

During the preparation of this report, a sufficient number of regional experts were found to make possible an analysis of geographic variability and some agreed to contribute. This may provide a basis for partitioning which could be considered in conjunction with regional habitat threat and population trend data.

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### 13. COLLECTIONS CONSULTED AND FIELD WORK

Information was obtained from the following: the Forestry Collection of Fredericton; Cornell University, Ithaca, NY; Canadian National Collection, Agriculture and Agri-food Canada, Ottawa (CNC ); and University of New Hampshire Collection (DENH). No field work was conducted specifically for this status report.

## ACKNOWLEDGEMENTS

Mr. Ross Layberry, Mr. Larry Speers and Ms. Annabelle Jessop assisted in making available and processing data from the database developed by Agriculture and Agri-food Canada in connection with production of "The Butterflies of Canada". Dr. Anthony W. Thomas of Fredericton provided extensive information on the occurrence and biology of *Callophrys lanoraieensis* in New Brunswick. Mr. Ken Neil provided information on ecology and distribution in Nova Scotia.

[to be completed depending on authorship]

## BIOGRAPHIC SUMMARY OF THE AUTHORS

**Vivian R. Brownell** received an honours B.Sc. from the University of Guelph in 1978 with a specialization in field botany. After graduating, she worked for several government departments including the Ontario Ministry of Natural Resources and the Canadian Parks Service, Ontario Region. Since 1983, she has worked as a biological consultant for municipalities, conservation authorities and government agencies. Her work primarily involves biological inventory and evaluation, rare species management, evaluation of natural areas and wildlife habitat and natural heritage systems planning. In 1996 she developed a computer software program (NADEP) which incorporates a databasing system and facilitates the evaluation of natural areas. She has authored or co-authored many papers in scientific journals and books on the subject of alvars, prairies, savannas, sand and rock barrens, orchid classification and plant geography. A partial list of papers, articles and reports can be obtained from the Canadian biodiversity guide to botanical specialists and literature which is accessible on the internet at <http://www.cciw.ca/eman-temp/scientists/botanists/intro.html>.

**Paul M. Catling** received an honours B.Sc. from the University of Toronto in 1975, with specialization in botany, and a Ph. D. in botany from the University of Toronto in 1980. From graduation to the present, he has worked as a research scientist with Agriculture and Agri-food Canada in Ottawa and has been an adjunct professor at University of Ottawa for 10 years. He is curator of the largest herbarium collection of vascular plants in Canada which contains specimens mounted on approximately one million sheets. His work involves the maintenance and development of the collection as well as systematic and ecological research on native wild plants of economic importance, including medicinal crops, berry crops, and invading alien plants. As an adjunct professor his work includes, field biology, conservation biology, entomology and general ecology. He has served as President of the Canadian Botanical Association and on many national and international expert committees. A partial list of his papers, articles and reports can be obtained from the Canadian biodiversity guide to botanical specialists and literature which is accessible on the internet at <http://www.cciw.ca/eman-temp/scientists/botanists/intro.html>.

