

**Nova Scotia Provincial Status Report**

on

**Ram's-Head Lady Slipper**  
**(*Cypripedium arietinum* R. Br.)**

prepared for

**Nova Scotia Species at Risk Working Group**

by

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## EXECUTIVE SUMMARY

### Species information

Ram's-head Lady Slipper (*Cypripedium arietinum*) is a small, herbaceous, perennial, orchid of open forests. Stems are 15-30 cm high and bear three to four (rarely five) narrowly ovate leaves. Flowers are solitary (rarely 2) and relatively small for the genus, with the sac-like lip petal of the flower white above, and purple to crimson below and is elongated into a downward-pointing, conical shape.

### Distribution

Ram's-head Lady Slipper occurs in east-central North America, concentrated in the Great Lakes-Saint Lawrence region, but extending from Nova Scotia, Maine and southern Quebec to central Saskatchewan, south to New England, New York, Michigan, Wisconsin and Minnesota. The species' southern limit is near the Great Lakes from Wisconsin to Connecticut (latitude ~42°N) and its northern limit is in Saskatchewan and Manitoba (latitude ~53°N). The species is considered extirpated from Connecticut and rare (S3) to extremely rare (S1) in each of the 14 jurisdictions where it presently occurs. In Nova Scotia it is known from five sites in West Hants Regional Municipality, all within 9 km of the hamlet of Poplar Grove, plus one site at Angevine Lake in northeast Cumberland County.

### Habitat

Ram's-head Lady Slipper is found in moderately open forests possessing cool, sub-acid or neutral soils. In Nova Scotia, it is largely associated with gypsum bedrock, and is found in moderately open, mesic woods on outcrops, cliff tops, river banks, moderate to steep slopes and in sinkholes. Forest cover at known sites includes deciduous-dominated, conifer-dominated and mixed stands of young-intermediate to mature forest. Elsewhere in its range, the species is also known from conifer swamps and fens, and open forests on limestone bedrock.

### Biology

Based on information from other lady slipper species, this species is likely relatively long-lived, maturing 10 to 16 years after germination and potentially living many years longer than that. Vegetative reproduction from basal offshoots is common. It flowers mid-May to mid-June and is an obligate out-breeder, pollinated by small and mid-sized bees. Seeds are very tiny and have the potential to disperse relatively long distances by wind, water or animals. As with most orchids, the seeds are dependent on the presence of a compatible fungal partner to initiate germination and seedling development.

### Population Sizes and Trends

The total counted population is 1344+ stems at six sites. One site has only two stems known, but all other sites have 124 to 487 stems known. Counts likely underestimate actual populations to some degree, as plants are often thinly dispersed over fairly wide areas making complete counts difficult. Numbers at known sites seem relatively stable at present, but the development of large gypsum mines over the past three generations (45-75 years) is estimated to have reduced populations by 59%. Additional undocumented

population reductions are likely to have occurred in the same time period with other habitat alterations and losses. These reductions are on top of that caused by historic land conversion in the region, which removed an estimated 40% of the suitable habitat available prior to European settlement.

### **Limiting Factors and Threats**

Gypsum mining, forestry and cattle grazing are demonstrated threats at particular known sites. Competition with exotic species, particularly the sedge *Carex flacca*, may be a threat at some sites. All terrain vehicle traffic is a potential, local threat and housing or other development could affect populations not yet discovered.

### **Special Significance of the Species**

Nova Scotia represents the easternmost occurrence for the species. Populations are over 330 km disjunct from the next closest site in Maine, and could thus be genetically distinct. The species' flower structure is unique among North American lady slippers and is considered structurally primitive. Ram's-head Lady Slipper is much appreciated for its beauty and is cultivated by some orchid enthusiasts. It may be available commercially from specialized growers. The species could possess useful medicinal qualities. *Cypripedium* species have been used historically or are presently contributing to the treatment of joint inflammation, menstrual pains, neuralgia and epilepsy.

### **Existing Protection**

Five of six Nova Scotia occurrences are on private land, with the other on crown land. No Nova Scotia occurrences have specific protection.

## SPECIES INFORMATION

### Name and Classification

Scientific name:	<i>Cypripedium arietinum</i> R.Br.
Common name:	Ram's-head lady slipper, Ram's-head, Ram's-head orchid
Synonymy:	<i>Arietinum americanum</i> L.C. Beck. <i>Criosanthes arietina</i> (Ait.f.) House. <i>Criosanthes arietinum</i> (R.Br.) House. <i>Criosanthes borealis</i> Raf.
Family:	Orchidaceae
Order:	Orchidales
Class:	Monocot

### Description

The following description has been derived from a number of sources, most notably Case (1964), Marie-Victorin (1964), Luer (1975), Case (1987), Gleason and Cronquist (1991), Cribb (1997) and Sabourin *et al* (1999). Figure 1 is a whole plant photograph illustrating some of the characters described.

Ram's-head Lady Slipper is a small, pubescent perennial species, producing short rhizomes with long, fibrous root systems. The above-ground parts of this species consist of solitary or clustered erect stems varying in height from 15 to 30 cm for floriferous plants and 5 to 15 cm for vegetative plants. The inconspicuously glandular-pubescent stems generally bear three to four (rarely five) elliptic-lanceolate to narrowly ovate bluish-green leaves. Leaves are finely ciliate and otherwise glabrous with undulate margins, 5 to 10 cm in length by 1.5 to 3.5 cm in width, and are spiraled around the stem and often folded. Floral bracts are ovate-lanceolate, 3 to 5 cm in length by 1 to 1.5 cm in width and ascend above the flower. Flowers are solitary (rarely 2), relatively small for the genus and give off a slight fragrance reminiscent of vanilla. The lip petal of the flower is saccate and prolonged downward into a conical shape, with its orifice densely long-pubescent with silky hairs. The lip pouch, 1.5 to 2.5 cm long by 1 to 2 cm wide, is white above and reticulated with purple to crimson (sometimes also with green) below. The staminode is suborbicular and concave in shape and the seed capsule is ellipsoid, approximately 2 cm in length, inflated and relatively less erect than that of most other species in the genus. Sepals are free to their base, a brownish-purple or green-streaked in color, the dorsal 1.5 to 2.5 cm in length by 1 to 2 cm in width, forming a hood above the pouch and often laying over it after pollination has occurred. The two lateral sepals are linear-lanceolate, 1.5 to 2 cm in length by 0.2 to 0.5 cm in width, and twist downward and away. Lateral petals are similar to lateral sepals but are narrower, 0.1 to 0.2 cm. Chromosome number is  $2n=20$ , similar to all eastern *Cypripedium* species (Case 1994).

Although overall size of plants and all parts can vary considerably according to habitat, with those of wet soils usually much larger, the species is easily identifiable when in flower. Viewed from the side, the lip petal somewhat resembles the head of a ram, hence

the species' scientific and common names. Vegetative plants can be confused with a number of species growing in similar habitats, particularly Yellow Lady Slipper (*Cypripedium parviflorum*) and Eastern Helleborine (*Epipactis helleborine*), a species of Eurasian origin introduced in Nova Scotia. Although both of these species are uncommon to rare overall in Nova Scotia, both commonly co-occur with Nova Scotia populations of Ram's-head Lady Slipper. Both *Cypripedium* species flower in late May and June while Eastern Helleborine flowers in July.

## **DISTRIBUTION**

### **Global range**

Ram's-head Lady Slipper is native to east-central North America, where it is concentrated in the Great Lakes-Saint Lawrence region. Its range extends from Nova Scotia, Maine and southern Quebec to central Saskatchewan, south to New England, New York, Michigan, Wisconsin and Minnesota (Figure 2). The species' reaches its southern limit near the Great Lakes from Wisconsin to Connecticut (approximate latitude 42°) and its northernmost limit in Saskatchewan and Manitoba (approximate latitude 53°). Occurrences are most concentrated in the areas surrounding Lake Huron and Lake Michigan. Many reported occurrences are historic or extirpated and the species is considered extirpated from the state of Connecticut (Dowhan 1979, Cook 1992). Ram's-head Lady Slipper is considered rare (S3) to extremely rare (S1) in all of the 14 jurisdictions where it presently occurs. Table 1 gives conservation status for Ram's-head Lady Slipper throughout its range.

