COSEWIC
Assessment and Status Report

on the

Redroot
Lachnanthes caroliniana

in Canada

SPECIAL CONCERN
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC
Assessment Summary

Assessment Summary – November 2009

Common name
Redroot

Scientific name
Lachnanthes caroliniana

Status
Special Concern

Reason for designation
A highly disjunct Atlantic Coastal Plain species restricted in Canada mainly to two connected, extensive, lakeshore populations in southern Nova Scotia. Comprehensive new surveys and other information indicate that the risk of extinction for this species is less than previously thought. Its lakeshore habitat has been subject to slow but steady loss and decline in quality due to cottage and residential development for 30 to 40 years. Losses are likely to continue through the foreseeable future with new development and intensification of existing development, but the proportion of habitat currently developed is still low and the species' locally widespread occurrence and asexual reproduction mitigates the threat of extirpation in the short term.

Occurrence
Nova Scotia

Status history
Designated Threatened in April 1994. Status re-examined and confirmed in May 2000. Status re-examined and designated Special Concern in November 2009.

COSEWIC
Executive Summary

Redroot
Lachnanthes caroliniana

Species information

Redroot (*Lachnanthes caroliniana*) is an herbaceous perennial within the monocot family Haemodoraceae. Its common name comes from the bright orange-red rhizomes, usually visible at or near the soil surface, and its red sap. Redroot has an erect, unbranched stem 15 to 40 cm tall (to 100+ cm in the southern part of its range), and is white-wooly when young, becoming tawny-hoary with age. The leaves are mostly basal and iris-like in shape and arrangement. Inflorescences are tight, flat-topped clusters of flowers having 6 dull yellow petal-like tepals. Under the most recent taxonomic treatment, Redroot is the only species in the genus *Lachnanthes* and the only Canadian and North American member of its predominantly tropical family. Despite a variety of synonyms having been applied to Redroot, there has never been any dispute regarding its taxonomic rank or its status as a distinct species.

Distribution

Redroot is fairly common within about 120 km of the Atlantic coast from eastern Louisiana to North Carolina and in southern New Jersey. It is rare in every other jurisdiction in which it occurs, from Virginia to Long Island, New York and in Nova Scotia. In Canada, Redroot is known from eight connected lakes in southern Nova Scotia. Its Extent of Occurrence is 117 km^2 but it occupies less than 1.24 km^2 of actual habitat.

Habitat

Redroot is a species of wet, acidic, nutrient-poor habitats, occurring primarily within the seasonally inundated shoreline zone of lake and pond shores in the northern part of its range. In the southern portion of its range, it also occurs in wet depressions within mesic pine forests and savannas and is frequent within these habitats in anthropogenically disturbed areas such as trails, ruts and ditches. In Nova Scotia, it is found on lakeshores on boulder, cobble, gravel, sand and peat substrates where seasonal flooding, wave action and ice-scour limit the establishment of more competitive species. Redroot tends to be most abundant on windward (west and south-facing) shores where wave action and ice scour are greatest. Although it can occur in areas remaining shallowly inundated throughout most years, flowering occurs primarily toward the landward limit of its shoreline distribution.

Population sizes and trends

Redroot population estimates could vary considerably depending on the percentage of infertile plants, making up about 99.9% of the total population, that are considered to be sufficiently mature to be reproductive, both asexually and sexually. Relative size of fertile and infertile plants suggests some portion of infertile plants are likely mature. In 2007, the estimated number of fertile plants was 1,000 to 1,100 whereas the total number of stems was roughly estimated at 675,000 to 750,000 in two extensive populations. However, perhaps only about 80% $^{+}$ (~ 540,000 to 600,000) might be considered sufficiently mature so as to be able to reproduce asexually and sexually. Population trends cannot be directly assessed, but based on habitat trends, populations are likely to have been slowly and continuously declining for more than the past three generations (15 years) as a result of cottage and residential development, which is likely to continue through the foreseeable future. Neither previous nor near-future losses are likely to exceed 30% of the total population.

Limiting factors and threats

Shoreline development is the major anthropogenic threat. Approximately 95% of the 690 buildings around lakes supporting Redroot have been built in the past 40 years. Several hundred cottages and homes likely have Redroot on their properties with more built annually. Where Redroot and shoreline development coincide, there is most often some but not complete loss of habitat and populations. No more than about 6% of available shoreline on lakes where Redroot is present has been developed at present but about 89% of that shoreline is in private hands. Shoreline development is unlikely to eliminate the species entirely but ongoing losses through new development and intensification of existing development are likely to continue through the foreseeable future.

With about 99.9% of plants infertile, a low rate of flowering and seed production, different from the southern part of the range, may be a natural limiting factor. This does not appear to limit persistence at known sites but could explain the limited Nova Scotia distribution and extensive unoccupied but apparently suitable habitat both near known populations and further south in Nova Scotia.

Special significance of the species

Redroot is biogeographically interesting, even among the many Atlantic Coastal Plain disjuncts in southern Nova Scotia, because of its strongly southern distribution in its American range. Being highly disjunct at the extreme northern limits of the species' distribution, the Canadian population could be significant for the genetic diversity of the species. Aboriginal peoples, including Mi'kmaq in Nova Scotia, have used the plant as a dye and medicine and Redroot extracts have been shown to have a phototoxic effect on microorganisms. Redroot's unusual biochemistry has also been investigated and further work could reveal useful economically valuable properties. Redroot has also been noted as a waterfowl food source, but due to its rarity it is probably not important in that regard in Canada.

Existing protection

Redroot is rare in ten of 17 provinces and states in which it occurs and has an additional province or state status designation in seven of those jurisdictions. Redroot was assessed by COSEWIC as Threatened in May 2000, and is protected as a Threatened species under the federal *Species at Risk Act* and the Nova Scotia *Endangered Species Act*. Alteration of its shoreline habitat is regulated by the province, although lack of public knowledge and compliance and lack of resources for government enforcement limits the extent to which regulations actually protect Redroot.

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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SPECIES INFORMATION

Name and classification

Scientific name:	*Lachnanthes caroliniana* (Lam.) Dandy
Synonyms:	*Lachnanthes tinctoria* (Walter ex J. F. Gmel.) Elliott
	Dilatris caroliniana Lam.
	Gyrotheca tinctoria (Walter ex J.F. Gmel.) Salisb.
	Heritiera tinctorum Walter ex J.F. Gmel.
English vernacular names:	Redroot
French vernacular names:	Lachnanthe de Caroline
Family:	Haemodoraceae (bloodwort family)
Major plant group:	Monocot flowering plant

Redroot is the only species in the genus *Lachnanthes* Lam. This genus is a member of the Haemodoraceae, a small family of about 107 species (Hopper *et al*. 1999; Robertson 2002). The family is composed of rhizomatous herbs, mostly perennial, often with red or orange sap. It is broadly distributed, with species in North America, tropical South America, southern Africa, New Guinea and Australia (Robertson 2002). The greatest diversity is in Australia, which is home to 87 species (Hopper *et al*. 1999).

Lachnanthes is the only genus in this family that occurs in North America although many floras also include *Lophiola* Ker Gawler in the Haemodoraceae (e.g. Gleason and Cronquist 1991; Zinck 1998; Robertson 2002). *Lophiola* is a monotypic genus broadly sympatric with *Lachnanthes* and growing in similar habitats. Recent investigations show that it is more appropriately placed in a different family (Robertson 2003), possibly the Nartheciaceae (Hopper *et al*. 1999). *Lachnanthes* is most closely related to *Dilatris* Berg. from South Africa, and *Haemodorum* Sm. from Oceania (Hopper *et al*. 1999).

Despite the variety of synonyms that have been applied to *Lachnanthes caroliniana,* there has never been a dispute about its taxonomic rank or its status as a distinct species. The genus is named for the wooly appearance of its flowers (Fernald 1950), whereas the species epithet is derived from its distribution in eastern North America.

