COSEWIC
Assessment and Update Status Report

on the

Maritime Ringlet
Coenonympha nipisiquit

in Canada

ENDANGERED
2009

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:

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Previous reports:

COSEWIC. 2000. COSEWIC assessment and update status report on the Maritime Ringlet *Coenonympha inornata nipisiquit* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. v + 18 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

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COSEWIC
Assessment Summary

Assessment Summary – April 2009

Common name
Maritime Ringlet

Scientific name
Coenonympha nipisiquit

Status
Endangered

Reason for designation
Globally, this species of Satyr butterfly is confined to 10 salt marshes in the small region of Baie des Chaleurs and Gaspésie. Only three populations are large enough for long-term survival to be probable. All populations are expected to experience habitat loss due to both sea level rise and increased storm frequency. The New Brunswick populations are also subject to threats associated with increased urban development and the collection of host plants.

Occurrence
Quebec, New Brunswick

Status history
Designated Endangered in April 1997. Status re-examined and confirmed in May 2000 and in April 2009.
Last assessment based on an update status report.

COSEWIC
Executive Summary

Maritime Ringlet
Coenonympha nipisiquit

Species information

The Maritime Ringlet, *Coenonympha nipisiquit*, is a member of the Family Nymphalidae (Brush-footed butterflies) and subfamily Satyrinae (Satyrs). No subspecies are recognized.

Distribution

The Maritime Ringlet is a species of butterfly found only in Canada where it has an extremely restricted distribution around Chaleur Bay in northern New Brunswick and the coast of the Gaspé Peninsula in Quebec. Only ten populations are known, four in Quebec and six in New Brunswick (two of the latter are introduced populations).

Habitat

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The entire life cycle of the Maritime Ringlet takes place within salt marshes with only occasional use of neighboring habitats, mainly by adults feeding on flowers. Adults are most common in sections of salt marsh with abundant stands of salt-meadow grass and sea lavender. Adults rarely stray outside the salt marsh habitat.

Biology

Adults are active for only about a four-to five-week period, usually from mid-July to the second or third week in August, and may live as long as two weeks. The primary food source of the adults is nectar from sea lavender flowers.

Eggs are laid singly at the base of the caterpillar's host plant, salt-meadow grass. The caterpillars do not appear to use any other species of grass for food. They stop feeding (usually in mid-to late October) and pass the winter at the base of the host grass, resume feeding in spring, complete development in July and form a chrysalis. The adults emerge about 10 days later.

Population sizes and trends

The Maritime Ringlet generally occurs in dense populations in relatively small areas. It is found in an area of only 76km^2 (64km^2 when introduced populations are removed from the calculations). It has a total of 27,000 to 37,000 adults in four populations, comprising one location, in New Brunswick (an additional 2-3,000 in two introduced populations) and less than 27,000 individuals in Quebec, in two locations, most in only one of the four populations. Only three populations, in two locations, are large enough for long-term survival to be probable.

There are little data on the past distribution and abundance of the Maritime Ringlet. This species was discovered in 1939, and all new populations have been discovered in the last 20 years. There is no evidence that any population has been lost. Most appear to be relatively stable in size and their habitat quality also seems stable at present but is threatened by sea level rise and associated impacts. Increasing urban development around Bathurst and Beresford, New Brunswick is a significant threat to at least one population, the largest in New Brunswick. This is also the area where this species was most likely first discovered. The picking of sea lavender is likely also a threat in New Brunswick.

Limiting factors and threats

The Maritime Ringlet occurs at only three locations globally and occurs in a series of disjunct populations. This limited distribution is one of the most important factors affecting the status of this species and its probability of long-term persistence.

Sea level rise and increasing damage to salt marshes through erosion and storm damage will likely impact all populations.

As a result of its reliance on salt marshes, this species is particularly susceptible to any potentially toxic chemicals (industrial sewage, detergents, industrial effluent, oil) entering its habitat. The probability of these kinds of disturbances is increasing as urbanization and waterfront development continues near salt marshes in New Brunswick. However, these threats are currently relatively low in Quebec as development is minimal near these populations.

Picking of the adult nectaring plant, sea lavender, is a threat in New Brunswick.

Special significance of the species

This species is only found in Canada. There is only one other butterfly species in Canada restricted to salt marshes, and the Maritime Ringlet is the only satyrine in North America known to live exclusively in a salt marsh habitat.

Existing protection or other status designations

The Maritime Ringlet has been listed as Endangered under the New Brunswick *Endangered Species Act*, since 1996, and listed as Endangered under SARA Schedule 1, since 2003. Watercourse and Wetland Alteration Regulations offer additional protection to the habitat of this species in New Brunswick. The New Brunswick Maritime Ringlet Recovery Strategy and Action Plan has been completed and is available online at http://www.gnb.ca/0078/fw/species/index-e.asp.

In Quebec, the Maritime Ringlet and its habitat are currently not protected at the provincial level. Steps are underway to add this species as threatened under the "*Loi sur les espèces menacées ou vulnerable*" (*Threatened and Vulnerable Species Act of Quebec*). However, this Act does not protect the species where it occurs on private land.

COSEWIC HISTORY

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 5, 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 (2009)

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 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.

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SPECIES INFORMATION

Name and classification

The Maritime Ringlet, *Coenonympha nipisiquit*, was first discovered and described by J. McDunnough in 1939 (as a subspecies of *C. tullia*), from salt marshes near the Peters River in what is now Beresford (near Bathurst), New Brunswick. This insect is a member of the Family Nymphalidae (Brush-footed butterflies) and subfamily Satyrinae (Satyrs) and the Order Lepidoptera. No subspecies are recognized. However, the classification of the Maritime Ringlet and other North American members of the *C. tullia* complex is currently unsettled. Davenport's (1941) taxonomic revision of *Coenonympha* showed that *C. tullia inornata* (Edwards) (Inornate Ringlet) and *nipisiquit* should be considered as subspecies of *C. tullia*. Later, the Maritime Ringlet was arbitrarily classified as a subspecies of *C. inornata* (Edwards) in Brown (1955), Miller & Brown (1981), and Hodges (1983), and as a subspecies of *C. tullia* in Scott (1986), and Opler & Malikul (1992). Recent molecular data (Sei and Porter, 2007) provide unambiguous evidence that the Maritime Ringlet is a discrete species, as had already been suggested (Layberry *et al.*, 1998).

Prior to the 1970s, the Maritime Ringlet was the only *Coenonympha* in New Brunswick. During the 1970s, *C. tullia inornata* moved into New Brunswick from the west and is now common throughout the province in almost any open grassy area including the edges of salt marshes (Christie 1983; Webster 1998). The Maritime Ringlet and Inornate Ringlet are now partially sympatric and they appear to be reproductively isolated as suggested by the following: (1) The adult flight seasons overlap only slightly; the Inornate Ringlet flies in mid-June to early July with only an extremely rare appearance of late August flying individuals in southern New Brunswick, while the Maritime Ringlet's main flight is from mid-July to mid-August. (2) The Inornate Ringlet is associated with open upland grassy fields and roadsides, while the Maritime Ringlet is limited to salt marshes. (3) The Inornate and Maritime Ringlets use different host plants; the larvae of the Inornate Ringlet cannot survive on the host plant used by the Maritime Ringlet (Webster 1998; Sei 2004). 4) Inornate Ringlet larvae in salt marshes exhibit much higher mortality rates due to submergence by tidal water than do larvae of the Maritime Ringlet (Sei, 2004). 5) Recent studies by Sei and Porter (2007), using mitochondrial and nuclear DNA markers, indicate that the Maritime Ringlet is the sister species to a complex that includes the Inornate Ringlet and four other taxa in the *C. tullia* complex.