Prov.	City	Location	Latitude	Longitude	Collector	Date	No. S	Collection	Reference
NB	Albert Co	Fundy natl. Pk. Caribou Plain (bog)	45.62	-65.06		1995-06-01	2 flyin		A.W. Thomas
NB	Charlotte County	Charlotte County	45.1667	-66.8333		1945-2-14		Canadian F	
NB	Gloucester Co.	3 km S jct. Hwys134 & 8 at airstrip. Black spruce forest	47.33	-66.43	RPW	1999-06-01	3 . U	New Brunsw	R. Webster
NB	Gloucester Co.	3.5 km SSW of jct Hwys 160 & 8, off Hwy 8 (black spru	47.44	-65.51	RPW	1999-06-01	6		R. Webster
NB	Gloucester Co.	Caraquet Island (black spruce bog)	47.83	-64.89	RPW	2000-06-06	5	To be depos	R. Webster
NB	Kent Co.	Kouchibouguac National Park	46.7833	-64.75	J.D.Lafontaine	1977-5-24		CNC	
NB	Kent Co.	Laketon	46.86	-65.12	ST	1997-06-09	4		Stu Tingley
NB	Kent Co.	Shediac Bridge	46.28	-64.58	ST	1997-06-11	6		Stu Tingley
NB	Northumberland Co	Black River	46.9667	-65.3333		1952-2-18		Canadian F	
NB	Northumberland Co	Boiseton	46.45	-66.4167	M.R. Peterson	1974-6-14		New Brunsw	
NB	Northumberland Co	Gloucester	47.5833	-65.4167		1940-2-14		Nova Scotia	
NB	Northumberland Co	Greystone Prov. Park	47.25	-65.4	ST	1997-06-09	8		Stu Tingley
NB	Northumberland Co	NB Bog #305, Hell's Gate Plain	46.91	-66.1	M.L. Holder, A.	2000-06-19	1	M.L. Holder,	M.L. Holder, A. L. Kingsle
NB	Northumberland Co	Rte. 8 (N of Bartibog)	47.32	-65.41	ST	1997-06-09	75		Stu Tingley
NB	Northumberland/Gl	1-2 km W of jct Hwy 8 & Blueberry Rd., Jack pine forest	47.32	-65.43	RPW	1999-06-01	10	RPW	R. Webster
NB	Queens County,	Upper Gagetown	45.85	-66.2333		1948-0-0		Canadian F	
NB	Sunbury	Sunbury	46.2	-66.1667		1940-2-13		Canadian F	
NB	Sunbury Co.	Acadia Forest Experiment Station, nr Rd 16 bog	46.02	-66.38	AWT	1999-05-03			A.W. Thomas
NB	Sunbury Co.	Acadia Forest Experiment Station, Rd. 3 bog	45.98	-66.36	AWT	1997-06-07	3		A. W. Thomas
NB	Sunbury Co.	Acadia Forest Experiment Station, Rd. 3 bog	45.98	-66.36	AWT	1997-06-09	1		A. W. Thomas
NB	Sunbury Co.	Fredericton Jctn.	45.6603	-66.615	M.R. Peterson	1967-6-24		New Brunsw	
NB	Sunbury Co.	Letty Lake Rd.	0	0		1945-7-12		Canadian F	
NB	Sunbury Co.	Peltoma Lake,	45.55	-66.87	AWT	1988-06-12	ca. 12		A.W.Thomas
NB	Sunbury Co.	Tracy,	45.41	-66.41					Canadian Forest Service,
NB	Westmorland Co.	New Scotland bog	46.23	-64.97	ST	1997-06-04	5		Stu Tingley
NB	Westmorland Co.	New Scotland bog	46.23	-64.97	JE	1997-06-09	8		Jim Edsall
NB	Westmorland Co.	New Scotland bog	46.23	-64.97	ST	1998-05-12			Stu Tingley
NB	York Co.,	Black Spruce bog, 17 km SW Fredericton,	45.83	-66.5		1990-05-15			Reginald Webster
NB	York Co.,	Black Spruce bog, 3 km SW Fredericton, (UNB Game	45.93	-66.65		1997-05-24			Reginald Webster
NB	York Co.,	Black Spruce bog, 3 km SW Fredericton, (UNB Game	45.93	-66.65		1997-05-29			Reginald Webster
NB	York Co.,	Black Spruce bog, 3 km SW Fredericton, (UNB Game	45.93	-66.65	RPW	1998-05-14	> 20.	None collec	R. Webster
NB	York Co.,	Black Spruce bog, 3 km SW Fredericton, (UNB Game	45.93	-66.65	RPW	1999-05-20	> 30.	RPW	R. Webster
NB	York Co.,	Canterbury	45.8953	-67.4689		1939-3-29		Canadian F	
NB	York Co.,	Hurley Meadow (black spruce bog)	45.825	-66.834	AWT	1989-05-27			A.W.Thomas
NB	York Co.,	Hurley Meadow (black spruce bog)	45.825	-66.834	AWT	1990-05-25			A.W.Thomas
NB	York Co.,	Hurley Meadow (black spruce bog)	45.825	-66.834	AWT	1991-05-15			A.W.Thomas
NB	York Co.,	Hurley Meadow (black spruce bog)	45.825	-66.834	AWT	1991-05-19			A.W.Thomas
NB	York Co.,	Hurley Meadow (black spruce bog)	45.825	-66.834	AWT	2000-05-21			A.W.Thomas
NB	York Co.,	Near Brockway Airstrip	45.31	-67.07					Reginald Webster
NB	York Co.,	Parish of Bright	46.1333	-67.05		1941-3-1		Canadian F	
NB	York Co.,	Tower Lake bog	45.91	-66.72	AWT	2000-05-22	ca. 6		A.W. Thomas