Morphological description

The following description is derived from Robertson (2002), Gleason and Cronquist (1991), Fernald (1950), and the personal observations of the report authors. Further embryological and anatomical details were reported by Simpson (1988, 1990, 1993).

Lachnanthes caroliniana is an herbaceous perennial with bright orange-red rhizomes usually visible at or near the soil surface and red sap. It has an erect, unbranched stem 20 to 100^{+} cm tall. Young plants are densely white-wooly, and become tawny-hoary as they age. The leaves are mostly basal and iris-like in shape and arrangement (i.e., equitant and linear-ensiform), up to 45 cm long x 2 cm wide. Stem leaves are smaller than the basal ones. Inflorescences are initially tightly rounded, ca. 3 cm wide, becoming open and corymbose, 15^{+} cm wide after flowering. Individual inflorescence branches resemble a helicoid cyme. Flowers are subtended by conspicuous bracts. Each flower has 6 dull yellow tepals 7–9 mm long x 1–1.5 mm wide, densely tomentose on the lower (abaxial) surface; 3 stamens, 8–10 mm long and surpassing tepals; an inferior 3-lobed ovary. The fruit is a 3-lobed capsule with a beak formed by the persistent tepals, 3–5 mm in diameter. *Lachnanthes* seeds are reddish brown, 2.5–3 mm in diameter, and are faintly wrinkled.

In Nova Scotia, the only plant that might be confused with *L. caroliniana* in flower is Golden Crest (*Lophiola aurea*). Both species have iris-like leaves and wooly stems and inflorescences. However, *Lophiola aurea* lacks the red rhizomes of *Lachnanthes caroliniana,* has a brilliant white-wooly stem colour at maturity and bluish-green rather than yellow-green foliage colour, 6 stamens (compared to 3) and a partially inferior ovary (compared to wholly inferior). In the field, the slightly smaller flowers of *Lophiola aurea* give it a somewhat more delicate appearance than *Lachnanthes.* Non-flowering individuals of *Lachnanthes* may also be confused with small Blue Flag (*Iris versicolor*) or Yellow-Eyed Grass (*Xyris difformis*), with which it commonly co-occurs. Both these species lack the red rhizomes, and Blue Flag has darker blue-purple tinged leaves, in contrast to the brighter yellow-green leaves of *Lachnanthes caroliniana.*

Population spatial structure and variability

Other than chromosome counts and limited genetic sequencing, no information is available on this subject. Ornduff (1979) reported a chromosome count of n=24 for *Lachnanthes caroliniana.* The chloroplast *trn*L-F region of a single individual has been sequenced and is available in GenBank (Hopper *et al*. 1999).

Designatable units

Only a single designatable unit is recognized since the entire Canadian population is restricted to two adjacent lakes within a single COSEWIC National Ecological Area (Atlantic).

DISTRIBUTION

Global range

The main range of Redroot falls along the Southeastern Plain from eastern Louisiana north to North Carolina, extending south into the Southern Coastal Plain in Florida, and east into the Mid-Atlantic Coastal Plain in North and South Carolina (ecoregion names follow Commission for Environmental Cooperation 1997). It reaches its northern limit in the Northeastern Coastal Zone in Massachusetts, with disjunct populations in Tennessee, Virginia, and in southern Nova Scotia. Redroot also occurs in Cuba.

Redroot is fairly widespread and common within about 120 km of the coast from Louisiana to North Carolina. Northward, Redroot is much more restricted to the immediate vicinity of the coast and is considered rare in every jurisdiction in which it occurs, with the exception of New Jersey where it is common on the pine barrens of the southern part of the state. An inland record mapped in the Hudson Valley of New York (Magee and Ahles 1999) is considered likely incorrect by the New York Natural Heritage Program (S. Young, pers. comm. 2008). Table 1 gives the conservation status in each jurisdiction in which Redroot is known.

Table 1. Redroot (*Lachnanthes caroliniana*) state and provincial S-ranks. (Ranks as provided by NatureServe (2007) and as verified on each jurisdictional heritage program website; November 2007.) S1 = Critically Imperiled, S2 = Imperiled, S3 = Threatened, S4 = Apparently Secure, S5 = Secure, SH = Possibly Extirpated (historic records only), SNR = Not Ranked (generally because it is not considered rare).

State / Province	S-rank	State / Province Status
Nova Scotia	S1	Threatened
Louisiana	S2	
Mississippi	SNR	
Alabama	SNR	
Florida	SNR	
Georgia	SNR	
Tennessee	S1	Endangered
South Carolina	SNR	
North Carolina	S4	
Virginia	SH	
Maryland	S1	Endangered
Delaware	S1	
New Jersey	S5	
New York	S1	Endangered
Connecticut	S1	Endangered
Rhode Island	S1	Threatened
Massachusetts	S3	Special Concern

Sorrie and Weakley (2001) documented a variety of phytogeographic patterns that characterized the coastal plains flora. They noted that the pattern of disjunct populations of Redroot is shared by a number of other species: 58 coastal plains taxa have disjunct populations in the Interior Plateau of Tennessee and Kentucky; nine taxa have disjunct populations in northwest Virginia; 19 taxa have disjunct populations in Nova Scotia; and 42 taxa have disjunct populations in Cuba. Carr (1940) argued that the TN, KY, and VA disjuncts are relict populations persisting from the Cretaceous period, prior to the uplifting of the Appalachian Mountains.

Canadian range

In Canada, Redroot is only known from two large lakes (Ponhook and Molega Lakes) and several immediately adjacent smaller lakes (Little Ponhook, First Christopher, Beartrap, Cameron, Hog and Beavertail Lakes) in Queens and Lunenburg Counties in southern Nova Scotia, 25 km to 35 km inland from Medway Harbour (Figure 2 and Figure 3). Populations are widespread but discontinuous on these lakes, which collectively have 44 km^2 of water surface and 247 km of shoreline, including islands. Extent of Occurrence is 117 km², measured to include all sites supporting Redroot by the shortest continuous boundary method (COSEWIC 2007) using MapInfo 8.5 GIS. The Index of Area of Occupancy is 95 km² using a 1x1 km grid and 132 km² using a 2x2 km grid. Actual area of habitat occupied is less than 1.24 km^2 (247 km of shoreline on all lakes x 5 m), although even this value is likely an overestimate because portions of the shoreline are unsuitable for the species.

Figure 1. A single flowering Redroot (*Lachnanthes caroliniana*) plant on Molega Lake. Photograph by Sean Blaney.