Morphological description

Adults

The upperside of males is usually dark ochre to ochre-brown which often shades to a smoky brown along the outer half of the margins of the front wing and on nearly the entire upper hind wing (Figure 1). The fringes are deep smoky brown on the front wing becoming progressively paler below the apex of the hind wing. The underside of the front wing is dark ochre shaded with grey apically and narrowly along the costa and margin toward the anal angle. There is a prominent creamy oblique band on the underside of the front wing and an apical eyespot is present in about 30% of the males. The eyespot (ocellus) sometimes appears on the upperside of the front wing as a dark spot with a lighter halo. The basal portion of the underside of the hindwing is dark brown, often becoming progressively suffused with grey towards the margin. The grey often has an olivaceous cast. There is a prominent irregular shaped cream coloured median band and traces of a diffuse brown marginal band on the underside of the hind wing. As males lose scales with age, they become progressively darker. The wing-span is 32-34 mm. Females exhibit the same maculation but are more ochre coloured than males (Figure 2). The apical ocellus is often better developed and is present in over 90% of the females. The wingspan is 33-36 mm.

Figure 1. Male Maritime Ringlet recently emerged from chrysalis. (Photo by A.W. Thomas.)

Figure 2. Female Maritime Ringlet. (Photo by A.W. Thomas.)

Similar species

The sympatric Inornate Ringlet, *C. tullia inornata* has the same maculation as the Maritime Ringlet. However, the upperside is usually lighter ochre in colour and often has cream coloured areas near the margin of the hind wing. Although the upperside of some males are as dark as in the Maritime Ringlet, they often exhibit light coloured patches near the margin of the hind wing. The underside is also lighter in colour and ranges from a light grey to almost cream. The oblique and median bands on the front and hindwings are cream coloured to nearly white. The apical ocellus occurs in about 50% of males and 80% of the females, although these values may vary depending on the population (Brown 1955; Wiernasz 1989). Maritime Ringlets can usually be separated by flight season and habitat alone. The Inornate Ringlet adult flight season usually ends before Maritime Ringlet adult emergence begins. The Inornate Ringlet's preferred habitats are upland fields and roadsides, although adults occasionally stray into salt marshes from nearby upland field habitats bordering salt marshes.

Egg

Eggs are subconical (widest at base), 1.0 mm in diameter and 1.1 mm in height (Webster 1998). Each egg has 40 to 48 shallow vertical ribs with a few transverse ridges. The micropyle lies in a slightly mounded prominence. The eggs are pale green when first laid and become light tan mottled with irregular light brown patches after 3 to 4 days.

Larva

The Maritime Ringlet has five larval instars. Only the last instar will be described (Figure 3; for more details see Webster, 1998). The mature last instar larvae are between 20.0 and 23.0 mm in length, broadest (3.5 to 4.0 mm in width) and slightly arched dorsally between segments 3 and 7, then tapering gradually and ending in two short conical tails or bifurcations (Webster 1998). The head is subglobose, narrowing toward the top and broader than the first and second segments behind the head. The head and entire body are covered with small tubercles each with a short, bent (usually directed downward or posteriorly), light brownish (semi-transparent) seta, giving the larvae a granular appearance. The overall colour of the larvae is green to yellow green with a series of longitudinal stripes (Figure 3). Going dorsally to ventrally, there is a dark green mid-dorsal stripe edged on either side by pale yellowish green, a broad pale green lateral stripe, a narrow dark green lateral stripe edged on either side with pale yellow green, a broad green lateral band that gradually becomes dark green, and a yellow lateral stripe. The brown spiracles are in contact with the upper margin of this yellow band. The head is dark green and the ocelli, mandibles, and labrum are brown or light brown. The underside of the body and thoracic legs are dark green, tarsi are brownish, and the prolegs are dark green with brown crochets. The two conical tails are yellowish green becoming reddish brown distally (Webster 1998).

Pupa

The pupae are about 12 mm in length and 4.5 mm in width. The shape is cylindrical, stout, with the anterior end truncate, the abdomen swollen and conical distally (Webster 1998). The pupae are usually suspended by the cremaster to a silk pad attached to a grass stem. Pupae are usually bluish green with a series of black stripes (Figure 4). However, there is much variability in the extent of the pattern of stripes between individuals. The extremes in patterns range from individuals in which the black stripes are completely absent to individuals which have the stripes expanded, obliterating all but a few green patches on the wing cases and between the abdominal segments (Webster 1998).

Figure 3. Last instar larva of Maritime Ringlet. (Photo by A. W. Thomas.)

Figure 4. Chrysalis (pupa) of Maritime Ringlet. (Photo by A. W. Thomas.)

Genetic description

Sei and Porter (2007) used mtDNA and AFLP data to demonstrate that the Maritime Ringlet is the sister species to a clade that includes the Inornate Ringlet and four other subspecies in the *Coenonympha tullia* species complex. Their data suggest a divergence time of 66,000 or 96,000 years before present (depending upon the data analysed), and although these estimates come with high variance, they are consistent with speciation occurring before the most recent glacial maximum (19,000-22,000 years before present).

Sei and Porter (2007) demonstrated that, despite the opportunity for introgression between Inornate and Maritime Ringlets, there is "clear isolation between the two taxa." This conclusion was based upon five pairs of samples, one each of the Maritime and Inornate Ringlets, at Daly Point, Carron Point and Peters River in New Brunswick and Pointe Labillois and La Butte in Quebec. In each area the two species are found in close proximity (at a distance of "at most a few kilometers").

Using the same paired populations, Sei and Porter (2007) demonstrated markedly higher levels of genetic divergence among Maritime Ringlet than among Inornate Ringlet samples, although this result is not unexpected given the comparatively recent immigration of Inornate Ringlets into the region of sympatry.

The proportion of AFLP loci that were polymorphic for individual Maritime Ringlet populations ranged from 23 to 27%. When all populations are pooled, this value increased to 38%.

Designatable units

Based upon analysis of AFLP data, Sei and Porter (2007) found that levels of genetic differentiation between their two Quebec and three New Brunswick populations were quite high (Table 1) and suggested that the two sets of populations have been isolated for a substantial length of time. Their mtDNA data also support separation of the two groups of populations. They concluded that "[u]ntil the extent of their ecological exchangeability and genetic compatibility becomes clear, it is safe to treat them [Quebec and New Brunswick populations] as two separate lineages of *C. nipisiquit* in conservation programs." This suggests that COSEWIC should treat these two groups of populations as separate DUs. The following discussion evaluates the possibility of assigning 2 DUs to the Maritime Ringlet based on COSEWIC's guidelines for recognizing DUs below the species level, which, in the absence of subspecies level designation, considers two groups of criteria for establishing 2 DUs: "discreteness" and "significance".

Table 1. Population structure data for Maritime Ringlet samples (from Sei and Porter, 2007).

Comparison	θ^B (a measure of F_{ST})	95% CL
Among all 5 populations*	0.0129	0.0090-0.0173
Among the 3 New Brunswick populations	0.0266	0.0192-0.0365
Between the 2 Quebec populations	0.0409	0.0253-0.0615
Between New Brunswick and Quebec populations	0.2326	0.1795-0.2879

* in New Brunswick: Daly Point, Carron Point and Peters River; in Quebec: Pointe Labillois and La Butte (both of which are in the St. Omer, Miguasha area in Figure 5).