Prov	City	Location	Latitude	Longitude	Collector	Date	No. S	Collection	References
NB	York Co.,	UNB Woodlot, Regent St. S Bog, Fredericton,	45.93	-66.65	AWT	1991-06-02			A.W.Thomas
NB	York Co.,	UNB Woodlot, Regent St. S Bog, Fredericton,	45.93	-66.65	AWT	1997-06-08			A.W.Thomas
NS	Halifax Co.,	Lowrie Park, Enfield	44.95	-63.5333		1973-7-10		Canadian F	
NS	Halifax Co.,	Waverley	44.7833	-63.6	P. Payzant	1980-5-18		Nova Scotia	Min. of Nat. Resources Ins
NS	Hants Co.	Lowrie Park, Enfield	44.95	-63.5333					Canadian Forest Service,
NS	Hants Co.	Petite Bog, UTM 20,426000 ,4999000	45.14	-63.94	M.L. Holder, A.	2000-06-14	sever	M.L. Holder,	M.L. Holder, A. L. Kingsle
NS	Kings Co.,	Greenwood	44.9833	-64.9					J. Banks
NS	Lunenburg Co.,	Bridgewater	44.3833	-64.5167	B. Wright	1969-5-11		Nova Scotia	
NS	Lunenburg Co.,	Chester Grant	44.6167	-64.3167		1967-7-20		Canadian F	Canadian Forest Service,
NS	Lunenburg Co.,	Gold River	44.5333	-64.3167	P. Ward	1969-4-27		Nova Scotia	
NS	Lunenburg Co.,	Gold River	44.5333	-64.3167	J.EDSELL	1976-5-6		CNC	Canadian National Collect
NS	Lunenburg Co.,	Gold River	44.5333	-64.3167	B. Wright	1986-6-10		Nova Scotia	
NS	Lunenburg Co.,	Simm's Settlement	44.6333	-64.0833	J. Edsall	1975-5-4		Nova Scotia	Nova Scotia Museum of N
ON	Prescott Co.	Alfred Bog, Caledonia Tp.	45.5333	-74.8167		1982-5-22		CNC	
ON	Prescott Co.	Alfred Bog, Caledonia Tp.	45.5333	-74.8167		1982-5-22	7	RALcoll	Cuddy (1983), Hess (1984)
ON	Prescott Co.	Alfred Bog, Caledonia Tp.	45.5333	-74.8167		1983-5-29	sever	RALcoll	Hall et al. (1984)
ON	Prescott Co.	Alfred Bog, Caledonia Tp.	45.5108	-74.8144	R. Layberry, Kir	1991-05-19	20 (hi		Hanks & Hess (1992), Lay
ON	Prescott Co.	Alfred Bog, Caledonia Tp.	45.5108	-74.8144	R. Layberry	1994-06-05			Hanks (1995)
ON	Prescott Co.	Alfred Bog, Caledonia Tp.	45.5108	-74.8144	P.M. Catling	2000-05-17	2	CNC	P.M. Catling pers. comm.
ON	Prescott Co.	Alfred Bog, Caledonia Tp.	45.5108	-74.8144	P.M. Catling	2000-05-29	1	CNC	P.M. Catling pers. comm.
ON	Prescott Co.	Alfred Bog, Caledonia Twp.,	45.5	-74.8167					Ross A. Layberry
ON	Stormont Co.	Black Creek Bog, 4 km NNW Long Sault	45.0667	-74.8833	P.M.Catling	1997-5-27		CNC	
ON	Stormont Co.	Black River Bog	45.0667	-74.8833		1997-5-27	10	RALcoll	
ON	Stormont Co.	Black River Bog	45.0667	-74.8833		1997-5-31	1	RALcoll	
ON	Stormont Co.	Black River Bog, Cornwall Twp.,	45.0667	-74.8833					Ross A. Layberry
ON	Stormont Co.	Newington Bog	45.1167	-74.9667	T. Sabo	1994-06-04		T. Sabo	Hanks (1995)
ON	Stormont Co.	Newington Bog	45.1138	-74.9833	P.M. Catling	1996-05-19	10	CNC	Layberry (1997)
ON	Stormont Co.	Newington Bog	45.1138	-74.9833	P.M.Catling	1996-5-19		CNC	
ON	Stormont Co.	Newington Bog	45.1138	-74.9833	P.M.Catling	1996-5-19		CNC	
ON	Stormont Co.	Newington Bog	45.1167	-74.9667	T. Sabo	1997-05-10		T. Sabo	Hanks (1998)
ON	Stormont Co.	Newington Bog	45.1167	-74.9667		1997-5-27	2	RALcoll	
ON	Stormont Co.	Newington Bog	45.1167	-74.9667		1997-5-31	2	RALcoll	Catling et al. (1998), Hank
ON	Stormont Co.	Newington Bog	45.1167	-74.9667	R. A. Layberry	1998-5-16		RAL	
ON	Stormont Co.	Newington Bog,	45.1167	-74.9833					Ross A. Layberry
ON	Stormont Co.	Newington Bog, edge of	45.1167	-74.9667	J.D. Lafontaine	1996-05-28	1		Layberry (1997)
QC	Arthabaska Co.,	15 km SW of Villeroy, open black spruce forested bog	46.3	-72.0167	R. Webster	1987-5-13	12 ad	R. Webster	
QC	Arthabaska Co.,	15 km SW Villeroy, bog	46.3	-72.0167	R. Webster	1988-05-12			Reginald Webster, Lep. S
QC	Arthabaska Co.,	2 km NW Blandford, St-Louis-de-Blandford Twp.,	46.2667	-72.0167					Francois Lessard
QC	Arthabaska Co.,	20 km SW of Villeroy, open black spruce forested bog	46.2667	-72.0667	R Webster	1988-5-12	20 ad	R. Webster	R. Webster
QC	Arthabaska Co.,	20 km SW of Villeroy, open black spruce forested bog	46.2667	-72.0667	R Webster	1988-5-9	9 adul	R. Webster	R. Webster
QC	Arthabaska Co.,	20 km SW Villeroy, bog	46.2667	-72.0667	R. Webster	1988-05-09			Lep. Soc. Season Summa