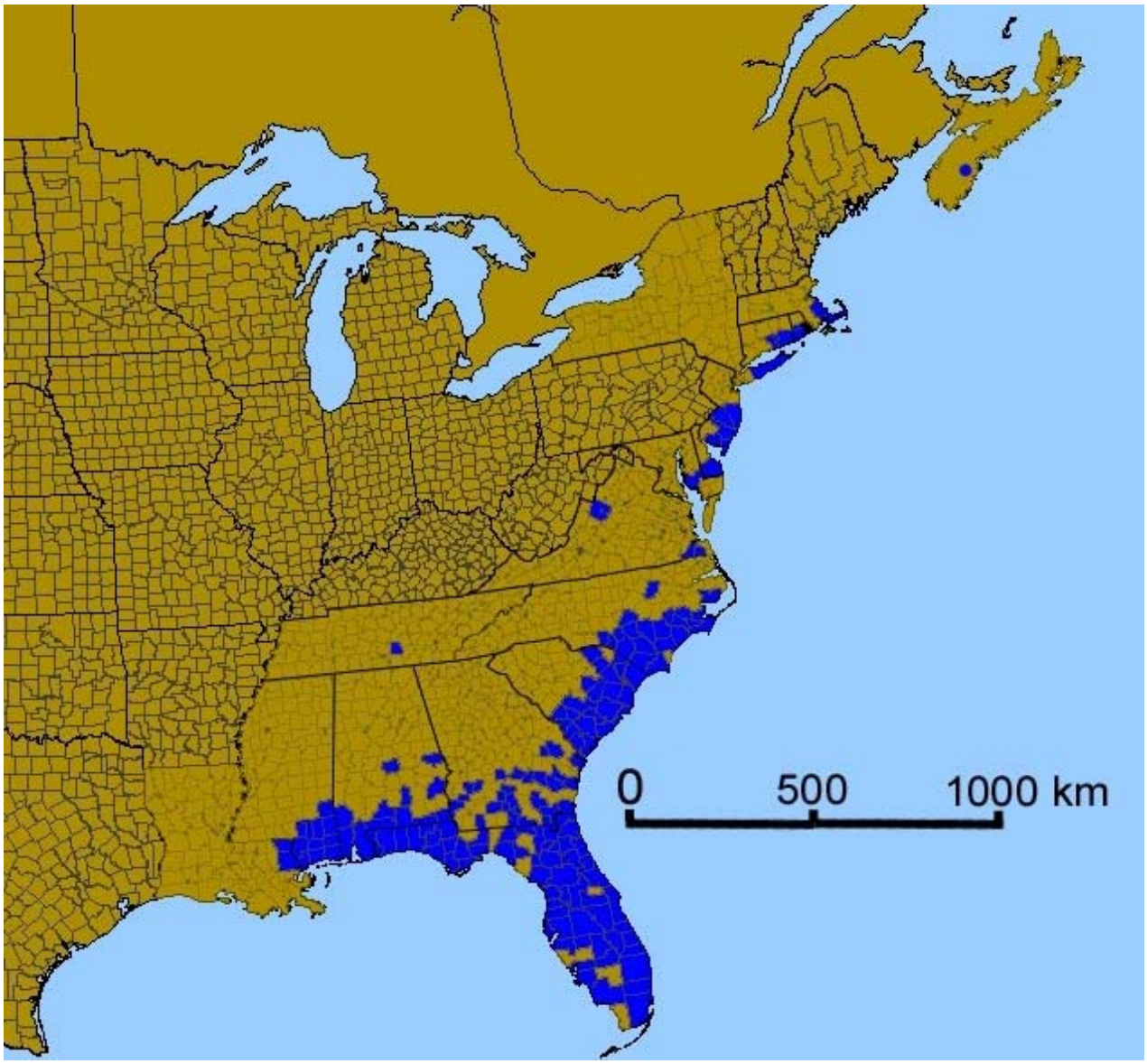

Figure 2. Range of Redroot (*Lachnanthes caroliniana*) in North America. United States range mapped by county (dark shading). Canadian range is indicated by a dot in southern Nova Scotia. The species also occurs in Cuba. (US range modified from Kartesz 2007, used with permission.)

Figure 3. Canadian range of Redroot (*Lachnanthes caroliniana*), indicated by dark-shaded lakes. Inset map of the Maritime provinces indicates the area covered by the larger map. Grid lines represent 0.25 degrees of latitude (28.9 km) by 0.5 degrees of longitude (39.6 km).

HABITAT

Habitat requirements

The only published detailed habitat description of *L. caroliniana* was prepared by Wisheu *et al*. (1994) from surveys of the Canadian population at Ponhook and Molega Lakes. They reported that it was: "…found on a variety of shoreline substrates from boulder to pebble beaches. It was most common on windward shores of cobble or peat that faced southwest. Vegetative plants occurred 15–100 cm above the August water line and more than 50 cm from the water's edge (horizontal distance). Flowering plants occurred near the upper limit of this distribution. Plant abundance seemed dependent on shoreline width, with larger populations occurring on broader, more gently sloping

shores. Plants typically associated with *L. caroliniana* included isoetids [plants *Isoetes*-like in morphology] and carnivorous species (*Drosera* spp., *Sarracenia purpurea*), *Cladium marisicoides* and other rare species."

This description is similar to the authors' observations, although *Sarracenia* was not typically closely associated with Redroot. Redroot plants were mostly on beaches within the zone of annual flooding, but even though water depths had receded significantly from spring maxima during the September 2007 fieldwork, plants were frequently growing in water up to 10 cm deep. The writers found small vegetative plants to be most abundant along the water's edge on pebble or cobble substrate, whereas larger flowering plants were most frequent slightly further from the water, often growing in shallow peaty soils over cobble and boulders. Common associated species were: Large Cranberry (*Vaccinium macrocarpon*), Redtop Panic Grass (*Panicum rigidulum* var. *pubescens**), Lance-leaved Violet (*Viola lanceolata*), Slender Fragrant Goldenrod (*Euthamia caroliniana**, including *E. galetorum* and *E. tenuifolia),* Smooth Twigrush (*Cladium mariscoides*), Swamp Yellow Loosestrife (*Lysimachia terrestris*), Golden Hedge Hyssop (*Gratiola aurea**), Water Parsnip (*Sium suave*), Tradescant's Aster (*Symphyotrichum tradescantii**), Bog Yellow-eyed-grass (*Xyris difformis**), Spoon-leaved Sundew (*Drosera intermedia),* Prairie Cord Grass (*Spartina pectinata*), Blue Flag (*Iris versicolor*), Pale St. John's-wort (*Hypericum ellipticum*), Woolly Panic Grass (*Dichanthelium spretum**), Brown-fruited Rush (*Juncus pelocarpus*), Canada Rush (*J. canadensis*), Thread Rush (*J. filiformis*), Short-tailed Rush (*J. brevicaudatus*), Bayonet Rush (*J. militaris*), Lesser Spearwort (*Ranunculus flammula var. filiformis*), White Buttons (*Eriocaulon aquaticum*), Water Lobelia (*Lobelia dortmanna*), Switch Grass (*Panicum virgatum* var. *spissum**), Lenticular Sedge (*Carex lenticularis*), Southern Bog Clubmoss (*Lycopodiella appressa**), Royal Fern (*Osmunda regalis var. spectabilis*), Bluejoint Reed Grass (*Calamagrostis canadensis*), Rose Pogonia (*Pogonia ophioglossoides*), Sweet Gale (*Myrica gale*), New York Aster (*Symphyotrichum novi-belgii*), Small-headed Beakrush (*Rhynchospora capitellata*) and Virginia Meadow Beauty (*Rhexia virginica**). Species followed by an asterisk (*) are Atlantic Coastal Plain species largely restricted in Nova Scotia to the southernmost part of the province. Other provincially uncommon or rare Atlantic Coastal Plain flora observed in close association with Redroot were Eastern Blue-eyed-grass (*Sisyrinchium atlanticum*), Toothed Flatsedge (*Cyperus dentatus*), Zigzag Bladderwort (*Utricularia subulata*) and Golden Crest (*Lophiola aurea*).

The shoreline habitats used by Redroot are nutrient-poor, due to the removal of organic matter by wave action and ice-scour (Hill and Keddy 1992, Wisheu and Keddy 1994, Wisheu *et al.* 1994) and to the acidic parent material from which the soils are derived. Wave action and ice-scour also act to limit the encroachment of woody plants into these habitats, protecting *L. caroliniana* and other rare coastal plain species from being crowded out by more competitive species (Hill and Keddy 1992).

Redroot has been included incidentally in floristic and ecological studies of wetlands across the U.S. coastal plain. It has been shown to be associated with: shoreline herbaceous vegetation in the Carolina Bays (Landers *et al.* 1976, Tyndall *et al.* 1990, Tyndall 2000), Long Island (Zaremba and Lamont 1993) and Cape Cod (Craine and Orians 2004) pondshore communities, depressions within *Pinus palustris* flatwood savannas in Louisiana (Keddy *et al*. 2006)**,** seasonal ponds and “cypress domes” in Florida (Landman and Menges 1999, Robertson *et al*. 1998) and the floating peat "batteries" and deep and shallow marshes of the Okefenokee swamp in northern Florida and southern Georgia (Cypert 1972, Gerritsen and Greening 1989). In Florida, Redroot also occurs in “depression marshes, bogs, mesic to wet flatwoods, and within ruderal settings such as mesic to wet sandy or clayey roads, logging trails, roadsides, and ditches” (B. Herring, pers. comm. 2008). In North Carolina, it occurs “in low spots in wet Longleaf and Pond Pine savannas, around the edges of pocosins [wetlands with deep, acidic, sandy, peat soils] (pocosin/savanna ecotone), and is especially abundant in disturbances within these habitats like ruts and ditches. Under favourable soil and moisture conditions, Redroot is able to persist in disturbed habitats after the original habitat is destroyed. Virtually all if not all of these habitats are seasonally or periodically inundated, and remain wet to damp throughout the growing season” (LeBlond, pers. comm. 2008). *Lachnanthes caroliniana* is considered to be a problematic weed in New Jersey cranberry farms (Meggitt and Aldrich 1951).