The data suggest that butterflies from the two provinces are distinctive at neutral genetic loci (criterion 1) which is suggestive of severely limited movement for an extended period of time (criterion 2). However, it is difficult to assess whether continued separation would result in the evolution of local adaptations (also a component of criterion 2), especially when the specialized habitat of the species is considered. The two groups of localities do not represent different ecozones or biogeographic zones (criterion 3).

Significance for DU designation can also be evaluated based upon several criteria. First, if the genetic differences are indicative of “deep intraspecific phylogenetic divergence” then the differences are significant. The lack of reciprocal monophyly in the results presented by Sei and Porter (2007) argue against application of this criterion. Criteria 2 and 3 also are not met because neither of the groups of populations exhibit unusual adaptations not known for the other group and the species is not more widespread in other regions (it is restricted to New Brunswick and Quebec).

The following points also argue against 2 DUs for the Maritime Ringlet:

i) Only 5 of 8 naturally occurring populations were sampled. In particular, the geographically isolated Forillon population in Quebec has not been studied genetically (though doing so would seem unwise considering this population’s small size).
ii) Neither the AFLP nor the mtDNA data suggest the two groups of populations form reciprocally monophyletic groups.
iii) Sei and Porter (2007, page 3318 and their Figure 4) suggest that regional differentiation between Quebec and New Brunswick populations of the Maritime Ringlet is “incomplete”.

Consequently, it is concluded that the Maritime Ringlet best be considered as one DU.

DISTRIBUTION

Global range

The Maritime Ringlet is a Canadian endemic with an extremely restricted global distribution in a small area near Chaleur Bay in northern New Brunswick and the southern coast of the Gaspé Peninsula in Quebec (Figure 5).

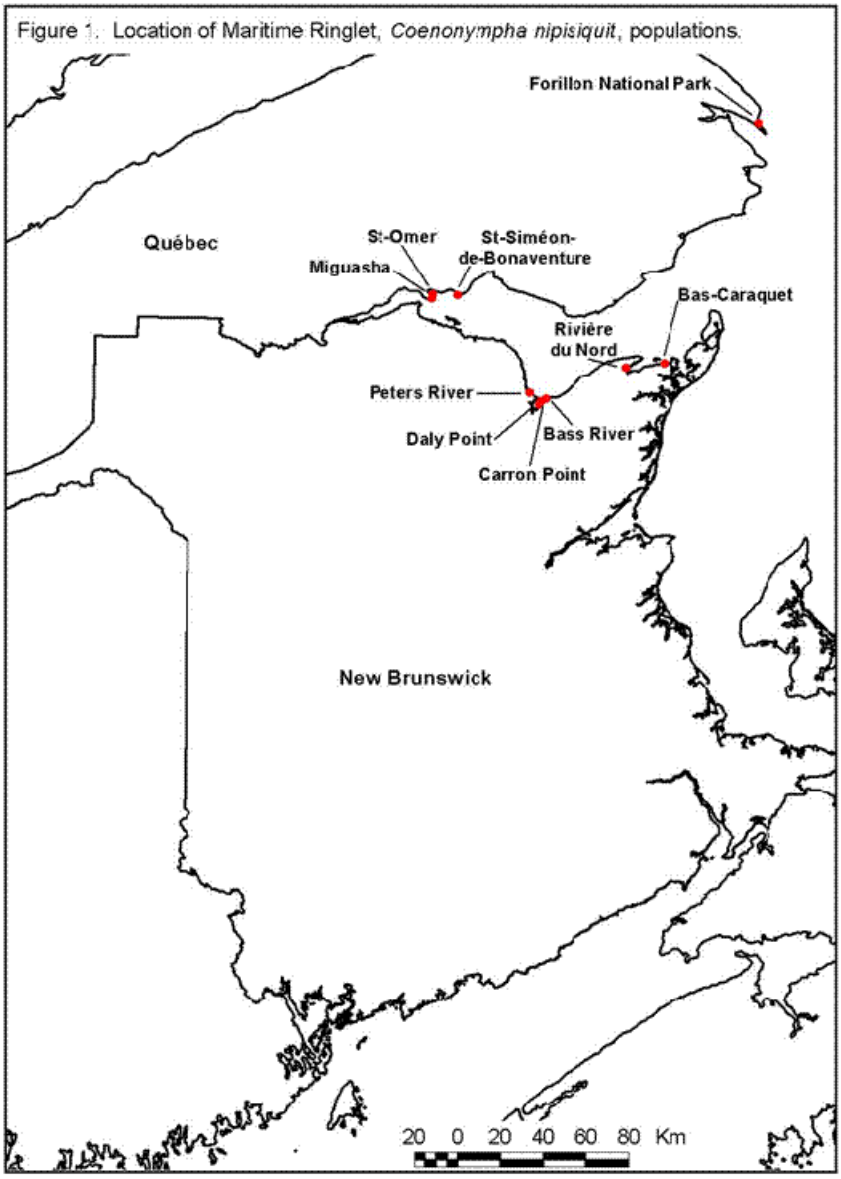

Figure 5. Global distribution of Maritime Ringlet (New Brunswick and Quebec).

Canadian range

The Maritime Ringlet generally occurs in relatively dense populations but is found in only three locations, with at most 10 populations (including two introduced ones that are outside of the species' previously known geographic range). Its extent of occurrence without the two introduced sites is approximately 5840 km^2, but most of this area is unsuitable for this salt marsh habitat specialist species. Data are available on the number of hectares of potential habitat (and in many cases areas actually used by the species) for each occupied marsh (Gouge 2003, New Brunswick Maritime Ringlet Recovery Team 2005). The area of occupancy of each population is relatively small (25 to 156 ha), and the total area of occupancy for the entire species is only about 455 ha (348 ha in New Brunswick, 106 ha in Quebec) (New Brunswick Maritime Ringlet Recovery Team 2005). Using the standard 2X2 km grid, the IAO can be estimated to be 76 km^2 but only 64 km^2 if the two introduced populations are removed from the calculations.

Six populations were known to the writer of the 2000 report, eight naturally occurring populations are known now. Of the two additional localities, only one (Forillon) represents a substantial range increase. The other locality not given in the 2000 report had been discovered in the mid-1990s but the information was not generally available until 2001 (Toner, personal communication).

In reality, there are three natural locations for the species, only two of which (the Bathurst region in New Brunswick and Rivière Nouvelle in Quebec) harbour large populations. The third location is in Forillon National Park of Canada where the population is sufficiently small for its long term survival to be doubtful.

In Quebec, the Maritime Ringlet has been reported from four salt marshes: the estuary of the Rivière Nouvelle near Nouvelle (Gouge 2002) including Point Labillois just to the north of Miguasha (Dion 1995; Gouge 2002, 2003), Forillon National Park of Canada (Penouille) (Gilbert 2005; Gouge 2003; Handfield 1999), near St-Omer (Savoi Brook and Robitaille Brook), and St-Siméon-de-Bonaventure (closest salt marsh is at St-Siméon) (Handfield 1999; Gouge 2002, 2003). The number of adults reported from marshes near St-Omer, and St-Siméon-de-Bonaventure was low (25-28 and 3, respectively) and adults were not observed at St-Simèon-de-Bonaventure in 2002 and 2003 (Gouge 2002, 2003). It is probable that individuals observed at St-Siméon-de-Bonaventure were strays from Nouvelle or St-Omer; they certainly do not appear to represent a viable discrete population. The Forillon population has been discovered since the last COSEWIC report and represents a significant increase in the range of the species in Quebec.