Prov	Cty	Location	latitude	longitude	Collector	Date	No. S	Collection	References
QC	Arthabaska Co.,	Blandford	46.25	-72		1988-5-20		Butterflies o	
QC	Arthabaska Co.,	St-Louis-de-Blandford,	46.2667	-72.0167					Francois Lessard
QC	Arthabaska Co.,	St-Louis-de-Blandford, near town, bog	46.2667	-72.0167	R.W. Boscoe	1990-05-25			Lep. Soc. Season Summa
QC	Bagot Co.,	4.5 km SE Acton-Vale, St-Andre-d'Acton Twp.,	45.6167	-72.5167					Francois Lessard
QC	Bellechasse Co.,	5 km E La Durantaye, bog	46.8333	-70.8	R. Webster	1988-05-21			Lep. Soc. Season Summa
QC	Bellechasse Co.,	5 km E of LaDurantaye, black spruce dwarf shrub bog	46.8333	-70.8	R. Webster	1987-05-10	1 wor	R. Webster	
QC	Bellechasse Co.,	5 km E of LaDurantaye, black spruce dwarf shrub bog	46.8333	-70.8	R. Webster	1988-05-21	5 adul	R. Webster	
QC	Bellechasse Co.,	St-Charles,	46.7833	-70.95					Louis Handfield
QC	Bellechasse Co.,	St-Charles, Dwarf shrub balck spruce bog, open foreste	46.7833	-70.95	R. Webster	1988-5-21	sever	R. Webster	R. Webster
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1932-6-12		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1933-5-2		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1934-5-27		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1935-6-2		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1935-6-2		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1937-5-30		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1938-5-22		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1941-5-11		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1952-5-24		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1953-5-23		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	Troubridge, J.	1977-5-21		MMMN	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	Troubridge, J.	1977-5-21		MMMN	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	D.N. Duffy	1977-5-26		Lyman	
QC	Berthier Co.	Lanoraie	45.9667	-73.2167	A.C. Sheppard	1978-5-22		Lyman	
QC	Berthier Co.	Lanoraie Bog	45.9833	-73.3					Canadian National Collect
QC	Berthier Co.	Lanoraie Bog	45.9833	-73.3	A.C. Sheppard	1933-5-21		CNC	
QC	Berthier Co.	Lanoraie Bog	45.9833	-73.3	A.C. Sheppard	1934-5-27		CNC	
QC	Berthier Co.	Lanoraie Bog	45.9833	-73.3	J. Troubridge	1977-5-22		CNC	
QC	Champlain Co.,	Cap-de-la-Madeleine,	46.3667	-72.05					Papillons du Quebec
QC	Champlain Co.,	St-Maurice,	46.4667	-72.5167					Papillons du Quebec
QC	Chicoutimi Co.,	Arvida,	48.4167	-71.1833					Papillons du Quebec
QC	Chicoutimi Co.,	Mont-Valin,	48.6167	-70.8					Papillons du Quebec
QC	Frontenac Co.,	Notre-Dame-des-Bois,	45.4	-71.0667					Jean-Paul Laplante
QC	Joliette Co.,	St-Thomas-de-Joliette,	46.0167	-73.35					Tommy Thouin
QC	Lac-St-Jean-Ouest	St-Gédéon,	48.55	-71.7833					Papillons du Quebec
QC	Lévis Co.,	Bog, 5 km SW St-Jean-Chrysostome,	46.7167	71.2667	R. Webster	1988-05-18			Lep. Soc. Season Summa
QC	Lévis Co.,	Bog, 5 km SW St-Jean-Chrysostome, Black spruce dw	46.7167	-71.7833	R. Webster	1987-05-04	1 wor	R. Webster	
QC	Lévis Co.,	Bog, 5 km SW St-Jean-Chrysostome, Black spruce dw	46.7167	-71.7833	R. Webster	1988-05-18	15-20	R. Webster	R. Webster
QC	Lévis Co.,	Bog, Bernières,	46.6666	-71.35					Lep. Soc. Season Summa
QC	Lévis Co.,	St-Etienne,	46.65	-71.3					Papillons du Quebec
QC	Lévis Co.,	St-Lambert,	46.5833	-71.2167					Louis Handfield
QC	Lévis Co.,	St-Rédempteur,	46.7	-71.2833					Louis Handfield