### **Distribution in Canada**

In Canada, the Ram's-head Lady Slipper occurs in east-central Saskatchewan, southern Manitoba, northwestern and southern Ontario, southern Quebec, north to the Clay Belt region adjacent along the border with northeastern Ontario and to Anticosti Island and in central Nova Scotia. The great majority of Canadian occurrences are concentrated between southern Lake Huron and the St. Lawrence River in southern Ontario and southwestern Quebec. It has not been found in New Brunswick, although it occurs in Maine and Nova Scotia relatively close to New Brunswick's borders and it may yet be found.



**Figure 1.** Ram's-head Lady Slipper (*Cypripedium arietinum*) (Photo: Janet Novak, used with permission).



**Figure 2.** Global range of Ram's-head Lady Slipper (*Cypripedium arietinum*), modified from *Flora of North America* (Sheviak 2003). Red dots are additional known locations. The northern boundary of Quebec range has been altered because it was overestimated in the original.

**Table 1.** Range-wide conservation status of Ram’s-head Lady Slipper. S-ranks are from the NatureServe Explorer website ([www.natureserve.org/explorer](http://www.natureserve.org/explorer), October 25, 2006). Numbers of occurrences are from province and state heritage program websites, accessed October 25, 2006, except for those marked with an asterisk, which are from a survey of natural heritage programs by Brzeskiewicz (2000), and may have changed since that time. Where present, province or state level status designations are given after S-ranks. Global rank is G3. National Status ranks are N3 in Canada and the United States.

<b>Jurisdiction</b>	<b>S-rank - Province/State Designation where present (#occurrences)</b>
Nova Scotia	S2 (6 occurrences)
Quebec	S2 – Vulnerable (38 occurrences, 33 seen in last 25 years)
Ontario	S3 (93 occurrences, 35 historic, 4 extirpated)
Manitoba	S2? (4 occurrences*)
Saskatchewan	S1 (known from 6 municipalities)
Connecticut	SH (1 historic occurrence)
Maine	S1 - Endangered (17 occurrences, 9 historic)
Massachusetts	S1 - Endangered (7 occurrences*)
Michigan	S3 (81 occurrences, 35 seen since 1982)
Minnesota	S2 - Threatened (62 occurrences*)
New Hampshire	S2 - Endangered (14 occurrences, only 3 seen since 1986)
New York	S2 - Threatened (15 extant occurrences, 22 historic*)
Vermont	S2S3 - Threatened (51 occurrences*)
Wisconsin	S2 - Threatened (25 occurrences*)

### **Distribution in Nova Scotia**

#### *Presently known distribution*

Ram’s-head Lady Slipper was first reported for Nova Scotia in 1954 from near Meadow Pond, south of the Wentworth Creek gypsum quarry (Erskine 1954, location confirmed by Ruth Newell, who was shown the site by Rachel Erskine in 1982). There are now six distinct and extant Ram’s-head Lady Slipper populations known in Nova Scotia, all of which have been observed since 1999. These are: 1. Meadow Pond, 2. St. Croix River International Biological Program (IBP) Site, 3. Weir Brook, 4. Poplar Grove, 5. Cogmagun River, and 6. Angevine Lake. Two records from the 1950s from “east side of Gore Road, Brooklyn” and “Ellerhouse Brook”, and a 1988 record from “Garlands Crossing” cannot be located with complete certainty but are considered here under the St. Croix River IBP, Weir Brook and Meadow Pond occurrences respectively. The St. Croix IBP and Weir Brook sites are separated by approximately 2.8 km, but they may have been connected historically, as suitable habitat would have been continuous along the gypsum bluffs between the sites. Atlantic Canada Conservation Data Centre (AC CDC) fieldwork in 2004 showed that Ram’s-head Lady Slipper was absent on at least 1 km of gypsum slope between the sites that was heavily grazed by cattle, and they are therefore considered separate sites. The Poplar Grove occurrence includes records separated by more than 1 km, but suitable habitat is likely present between the records and there are no surveys to indicate a lack of plants between them. One additional report, from Pronych and Wilson (1991), lists the species as occurring in the 10 km UTM grid square centred

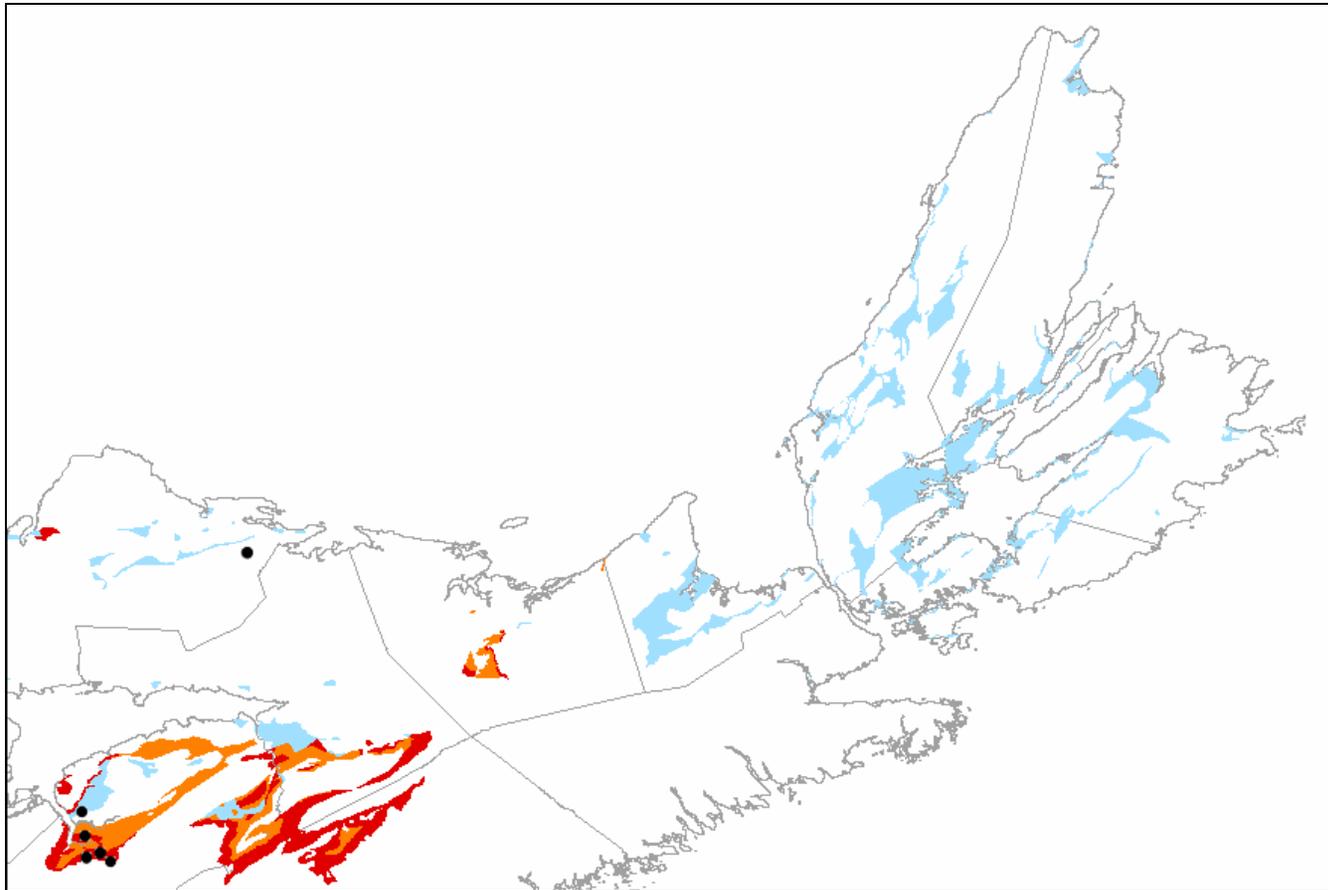
near Avonport Station. We have been unable to find any basis for this report and consider it to be in error until supporting details can be provided. The first five of the confirmed populations are in northwestern Hants County within a 9 km radius of the settlement of Poplar Grove, in the general vicinity of Windsor. The Angevine Lake population is 90 km northeast of this area in northeastern Cumberland County.