In New Brunswick, the Maritime Ringlet is known from six populations, two of which are introductions outside the known native range of the species. Natural populations occur at Peters River (Beresford), Daly Point, Carron Point, and Bass River (Webster 1997; New Brunswick Maritime Ringlet Recovery Team 2005). The two introduced populations are at Bas Caraquet and Rivière du Nord, about 45 km northeast of Bathurst (Webster 2002). No other populations of the Maritime Ringlet were found during recent intensive surveys of suitable salt marshes in Quebec by Gouge (Gouge 2002, 2003), or in New Brunswick by Webster (Webster, 2006).

HABITAT

The species is restricted to salt marshes in Chaleur Bay. It is likely that this is a result of speciation nearby as a result of isolation in a glacial refugium during a past ice age (Sei and Porter, 2007). Whether the site of this event, combined with the species' low vagility, has resulted in its unusual present day distribution is difficult to assess.

The habitat requirements of the Maritime Ringlet are well-studied (Webster 1995, 1998; Sei and Porter 2003; Sei 2004). The entire life cycle takes place within salt marshes with only occasional use of neighbouring habitats, mainly for flower visitation (Figure 6). The most common plants in sections of the salt marsh inhabited by this butterfly are salt-meadow grass (*Spartina patens* (Aiton) Muhl.), one of the caterpillar host plants (Webster, 1995, 1996), salt-water cord grass (*Spartina alterniflora* Loisel), seaside plantain (*Plantago maritima* L.), sea milkwort (*Glaux maritime* L.), Carolina sea lavender (*Limonium carolinianum* (Walter) Britt.), seaside goldenrod (*Solidago sempervirens* L.), and Eged's silverweed (*Potentilla egedii* Wormsk.*).* The density of each of these plant species varies throughout the marsh and they often form a series of distinctive plant communities that occur in zones and/or in a mosaic within the marsh (Webster 1995, 1996, 1998). The distribution of these plant communities presumably depends on interplay between the frequency and duration of flooding during the tide cycle, the salinity of the water, and the underlying soil types. The salt marsh community is usually bordered either by sand dunes of varying sizes, fresh water marshes or forest communities with an adjacent and often narrow zone of marsh edge vegetation that consists of plant species more typical of drier (non-saline inundated) upland habitats. In several sections of the salt marsh at Peters River the transition zone habitats have been lost or modified by development and road construction. Tidal streams and ponds surrounded by dense stands of salt-water cord grass are common throughout most of these salt marshes.

Figure 6. Salt marsh (Estuary of Peters River) inhabited by Maritime Ringlet. (Photo by R. Webster.)

Trends

No information is available on the former distribution of this species. There is no historic evidence that the Maritime Ringlet was more widespread in the past or that any populations have disappeared. Two new populations were established in New Brunswick at Bas Caraquet and Rivière du Nord, about 45 km northeast of Bathurst (Webster 2002). The species had not been recorded from these localities prior to introduction. These populations now appear to be well established (Webster, unpublished).

Protection/ownership

In New Brunswick, the largest population of the Maritime Ringlet occurs within the estuary of the Peters River. This entire salt marsh is owned by a total of 315 private land owners (New Brunswick Maritime Ringlet Recovery Team 2005). The town of Beresford was involved in a stewardship project (2002-2004) to contact salt marsh property owners and provide them with information on land use practices beneficial to the Maritime Ringlet. The second largest natural population in New Brunswick, at Daly Point, Bathurst, is currently owned by the City of Bathurst, which is in the process of pursuing partnerships to continue stewardship activities initiated with the former owner, Brunswick Mining and Smelting Corp. Ltd. Much of the salt marsh at Carron Point is currently owned by Ducks Unlimited Canada. The Bass River population is privately

owned (8 land owners), and the area surrounding the salt marsh is currently largely undeveloped. Rivière du Nord has an introduced population on land that is entirely owned by the provincial government, occurring within the boundaries of the Village Historique Acadien. The introduced population at Bas Caraquet occurs in a marsh that is privately owned.

A small population is protected within the confines of Forillon National Park of Canada in the province of Quebec. A total of 86 ha of habitat has been acquired at the Nouvelle locality in Quebec (Société de conservation des milieux humides du Québec) and steps are underway to protect the entire salt marsh at this locality, which is home to the largest population of the Maritime Ringlet in the province (See http://www.scmhq.ca/ereserve.htm).

BIOLOGY

General

Like all species of butterflies, the Maritime Ringlet undergoes complete metamorphosis with adult, egg, caterpillar, and pupal stages. Each stage often has different resource and microhabitat requirements.

Adult activity period

Adult Maritime Ringlets have only one generation per year. The flight season, which usually lasts about four weeks, begins between mid-and late July and ends during the second or third week in August. Depending on the season, peak flight is reached between July 25 and August 10. Peak flight of males precedes that of females by about four days. The timing of the adult flight season is delayed or advanced depending on the spring and summer temperatures. Warm temperatures accelerate larval and pupal development advancing the adult emergence period (Webster 1995, 1996, 1998).

Adult food resources

The primary food source of the adults is sea lavender, *Limonia carolinianum* (Webster 1995, 1996, 1998) in New Brunswick and probably in Quebec. This species accounts for 96% of all flower visitations by both sexes and about 90% of the available nectar sources in the salt marsh during the flight season of the Maritime Ringlet in New Brunswick. Other species of flowers in the salt marshes, in descending order of usage, were: *S. sempervirens*, *G. maritima*, and *P. egedii*. Adults have been observed nectaring at flowers in the vegetation bordering the salt marsh. These include *Achillea millefolium*, and *Sonchus* sp. Although *S. sempervirens* was often abundant in salt marshes, this plant often does not begin flowering until the end of the adult flight season except during cool late seasons. Females appear to spend more time nectaring than do males. The time spent nectaring progressively increases with butterfly age (Webster

1995, 1996). Because females continue to develop eggs after emergence they may require additional energy to develop subsequent eggs once the reserves obtained during the larval stage have begun to be depleted. This may be why the proportion of females nectaring increases with age and why females nectar more frequently than males (Webster 1996).

Courtship behaviour

Females mate only once, typically on the day of emergence and close to the pupation site (Webster 1996). Males, in contrast, are usually between two and eight days old at the time of mating and probably mate more than once. Unmated females often rest near the top of the canopy of *S. patens* with the head facing upwards. Males patrol the salt marsh and will approach any orange coloured object they encounter, including orange coloured leaves. Only a few complete mating sequences have been observed. Typically, once a male is within a few cm of the female, the female opens her wings and begins to vibrate them in a nearly horizontal plane. The male will land alongside the female and while continuing to flutter his wings will copulate with her. The entire courtship sequence takes about 20 seconds. Pairs remain in copula between 1.0 and 1.5 hours. Mated females respond differently to male mating attempts. In these cases females vibrate their wings, but keep the wings closed. In these instances the males usually leave after five to fifteen seconds (Webster 1996).

Oviposition behaviour and fecundity

Females emerge with a combination of mature (mean = 24) and undeveloped oocytes (mean = 114) (Webster 1996). Females begin laying the initial complement of mature eggs shortly after mating and then continue to mature and lay additional eggs over the rest of their life span until most of the undeveloped oocytes have been depleted. Females on average live about 6 days (based on mark-release-recapture data), but can live as long as 14 days. A female with a life span of 7 days could potentially lay between 115 and 130 eggs (Webster 1996).