Prov	Cty	Location	latitude	longitude	Collector	Date	No. S	Collection	References
QC	Lévis Co.?	3 km W of Bernieres, near rest area on Can 20 (exit 30	46.6667	-71.35	R. Webster	1987-5-18	25 ad	R. Webster	
QC	Lotbinière Co.,	20 km SW of Villeroy, open black spruce forested bog	46.2667	-72.0667	R. Webster	1988-5-20	100's	R. Webster	R. Webster
QC	Lotbinière Co.,	Villeroy,	46.3833	-71.8833					Claude Monnier
QC	Portneuf Co.,	Pont-Rouge,	46.75	-71.7					Yves-Pascal Dion
QC	Portneuf Co.,	Ste-Christine,	46.8167	-71.9833					Papillons du Quebec
QC	Québec Co.,	Dosquet,	46.9333	-71.5333					Louis Handfield
QC	Québec Co.,	Ste-Foy,	46.7833	-71.2833					Jean-Paul Laplante
QC	St-Maurice Co.,	St-Mathieu,	46.6	-72.9166					Louis Handfield
MA		Tom's Swamp, near Petersham	42.5167	-72.2	D. Wagner	1997-05-24	sev.	Smithsonian	M. Nelson per.com.
ME	Cumberland Co.	0.7 mi N of Edes Falls on gravel road E of Crooked Riv	44.0166	-70.55	D. Schweitzer	1984-5-22	5 adul		Dale Schweitzer
ME	Cumberland Co.	Otisfield	44.0166	-70.55	D. Schweitzer	1984-5-22		Dale Schwei	Lep. Soc. 1984 Season S
ME	Hancock	Bar Harbor	44.3875	-68.2044	A. Brower	1970s			Brower (1974)
ME	Hancock	Hooper Heath, Open forested black spruce bog	44.6333	-68.2333	RPW	1999-05-16	41 ad	Maine Dept	RPW
ME	Penobscot				L.P. Grey	1976	a few	L.P. Grey	Lep. Soc. 1976 Season S
ME	Penobscot	ca 2.5 mi E of Passadumkeag, along forest road throug	45.1833	-68.5833	RPW	1984-05-22	Over	RPW	RPW
ME	Penobscot	Lincoln area	45.3617	-68.505	W.J. Clayton	1920s			Brower (1974)
ME	Penobscot	Lincoln area, Dead Stream Bog	45.3617	-68.505	A.E. Brower	1938-05-28	5	DENH	D. Chandler pers. comm.
ME	Penobscot	Lincoln area, Dead Stream Bog	45.3617	-68.505	A.E. Brower	1939-05-26	5	DENH	D. Chandler pers. comm.
ME	Penobscot	Lincoln area, Dead Stream Bog	45.3617	-68.505	A.E. Brower	1948-05-29	5	DENH	D. Chandler pers. comm.
ME	Penobscot	Lincoln area, Dead Stream Bog	45.3617	-68.505	A.E. Brower	1949-05-16	5	DENH	D. Chandler pers. comm.
ME	Penobscot	Lincoln area, Dead Stream Bog	45.3617	-68.505	A.E. Brower	1950-05-27	5	DENH	D. Chandler pers. comm.