A map of the Nova Scotia locations of Ram's-head Lady Slipper is provided in Figure 3, with a detailed map of western Hants County locations provided in Figure 4. Nova Scotia records are summarized in Table 2.

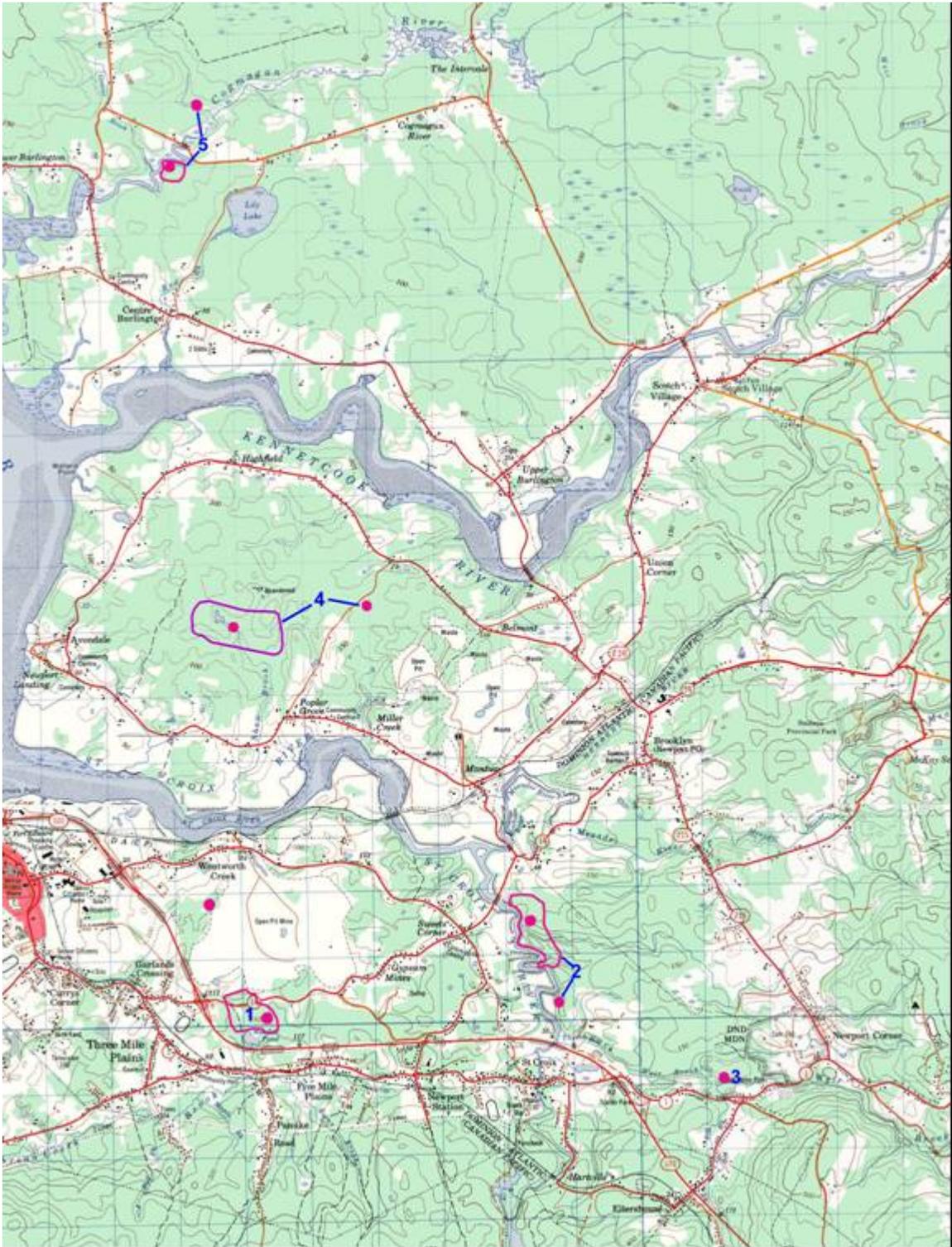
*Survey effort and potential for additional sites*

Ram's-head Lady Slipper is of substantial interest to the small community of botanists in Nova Scotia, and there have been many botanists' outings to known sites, some informal effort to find additional sites, and two days of targeted AC CDC fieldwork in the Oxford area in 2004, and six days of targeted fieldwork on behalf of Fundy Gypsum around the Meadow Pond, Poplar Grove and St. Croix River sites in 2006. Areas of gypsum bedrock, especially outcrops, generally attract botanists' attention because of the many rare plants they support, so provincial coverage of the species' habitat is better than for many other species. The level of search effort by Nova Scotia botanists is certainly sufficient to determine that Ram's-head Lady Slipper is very rare in the province, even within its specialized habitat. However, most gypsum areas, even those in western Hants around the known locations, have likely not been surveyed comprehensively for the species. Also, while locations of gypsum outcrops and cliffs are generally well known, Ram's-head Lady Slipper sites in Nova Scotia are mostly not on the outcrops themselves but rather in forested areas nearby, making them harder to pinpoint using GIS and local knowledge. New sites similar to the Angevine Lake site would be even more cryptic to find by GIS since there are no nearby gypsum outcrops or karst topography, and there is nothing obviously distinctive about the forest community or bedrock geology where the species occurs.

Thus, although undoubtedly a very rare plant in Nova Scotia, there is some potential for additional Ram's-head Lady Slipper sites to be found with further targeted searching. Virtually all of Nova Scotia is within the zone of climatic tolerance of the species, given that it occurs three degrees above the latitude of northern Cape Breton within the Gulf of St. Lawrence at Anticosti Island, Quebec. The western Hants County and Angevine Lake occurrences are highly disjunct from the next nearest populations in Maine and the existence of this level of disjunction suggests that suitable habitat anywhere in Nova Scotia has some possibility of supporting Ram's-head Lady Slipper. The most likely locations for new populations are central mainland gypsum outcrops in western Hants and northern Halifax counties, in the Maitland - Brookfield - Shubenacadie - Musquodoboit region and in the area around Oxford in Cumberland County. Limestone bedrock sites, especially those in the Windsor area, could also support Ram's-head Lady Slipper occurrences as they do elsewhere in the species' range. Gypsum or limestone areas further from known sites, as around Antigonish or in Cape Breton should also be considered as a secondary priority if broader surveys for the species are undertaken. Figure 3 indicates gypsum and limestone bedrock areas of Nova Scotia in relation to known Ram's-head Lady Slipper occurrences.



**Figure 3.** Map of Ram's-head Lady Slipper occurrences in Nova Scotia (dots) with Windsor Group bedrock. Red (darkest shading) indicates the highest potential areas of Middle and Lower Windsor Group bedrock, which is predominantly gypsum and limestone. Orange (medium shading) is bedrock of the Upper Windsor Group which includes only minor occurrences of gypsum and limestone, and is thus less likely to support the species. Blue (palest shading) is unspecified Windsor Group bedrock for which high or low potential for occurrence cannot be specified. Gypsum is almost entirely restricted in Nova Scotia to Windsor Group bedrock but limestone occurs much more widely on mainland Nova Scotia, often as an uncommon and unmapped component of other bedrock groups. Potential habitat on limestone is therefore more widely present than is mapped here.