Habitat trends

The only significant impact on the quantity and quality of Redroot habitat at present is shoreline development and alteration. Other issues identified under *Threats and Limiting Factors* have, at most, local effects on habitat quality and minimal effects on habitat quantity.

There are 1,414 different parcels of land touching the lakes known to support Redroot (excluding Beavertail and First Christopher Lakes where small populations were discovered after this analysis) and there are 690 buildings on that land (Connors, pers. comm. 2007). Without investigation of hard-copy building permits, there is no way to determine the age of existing development (W. Connors, pers. comm. 2007), but most has been within the last 20-30 years and a large portion has been in the last 15 years (3 generations) relevant for COSEWIC status evaluation. An aerial photo study by the Nova Scotia Nature Trust (2002) showed buildings and docks on Ponhook Lake have increased from eight in 1955 to eleven in 1965 to 230 in 2001, suggesting that approximately 95% of development around Redroot lakes has occurred within the past 40 years. Significant development is continuing on lakes supporting Redroot. The authors observed at least five new cottages or homes being constructed during 2007 fieldwork, which sampled only a small portion of the total shoreline of lakes where Redroot is found. At least two newly constructed access roads around the Redroot lakes and signage indicating new cottage subdivisions were also seen. It is likely that residential development will continue through the future until virtually all suitable, unprotected private land is built upon. This may take another 20 or more years.

If existing buildings are assumed to be placed randomly with respect to Redroot location (which may not be true because broad shoreline zones especially suitable for Redroot could be preferred development sites) and that there is a complete loss of 20 m of shoreline habitat for each of the 690 buildings on Redroot lakes (which is probably an overestimate), this only amounts to 13.8 km (5.9%) out of 233 km (excluding Beavertail and First Christopher Lakes) of Redroot lake shoreline lost to development, some of which occurred more than 15 years ago. A similar or slightly lower proportion of shoreline is altered on Beavertail and First Christopher Lakes (Sean Blaney, pers. obs.). The overall estimate of about 6% potential loss of shoreline habitat due to residential developments may represent an underestimate, considering that not all of the shoreline of these lakes is suitable habitat for the species.

Habitat protection/ownership

The lakeshores known to support Redroot are predominantly private land owned by small landowners or developers with plans to subdivide and sell cottage lots. Of the 247 km of shoreline on the Redroot lakes, 14.6 km are within the Ponhook Lake Nature Reserve[1], approximately 6 km are within other provincial crown land[2], 0.45 km are within a site recently acquired by the Nova Scotia Nature Trust and 0.13 km are within Wildcat Indian Reserve 12 of the Acadia First Nation. The Nova Scotia Nature Trust has also secured a conservation easement on 3.8 km of lakeshore on the northeast side of Molega Lake and has five non-binding stewardship agreements with landowners on Ponhook and Molega Lakes. Redroot is known or likely to be present on almost all of the parcels mentioned above, including occurrence on at least 29 of the 39 small parcels on Ponhook, Molega and Hog Lakes that make up the 42.7 ha Ponhook Lake Nature Reserve. In all, about 8% of the Redroot lakes' shoreline habitat is well protected, an additional 2.6% has crown ownership and/or non-binding conservation status and 89% is private land, protected only by the measures of the federal *Species at Risk Act* and the Nova Scotia *Endangered Species Act* and by the provincial requirements for permits for any construction or infilling below the regular high water mark (Nova Scotia Department of Natural Resources 2008). A lack of public knowledge and compliance and lack of resources for government enforcement in relation to these acts and policies limits the extent to which they can actually protect Redroot.

[1] Provincial nature reserves are protected in Nova Scotia under the *Special Places Act*, which prohibits any activity or acts which may "alter any part of the terrain or of the vegetation" or "disturb the flora and fauna within the designated site".

[2] Some provincial crown land and much private land on the Redroot lakes is within the Ponhook Lake Site of Ecological Significance. This designation indicates an area the province recognizes as ecologically significant but it does not offer any specific protection. Sites of Ecological Significance on crown land are, however, usually excluded from extractive uses, recognizing that the intent for most is that they eventually be designated as nature reserves (D. MacKinnon, pers. comm. 2008).

BIOLOGY

Relatively little is known about the life history of *L. caroliniana.* Most ecological work has been done in the context of the habitat requirements of this and other rare coastal plain species in Nova Scotia (Hill and Keddy 1992, Wisheu and Keddy 1994, Wisheu *et al.*1994).

Life cycle and reproduction

Lachnanthes caroliniana is a perennial herb. It is reported to be self-compatible, although no experimental evidence has been published (East 1940). Nichols (1934) reported an absolute requirement for cold stratification prior to seed germination. However, this trait must be variable over the range of the species, as populations in Florida and especially Cuba are unlikely to be exposed to low temperatures. Redroot is capable of producing a substantial seed bank in the southern part of its range. Gerritsen and Greening (1989) recorded 300 and 700 Redroot seeds per m^2 in an *ex situ* germination experiment using deepwater macrophyte marsh and shallow *Carex walteriana* marsh sediments from the Okefenokee Swamp in Georgia. Under near natural light and temperature regimes in their experiment, germination occurred throughout the year in moist but not inundated and moist then inundated treatments but was greatest in summer. Germination in their inundation treatment was reduced and only occurred in spring and summer, but this treatment produced the greatest seedling growth rates. This indicates that ideal conditions for establishment are summer low water followed by increasing water levels into the fall. This is consistent with Landers (1976), who reported summer drawdown as a management technique for fostering growth of *L. caroliniana*. Landers (1976) also noted that prescribed burning of peatlands was used to maintain populations of this species.

Field surveys (C. Keddy 1989, Blaney and Smith in 2007-08 as documented in ACCDC 2009) indicate that flowering is very rare in the Nova Scotia population of *L. caroliniana*, which is not the case in Florida and North Carolina (B. Herring and R. LeBlond, pers. comm. 2008). Wisheu *et al.* (1994) documented tens of thousands of plants in Nova Scotia, but only 200 in flower. During fieldwork in 2007 about 99.9% of observed plants at the Canadian populations were infertile. In both surveys, flowering plants were found further from the water than non-flowering plants. Seeds appeared to be developing normally in the flowering plants checked in 2007.

Frequent vegetative reproduction by rhizomes was observed by the writers and by Keddy (Keddy 1989). Redroot's abundance on exposed shorelines may indicate a capacity for spread and establishment via rhizome fragments. No data documenting the extent of vegetative reproduction have been published, but observations suggest that it is probably very important in the Nova Scotia populations.

No additional information specific to the life cycle of *L. caroliniana* is available. However, studies of coastal plain communities in Ontario and New York indicate that these species depend on periodic flooding for their long-term persistence (Keddy and Reznicek 1982, Schneider 1994). Most members of the coastal plain community are small herbs, incapable of competing with larger shrubby species. The cyclical flooding of the shoreline habitat occupied by coastal plain herbs removes their shrubby competitors. Herbs are either able to persist through flooding or are able to re-establish themselves from the seed bank after flooding recedes.