ME	Penobscot	Lincoln area, Dead Stream Bog	45.3617	-68.505	A.E. Brower	1950-05-28	5	DENH	D. Chandler pers. comm.
ME	Penobscot	near Enfield	45.1833	-68.5833	L.P. Grey	1979	preval	L.P. Grey	Lep. Soc. 1979 Season S
ME	Penobscot	Passadumkeag	45.1833	-68.5833	R. Stanford	1972-05-29	batch	R. Stanford	Lep. Soc. 1972 Season S
ME	Penobscot	Passadumkeag	45.1833	-68.5833	E. Peters	1972-06-04	2 wor	E. Peters	Lep. Soc. 1972 Season S
ME	Washington	Allen Heath,(Dwarf shrub bog with open grown (30-40 ft	44.85	-67.9333	RPW	1999-05-16	9 adul	Maine Dept	RPW
ME	Washington	Denbo Heath, 1 mi N of Deblois off Hwy 193 (Wet fores	44.75	-68.0166	RPW	1999-05-16	4 adul	Maine Dept	RPW
ME	Washington	Duck Pond, Forested (wet) black spruce bog	44.8333	-67.8667	RPW	1999-05-16	1 adul	Maine Dept	RPW
ME	Washington	Harrington	44.6192	-67.8108	A. Brower	1970s			Brower (1974)
ME	Washington	Harrington, black spruce dwarf shrub bog north of Hwy	44.6083	-67.8167	RPW	1999-05-15	12 ad	Maine Dept	RPW
ME	Washington	Joe Hanscom Heath (Dwarf shrub black spruce bog)	44.9667	-67.55	RPW	1999-05-18	6 adul	Maine Dept	RPW
ME	Washington	Montegail Stream, 2.0 mi WNW of Montegail Pd. Raod	44.7667	-67.8	RPW	1999-05-18	6 adul	Maine Dept	RPW
ME	Washington	Pine Corner, near jct. Station & Smith Ridge Roads (Fo	44.9833	-67.3	RPW	1999-05-14	3 adul	Maine Dept	RPW
ME	Washington	Pretty Pond Heath (Dwarf shrub bog with red pine and s	44.8167	-67.9	RPW	1999-05-17	5 adul	Maine Dept	RPW
ME	Washington	Runaway Heath (Black spruce dwarf shrub bog)	44.7333	-67.4333	RPW	1999-05-14	16 ad	Maine Dept	RPW
ME	Washington	Wesley	44.9522	-67.6614	A. Brower	1970s			Brower (1974)
ME	Washington	Whitneyville/Dublin St. Heath (Black spruce dwarf shru	44.6833	-67.5	RPW	1999-05-15	11 ad	Maine Dept	RPW
ME	York	Berwick	43.2658	-70.865	A. Brower	1970s			Brower (1974)
ME	York Co.	Near Picture Pond (Atlantic white cedar/black spruce bo	43.4	-70.7667	RPW	2000-05-17	8 adul	Maine Dept	RPW
ME	York Co.	near Sand Pond off Sand Pond Road (Atlantic white ce	43.3833	-70.75	RPW	2000-05-17	6 adul	Maine Dept	RPW
ME	York Co.	Saco Heath off Heath Road	43.55	-70.4667	J. Albright	1987-5-9	3 indi		John Albright