**Figure 4.** Map of Ram's-head Lady Slipper distribution in western Hants County. Pink dots are central points of occurrences. Pink polygons delimit concentrations of documented occurrences, and undocumented plants may extend beyond these boundaries. Occurrence numbers correspond to those in Table 2 and Table 3.

**Table 2.** Populations and most recent observations at current Ram’s-head Lady Slipper sites. Site numbers correspond to those mapped in Figure 4, except for number 6 - Angevine Lake, which is the northern site mapped in Figure 3.

Site	Most recently observed	Minimum # stems	Comments on Count
1. Meadow Pond	2006	487	Precise counts from Sean Blaney, Tom Neily, Art Crowell & Bernard Forsythe. Ruth Newell also saw “a small number”, counted here as 15, in at least one area different from all other counts.
2. St. Croix River IBP Site	2006	308	Precise counts from Sean Blaney, Tom Neily & Lawrence Benjamin.
3. Weir Brook	1999	2	Precise count from Art Crowell. 1956 Erskine record from “Ellerhouse Bk.” gives no population numbers, but was likely >2 at the time of collection.
4. Poplar Grove	2006	124+	Precise count from Tom Neily.
5. Cogmagun River	2006	282+	Precise count from Tom Neily.
6. Angevine Lake	2002	141	Precise count from Ross Hall, probably representing all or nearly all plants at this site.
<b>TOTAL</b>		<b>1344+</b>	

## HABITAT

### Habitat requirements

Ram’s-head Lady Slipper is generally found in areas possessing cool, sub-acid or neutral soils (Brackley 1985, Case 1964, Cribb 1997). Cool soils seem to play an important part in defining its range, as it is found in cold bogs or cool, north-facing bluffs in the southern part of its range (Penskar & Higman 1999, Brzeskiewicz 2000). Habitat preference varies considerably across Ram’s-head Lady Slipper range, as do the species found in association. Three general habitat types have been identified:

- 1) Cool, dense cedar - balsam fir - spruce - tamarack swamps or more open fens with the same tree species (Case 1964, Brackley 1985, Sabourin *et al.* 1999, Brzeskiewicz 2000),
- 2) Nearly pure sand over limestone beach cobble or bedrock, mulched with the needles of coniferous trees such as pine, cedar or juniper (Case 1964, Brzeskiewicz 2000) and
- 3) Mesic soil of sandy loam, or clay under the partial shade of mixed hardwood/conifer forest (Brower 1977, Sabourin *et al.* 1999, Brzeskiewicz 2000), sometimes in thin soils over limestone or gypsum bedrock (Whiting and Catling 1986, Roland and Smith 1969), as is the case in Nova Scotia.

Although it grows to its largest size in swamps or bogs, where it is usually found as a single stem, the species is most abundant in the drier upland habitats, where it can often

be found growing in many-stemmed clumps (Case 1964). Populations are known from both mineral-rich and mineral-poor sites, with soils of clay, loam (Smith 1981) or sand (Case 1964) in upland sites and nutrient-poor peat in lowland sites (Ostlie 1990). When found in drier upland areas, the species is often reported to favor moderate slopes or ledges on slopes (Rousseau 1974, Bouchard *et al.* 1983, Brackley 1985, Ostlie 1990), sometimes near water (Sabourin *et al.* 1999, Atwood 1984). Stand age where populations occur is varied, but Ram's-head Lady Slipper appears to prefer second growth mid-successional forests formed from old disturbance such as wind throw or fire (Brzeskiewicz 2000). It can also occupy areas such as ice-scoured shores (Atwood 1984), wind-blown ledges, lake bluffs and abandoned pastures (Fleming 2000).

Openings in the forest canopy are important. The species occurs in areas with forest cover ranging from 30% to 80% (Sabourin *et al.* 1999), and plant size and percentage of sexually reproductive individuals are higher in habitats of lower percent canopy cover (Fleming 2000). Full exposure can, however, be detrimental to the species, particularly if this raises soil temperatures over 25°C (Correll 1950, Cash 1991). Element occurrence data gathered from throughout Ram's-head Lady Slipper's range indicate that it requires at least partial canopy cover (Brzeskiewicz 2000). The largest concentrations can therefore be expected to occur under moderately open forest canopies. A common feature of most sites is an open, uncrowded understory with low competition from other species (Alverson and Solheim 1980). On Quebec population sites, soil pH varies from alkaline to slightly acidic with an average of 6.8 (Sabourin *et al.* 1999). Uppermost soil horizons are often acidified by an accumulation of conifer needles while the lower tend to be more alkaline due to underlying calcareous rock (Sabourin *et al.* 1999). Cribb (1997) found that in propagation attempts, best results were obtained at a pH of 6.0.

In Nova Scotia, the species is strongly associated with gypsum bedrock, and is found growing in moderately open, mesic woods on outcrops, shaded tops of cliffs, terraces, moderate to steep wooded slopes and in sinkholes (Erskine 1954, Pronych and Wilson 1993, AC CDC database records). Forest cover at known sites includes deciduous-dominated, conifer-dominated and mixed stands of young-intermediate to mature forest. Tree species noted as present in the field are large-toothed aspen, beech, white birch, black cherry, balsam fir, hemlock, red maple, sugar maple, white pine, red spruce, white spruce, and red oak. All locations except for the one at Angevine Lake, Cumberland County are from areas having extensive surface exposures of Windsor Group gypsum bedrock nearby and, with the exception of the Cogmagun site, having karst topography. No bedrock of any type is exposed at the Angevine Lake site, which shows little or no evidence of basic soils in its flora. Bedrock geology maps show that site to be of the Late Carboniferous Cumberland Group on the boundary of the Malagash and Ragged Reef Formations, which are predominantly sandstones with rare limestone beds (Keppie 2000, Ryan & Boehner 2006).

Remotely classified forest inventory information (received from Lawrence Benjamin, NS DNR Kentville), for known sites (n = 20 stands) indicated 11 were in mixed forest, 6 were in hardwood dominated stands and 3 were in softwood dominated stands. First or second dominant trees were as follows (n = 20 stands, each with first and second

dominants): intolerant hardwoods (16 stands), tolerant hardwoods, eastern hemlock and other softwoods (each from 4 stands), trembling and/or largetooth aspen and red and/or black spruce (each from 3 stands), white spruce, balsam fir, and other hardwoods (each from 2 stands). White pine was also listed as a third or fourth dominant in three stands. Forest age was classified, based on estimated tree height, as 31 to 96 years (n = 12 stands, average = 64 years, values here include addition of 14 years from the 1992 assessment; 8 mixed age stands were excluded). Crown closure was between 30% and 75% (n = 20 stands, average 64%). Seven occurrences were mapped in sites classified as non-forested, but this probably reflects imprecise geolocations or forest mapping, rather than use of open habitats by the lady slipper.

Potentially suitable conditions for Ram's-head Lady Slipper (i.e. open forest with limestone or gypsum bedrock close to the surface) only occur in a small fraction of the landscape, but there are relatively large areas of apparently suitable forest on gypsum, including areas quite close to existing populations, which are unoccupied by the species. This patchy distribution within apparently suitable habitat could be due to many factors, but it may relate to the fact that orchid germination and development are dependent on the presence of a compatible and possibly highly specific mycobiont (Zelmer *et al.* 1996, Rasmussen 2002, Shefferson 2005).

### **Habitat Trends**

Suitable habitat for Ram's-head Lady Slipper was undoubtedly formerly more contiguous and extensive before European settlement. The occurrences in western Hants County occur within a landscape substantially fragmented by agricultural, residential and industrial development. GIS data show that 40% of upland on potentially gypsum-bearing bedrock (Early Carboniferous bedrock in the Windsor Group) around West Hants occurrences<sup>1</sup> is unforested as a consequence of conversion to human use (GIS data from Lawrence Benjamin, NS DNR Kentville). Most of this habitat conversion likely took place within 50-100 years of initial European settlement, and is therefore outside the maximum 75 year window for consideration here (three times average age of reproductive individuals, estimated at 15-25 years), but it likely has substantially reduced Ram's-head Lady Slipper populations.