Oviposition usually begins after a short flight (10 to 20 m) just above the canopy of the grass. Most females abruptly drop down into the canopy and land on the litter near the base of the grass and then begin to walk on the litter. Eggs are laid singly near the tips of the thin (0.2 to 0.5 mm in diameter) dead blades of *S. patens* near the litter zone at the base of the stems of the plant. Each female usually lays between two and five eggs (at most one per grass blade) before moving (flying) to another area. Eggs are scattered, but are usually placed 3.0 to 15.0 cm from each other. Females oviposit in a variety of microhabitats or plant communities within the salt marsh. However, eggs are laid only on *S. patens*. Females were observed ovipositing on *S. patens* even in areas where stems of this plant made up less than 10% of the total plant stems (Webster 1995, 1996, 1998).

Larval resources

The primary host plant for the immature stages of the Maritime Ringlet is *S. patens*. Larvae will complete development under laboratory conditions on *Festuca rubra* L., another grass species found in salt marshes. However, this grass species is generally not very common in the salt marshes inhabited by the Maritime Ringlet, larvae have not been found on it, and females have not been observed ovipositing on this plant.

Larval development and behaviour

The Maritime Ringlet has five larval instars. The second instar is the over-wintering stage (Webster 1998). At least one life stage is present in the salt marsh habitat throughout the year.

Pre-diapause

Under field conditions eggs hatch in 10 to 14 days after they are laid (late July to third week in August). The neonate larvae initially feed on the egg shell and often feed on the end of the dead grass blade on which the egg was attached before moving to young shoots of *S. patens*. Most larvae feed on the tips (head end up) of the young shoots that are within or just protruding from the litter region at the base of the larger mature grass stems, although a few caterpillars also feed higher up within the canopy on the tips of mature grass stems. The caterpillars usually consume only the distal 0.5 to 0.75 cm of the shoot before moving to another stem. When larvae are not feeding they rest with the head facing downwards (Webster 1998).

The first instar larvae moult to the second instar after 15 to 17 days (in early to mid-September). The second instar larvae continue to feed on the developing shoots within the litter zone. In mid-to late October the second instar larvae stop feeding and enter diapause (Webster 1998).

Diapause

Except for becoming slightly deeper green, the colour pattern of the second instar larvae changes little after the onset of diapause. Diapausing larvae are about 5.4 mm long and typically rest along the undersides of dead grass stems between 2.0 and 4.0 cm below the surface of the previous years litter (top layer) and 3.0 to 5.0 cm above the soil surface (which is often saturated) (Webster 1998).

Post-diapause

The second instar larvae resume feeding on the developing shoots of *S. patens* in late April to late May, depending on the season (Webster 1998). Early in the season most larvae feed on the new shoots within the litter zone. Later, as the shoots begin to protrude above the litter layer the larvae move up to feed on the newly emerged shoots.

During much of May and June the larvae feed diurnally until late afternoon (17:00 h) and then crawl into the litter layer, even on warm nights (Webster 1998). The second instar larvae moult to the third stage from mid-to late May. The third instar lasts about 14 days. The behaviour of the third and fourth instar larvae differs little from that of the second instars other than most larvae now feed near the top of the grass canopy during the day. The fourth instar caterpillars feed on about 2.0 to 3.0 cm of new growth before moving to another stem. This instar lasts about 14 days (Webster 1998).

From mid June to early July caterpillars begin moulting to the fifth and final instar. This stage lasts about 15 days and unlike the previous instars, at this stage the larva feeds both nocturnally and diurnally. The fully grown caterpillars begin pupating in late June and continue to pupate into August. The timing varies greatly between individuals, possibly due to a combination of microclimatic differences within the different plant communities in the salt marsh and to genetic differences between individuals. During the season, larvae will be present in the salt marsh from early August (neonates) to late July (last instars) the following season (Webster 1998).

Pupation

Maritime Ringlet larvae pupate near the base of grass stems within the grass canopy. In stands of 35 cm high *S. patens*, pupae are attached via a silk pad to living grass stems between 2.5 and 22.5 cm above the litter zone (Webster 1998). In other plant communities within the salt marsh pupae are sometimes attached to the stems of other plant species. The duration of the pupal stage is between 9 and 11 days (Webster 1998).

Adult eclosion

Most adults emerge from the pupae between 9:00 h and 18:00 h. After emerging, adults climb to a position near the top of the canopy and expand their wings. Adults are ready to fly about one hour after emergence. Females usually remain near the pupation site until they have mated (Webster 1998).

Natural mortality factors

There was little sign of avian predation (beak marks) observed during extensive field studies, and few birds were observed in the marshes (Webster 1995, 1996, 1998). A few adults have been found trapped in spider webs and one adult was observed being caught by a robber fly (Webster 1995, 1996). Few invertebrate predators have been observed in the salt marshes and few parasitoids have been recovered from field collected larvae.

Movements/dispersal

The Maritime Ringlet is a patrolling species. Males spend much of the day flying over the salt marsh where receptive females might be found (Webster 1995, 1996). Most female movements are probably related to the selection of oviposition sites and nectaring. Based on distance travelled between recapture points during a mark-release-recapture study, males and females travel about 120 m, although some individuals travelled as far as 1,076 m (Webster 1996). The home range or standard area of activity (Hayne 1949; Brussard *et al.* 1974) of males and females was around 1.80 ha, but was as high as 5.75 ha for some individuals (Webster 1995, 1996). There were no differences between males and females in these parameters. There was considerable overlap of home ranges among individuals with little partitioning of the habitat. Maritime Ringlets do not select or “defend” a territory (Webster 1995, 1996).

Although the vegetation within the salt marshes appears to be relatively uniform to our eyes, population density varies considerably within the salt marsh (Webster 1995, 1996, 1998). Highest adult densities occur in areas where the larval host plants and adult nectar sources are highest. Few or no adults were observed in areas where larval and adult nectar sources were not present, such as upland habitats along the perimeter of the salt marsh, adjacent forested areas, and fresh water marshes.

The salt marsh vegetation in the estuary of Peters River is divided into sections by various landforms such as rivers, sand dunes, and roads. Although these landforms are not large enough to prevent movement of adults between sections of the marsh, they may hinder such movement, as most individuals remain in the section of the marsh in which they originally emerged (Webster 1996). Because the Maritime Ringlet rarely moves far from its preferred habitat within the salt marsh complex, the proportion immigrating and emigrating from or to other salt marshes is probably very low due to the absence of corridors of suitable habitat connecting existing salt marshes in the Bathurst region. Movement of adults between Quebec and New Brunswick is very unlikely based upon ecological criteria alone as it would involve movement over the ocean. Movement between Forillon and the other Quebec populations is similarly unlikely due to the distances involved. Dispersal among the other Quebec or among New Brunswick populations is expected to be limited. These suggestions are supported by the population genetic data of Sei and Porter (2007).

Interspecific interactions

Few interspecific interactions have been observed. Few other species of butterflies occur in the salt marshes*. Lycaena dospassosi* McDunnough is common in areas with *Potentilla egedii*, but does not appear to interact with the Maritime Ringlet.

Adaptability

The Maritime Ringlet lives only in salt marshes. The larvae are able to survive submergence by tidal (brackish) water for at least 24 hours (Sei 2004) and appear to use as their host foodplant only *S. patens,* a species restricted to salt marshes (Webster 1998; Sei 2004). Sei and Porter (2003) showed that larval survival was highest in microhabitats where larval and adult resources were most common. Survivorship was lowest in microhabitats with more frequent (or longer) tidal inundation and in dryer habitats with less tidal inundation. The plant community required for maximal survivorship of both larval and adult Maritime Ringlets appears to be restricted to areas within the salt marsh with good stands of larval and adult food resources. This plant community is dependent on an interplay between the frequency and duration of flooding during the tide cycle, the salinity of the water, and the underlying soil types. Factors that influence this regime, such as changes in flow patterns of the streams entering the estuary and water borne pollutants, could have a major impact on the plant community and microhabitat required for the survival of the Maritime Ringlet.

