A LARGE POPULATION OF YELLOW LADY'S SLIPPER IN A CRP GRASSLAND IN CENTRAL NORTH DAKOTA -- In 1985, the United States Congress authorized the Conservation Reserve Program (CRP) in Title XII of the Food Security Act (Public Law 99-198). The primary goals of the CRP were to decrease soil loss on highly erodible land, to reduce crop surpluses, and to improve wildlife habitat. Since its inception, the CRP has resulted in the conversion of millions of hectares of cropland to perennial cover, usually for periods of 10 to 15 years. In the early years of this program in the northern Great Plains, most cropland fields enrolled in the CRP were planted to a mixture of introduced grasses (mostly cool-season) and legumes and, to a lesser extent, common native grass species (Johnson and Schwartz 1993). Given the cropping history of these fields and the early emphasis on non-native seeding mixtures, CRP fields in this region have not been considered protected habitats or refugia for rare native plant species. Nevertheless, some CRP fields have been out of agricultural production since the late 1980's and have undergone varying levels of succession and colonization. The plant species composition in those fields might be quite different from the original seeding mixtures, and native plant species are now well established in some fields (Gill et al. 2006; Igl and Johnson, unpublished data). Although the benefits of CRP grasslands for mammals and birds are well known (e.g., Gould and Jenkins 1993, Johnson and Igl 1995), few studies have reported on the colonization of CRP grasslands by native plant species (e.g., Gill et al. 2006). In this note, we report on a large population of a rare native orchid, the yellow lady's slipper (*Cypripedium parviflorum* Salisbury), in an idle CRP field in central North Dakota.

Since 1990, staff from the United States Geological Survey's Northern Prairie Wildlife Research Center have conducted annual surveys of breeding birds in 300-400 CRP grassland fields in nine counties in North Dakota, South Dakota, Minnesota, and Montana (Johnson and Schwartz 1993, Johnson and Igl 1995). In 2001, while conducting breeding bird surveys in central Eddy County, North Dakota, we counted 40 flowering stems of yellow lady's slipper scattered in the upland vegetation in a 4.2-ha grassland field that had been enrolled in the CRP in 1989 and that has been surveyed annually for birds since 1991. This observation seemed noteworthy given that we previously had not encountered the yellow lady's slipper in this or any other CRP fields during this study and that this orchid is a species of special concern in North Dakota (ESC 1986). In subsequent years (2002-2008), we counted the number of yellow lady's slipper in that field to document changes in the flowering population.

The following methods were used to count yellow lady's slipper in the CRP field. Individual flowering stems were used as the counting unit. Anthesis (i.e., flowering) of yellow lady's slipper typically occurs in June in North Dakota (Stevens 1963), which coincides with the timing of our bird surveys (Johnson and Schwartz 1993). Available time and personnel limited the

yellow lady's slipper surveys to a single count on one day each year in late June, corresponding to the day of the grassland bird survey in this field. In sparsely populated areas of the field (i.e., ≤ 5 yellow lady's slipper flowering stems per 100 m^2), we counted individual flowering stems while we were conducting the bird survey. In densely populated areas of the field (> 5 lady's slipper flowering stems per 100 m^2), we counted flowering stems after the bird survey within a series of parallel belt transects, each 5 m wide and running in an east-west direction. This orchid species is prone to clumping (i.e., multiple stems per individual plant), and we separately tallied flowering stems that occurred in clumps of two or more flowering stems and those that occurred singly. Many non-flowering yellow lady's slipper plants and stems also were observed in 2002 through 2008, but we made no attempt to count them. Although a single stem of this orchid species rarely might support two flowers (Sheviak 2002), we used the number of flowering stems as an index of the flowering population because: 1) the vegetation in this field was fairly short and sparse, and the flowering stems typically jutted above the dominant vegetation, and 2) we did not note any cases of two-flowered stems in this population. To facilitate identification, we measured the lip length of 7 to 10 flowers per year in 2003 through 2006.

In 2001 through 2008, we counted between one and 4432 yellow lady's slipper flowering stems in the CRP field (Fig. 1). The number of flowering stems peaked in 2004. In each year, 90% or more of the flowering stems occurred in the densely populated area, which was within 3 to 15 m of the edge of two small, semipermanent wetlands near the center of the field. Seventy-five percent or more of the flowering stems in each year occurred individually, with the remaining flowering stems occurring in clumps with 2 to 43 flowering stems. No flowering stems were counted or observed within the wetland basins or wetland-associated vegetation, even in the years in which the wetlands were nearly dry (2002, 2003, and 2007) or completely dry (2006). In 2004, many of the flowers had been damaged badly by late-June frosts. In 2006 and 2007, the diminutive size and reduced number of both the plants and the flowers suggested that the orchid plants might have been stressed by prevailing dry conditions and above-average temperatures. Only one flowering stem was counted in 2007, although several hundred non-flowering plants were observed in the field. The flowering population rebounded in 2008, when nearly 3000 flowering stems were counted. Fruit capsules with seeds from the previous growing seasons were observed in 2003 through 2006, which indicated that pollination and seed production had occurred in this population in some years.