The importance of flood/drought cycles in maintaining diversity in wetland communities is well established (van der Valk and Davis 1978). However, it may not hold in all situations. Wisheu and Keddy (1989) examined the seed bank at Wilson Lake in the Tusket River system in southwestern Nova Scotia. They found that the coastal plain community (which lacks Redroot) was under-represented in the seed bank. Thus, in contrast to the situation documented at Matchedash Lake in Ontario (Keddy and Reznicek 1982), the long-term persistence of the coastal plain species at Wilson Lake depends on protection of established adult plants.

The rarity of flowering and seed set in the Nova Scotia *L. caroliniana* population suggests that reproduction by seed and seed banking is less frequent and important in Nova Scotian populations than appears to be the case in the Okefenokee populations (Gerritsen and Greening 1989). Detailed study is required to establish the relative importance of the seed bank and mature plants in the long-term persistence of *L. caroliniana* in Nova Scotia.

Flowering plants are clearly several years old based on relative size of small vegetative plants. Considering that the habitat is nutrient poor and growth rates are likely slow, generation time is estimated to be about 3-5 years.

Herbivory

No signs of substantial herbivory were detected during field surveys and there is no mention of this in the literature. *Lachnanthes caroliniana* is known to contain photodynamic toxins that presumably limit herbivory by insects and at least some vertebrates (Darwin 1872, Kornfeld and Edwards 1972, Edwards and Weiss 1974). These compounds do not affect waterfowl, as *L. caroliniana* is an important food for ducks (Landers *et al.* 1976).

Dispersal

There are no data on dispersal of *L. caroliniana*. The small seeds have no obvious features that suggest they are wind-borne or dispersed by animal vectors. Seeds are likely dispersed locally by gravity, with possible secondary transport by water. It is also possible that rhizome fragments, either singly or as part of peat mats, could provide an additional mechanism for dispersal. Rare long-distance dispersal events may be facilitated by migrating waterfowl.

In Nova Scotia, lake-to-lake dispersal may be a limiting factor, given the species' restriction to two connected lake systems despite extensive suitable lakeshore habitat further south in the province. Unoccupied but apparently suitable habitat near known sites was observed in 2007 on Molega Lake and several nearby lakes. The best example of this was at Black Rattle Lake, where Redroot was absent from suitable habitat although separated from abundant populations around Molega Lake by only 170 m of upland. Whether this apparent limitation is a consequence of poor dispersal of the seeds, limited seed production or some other factor is unclear, although the limited seed production seems most likely given the observed infrequency of flowering.

Interspecific interactions

Lachnanthes caroliniana is an important food plant for waterfowl in areas where it is abundant (Landers 1976). The only other documented interspecific interactions of *L. caroliniana* relate to the photodynamic toxins. Darwin (1872) documented reports from farmers (most likely from Florida, see Dupree 1951) indicating that white pigs were susceptible to these toxins, while black pigs were not. Biochemical investigations revealed a number of photodynamic pigments are present in the tissues of the plant, most concentrated in the seed capsules (Kornfeld and Edwards 1972, Edwards and Weiss 1974). These compounds are toxic to some herbivorous insects.

Physiology/Adaptability

Gerritsen and Greening (1989) reported that in an *ex situ* experiment on germination from marsh soil seed banks in southern Georgia: A) under a moist then inundated treatment, Redroot seedling germination was significantly increased by addition of nitrogen plus phosphorus and seedling growth was significantly increased by addition of nitrogen and nitrogen plus phosphorus; B) under an inundated treatment, Redroot seedling growth was significantly increased by addition of phosphorus and significantly decreased by addition of nitrogen. However, it is unlikely that such treatments would benefit *in situ* populations of *L. caroliniana*, as nutrient enrichment would likely be of greater benefit to more competitive species (Hill and Keddy 1992, Wisheu *et al.* 1994, Wisheu and Keddy 1994). No other physiological information is available for *L. caroliniana*, beyond what is reported above relating to germination conditions and secondary chemicals.

POPULATION SIZES AND TRENDS

Search effort

The occurrence of Atlantic Coastal Plain flora in southern Nova Scotia has been well documented since Fernald's expeditions (Fernald 1921, 1922). These expeditions did not visit the Ponhook-Molega Lakes area and Redroot was not discovered in Nova Scotia until 1941 (Weatherby 1942). Fairly extensive floristic work focused on coastal plain flora in southern Nova Scotia has been undertaken starting in the 1950s to the 1970s (Roland and Smith 1969). Detailed studies on the ecology, distribution and local diversity of Nova Scotian coastal plain flora have focused on conservation implications (Keddy 1984, 1989, Keddy and Wisheu 1989, Wisheu and Keddy 1991, Hill and Keddy 1992, Wisheu and Keddy 1994, Wisheu *et al.* 1994, Holt *et al.* 1995, Morris *et al*. 2002). There have also been recent floristic and conservation studies (i.e., Eaton and Boates 2003, Blaney 2002, 2004, 2005a, 2005b). In 2007-08, Blaney and Smith surveyed 16 potential lakes within 15 km of Ponhook and Molega Lakes specifically looking for Redroot (Figure 4) but found it only at Beavertail Lake (connected to Molega Lake) and First Christopher Lake (connected to Cameron Lake), both of which represented less than 1 km extensions of the known range. In all, botanists capable of identifying vegetative plants have probably spent well over one hundred field days within Redroot's potential range. Search effort is sufficient to conclude that the species is rare within the coastal plain zone of Nova Scotia and not likely present on the lakes of the lower Tusket River system in extreme southwest Nova Scotia. There are still many lakes around the Ponhook-Molega region and in more remote areas southward that have had little or no botanical survey. It is possible that additional populations could be found, especially since small, infertile populations of the species are cryptic. However, few of the less surveyed lakes have the combination of characteristics (natural water levels, large size and low position in their watersheds) identified as being most associated with Redroot (Hill and Keddy 1992), although with only two adjacent populations, it is difficult to determine exactly how important lake size and watershed position are for Redroot in Nova Scotia.