Adults rarely disperse far from the salt marshes in which they live. Although there are populations in clusters of salt marshes, the clusters themselves are widely dispersed (often separated by 10s of kilometres) and natural establishment of populations in unoccupied salt marshes is unlikely, although introduced populations have been successfully established.

Factors that result in the loss of microhabitats required for larval survival (major changes in the salt marsh vegetation or tidal inundation pattern) will result in the loss of this insect from these localities. Following loss of a population, it is very unlikely that this species could repopulate any isolated locality should it be restored to suitable habitat without active intervention.

POPULATION SIZES AND TRENDS

Search effort

The following surveys have been carried out in New Brunswick for this species at marshes in addition to those known to have the species. Surveys of sites known to have the species have been more frequent.

i. 1970 (Aug. 3 - 5) - D. Christie - 9 marshes in New Brunswick, including observation of populations at Peters River and Carron Point. Note, Maritime Ringlet not found at Bass River at that time (it was found here for the first time in 1995 and this was the observation not included in the previous COSEWIC report).
ii. 1979 (July 27 - Aug 2) - A. Thomas - 7 marshes in New Brunswick, including observations of populations at Peters River and Caron Point.

iii. 2006 (July - Aug) - R. Webster and J. Edsall - During late July and August, 62 salt marshes along the northern and eastern coast of N.B., were surveyed for the Maritime Ringlet out of the 138 salt marshes of at least 8.0ha known from the province. Although most of the salt marshes appeared to be suitable for the Maritime Ringlet, none had populations of this butterfly (Webster. 2006).

Abundance

Since population estimates to monitor relative abundance in New Brunswick were initiated in 1996 (Webster 1999b), one cannot determine population trends for this species from before this period. Because rigorous population estimates have not been done at all localities, it is difficult to give precise estimates of the overall abundance of the Maritime Ringlet. Furthermore, different methods of assessment have been used even for the same population in different years.

However, recent surveys, as well as anecdotal evidence from repeated visits indicate that populations at Peters River have remained relatively stable, although apparent temporary declines were observed during the early 2000s (Webster 2002, Doucet 2002, Les Amis du Village Historique Acadien, 2004). Population numbers at Daly Point were considerably reduced in 1996, apparently because of a severe winter storm in December 1995 (see below). These populations have gradually increased and appear to be approaching pre-1996 levels (Webster, unpublished). Population numbers at Bas Caraquet and Rivière du Nord have progressively increased since their introduction, although numbers at Bas Caraquet appear to be levelling off (Webster 2002, Doucet 2002, Les Amis du Village Historique Acadien, 2004). No data are available on population dynamics for populations in Quebec.

Population estimates are available at four of the six populations in New Brunswick. Based on these estimates, the total population in New Brunswick is probably between 27,000 and 37,000 adults at naturally occupied sites with an additional 2-3,000 at introduced ones (Webster 1995, 1996, 1999, 2001). The largest population occurs in the estuary of the Peters River in Beresford and Bathurst, with a population conservatively estimated at around 27,000 adults in the 156.4 hectares marsh complex. This estimate is based on the combination of a mark-release-recapture (MRR) study (Webster, 1996), rigorous daily counts (Webster 1999) and line transect counts (Webster 2001) in various sections of this large marsh complex. A large population (9,500 adults, based on MRR) was present at the Daly Point Reserve in 1994, but this population declined considerably in 1996 (New Brunswick Maritime Ringlet Recovery Team 2005). However, numbers have progressively increased since then (Webster, 2006). A recently established population (the result of an experimental introduction) in the estuary of the Rivière du Nord may currently have 2,000 or more individuals present, although more precise estimates are needed (Doucet 2002, Webster 2002). The introduced population at Bas Caraquet had 950 adults in 1998, but numbers have been somewhat lower since then. Populations at Carron Point and Bass River are relatively small (100’s of adults) (New Brunswick Maritime Ringlet Recovery Team 2005, Webster 2006).

Estimates are available for three populations in Quebec. The population near Nouvelle within the estuary of the Rivière Nouvelle was estimated to be around 26,000 within the 101 ha marsh complex, making it one of the largest populations (Gouge 2002). Only a few adults have been observed at each of the three other known localities in the province. The population at the Forillon National Park of Canada appears to be small, probably less than 100 individuals (Gouge 2003, Gilbert 2005).

Only the St. Peters, Daly Point Reserve and Rivière Nouvelle natural sites have large enough populations for long term persistence to be probable. It is too early to state whether the two introduced populations will become sustainable.

The populations of the Maritime Ringlet in New Brunswick and Quebec are separated by 70 to 160 km by the open waters of Chaleur Bay, and gene flow between them is unlikely as suggested by population genetic data (Sei and Porter, 2007). However, within each province the populations are generally clustered (Figure 5). The four populations at Nipisiquit Bay are within a 10 km radius of Bathurst and are probably connected by occasional gene flow, albeit low in comparison to other Lepidoptera separated by similar distances (compare data in Sei and Porter 2007 with those in Packer and Owen, 2000). The current known populations in Quebec are within 13 km of each other with the exception of the population at Forillon, which is about 160 km to the northeast. Genetic data for the latter population are not available, but the two former populations also appear to have limited gene flow for their distance.

Rescue effect

As this species is a Canadian endemic, no rescue effect is possible.

LIMITING FACTORS AND THREATS

The small number of viable populations makes any threat to any one of them a serious issue for the survival of this species. The proximity of the main localities in New Brunswick to human population centres exacerbates these risks, although this is not such an issue for the Quebec populations. The limited vagility of adults, low fecundity and short adult lifespan all indicate that the loss of any one population for any reason is unlikely to result in natural recolonization.

Flooding and sea level rise

All the life stages of the Maritime Ringlet are subject to flooding by brackish water during high tides that may flood the marsh to a depth of 1-2 metres. The plant community on which the Maritime Ringlet is dependent is maintained by the flooding regime created by the tide cycle. The larval host plants and adult nectar plants are all dependent on that flooding regime. Nearly all the salt marshes inhabited by the Maritime Ringlet are in estuaries or are associated with river systems flowing into harbours. Factors that influence the flooding regime may have a significant impact on the plant

community and all life stages of the Maritime Ringlet. Disturbances that result in the release of dilutable or suspendable substances into one section of a marsh or into a stream system entering the marsh will likely impact the entire ecosystem as tide waters wash through the marsh. As a result, this species is particularly susceptible to any potentially toxic chemicals (residential pesticides, sewage, industrial effluent, oil) entering the estuaries or harbours surrounded by salt marshes inhabited by this insect. The effects of these threats may be exacerbated by sea level rise.

Sea levels in the region of the Maritime Ringlet's locations has risen by over 3mm per annum since 1911 (Forbes *et al*., 2004) and is predicted rise by between 0.4 and 0.7m over the next 100 years (Forbes *et al*., 2004). This suggests that there will be increased inundation of the salt marshes and that currently suitable areas may become unsuitable as a result. Increased erosion of salt marsh habitat resulting from increased frequency and intensity of storms will likely exacerbate this effect. The areas of coastline inhabited by the Maritime Ringlet have been assessed as moderately to highly sensitive to the impacts of sea level rise (NRCAN, 2007).