Prov.	City	Location	Latitude	Longitude	Collector	Date	No. S	Collection	References
NH	Carroll Co.	Effingham	43.7611	-70.9969	DE,REG,JW	1994-06-04			Lep. Soc. Season Summa
NH	Carroll Co.	Effingham	43.7611	-70.9969	DE,REG,JW	1994-06-21			Lep. Soc. Season Summa
NH	Stafford Co.	Spruce Hole, sw of Durham	43.125	-70.9683	Weed & Fiske	1896-06	1	DENH	Brower (1974), D. Chandl
NY	Onondaga	Cicero Swamp	43.1419	-76.0308	D.G. Miller	1986-05-09		CUIC	Miller (1995)
NY	Onondaga	Cicero Swamp	43.1419	-76.0308	D.G. Miller	1988-05-09		CUIC	Miller (1995)

## Appendix 2. Evaluation using IUCN Red List Categories and Criteria

Data for *Callophrys lanoraieensis* in Canada indicated by arrow.

COSEWIC (2000)	Endangered		Threatened	Special Concern
IUCN (1994)	Critically Endangered	Endangered	Vulnerable	Special Concern
<b>A. Declining Total Population</b>	80% in 10 years or 3 generations	50% in 10 years or 3 generations	20% in 10 years or 3 generations	<20% in 10 years or 3 generations
<b>B. Small Distribution and Decline or Fluctuation</b> <i>Either</i> extent of occurrence <i>or</i> area of occupancy <i>and</i> any 2 of the following: (1) severely fragmented: or known to exist at # locations (2) continuing decline (3) fluctuation	<100 km <sup>2</sup>  <10 km <sup>2</sup>  1  any rate >1 order of magnitude	<5,000 km <sup>2</sup>  500 km <sup>2</sup> <b>→~189 km<sup>2</sup></b>  <6  any rate >1 order of magnitude	<20,000 km <sup>2</sup>  <2,000 km <sup>2</sup>  <11  any rate >1 order of magnitude	>20,000 km <sup>2</sup> <b>(&gt;20,000)</b>  >2,000 km <sup>2</sup>  >10  any rate >1 order of magnitude
<b>C. Size Small Total Population and Decline</b> Number of mature individuals <i>and</i> 1 of the following 2: (1) rapid decline rate of at least (2) continuing decline <i>and</i> either (a) fragmentation or (b) all individuals in a single population	<250  25% in 5 years or 1 generation  any rate all sub-pop. <51	<2,500  20% in 5 years or 2 generations  any rate all sub-pop. <251 <b>→max. 200 at 1 site)</b>	<10,000  10% in 10 years or >3 generation  any rate all sub-pop. <1001	>10,000  <10% in 10 years or >3 generation  any rate some sub-pop. >1000
<b>D. Very Small or Restricted</b> <i>Either:</i> (1) # of mature individuals <i>or</i> (2) population is susceptible	<50	<250	<1,000 and area of occupancy <100 km <sup>2</sup> or no. of locations <5	>1,000 and area of occupancy >100 km <sup>2</sup> or no. of locations >5 <b>→189 km<sup>2</sup></b> )
<b>E. Quantitative Analysis</b>	50% in 10 years or 3 generations	20% in 20 years or 5 generations	10% in 100 years	