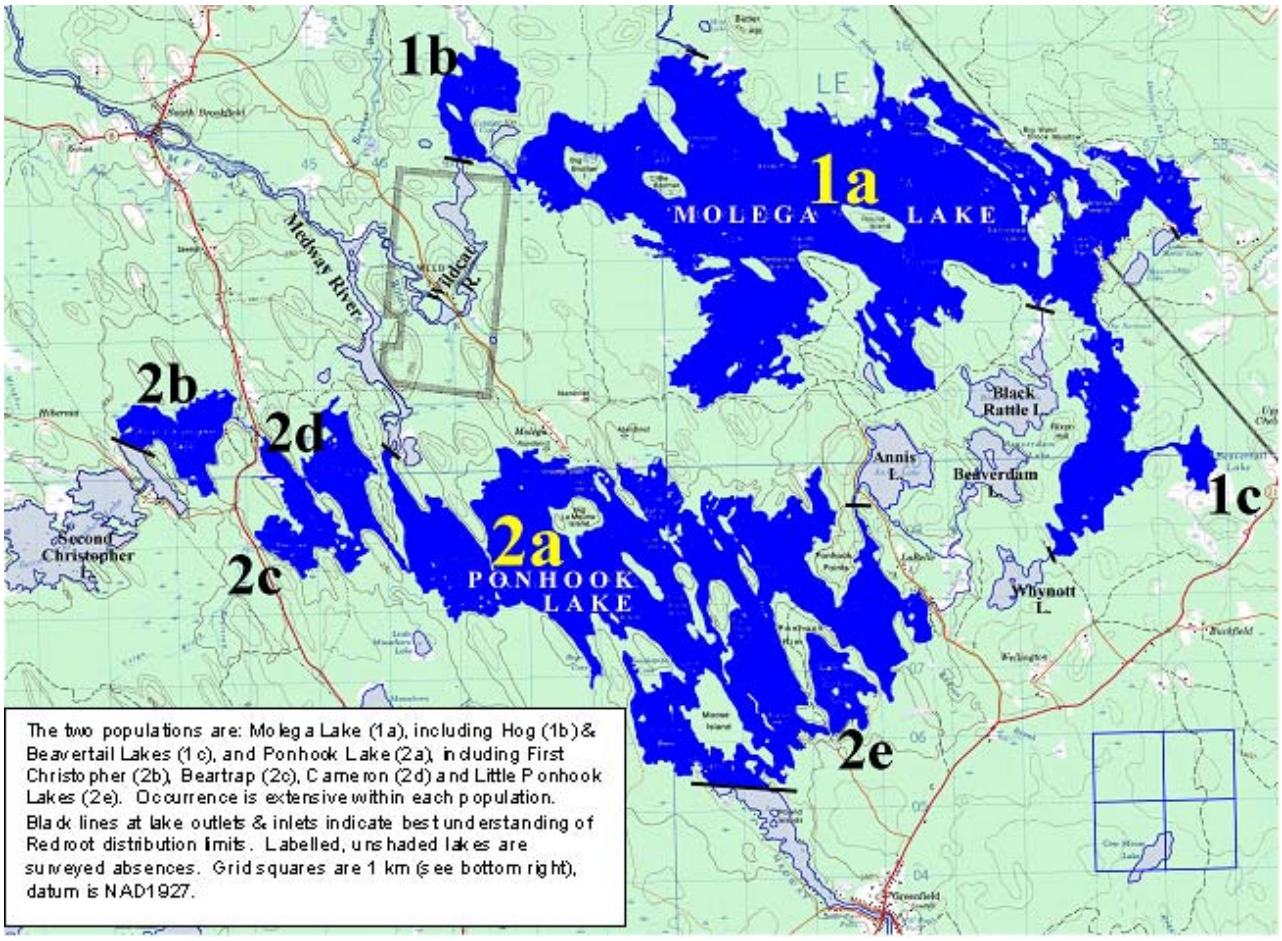

Figure 4. Map of lakes (dark shading) supporting Redroot in Nova Scotia.

Number of populations

This report divides the many Redroot locations into two populations: 1) Ponhook Lake (including the adjacent First Christopher, Beartrap, Cameron and Little Ponhook Lakes – 151 mapped occurrences, AC CDC 2009); and 2) Molega Lake (including the adjacent Hog Lake and Beavertail Lakes – 114 mapped occurrences, AC CDC 2009). These precise occurrences, mapped on the basis of linear segments of 10 m width, cover <20% of shorelines for Molega population lakes and <10% of Ponhook population lake shorelines. These two lake systems are connected via 9 km of the Wildcat and Medway Rivers, most of which is persistently unsuitable habitat. It is conceivable that seeds (or less likely, vegetative fragments) could flow downstream from Molega to Ponhook Lake with all occurrences possibly representing a single population. However, two separate populations are recognized following the standard used by conservation data centres' the "Habitat-based plant element occurrence delimitation guidelines" of NatureServe (2004). Under these guidelines, occurrences sharing "linear water-current flow in the same riparian/shore system" are considered a single population if they are separated by < 3 km (following water flow) of persistently unsuitable habitat.

The number of locations, as determined under COSEWIC/IUCN definition based on the most serious threat, residential development along the shoreline of lakes with Redroot present, cannot be readily determined. Not all of these shorelines have been surveyed in detail but based on the known occurrences and the considerable extent of shoreline that has not been surveyed, the total number of locations exceeds threshold values for assessment criteria.

Abundance

A) Ponhook Lake population

Redroot is widespread and locally very abundant on Ponhook and Cameron Lakes and locally common on Beartrap Lake. Numbers were small (under 100) at First Christopher Lake in 2008 but the full lakeshore has not been surveyed. There is no recent population information from Little Ponhook Lake but numbers recorded there in the past were small (between 105 and 1000 plants, C. Keddy 1989). On the northwest shore of Ponhook Lake, up to about 100 plants per metre of shorefront were recorded in a zone of occurrence 2-3 m wide, and numbers averaged at least 25 per metre of shoreline over 2 km sampled in this area. Some areas at the heads of bays in this area of the lake had zones of occupied habitat more than 10 m wide and probably had more than 100 plants per metre of shoreline, but counting plants in these areas was difficult and was not attempted. Therefore there are an estimated 50,000 plants over a habitat that probably makes up at least 10% of the entire shoreline of the Ponhook Lake occurrence, with much of the remaining shoreline being somewhat less ideal for Redroot but still supporting significant numbers of plants with some areas possibly having higher densities. A rough but probably conservative estimate for the Ponhook Lake population is thus 500,000 stems. In 1998, David MacKinnon (Nova Scotia Department of Environment and Labour, unpublished field notes) estimated 100,000 to 500,000 over 200 m of shoreline on Ponhook Lake not sampled in 2007. This would be a much higher density than any sites visited in 2007 and may be somewhat overestimated, but does support the idea that the 500,000 estimate for the whole lake is conservative, perhaps substantially so.

B) Molega Lake population

Redroot is widespread and locally common on Molega and Hog Lakes and uncommon on Beavertail Lake. There are long stretches of shoreline in the southern part of Molega Lake, especially on the southwest side, where there are few plants or none. There are also large stretches on the north shore that probably support plants but were not surveyed in 2007 or in earlier fieldwork (David MacKinnon, 1998 unpublished field data in ACCDC 2009, Cathy Keddy 1989). In 1998, MacKinnon found a dense population at the west end of the lake. He estimated 100,000 to 500,000 stems over about 500 m. This number may be somewhat overestimated, but taking the lower value and extrapolating 2007 observed densities (10-20 plants per metre of shoreline on two one kilometre stretches representing not more than 20% of good habitat on Molega Lake), gives a rough estimate of 175,000 to 250,000 stems for the whole population.

This could still be an underestimate if high density occurrences are widespread in the northern part of the lake.

C) Total population

It is unclear what proportion of the large numbers of infertile plants observed were potentially reproductive (sexually or asexually). Many smaller, infertile plants included in the estimate of 675,000 to 750,000 stems were likely too immature to flower but most (perhaps 80%$^{+}$) may have been of sufficient age to produce asexual shoots. Many other infertile plants were of sizes similar to plants observed in flower, suggesting they were probably mature. The authors observed only 153 flowering plants in 2007, out of a conservatively estimated 100,000. This ratio multiplied by the total population estimate gives an estimated flowering population of 1,033 to 1,148 plants. However, for status assessment purposes based on COSEWIC/IUCN guidelines, all shoots of sufficient maturity that could possibly reproduce either asexually or sexually must be included in a count of total mature individuals. It is assumed that a large proportion, perhaps 540,000 to 600,000 (80%$^{+}$) of the total count estimate might be considered sufficiently mature to be included as mature individuals. This clearly exceeds the upper critical value for criteria assessment.

Fluctuations and trends

There is no evidence of large year-to-year population fluctuations in Nova Scotia or elsewhere, though Redroot's detectability can vary with water levels (Keddy 1986, 1989). Given that the Nova Scotia population is mostly vegetative and the species is adapted to persist under fluctuating water levels, it would likely take an especially long series of very dry or wet growing seasons to influence the population substantially.

Existing data are inadequate to assess precisely population trends. Keddy (1989) reported between 33,700 and 112,900 stems in the Ponhook population and between 3,500 and 15,200 stems in the Molega population. The large differences between these and current estimates resulted from Keddy reporting only observed plants (confirmed by Keddy, pers. comm. 2008). Present writers extrapolated values across the whole area of occupancy. Blaney noted a plant density of 60/m^2 on the isolated tip of Maplesue Point [on Molega Lake]. This density of stems is slightly higher than the highest density recorded in that area in 2007 (30-50/m^2) but does not necessarily suggest any change in numbers as 2007 surveys were averaged over larger areas that could have reduced the numerical effects of very densely populated local areas within them.

Numbers of flowering plants found in different studies have been similar [100 flowering out of 39,000 to 119,000 by Keddy (1989), 200 flowering out of tens of thousands by Wisheu *et al*. (1994) and 153 out of roughly 100,000 in 2007 (Blaney and Smith data in ACCDC 2009)]. It is likely, however, that ongoing development of new shoreline properties and intensification of development on existing shoreline properties is causing a slow but steady population decline that will continue in the foreseeable future. Past or future declines in habitat area would likely be substantially less than 30% over three generations (15 years).