Ice scouring of the substrate can occur during winter storms in salt marshes that are not protected by barrier beaches. While this is mostly a threat to the Daly Point and Carron Point populations, rising sea levels may make this a more widespread threat. Ice scouring can directly reduce populations of the Maritime Ringlet through mortality of diapausing larvae as apparently happened in December 1995 at the Daly Point Reserve (Webster, unpublished): an intense storm washed large volumes of ice over the salt marsh and was probably responsible for the drastic population reduction observed in 1996 at this locality. These kinds of events appear to be rare and episodic in nature, although they are probably increasing. They cannot be mitigated.

Limited distribution

The Maritime Ringlet occurs at only a few sites globally. This limited distribution is one of the most important factors affecting the status of this species and its probability of long-term persistence. Reductions in distribution caused by habitat loss or loss of a population due to other factors could have a significant global impact on the species by reducing genetic variability of the overall population and negatively influencing its ability to adapt to future environmental changes such as global warming.

That all populations of this species are found within a small geographic area makes the species susceptible to extinction from single large-scale events.

Habitat fragmentation

The distribution of the Maritime Ringlet, a series of disjunct populations along the shores of Chaleur Bay, is fragmented (Figure 5). This is in part the result of the naturally fragmented distribution of salt marshes that are often associated with estuaries of river systems. This fragmentation is further accentuated because not all suitable intervening salt marshes are occupied by populations of the Maritime Ringlet. The long-distance

dispersal abilities of the Maritime Ringlet are not known. However, studies by Webster (1996, 1999) show that adults rarely move more than tens of metres outside their salt marsh habitat, and it is very unlikely that there is any gene flow between populations in Quebec and New Brunswick, a view supported by the comparatively high level of genetic differentiation between samples from the two provinces (Sei and Porter, 2007). Populations along Nipisiquit Bay in New Brunswick are relatively close to each other and gene flow between these populations is more likely, but again based upon genetic data, seems not to be extensive (Sei and Porter, 2007). Furthermore, residential development is altering the shoreline habitats connecting these populations, eliminating habitats that could be used by the Ringlets for dispersal between populations. Continued development may eliminate these corridors for dispersal amplifying the natural levels of fragmentation and isolation. Gene flow is unlikely between populations associated with the estuary of the Rivière Nouvelle near Nouvelle and Forillon National Park of Canada in Quebec.

Waterfront development

Forest and beach front properties adjacent to salt marshes are prime sites for cottages and houses. Loss of dune and forest habitat adjacent to salt marshes may have a detrimental impact on the adjacent salt marshes by causing changes in nutrient cycling from adjacent upland habitats. However, the greatest effect on the salt marshes is the increased risk for release of residential pesticides and residential sewage from properties as development continues.

This threat is greatest for populations near Bathurst Harbour and the estuary of the Peters River in New Brunswick, where the activities of 315 land owners could impact the species' largest known population. This threat is currently minimal in Quebec.

The potential threat of residential pesticide pollution is related in large part to urban development. All life stages of the Maritime Ringlet are vulnerable to pesticide run-off from adjacent lands. There is also a possibility that the species, and particularly the adults, could be affected by wind-drift of aerially applied pesticides. Currently there are no data available on pesticide use in residential areas near Maritime Ringlet localities, or on the prevalence of these substances in the salt marsh systems. Should this factor be a valid concern, the greatest degree of threat likely occurs at Peters River, where residential development is occurring adjacent to much of the marsh system. However, the Daly Point and Point Carron populations, while not immediately affected by adjacent development, are located in Bathurst Harbour, which is surrounded by developed, urban areas. The Bas Caraquet salt marsh is also located adjacent to a residential area.

The potential threat of sewage pollution is also directly related to urban development. The greatest threats are for populations near Bathurst Harbour and the estuary of the Peters River in New Brunswick. Wetting agents, such as detergents or oils and increased nutrient levels entering the estuaries from faulty septic systems or sewage treatment system failures may have negative impacts on the Maritime Ringlet. Surfactants (wetting agents) such as detergents and oils in the water flooding the

marshes during the tide cycle could increase mortality rates of all life stages of the Maritime Ringlet, especially adults which become wet and incapable of flight. In recent years there have been significant, albeit temporary, declines in adult numbers following higher than normal tides. Similar declines were not evident at these localities during previous years (1995, 1996).

Currently, there is little development in or near salt marshes occupied by the Maritime Ringlet in Quebec and thus this threat will be minimal in this region.

Industrial effluent

A number of heavy industries are located in Bathurst Harbour where two populations of the Maritime Ringlet exist. However, one of the largest mills in the harbour area closed in 2005. Industrial effluent containing wetting agents or toxic chemicals entering Bathurst Harbour may have a negative impact on the Maritime Ringlet. This threat will be minimal at localities in Quebec.

Marsh infilling

The largest populations in New Brunswick are located within urban areas. The population in the estuary of the Peters River is owned by numerous landowners and is under constant development pressure. Small-scale infilling has occurred within this marsh complex resulting in the direct loss of Maritime Ringlet habitat. The cumulative impact to date has been minimal, but should continue to be monitored. This threat will be minimal at localities in Quebec.

Oil spills

An oil spill (or a spill of other toxic chemicals) would directly impact a Maritime Ringlet population by causing high mortality of all life stages exposed to the spill and would likely at least temporarily destroy the plant community of the salt marsh, should the spill enter the estuary or harbour adjacent to a population. Boat traffic near most populations is limited to small craft. Larger spills in Chaleurs Bay are possible. Spills from road tanker traffic are also possible but are expected to have small-scale impact. Although the potential impact of an oil spill on a population could be catastrophic, the probability of occurrence at a given locality is very low (New Brunswick Maritime Ringlet Recovery Team, 2005).

Specimen collection

Collecting this species for natural history specimens is illegal without a permit under provincial laws. Given the relatively large size of the adult population and the high reproductive capacity of this species (high fecundity) illegal collecting would be a minor threat to this species in any of the larger populations. However, small populations like those at Forillon could be negatively impacted by poaching, and the recent designation of the Maritime Ringlet as a full species, rather than a subspecies (Layberry *et al.*, 1998), may result in increased pressure from collectors.

Insect control programs

Insecticide use to control mosquitoes or other insects in salt marshes adjacent to developed areas is a potential threat to the Maritime Ringlet, especially in light of a possible outbreak of West Nile Virus or other arboviruses. The biological control agent *Bacillus thuringiensis* var. *israelensis* is currently in use by some municipalities in New Brunswick (New Brunswick Maritime Ringlet Recovery Team 2005) but this form is not believed to affect Lepidoptera. Currently little data are available on the impact that any of the current mosquito control agents might have on the life stages of the Maritime Ringlet.

Recreational vehicles

Use of recreational vehicles (ATVs) on salt marshes can cause significant habitat degradation and could cause some direct mortality of immature stages and adults. However, few of the marshes are accessible to this activity and ATV use has been noted in only one such marsh, recently, at St. Peters, the largest known population of the species. This threat was rated as low by the New Brunswick Maritime Ringlet Recovery Team (2005).

Picking of sea lavender

Commercial picking of sea lavender for use in dried flower arrangements is a possible but minor potential threat to the Maritime Ringlet. However, while no commercial operations are currently known, some individuals do collect large amounts of the plant. Sea lavender is a critical resource of the adults required for energy and maximizing fecundity.