The flowers in this population typically were large (average lip length = 39.7 mm, range = 26-50 mm, n = 33); small flowers (< 30 mm) were noted in some years, especially in the recent dry years. The sepals and petals were usually marked, but not suffused, with reddish brown. The sepals and petals of some plants were

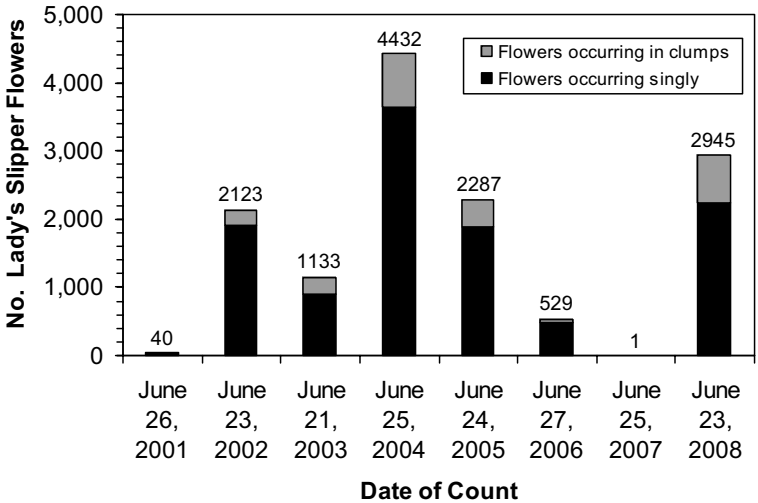

Figure 1. The number of yellow lady's slipper (*Cypripedium parviflorum* var. *pubescens*) flowering stems in a small Conservation Reserve Program field in Eddy County, North Dakota, 2001-2008.

unmarked. We noted only a faint floral fragrance or none at all. Based on morphological characteristics of the yellow lady's slipper flowers in this field, we identified the variety as *C. parviflorum* var. *pubescens* (Sheviak 2002). C. J. Sheviak (New York State Museum, Albany, personal communication) confirmed the identification of the variety based on color photographs of representative flowers and plants.

Historically, yellow lady's slippers in North America were classified as one or more varieties of a circumboreal species, *Cypripedium calceolus* Linnaeus (Sheviak 1994). In 1986, the North Dakota Chapter of The Wildlife Society (ESC 1986) included *C. calceolus* in its list of threatened species, which were defined as native species or subspecies likely to become endangered in the foreseeable future because of small populations, because the species occurs in scarce or sensitive habitats, or because of environmental deterioration. The current status of the yellow lady's slipper in North Dakota and elsewhere, however, is complicated by recent taxonomic and nomenclatural changes. North American plants are now recognized as a distinct species (*C. parviflorum*) that differ markedly from plants (*C. calceolus*) in Eurasia (Atwood 1984; Sheviak 1993, 1994, 1995). The morphological characteristics of *C. parviflorum* are quite variable under different environmental conditions and might overlap among varieties (Sheviak 1993, 1994, 1995; Mergen 2006). Currently, three varieties of *C. parviflorum* are recognized in North America, two of which occur in North Dakota (Sheviak 2002, NatureServe

2007). These include *Cypripedium parviflorum* Salisbury var. *makasin* (Farwell) Sheviak and *Cypripedium parviflorum* Salisbury var. *pubescens* (Willdenow) O. W. Knight. Given the recent taxonomic changes and uncertainty in the subspecific classification and identification, the distribution and status of these two varieties within North Dakota has not been resolved completely. NatureServe (2007) listed the current conservation status of the two varieties in North Dakota as being "not ranked/under review."