The following factors are considered relevant to the extent of Ram's-head Lady Slipper habitat for the period from 75 years ago to 10 years into the future (1931-2016) in the western Hants County area of occupancy. With the exception of gypsum mining, the trends outlined below are generally applicable to other areas that might support populations in Colchester, Cumberland and Halifax Counties.

#### *Gypsum mining*

Gypsum mining has occurred in Hants County since 1770, initially with many small mines operated primarily by farmers (Adams 1991). The industry expanded substantially in the mid-1900s, becoming dominated by large, industrial operators (Adams 1991).

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<sup>1</sup> Figure based on calculation within 20km of hamlet of Poplar Grove, which is roughly central to the West Hants occurrences of Ram's-head Lady Slipper.

Presently, gypsum mining within the known Nova Scotia range of Ram's-head Lady Slipper is restricted to large quarries at Millers Creek (near the Poplar Grove occurrence) and Wentworth Creek (immediately adjacent to the northern portion of the Meadow Pond occurrence). These quarries produce 1.7 million tonnes of gypsum annually (Adams 1991), and are slowly expanding in area. Two recent gypsum mining-related impacts on habitat are known. An old road was upgraded in 2005 or 2006 at the Meadow Pond site, within occupied habitat north of Highway 14, though the area affected may not have supported any plants. Recent forest cutting and exploratory drilling for gypsum mining has taken place within the Poplar Grove population (Mark Elderkin, NS DNR Kentville, pers. comm.). Test drilling sites on Fundy Gypsum lands at Poplar Grove were pre-screened for above-ground presence of Ram's-head Lady Slipper (Peter Oram and Elizabeth Cameron, Conestoga-Rovers and Associates, pers. comm.), so any effect was likely primarily on habitat rather than population.

Over the longer term, the Millers Creek, Wentworth Creek and MacKay Section quarries have certainly removed suitable habitat for Ram's-head Lady Slipper. The area of these three active or recent gypsum quarries is 790 ha, representing 2.4% of gypsum bearing bedrock (Carboniferous age bedrock of the Windsor Group) within 20km of Poplar Grove (Lawrence Benjamin, NS DNR Kentville, pers. comm.). The 2.4% figure can thus serve as a minimum estimate of the proportion of potential Ram's-head Lady Slipper habitat lost to gypsum mining in the past 75 years. The proportion of *occupied* habitat removed by the three quarries is likely significantly greater than that, because most of the known occurrences are clustered near the quarries and much of the potentially suitable habitat identified in the above analysis may never have supported Ram's-head Lady Slipper.

#### *Forestry*

Effects of forestry on Ram's-head Lady Slipper are likely to vary with harvesting techniques and intensity. The species is evidently somewhat tolerant of post-harvest conditions, at least those that prevailed in the past, because seven records are found in forest estimated to be under 75 years old (GIS data from Lawrence Benjamin, NS DNR Kentville). Modern clear cutting using heavy equipment has, however, been widely identified elsewhere as a threat to habitat and populations (Ostlie 1990, Sabourin *et al.* 1999, Fleming 2000, Brzeskiewicz 2000). Forest harvesting on private land is common in West Hants, as it is throughout Nova Scotia. Only 2.1% of forest on Windsor Group bedrock within 20km of Poplar Grove is estimated at over 75 years old and 27.0% is considered "mixed age", which may also include older forest (GIS data from Lawrence Benjamin, NS DNR Kentville). Thus a minimum of 71% of private land forest potentially supporting Ram's-head Lady Slipper has been subject to clear-cutting or heavy harvesting in the past 75 years. The rate of clear-cutting in that same region from 1982-1992 was 1.8% of total forest cover per year (GIS data from Lawrence Benjamin, NS DNR Kentville), suggesting that any private land sites have a roughly 18% likelihood of being subjected to clear-cutting in the next 10 years.

### *Residential and other development*

Due to distance from roads, ownership by gypsum companies or rugged, sinkhole terrain, none of the known Ram's-head Lady Slipper sites seem likely to be immediately threatened by residential development, but undiscovered sites could have been impacted or could be impacted by new building. Rural population in the Municipality of West Hants was stable between 1996 and 2001 (census statistics cited in NS Federation of Agriculture 2002), but has been increasing since, associated with rapid growth in Halifax Regional Municipality (Clayton Research 2004). Between 2001 and 2005, an average of 66 new residential development permits were issued by the municipality, 58% of which were in unserviced rural areas away from designated growth centres at Falmouth and Five Mile Plains (Windsor - West Hants Planning Department 2005). Other significant developments affecting potential habitat in the vicinity of known Ram's-head Lady Slipper sites include the twinning of Highway 101 over approximately 16 km from St. Croix to Mount Denson (in progress in 2006-07) and construction of the Coyote Hill Golf Course at Newport Corner.

### *Cattle grazing*

Only the southern portion of the St. Croix River IBP Site appears to be influenced by cattle grazing, although cattle are grazed near the Poplar Grove and the Weir Brook sites. Most of the rural land not owned by gypsum companies within the West Hants range of Ram's-head Lady Slipper is farmer-owned. West Hants Municipality had 68 beef, dairy and mixed livestock farms in 2001 (NS Federation of Agriculture 2002), and there is thus a reasonable likelihood that undiscovered populations of Ram's-head Lady Slipper are or were formerly present on other grazed land. Impacts of cattle grazing on Ram's-head Lady Slipper are likely decreasing slightly since the number of beef, dairy and mixed livestock farms in Halifax and Hants Counties decreased by 18% between 1996 and 2001 (NS Federation of Agriculture 2002).

### **Protection/ownership**

All five occurrences in western Hants County are on private land. Most of the Poplar Grove site and all of the Meadow Pond site are owned by gypsum mining companies. The Angevine Lake site is on provincial crown land. There is no specific protection for any of the Nova Scotia occurrences of Ram's-head Lady Slipper, but sites are in the NS Department of Natural Resources Significant Habitats Database, so the presence of Ram's-head Lady Slipper would be made known in any environmental assessment screening process in which Department of Natural Resources was involved.

## **BIOLOGY**

### **Life cycle and reproduction**

Ram's-head Lady Slipper is a spring-flowering perennial species first emerging in early May. Emergence of leaves and leaf expansion occurs in mid-May to early June.

Flowering generally begins in late May and ends in mid to late June, extending over a two to four week period. Flowering period varies year to year, as does the percentage of plants bearing flowers. Percentage of flowering individuals in populations has been noted to vary from 22 to 44% in a Wisconsin study referred to by Ostlie (1990), from 10% to 85% in a Quebec study (Sabourin *et al.* 1999) and from 4 to 96% in a study carried out in New England (Fleming 2000). Flowers can persist up to a week if pollination does not occur and temperature remains cool (Luer 1975, Case 1989). Because plants vary from year to year in terms of size and capacity to produce flowers, these characteristics are not useful in determining the age of specific plants (Bender 1989). According to Bender (1989), plants attaining a height of 11 cm or more generally flower, but tend to remain vegetative the following year. Although presently unknown, time between germination and first flowering could be comparable to other lady slipper species and therefore range between 10 and 16 years (CDPNQ 2006).

Ram's-head Lady Slipper appears for the most part to reproduce vegetatively via offshoots from parent plants (Brower 1977, Ostlie 1990). Plants also reproduce sexually but with less success, in part because they are obligate outbreeders and depend on the presence of appropriate insect species to accomplish cross-pollination. As an attractant to potential pollinators, a light, sweet, vanilla-like odor is produced by the lateral petals, sepals and labellum (Stoutamire 1967). The labellum plays a greater role in odor production in Ram's-head Lady Slipper than any other local species within the genus (Stoutamire 1967). Plants in bloom attract pollinators by producing this fragrance but offer no nectar in reward, and are thus an example of "food-deceptive" flowers (Gumbert and Kunze 2001). Crimson spots and reticulations on the floral structures also act as significant visual attractants and false nectar guides (Kull 1999). As has been observed with several other food-deceptive orchids, bees may learn to avoid the species, thus making pollination less likely (Gumbert and Kunze 2001). Such plants therefore exhibit strong visual and olfactory signals to elicit high spontaneous response from pollinators (Nilsson 1983), with pollination tending to be carried out by bees that are either inexperienced or have exhausted their preferred food sources (Gumbert and Kunze 2001).