Rescue effect

The next nearest Redroot populations are 500 km to the southwest on Cape Cod, Massachusetts with most of that distance being across open ocean. There is only a remote chance of dispersal via migrating waterfowl across that distance; consequently the potential for a rescue effect from outside Canada is likely negligible.

LIMITING FACTORS AND THREATS

Shoreline development

Shoreline development is the most serious threat to Redroot populations. There are likely several hundred cottages having Redroot on their properties and more are built every year. Observations of shoreline conditions indicate that where Redroot populations and cottage or residential development coincide, there is most often some loss of population and habitat. Impacts of shoreline development vary by property, from nearly complete destruction of natural habitat to minimal impact. Most commonly, cottagers use a portion of their shorefront intensively for docks, boat launches, patios or swimming areas that reduce or eliminate redroot populations. The remaining shorefront is used less intensively in ways that could allow persistence of some Redroot plants. In most cases there are also relatively undisturbed portions of shoreline between adjacent cottages. Impacts of shoreline alteration are not limited to newly constructed cottages. Existing development sites continue to add “improvements” over time and the authors observed numerous instances of established cottages having recent infilling or hardening of shorelines, dumping of sand or gravel for beaches or boat launches, construction of docks and manicuring of shoreline vegetation.

The total percentage of highly altered shoreline is still low (estimated 5.9% or less lost to Redroot). Shoreline development is unlikely to eliminate Redroot entirely from any of the lakes on which it occurs, but 89% of available habitat is in private hands and new development and intensification of existing development is likely to continue to cause slow decline in populations and habitat quality through the foreseeable future.

Shoreline residential development is the major threat to the species. However, such a threat encompasses not only the physical destruction or disturbance of shoreline habitat when houses and other structures are built, but includes the cumulative effect, over time, of a suite of impacts resulting from intensive urbanization of the lakeshores. Such impacts include eutrophication, increased ATV use, potential pressure by cottage owners for stabilized water levels, and influx of exotic species, all potential effects of increased population levels. Infrequent flowering may also contribute to the rarity of the species in Nova Scotia.

Eutrophication

Wisheu *et al.* (1994), Wisheu and Keddy (1994) and Hill and Keddy (1992) all emphasized the dependence of *L. caroliniana* and other coastal plain species on nutrient poor habitats. Eutrophication from agriculture and/or urbanization had a detrimental impact on coastal plain plant communities in Long Island and New Jersey (Zaremba and Lamont 1993, Ehrenfeld 1983) and eutrophication from both residential and agricultural sources was identified as a concern for Nova Scotia coastal plain species (Eaton and Boates 2003 and Eaton *et al*. 2007). Agriculture is limited but plans for intensification of housing development within the immediate vicinity of Redroot lakes and in their larger watersheds have already been submitted. Nutrient inputs through septic systems and lawn fertilization will undoubtedly escalate in association with increased shoreline development on Redroot lakes. There is no evidence, presently, that eutrophication is impacting the shoreline flora.

Off-road vehicle traffic

Off-road vehicle traffic has been identified as a threat to coastal plain flora in Nova Scotia (Wisheu and Keddy 1994 and Eaton *et al*. 2007). Wisheu and Keddy (1994) suggest that ATV disturbance could be especially problematic for coastal plain shoreline species with lower growth rates than competitors and those poorly represented in the seed bank. The extent to which this applies to Redroot in Nova Scotia is unknown. ATV use on shorelines did not appear to be extensive in 2007, probably because much of the shore is too rocky and narrow and the lakes tend to have good gravel roads around their margins. Where regular ATV use was obvious, Redroot plants were locally damaged and occasionally uprooted but populations did not appear to be affected substantially, with effects on the overall population minimal. In North Carolina, Redroot is noted as especially abundant in disturbances such as ruts and ditches within its habitat (R. LeBlond, pers. comm. 2008), so the species could even benefit from limited ATV disturbance. With increased urbanization of Redroot lakes, ATV use will likely increase although its impact is uncertain.

Altered water levels

Many coastal plain lakeshore species require fluctuating water levels to create habitat that is not dominated by more competitive species (Wisheu and Keddy 1994, Schneider 1994). Stabilization of water levels is widely recognized as a threat to coastal plain shoreline flora (Keddy and Reznicek 1982, Zaremba and Lamont 1993, Wisheu and Keddy 1994, Eaton *et al.* 2007). Keddy (1989) identified damming for hydroelectric power at the Ponhook Lake outlet as a possible threat to Redroot, but this is not currently being considered by Nova Scotia Power (M. Allen, pers. comm. 2008). The hydroelectric dam that created Lake Rossignol out of a series of large lakes on the Mersey River west of Ponhook Lake in the 1920s could have flooded Redroot populations.

Exotic species

Exotic species, especially when combined with eutrophication, are a possible threat to Nova Scotia's coastal plain flora (Wisheu and Keddy 1994, Eaton *et al*. 2007). The nutrient-poor, fluctuating shorelines inhabited by Redroot and other Atlantic coastal plain species appear to be very resistant to invasion by exotic species in the absence of eutrophication or artificial water level manipulation (Hill *et al.* 1998, Blaney *et al*. data in Eaton and Boates 2003, Hill and Blaney 2007). No invasive species likely to affect Redroot directly were found in 2007. A substantial increase in urbanization planned for the region may, in the coming decades, in association with eutrophication, promote the spread of exotic species that do not appear to be an issue at present.

Infrequent flowering and low rates of seed production and dispersal

The low rate of flowering noted by Keddy (1991, 1994), David MacKinnon (unpublished field data) and in 2007 fieldwork could be a natural limiting factor. The cause is unknown but seeds appeared to be developing normally in the few flowering plants checked in 2007. The simplest, though far from only, explanation is that the Nova Scotia climate is so marginal for Redroot that few plants are able to flower in any given year. The rate of seed production in Nova Scotia is unclear but is much lower than in Florida and North Carolina where flowering is noted as being common or abundant (B. Herring and R. LeBlond, pers. comm. 2008). Any lack of seed production is obviously not preventing persistence of large numbers of plants at the known sites. Observed patterns of distribution, however, suggest something limits dispersal and spread within Nova Scotia, with lack of seed production the likely cause. There is much unoccupied but apparently suitable habitat both very near to known sites and around lakes further south in Nova Scotia.

SPECIAL SIGNIFICANCE OF THE SPECIES

Redroot is biogeographically interesting, even among the many Atlantic Coastal Plain disjuncts in southern Nova Scotia, because of its strongly southern distribution in its American range. Being highly disjunct at the extreme northern limits of the species' distribution, the Canadian population could be significant to the genetic diversity of the species. Native Americans, especially the Seminoles of Florida, used the plant as a narcotic and in treating a variety of ailments (Millspaugh 1887). Todd Labrador (pers. comm. 2008) from the Acadia First Nation did not know of any traditional uses of the plant or any band members likely to have knowledge of the plant but Laurie Lacey (pers. comm. 2008), author of *Micmac Medicines*, was familiar with the species, differentiating it from Bloodroot (*Sanguinaria canadensis*) and he mentioned that one elder he had interviewed years ago knew Redroot as a dye plant and a medicine. Redroot extracts have been shown to have a phototoxic effect on microorganisms (Kornfeld and Edwards 1972). Redroot's unusual biochemistry has also been investigated in a number of studies (Cooke 1970, Edwards and Weiss, 1970, 1972, 1974, Kornfeld and Edwards 1972, Edwards *et al.* 1972, Bazan and Edwards 1976).

Further work could reveal useful properties for economic exploitation. Redroot is an important waterfowl food source in the US (Landers 1976), but due to its rarity it is probably not important in that regard in Canada.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

NatureServe subnational S-ranks and provincial or state status designations are given in Table 1. On the southwest margin of its range, Redroot just enters eastern Louisiana and is rare. It is ranked as not rare from Mississippi to North Carolina and in southern New Jersey, but otherwise rare in all states and provinces of occurrence, with provincial/state status designations in Nova Scotia, Tennessee, New York, Connecticut, Rhode Island and Massachusetts.