SPECIAL SIGNIFICANCE OF THE SPECIES

The Maritime Ringlet is one of only two butterfly species in Canada, and the only member of the Satyrinae in North America, known to live exclusively in salt marsh habitat. This species appears to possess adaptations that allow it to survive in this environment and these adaptations are not possessed by closely related species (Sei and Porter 2003; Sei 2004). Sei and Porter (2007) indicate that the species has persisted as a discrete entity since before the last glacial maximum, presumably on a refugium on the present day continental shelf from where it moved to its currently known natural habitat as sea levels decreased.

The other salt march inhabiting butterfly, the Maritime Copper, *Lycaena dospassosi* McDunnough, inhabits the same salt marshes as the Maritime Ringlet, as well as numerous other salt marshes in New Brunswick and the Gaspé Peninsula (Thomas 1980; Handfield 1999, Webster 2006).

The Maritime Ringlet represents part of a fauna and flora that was isolated from their western relatives during the last period of glaciation. Some of these populations, such as the Maritime Ringlet and Maritime Copper, have diverged sufficiently to be recognized as distinct species. The Maritime Ringlet therefore has significant ecological and evolutionary importance. This species may have some economic importance for ecotourism.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The Maritime Ringlet has been listed as Endangered under the New Brunswick *Endangered Species Act* since 1996 and under Schedule 1 of the *Species at Risk Act* since 2003.

The New Brunswick legislation protects the individual butterflies, their residence, and the habitat that is critical to the survival of any individual. No individual or organization may sell, harm or attempt to harm any individual butterfly or its habitat. Watercourse and Wetland Alteration Regulations offer additional protection to the habitat of this species in New Brunswick. The New Brunswick Maritime Ringlet Recovery Strategy and Action Plan has been completed and is available online at http://www.gnb.ca/0078/fw/species/index-e.asp.

In Quebec, the Maritime Ringlet and its habitat are currently not protected at the provincial level. Steps are underway to add this species as threatened under the "*Loi sur les espèces menacées ou vulnerable*" (*Threatened and Vulnerable Species Act of Queec*). However, this Act does not protect the species where it occurs on private land.

TECHNICAL SUMMARY

Coenonympha nipisiquit
Maritime Ringlet Satyre fauve des Maritimes
Range of Occurrence in Canada: New Brunswick and Quebec

Demographic Information

Generation time (average age of parents in the population)	1 yr
[Observed] percent [increase] in total number of mature individuals over the last [10 years].	Increase observed at one site since a decline in 1995/6 but it is impossible to estimate a percentage as census methods changed.
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [2 generations].	NA. Insect populations can increase or decrease by orders of magnitude in a single year for a very large number of different reasons.
[Observed] percent [reduction AND increase] in total number of mature individuals over any [10 years] period, over a time period including both the past and the future.	Substantial declines were noted in the mid-990s, increases have occurred since then. So, over a single 10 year period both occurred. But, it is not possible to estimate percentages due to variation in census methods.
Are the causes of the decline clearly reversible?	In the one documented case it was.
Are the causes of the decline understood?	In one instance somewhat.
Have the causes of the decline ceased?	Increased weather variability means that the cause of the documented decline is unlikely to cease and is likely to increase in frequency. Urban development and associated threats are also unlikely to abate.
[Observed] trend in number of populations	The number of viable natural populations remains the same, two additional populations have arisen through introduction
Are there extreme fluctuations in number of mature individuals?	No, but at one locality a substantial reduction has been observed, with subsequent increase to near pre-reduction levels.
Are there extreme fluctuations in number of populations?	Not for natural populations.

Extent and Area Information

Estimated extent of occurrence	5840 km² if only natural localities are included
[Observed] trend in extent of occurrence	Stable for natural populations
Are there extreme fluctuations in extent of occurrence?	Not for natural populations

Index of area of occupancy (IAO)	At most 76 km², but 64 km² if only natural localities are included. In reality, only 455ha are occupied (<5 km²)
[Observed] trend in area of occupancy	Relatively stable for natural populations
Are there extreme fluctuations in area of occupancy?	No
Is the total population severely fragmented?	Yes
Number of current locations	3 natural locations (2 in Quebec, 1 in New Brunswick)
Trend in number of locations	Stable
Are there extreme fluctuations in number of locations?	No
Trend in [area and/or quality] of habitat	Stable in Quebec, slight decline in New Brunswick

Number of mature individuals in each population

Population	**N Mature Individuals**
Peters River, New Brunswick (27,000) Daly Point Reserve, New Brunswick (9,500) Carron Point, New Brunswick (100s) Bass River, New Brunswick (100s) Rivière du Nord (introduced population), New Brunswick (2,000-3,000) Bass Caraquet (introduced population) (500-1,000) Rivière Nouvelle, Quebec (26,000) St-Omer, Quebec (20-30) St-Siméon-de-Bonaventure, Quebec (<10) Forillon National Park of Canada, Quebec (<100)	
Total	56,000 to 66,000 individuals total. Maximum estimate = 63,000 in natural populations and 3,000 in introduced ones
Number of populations (locations)	10 (3)

Quantitative Analysis

	Not performed

Threats (actual or imminent, to populations or habitats)

Flooding and Sea Level Rise Limited Distribution Habitat Fragmentation Waterfront Development Industrial Effluent Marsh Infilling Oil Spills Specimen Collection Insect Control Programs Recreational Vehicles Picking of Sea Lavendar

Rescue Effect (immigration from an outside source)

Status of outside population(s)? NONE	
Is immigration known?	No, it is not possible for a Canadian endemic.
Would immigrants be adapted to survive in Canada?	Not applicable
Is there sufficient habitat for immigrants in Canada?	Not applicable
Is rescue from outside populations likely?	No, it is impossible for a Canadian endemic

Current Status

COSEWIC: Endangered (April 2009) Endangered - New Brunswick *Endangered Species Act*

Status and Reasons for Designation

Status: Endangered	**Alpha-numeric code:** B1ab(iii) + 2ab(iii)
Reason for Designation: Globally, this species of Satyr butterfly is confined to 10 salt marshes in the small region of Baie des Chaleurs and Gaspésie. Only three populations are large enough for long term survival to be probable. All populations are expected to experience habitat loss due to both sea level rise and increased storm frequency. The New Brunswick populations are also subject to threats associated with increased urban development and the collection of host plants.	

Applicability of Criteria

Criterion A: Not applicable.
Criterion B: Meets Endangered B1ab(iii)+2ab(iii). EO is less than 5000 km² when the ocean is removed and IAO is 64 km², but less than 5 km² of this is suitable habitat. There are three locations that are severely fragmented. Impacts associated with increased urban development, including picking of sea lavender are likely serious threats in New Brunswick. Projected sea level rise and associated erosion and ice scouring are longer term threats throughout the species' range.
Criterion C: Not applicable as there are more than 10,000 individuals.
Criterion D: Not applicable.
Criterion E: Not performed.

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Reginald P. Webster is currently working as a private consultant. He holds a PhD degree in Entomology from the Department of Entomology, Michigan State University and has authored or co-authored over 20 scientific publications including recent papers on the life history of the endangered Maritime Ringlet butterfly and a description of a new species of moth. He has also authored numerous reports on the biology, ecology and population structure of the Maritime Ringlet and taught courses in Population Biology and Ethology at the University of New Brunswick. Since 1999, Dr. Webster has been doing surveys of rare and endangered butterflies for the Maine Department of Inland Fisheries & Wildlife, and during the past 10 years he has been conducting inventories of butterflies, moths and beetles in New Brunswick. He is a past member of the Arthropods Species Specialist Subcommittee of COSEWIC.

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