The 1 to 2 mm entry opening near the summit of the labellum and 1 mm exit opening situated behind the anthers restrict access to smaller sized insects, while the hair-like trichomes of the labellum ensure that only insects heavy enough to push through are allowed entry (Brzeskiewicz 2000). Nothing is known of pollination in Nova Scotia, but known pollinators of Ram's-head Lady Slipper and the similarly sized Sparrow's-Egg Lady Slipper (*C. passerinum*) elsewhere are bees in the genera *Dialictus* (= *Lasioglossum*, family Halictidae, Stoutamire 1967) and *Megachile* (family Megachilidae, Van der Pijl and Dodson 1966, Keddy *et al.* 1983, Brackley 1985). In an Ontario population, Stoutamire (1967) observed *Dialictus caeruleus* and *Dialictus* sp., penetrating the labellum and emerging from the exit opening behind the anthers with pollen-covered thoraxes. Nine species of *Megachile* bees and 15 species of *Lasioglossum* subgenus *Dialictus* bees are known from Nova Scotia (Sheffield *et al.* 2003). Sheffield *et al.* (2003) list 18 genera of bees in the families Colletidae, Andrenidae, Halictidae, Mellitidae, Megachilidae and Apidae which are active in Nova Scotia in early June and

thus are potential pollinators. Flies and other insects visit Ram's-head Lady Slipper flowers as well but do not effectively contribute to pollination (Stoutamire 1967).

If the bloom is pollinated, hormones from the pollen on the stigma cause the upper sepal to drop down and seal the entry to the lip within one or two hours, preventing other insect visitors from disturbing ovary development (Case 1987). Seed capsule formation becomes apparent one to two weeks after pollination has occurred (Fleming 2000). *Cypripedium* species are known to often retain a quantity of seeds during the dormant period and release them slowly (Stoutamire 1974). In ram's-head lady slipper, seeds are produced in summer and dispersal begins in the fall, mostly starting in October and continuing through to spring and summer of the following year (Sabourin *et al.* 1999). As in other orchids, seeds are almost microscopic in size and are extremely lightweight, with air representing approximately 96% of their volume (Smith 1993). Size, weight and ability to float for extended periods of time could allow for long-distance propagation by wind or water. Brower (1977), however, suggests that seeds are probably only dispersed in relative proximity to parent plants since the species usually occurs in densely vegetated habitats. Where populations occur near water, seasonal flooding and ice scouring may contribute to propagation.

Animal-assisted dispersal is also a possibility. Sabourin *et al.* (1999) observed the species growing in proximity to white-tailed deer (*Odocoileus virginianus*) and beaver (*Castor canadensis*) activity and suggests that these species, along with snowshoe hare (*Lepus americanus*) could contribute to the dissemination of seeds.

The great seed production in orchids suggests an exceedingly high rate of mortality in seeds and seedlings (Rasmussen 2002). In addition to the challenges faced by any viable seed, such as unsuitable substrate and adverse physical conditions, orchid seeds are also dependent on the presence of a compatible, often highly specific, mycobiont to initiate germination and seedling development (Zelmer *et al.* 1996, Rasmussen 2002). These Mycorrhizal fungi also have a strong influence on plant fitness throughout life in many orchid species (Rasmussen 2002). Shefferson *et al.* (2005) and others, have shown very high specificity between *Cypripedium* species and their associated mycorrhizal fungi. This specificity could be a reason for rarity and vulnerability of Ram's-head Lady Slipper and is certainly relevant to conservation efforts.

## **Herbivory**

Field observations indicate that plants subjected to herbivory by insects or mammals frequently do not appear above ground the following year (Bender 1989). In an evaluation of extant New England occurrences in 1999, every population assessed had experienced some degree of herbivory and trampling by deer (Fleming 2000). Fleming (2000) stated that generally only a small fraction of individuals in a population were affected by predation and that trampled plants remained photosynthetic. Browsing could, however, be significant in areas with high white-tailed deer numbers, as has been noted for numerous other rare forest plants (reviewed in Russell *et al.* 2001).

Cattle grazing on Ram's-head Lady Slipper were reported by Brzeskiewicz (2000). During AC CDC field surveys of the St. Croix IBP Site population in 2004, plants were observed along the slope of the Avon River over more than 1 km, but once we crossed a property line onto similar forest habitat grazed by cattle, no further plants were found over 1 km of grazed land. It seems very likely that cattle were limiting lady slipper occurrence at this site. A portion of the Poplar Grove site is also near grazed land, but impacts of cattle have not been noted there (Ruth Newell, pers. comm.).

A field report from the Massachusetts National Heritage Program (1999) also indicated that slug predation had inhibited flowering and seed production in certain individuals. The most common slugs at many sites in the northeast are exotic species (i.e. Ferguson 2000, Davis 1990), meaning levels of slug herbivory may now be beyond historic levels. Slug populations seem extremely high in some humid forests near the Bay of Fundy, to the point of defoliating a significant portion of forest plants in the lily family (i.e. Cape Split, Sean Blaney, pers. obs.). There is, therefore, some potential that slug predation could be a limiting factor in Nova Scotia.

No specific information on other invertebrate herbivores was found during preparation of this report.

### **Physiology**

If site conditions become unfavorable, orchid species can become dormant for extended periods of time (Tamm 1972, Wells 1981, Rasmussen 1995). Although the length of dormancy for Ram's-head Lady Slipper has not been determined, average length of dormancy for *Cypripedium* species is known to be one to four years (Kery & Gregg 2004, Primack & Hall 1990). This adaptation is of particular concern for monitoring efforts. Where a large number of individuals remain dormant in the soil as seeds or root structures, the counting of above ground shoots may not give an accurate indication of population size (Shefferson *et al.* 2001).

## **POPULATION SIZES AND TRENDS**

### **Abundance**

Table 2 lists population data by site, with counts being of stems (flowering and infertile), rather than genetic individuals. Given that mature plants do not flower annually (Bender 1989), this probably is a more accurate estimation of number of mature individuals than flowering plant counts would be, even though some immature plants were likely included. The total confirmed population in Nova Scotia is a minimum of about 1344 stems. John Erskine's 1956 Ellershouse Brook record, from the general area of the Weir Brook site, likely involved different plants than the two individuals recorded below, but these plants have not been relocated. The total of 1344 stems likely underestimates actual numbers to some degree. At the Meadow Pond, St. Croix River IBP Site, Cogmagun River and Poplar Grove sites, plants are relatively widespread and very likely occur outside the areas thus far sampled and documented.

### **Fluctuations and trends**

Year-to-year fluctuation in numbers of plants appearing above ground is known in orchids, including *Cypripedium* species (Tamm 1972, Wells 1981, Rasmussen 1995, Primack & Hall 1990, Kery & Gregg 2004). The only available monitoring data indicating potential fluctuation or decline comes from Bernard Forsythe, who has recorded numbers at one portion of the Meadow Pond site (north of Highway 14) in four different years between 1998 and 2003. Numbers there went from 200 in 1998 to 60 in 2001, 75 in 2002 and 60 in 2003. It is unclear whether this represents loss of individuals, variation in above ground appearance or slight differences in survey area or methods.

Populations at known sites seem relatively stable overall at present, with recent impacts on occupied habitats appearing to have had limited effect on populations, as noted above under Habitat Trends.