The species was assessed by COSEWIC as Threatened in May 2000. It is currently is listed in Canada as Threatened under the *Species at Risk Act* and is on Schedule 1 of the Species at Risk Public Registry (Government of Canada 2009). The species has been designated Threatened under the Nova Scotia *Endangered Species Act* (Nova Scotia Department of Natural Resources 2009). These acts provide legal protection from destruction for the species and its habitat on both public and private land.

TECHNICAL SUMMARY

Lachnanthes caroliniana
Redroot Lachnanthe de Caroline
Range of occurrence in Canada: Nova Scotia

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2008) is being used)	3-5 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	<6%
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	<6%
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	<6%
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown but perhaps at least 6%
Are the causes of the decline clearly reversible and understood and ceased? Habitat loss through shoreline development	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	117 km²
Index of area of occupancy (IAO) Actual area occupied is less than 1.15 km^2 (233 km shoreline x 5 m average width although it is likely less because undetermined stretches of the shorelines are not suitable habitat)	95 km² (1x1 km grid) 132 km² (2x2 km grid)
Is the total population severely fragmented?	No
Number of “locations” (as per definition, in relation to threat) Based on the most serious threat, residential development of the shoreline and an incomplete survey of all shorelines within Redroot lakes, it is difficult to determine the number of locations that may be represented. However, these likely exceed assessment criteria maxima.	Greater than assessment criteria maxima.
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	No (stable)
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	No
Is there an [observed, inferred, or projected] continuing decline in number of populations?	No
Is there an [observed, inferred, or projected] continuing decline in number of locations?	No
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?	Decline (<6%) in area and decline in quality
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations (as per definition, in terms of threat)?	No
Are there extreme fluctuations in extent of occurrence?	No

Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
1) Ponhook Lake – ~770 flowering, ~500,000 vegetative 2) Molega Lake – ~270 to 380 flowering, ~175,000 to 250,000 vegetative	~400,000 ~140,000 to 200,000
Total ~1,040 to 1,150 flowering, ~675,000 to 750,000 vegetative. Likely a large proportion (80%$^{+}$) of the estimated total shoots should be considered as mature individuals based primarily on the ability to reproduce asexually.	~540,000 to 600,000

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	None available

Threats (actual or imminent, to populations or habitats)

Habitat degradation and loss through shoreline development for cottages or residences.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: nearest populations small and threatened (NY, S1; MA, S3)	
Is immigration known or possible?	Unlikely
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Likely
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Special Concern (November 2009)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	Not applicable

Reasons for designation:

A highly disjunct Atlantic Coastal Plain species restricted in Canada mainly to two connected, extensive, lakeshore populations in southern Nova Scotia. Comprehensive new surveys and other information indicate that the risk of extinction for this species is less than previously thought. Its lakeshore habitat has been subject to slow but steady loss and decline in quality due to cottage and residential development for 30 to 40 years. Losses are likely to continue through the foreseeable future with new development and intensification of existing development, but the proportion of habitat currently developed is still low and the species' locally widespread occurrence and asexual reproduction mitigates the threat of extirpation in the short term.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Uncertain of declines or increases due to much more extensive surveys in recent years.
Criterion B (Small Distribution Range and Decline or Fluctuation): EO and IAO are below threshold values for Endangered but the number of locations could not be determined because of uncertainty over the extent of shoreline impact due to development of recreational properties planned within the species' habitat. Extreme fluctuations of EO, IAO or number of individuals do not occur.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population size is too large.
Criterion D (Very Small Population or Restricted Distribution): Not applicable. Population size and IAO are too large and the number of locations could not be determined with certainty.
Criterion E (Quantitative Analysis): None available.

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AUTHORITIES CONSULTED

Atlantic Canada Conservation Data Centre Database, Sackville, NB (regarding previously documented occurrences)

Dr. Sherman Boates, Manager, Wildlife Resources – Biodiversity, Nova Scotia Department of Natural Resouces (regarding shoreline alteration permitting and coastal plain flora recovery planning)

Wendy Connors, Planning Assistant/Development Officer with the Region of Queens Municipality (regarding development on Redroot lakes)

Alain Filion, COSEWIC Secretariat (regarding mapping extent of occurrence and area of occupancy)

Gloria Goulet, Aboriginal Traditional Knowledge Coordinator, COSEWIC Secretariat (regarding sources for Aboriginal traditional knowledge of Redroot)

Brenda Herring, Botanist, Florida Natural Areas Inventory (regarding Redroot habitat and ecology in Florida)

Dr. Nicholas Hill, Bellingham, WA. Plant ecologist and researcher on coastal plain flora in Nova Scotia (regarding Redroot populations on Ponhook Lake)

Dr. Paul Keddy and Cathy Keddy, Ponchatoula, LA. Plant ecologists and researchers on coastal plain flora in Nova Scotia (regarding Redroot populations in Nova Scotia and habitat use in Louisiana)

Todd Labrador, Acadia First Nation (regarding Acadia band property and Aboriginal traditional knowledge)

Laurie Lacey, Expert on Mi'kmaq medicines (regarding Aboriginal traditional knowledge)

Richard LeBlond, Botanist, North Carolina Natural Heritage Program (regarding Redroot habitat and ecology in North Carolina)

David MacKinnon, Ecological Planner, Nova Scotia Department of Environment and Labour, Protected Areas Branch (regarding protected areas designations on Redroot lakes and field notes on Redroot)

Michael Allen, Environmental Specialist, Environmental Operations and Approvals, Nova Scotia Power (regarding possible hydroelectric damming of the Medway River)

Steve Young, Botanist, New York Natural Heritage Program (regarding New York occurrences)

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Kartesz, J.T. 2007

BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Sean Blaney is the Botanist and Assistant Director of the Atlantic Canada Conservation Data Centre (AC CDC), where he is responsible for maintaining status ranks and a rare plant occurrence database for plants in each of the three Maritime provinces. Since beginning with the AC CDC in 1999, he has conducted an extensive fieldwork program across the Maritimes region, discovering dozens of new provincial records for vascular plants and documenting several thousand rare plant locations. Sean is also a member of the COSEWIC Vascular Plant Species Specialist Subcommittee, the Nova Scotia Atlantic Coastal Plain Flora Recovery Team, and has co-authored several COSEWIC and provincial status reports. Prior to employment with AC CDC, Sean received a B.Sc. in Biology (Botany Minor) from the University of Guelph and an M.Sc. in Plant Ecology from the University of Toronto, and worked on a number of biological inventory projects in Ontario as well as spending eight summers as a naturalist in Algonquin Park, where he co-authored the second edition of the park's plant checklist.

Tyler Smith, at the time of report preparation, was a post-doctoral fellow at Saint Mary's University. He received a B.Sc. in Ecology (Botany Minor) from the University of Guelph and a Ph.D. in Plant Science from McGill University. His dissertation research was an investigation of the systematics and niche evolution of a group of *Carex* species, and included extensive fieldwork across eastern North America, traditional and molecular taxonomic research, and niche analysis based on fieldwork and herbarium collections. Tyler was the field botanist for Royal Botanical Gardens in Hamilton, Ontario, from 1998 to 2002. While there he managed the herbarium collection, directed the vegetation component of the Cootes Paradise wetland restoration, and conducted an extensive program of floristic and conservation research. He was a member of the *Morus rubra* recovery team, and chaired the recovery team for *Trichophorum planifolium*. He has co-authored several COSEWIC reports, as well as the recovery strategy for *Trichophorum planifolium.*

COLLECTIONS EXAMINED

Redroot collections from the E.C. Smith Herbarium, Acadia University (ACAD) and the Nova Scotia Museum of Natural History had already been databased by the Atlantic Canada Conservation Data Centre prior to this report. No further collections were examined.