### **Rescue effect**

Nova Scotia populations are peripheral and disjunct from the species' main range. The closest extant populations are in Maine over 330 km to the west. Considering what is presently known of Ram's-head Lady Slipper's dispersal potential, the possibility of interaction between Nova Scotia occurrences and out-of-province occurrences is very low. Furthermore, due to differences between preferred habitat types, it is unclear whether plants introduced from Maine populations would survive in Nova Scotia.

## **LIMITING FACTORS AND THREATS**

The specialized habitat and small area of occupancy of Ram's-head Lady Slipper in Nova Scotia are limiting factors that make it intrinsically vulnerable to extirpation. The main threats to Ram's-head Lady Slipper populations in Nova Scotia are gypsum mining and habitat loss or alteration through cattle grazing, forestry and potentially through housing or other development. Other potential threats identified from elsewhere in the species' range but not well understood or documented in Nova Scotia include loss of natural disturbance regimes causing successional change in occupied habitat, removal of plants by collectors, all terrain vehicle traffic, and high deer or non-native slug populations causing unnaturally high levels of herbivory. Competition with exotic species, especially with the sedge *Carex flacca*, may also be a factor at some Nova Scotia sites.

### *Gypsum mining*

Gypsum mining is the only threat for which a reasonable estimate of impacts on Ram's-head Lady Slipper can be made. Because of proximity of known sites to gypsum mines and because of similarity of presently occupied habitat to habitats that would have been removed by gypsum mining, it is reasonable to assume that Ram's-head Lady Slipper plants have been lost to gypsum mining within the 45-75 year time frame relevant for trend assessment here. This time frame equals three times the generation time, defined as

being the average age of reproductive individuals in the population, which is here estimated as between 15 and 25 years, based on estimated age of first reproduction being 10 to 16 years (CDPNQ 2006). The Meadow Pond occurrence is immediately adjacent to the large, active gypsum quarry at Wentworth Creek and to a former quarry that became Meadow Pond. The Poplar Grove site occurs within 800m of the Millers Creek gypsum quarry, and within an area containing several smaller, inactive quarries. These sites are largely (Poplar Grove) or entirely (Meadow Pond) owned by gypsum mining companies (property information provided by Lawrence Benjamin, NS DNR Kentville).

Most or all of the development of the Wentworth Creek and Millers Creek quarries has taken place within the last 75 years. Although gypsum mining has taken place around the Meadow Pond site for over 150 years, the Wentworth Creek quarry is known as the “newer quarry” (Adams 1991), and most of that pit’s area has likely been created in the last 75 years. The Millers Creek quarry was begun in 1956 (Adams 1991). Ram’s-head Lady Slipper population losses at these quarries are unknown because of lack of early population data, but we can estimate them based on density of plants occurring at each adjacent site (15.41 stems / ha at the Meadow Pond site and 1.55 stems / ha at the Poplar Grove site) extrapolated over current quarry areas (351 ha at Wentworth Creek and 392 ha at Millers Creek). If we assume that 30% and 50% of quarry land was formerly suitable forested habitat at Wentworth Creek and Millers Creek respectively (based on forest cover in the surrounding area), this translates to an estimated loss of 1623 stems at Wentworth Creek and 304 stems at Poplar Grove and would represent a loss of 59% of the provincial population assuming stable populations at all other sites. Another gypsum quarry at MacKay Section, begun in 1943 (Adams 1991) and closed in 1997, could have also eliminated some plants, although plants were never known from the immediate area.

The two active quarries continue to expand and Fundy Gypsum Company is investigating the potential for development of a new gypsum mine in and around the Poplar Grove population. Two recent gypsum mining-related impacts on habitat are known, but population effects appear to be small. An old road was upgraded in 2005 or 2006 at the Meadow Pond site, within occupied habitat north of Highway 14, though the area affected may not have supported any plants. Recent forest cutting and exploratory drilling for gypsum mining has taken place within the Poplar Grove population (Mark Elderkin, NS DNR Kentville, pers. comm.). Test drilling sites on Fundy Gypsum lands at Poplar Grove were pre-screened for above-ground presence of Ram’s-head Lady Slipper (Peter Oram and Elizabeth Cameron, Conestoga-Rovers and Associates, pers. comm.), so any effect was likely primarily on habitat rather than population.

#### *Cattle grazing*

As noted above under *Herbivory*, cattle grazing has almost certainly impacted the extent of the species’ occurrence at the St. Croix IBP site. Cattle graze in the vicinity of the Poplar Grove site, but appear to remain on trails in the area (Ruth Newell, pers. comm. 2006), and cattle grazing does not appear to be a threat at other known sites. It is quite possible that cattle grazing could have reduced or eliminated unrecorded populations elsewhere in western Hants County in the general vicinity of existing occurrences. This area is strongly agricultural with 68 cattle farms in 2001 (Nova Scotia Federation of

Agriculture 2002). Many of the region's farmer-owned woodlots, especially those adjacent to cleared land, were likely used for cattle grazing in the past even if they are not actively grazed at present.

### *Forestry*

Effects of forestry are likely to vary with harvesting techniques and intensity. Light selective harvesting could sometimes be beneficial or at least neutral in the longer term given that some Nova Scotia occurrences are in very young forest and occurrences rangewide are frequently in relatively open-canopy forests. Modern clear cutting using heavy equipment has, however, been widely identified elsewhere as a threat to habitat and populations (Ostlie 1990, Sabourin *et al.* 1999, Fleming 2000, Brzeskiewicz 2000). Element occurrence records across the species' range indicate a requirement for at least partial canopy cover (Brzeskiewicz 2000) and removal of forest cover can subject populations to intolerable conditions as light intensity and competition increase, soil moisture is modified and temperature fluctuations become more significant. Ram's-head Lady Slipper habitat is sometimes somewhat protected from modern clear-cutting because the abundance of sinkholes and other karst topography features limits heavy equipment access. Forest cutting has, however, been observed recently at the Poplar Grove site (Mark Elderkin, NS DNR Kentville, pers. comm.) and small-scale forest harvesting has occurred near the Weir Brook site (Sean Blaney, pers. obs.). Effects of this cutting on Ram's-head Lady Slipper populations are unknown. NS DNR forest cover data from 1992, the most recent available for the area, shows that 18% of forest on gypsum-bearing bedrock in the region of Ram's-head Lady Slipper occurrence was under 10 years old (GIS data from Lawrence Benjamin, NS DNR Kentville). This level of cutting suggests that any Ram's-head Lady Slipper plants on private land are reasonably likely to be subjected to some level of forestry activity over the short to medium term.

### *Housing and other development*

None of the currently known Ram's-head Lady Slipper sites are especially likely to be threatened by housing development, with the possible exception of the north end of the St. Croix IBP site near Highway 14, and even at this site building potential is probably limited by the abundant sinkholes. Other sites are either too far from existing roads (Cogmagun River, Poplar Grove, most of St. Croix IBP Site), isolated by gypsum cliffs (Weir Brook) or owned by gypsum mining companies (Poplar Grove - in part, Meadow Pond). The Angevine Lake site is on provincial crown land along the lake and as such is unavailable for cottage development. Rural housing development in western Hants County could certainly affect populations that have not yet been discovered. Between 2001 and 2005, the Municipality of West Hants issued an average of 66 new residential building permits per year, with 58% in rural areas (Windsor – West Hants Planning Department 2005). Rates of development may increase in future with rapid growth in Halifax Regional Municipality. Other large developments near known sites, such as the twinning of Highway 101 and the construction of the Coyote Hill golf course at Newport Corner have not affected known populations but could have affected undiscovered populations.

### *Potential Threats*

In the absence of natural disturbances that increase light availability and reduce competition for resources, development of understory vegetation and closing of the forest canopy can cause decline or extinction of populations (Bender 1989, Ostlie 1990, Sabourin *et al.* 1999, Brzeskiewicz 2000, Fleming 2000). Bernard Forsythe has noted movement of the best area for Ram's-head Lady Slipper in the Meadow Pond site by approximately 90 m in association with an increased cover of poison-ivy (*Toxicodendron rydbergii*) and young balsam fir (*Abies balsamea*). He does note, however, that the overall population appears to have remained relatively stable at this site. Bernard Forsythe has also noted an increase in poison-ivy cover at the portion of the Meadow Pond site north of Highway 14, where the population has decreased or fluctuated from 200 stems in 1998 to 60 stems in 2003 (B. Forsythe, pers. comm. to S. Blaney). Most of the Nova Scotia occurrences are in forests of relatively young age and it is possible that similar reductions could occur over time if sites develop dense, shrubby understory vegetation. Long term impacts of succession would then depend on whether populations were able to move to more suitable habitats nearby.

As noted above under *Herbivory*, white-tailed deer and slugs have been identified elsewhere as having impacts on Ram's-head Lady Slipper, but no evidence of their impacts in Nova Scotia is known. ATV trails are present in some populations, but we have no reports of damage to lady slipper plants. The exotic sedge, *Carex flacca*, is extremely abundant in some areas within forest supporting Ram's-head Lady Slipper at the Meadow Pond and St. Croix IBP sites (Sean Blaney, pers. obs.) and locally at the Poplar Grove site (Ruth Newell, pers. comm.). We do not have adequate information to determine whether this impacts the Ram's-head Lady Slipper, but the density of some of the exotic sedge patches is such that impacts are possible.

## **SPECIAL SIGNIFICANCE OF THE SPECIES**

Nova Scotia populations are unique in representing the eastern limit of the species' range and are over 330 km disjunct from the closest occurrence in Maine. Isolation by natural or anthropogenic fragmentation can have significant structural, ecological and genetic impacts on populations. Through local adaptation, the effects of isolation, genetic drift and natural selection can produce genetic and morphological divergence in peripheral populations (Lesica and Allendorf 1995, Garcia-Ramos and Kirkpatrick 1997). Acting as repositories for intraspecific diversity, these populations can have evolutionary and ecological significance that is disproportionately large relative to their numbers or proportion of overall range (Mayr 1982, Lesica and Allendorf 1995, Fraser 2000, Trenton *et al.* 2003). The genetic distinctness of Nova Scotia Ram's-head Lady Slipper populations is unknown, but should be investigated. From a monitoring point of view, boundary conditions and marginal populations can also be more effective and informative in determining species declines (Guo *et al.* 2005).

Botanically, the species is of interest because the size and shape of its labellum and free sepals are known from no other congeneric North American species. Of particular

importance is the lack of fusion of the sepals into one synsepal, which indicates that this is a structurally primitive species (Atwood 1984, Brackley 1985).

Ram's-head Lady Slipper is much appreciated for its beauty. Although relatively small, the plant is very pleasing aesthetically in its appearance and delicate fragrance. The difficulty inherent in its cultivation also represents an attractive challenge for experienced orchid gardeners (Sabourin *et al.* 1999), and it may be available commercially from a few specialized growers (e.g. Vermont Lady Slipper Company, [www.vtladyslipper.com](http://www.vtladyslipper.com)). With regards to medicine, the species could possess useful qualities. *Cypripedium* species have been used historically or are presently contributing to the treatment of joint inflammation, menstrual pains, neuralgia and epilepsy (Correll 1950, Cash 1991, Cech 2002).

## TECHNICAL SUMMARY

*Cypripedium arietinum* (L.) R.Br.

Ram's-head Lady Slipper

Range of occurrence in Nova Scotia:  
West Hants Regional Municipality and northeast Cumberland County.

<b>Extent and Area Information</b>	
<ul style="list-style-type: none"> <li>Extent of occurrence</li> </ul>	80 km <sup>2</sup> (polygon around all West Hants occurrences, excluding tidal waters, plus area of Angevine Lk occurrence)
Specify trend in EO	Stable
Are there extreme fluctuations in EO?	No
<ul style="list-style-type: none"> <li>Area of occupancy (AO) km<sup>2</sup></li> </ul>	1.84 km <sup>2</sup>
Specify trend in AO	Decline in last 3 generations. Recent declines not clearly documented.
Are there extreme fluctuations in AO?	No
<ul style="list-style-type: none"> <li>Number of known or inferred current locations</li> </ul>	6
Specify trend in #	Stable as far as is known.
Are there extreme fluctuations in number of locations?	No
<ul style="list-style-type: none"> <li>Specify trend in area, extent or quality of habitat</li> </ul>	Decline in last 3 generations. Recent habitat loss & decline in habitat quality at Poplar Grove site, with further losses anticipated due to gypsum mine expansion.

<b>Population Information</b>	
<ul style="list-style-type: none"> <li>Generation time (average age of parents in the population) (indicate years, months, days, etc.)</li> </ul>	Estimated at 15 – 25 years (based on 10 - 16 years to reach flowering in other <i>Cypripedium</i> spp.)
<ul style="list-style-type: none"> <li>Number of mature individuals (capable of reproduction) in the Nova Scotia population (or, specify a range of plausible values)</li> </ul>	1344+ stems counted
<ul style="list-style-type: none"> <li>Total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals</li> </ul>	Declining over last 3 generations. Apparently stable recently.

If decline, % decline over last/next 10 years or 3 generations, whichever is greater (or specify if for shorter period)	Estimated 59% decline due to large gypsum quarries over ~3 generations, assuming stable populations elsewhere. Likely other undocumented losses beyond this.														
Are there extreme fluctuations in number of mature individuals (>1 order of magnitude)?	No														
<ul style="list-style-type: none"> <li>List each population and the number of mature individuals in each</li> </ul> <p><i>*Note that counts are of stems rather than individuals reproducing in any one year. This probably more accurately reflects numbers since mature plants do not flower every year, though some immature plants may be included in totals.</i></p>	<table> <tr><td>1) Meadow Pond</td><td>487</td></tr> <tr><td>2) St. Croix River IBP Site</td><td>308</td></tr> <tr><td>3) Weir Brook</td><td>2</td></tr> <tr><td>4) Poplar Grove</td><td>124+</td></tr> <tr><td>5) Cogmagun River</td><td>282+</td></tr> <tr><td>6) Angevine Lake</td><td>141</td></tr> <tr><td><b>*TOTAL</b></td><td><b>*1344+</b></td></tr> </table>	1) Meadow Pond	487	2) St. Croix River IBP Site	308	3) Weir Brook	2	4) Poplar Grove	124+	5) Cogmagun River	282+	6) Angevine Lake	141	<b>*TOTAL</b>	<b>*1344+</b>
1) Meadow Pond	487														
2) St. Croix River IBP Site	308														
3) Weir Brook	2														
4) Poplar Grove	124+														
5) Cogmagun River	282+														
6) Angevine Lake	141														
<b>*TOTAL</b>	<b>*1344+</b>														
<ul style="list-style-type: none"> <li>Specify trend in number of populations (decline, stable, increasing, unknown)</li> </ul>	Stable														
<ul style="list-style-type: none"> <li>Are there extreme fluctuations in number of populations (&gt;1 order of magnitude)?</li> </ul>	No														

<b>Threats (actual or imminent threats to populations or habitats)</b>
Expansion of gypsum mines; Cattle grazing; Clear-cut forestry. Housing or other development and disturbance by all-terrain vehicle traffic are lesser threats.

<b>Rescue Effect (immigration from an outside source)</b>	Low
<ul style="list-style-type: none"> <li>Does species exist elsewhere (in Canada or outside)</li> </ul>	Yes (present in 13 other jurisdictions in northeast USA & adjacent Canada)
Status of the outside populations	Extirpated or rare and/or declining in all jurisdictions. S-ranks and provincial and state designated status ranks are given in Table 1.
Is immigration known or possible?	Unknown, but unlikely based on disjunct range.
Would immigrants be adapted to survive here?	Probably, but habitat differences could be a factor.
Is there sufficient habitat for immigrants here?	Yes

<b>Quantitative analysis</b>	N/A
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