In a two-year study of native and naturalized vascular plants in Eddy, Foster, and Wells counties in North Dakota, Meinke (1991) did not collect any specimens or report any historical records of this species from these three counties. However, in the North Dakota Natural Heritage Inventory database, there is one record (10 plants) of *C. parviflorum* var. pubescens from northeastern Eddy County in 1994 (J. L. Parks, North Dakota Parks and Recreation Department, Bismarck, personal communication). The present paper confirms the presence of this variety in Eddy County. Clearly, this small CRP field supports a sizeable population of yellow lady's slipper, perhaps larger than any encountered in the state or this region. In contrast, the literature indicates that the yellow lady's slipper generally occurs in small populations that are not frequently abundant (Mergen 2006). For example, Mergen (2006) summarized known yellow lady's slipper occurrences for South Dakota, Nebraska, Kansas, Wyoming, and Colorado and found that only nine of 224 known occurrences exceeded 100 plants and only one exceeded 1000 plants. Currently, the largest population of *C. parviflorum* var. *pubescens* included in the North Dakota Natural Heritage Inventory database is 100 plants in Benson County in central North Dakota (J. L. Parks, personal communication).

Although the number of flowering stems likely provided a reasonable measure of the flowering population of yellow lady's slipper in this field, we recognize that we underestimated the overall population size by ignoring individual plants that had not flowered or that failed to produce aboveground plant parts. Population surveys of species that occur in the genus *Cypripedium* can be difficult because of prolonged development after germination, delayed onset of flowering, intermittent flowering among years, rhizomatous growth and vegetative reproduction, and mature whole-plant dormancy (i.e., aboveground shoot fails to form in one or more consecutive years) (Shefferson et al. 2001, Mergen 2006). For example, the first aerial leaf of *C. parviflorum* might appear between the first and fourth year after germination, and the first flowering shoot typically appears 7 to 13 years later (Curtis 1943, Kull 1995, Shefferson et al. 2001, Mergen 2006). Individual plants might not flower in each year (Mergen 2006), and lateral rhizomes can initiate the growth of multiple stems or ramets per individual plant or genet (Shefferson et al. 2001). Moreover, a large proportion of the adult population might become dormant each year, and individual plants might remain dormant for one or more consecutive years (Shefferson et al. 2001, Shefferson 2006). Shefferson (2006) observed dormant periods of 1 to 7 years for individual plants in this species.

Dormancy in this long lived clonal species appears to be driven largely by climatic factors and is considered a means of buffering adult survival against environmental stochasticity and stress (Shefferson et al. 2001, Shefferson 2006).

Cypripedium parviflorum var. *pubescens* typically is found in soils that have developed over a limestone- or calcareous-derived substrate (Sheviak 1995, Mergen 2006). Soils in this CRP field include Cathay-Heimdal loams (Order Mollisols) on glacial till plains; the substratum of this soil contains an accumulation of lime (Wright and Sweeney 1971). These soils are well suited for grasses and small grain crops but are poorly suited for legumes. In the years prior to being enrolled in CRP, this field was in agricultural production, primarily small grains and sunflowers (*Helianthus* sp.). In 1989, this field was planted to a mixture of smooth brome (83%; *Bromus inermis*), alfalfa (9.6%; *Medicago sativa*), and sweetclover (7.4%; *Melilotus* spp.). The field has been idle since then. In 2005, the vegetation composition consisted of 10% smooth brome, 25% Kentucky bluegrass (*Poa pratensis*), 20% goldenrod (*Solidago* spp.), 5% wheatgrass (*Agropyron* spp.), 30% litter, and 5% standing residual vegetation. The remaining 5% of vegetation composition consisted of miscellaneous plant species, including the yellow lady's slipper.

The changes in plant species composition within this CRP field are indicative of succession and colonization by both non-native and native species following profound habitat changes that accompanied cropland conversion to idle grassland cover. *Cypripedium parviflorum* was first observed in this field in 2001, 12 years after the field was converted to grassland cover and 10 years after we had begun our grassland bird surveys on this site. Although we lack information on the perennial plant species that occurred on this site during cultivation, we reasonably can infer that aboveground plant parts of *C. parviflorum* were not present at the time the field was removed from annual crop production. *Cypripedium parviflorum* generally occurs in successional habitats (Mergen 2006) but, to our knowledge, is not known to grow in annual crops. Thus, the establishment of this population likely reflects dispersal through time (i.e., dormancy of belowground plant parts, including seeds or rhizomes) or through space (i.e., short- or long-distance dispersal from a nearby population). The presence of a seed bank in *C. parviflorum* is strongly presumed in the literature (Curtis 1943, Mergen 2006), but the minute seeds of *C. parviflorum* lack nutritional reserves (Shefferson et al. 2001), and it is unlikely that seeds of this species persisted in the seed bank during many years of intensive agricultural cultivation at this site. For some species, seed viability in seed banks is affected negatively by common agricultural practices (Bekker et al. 1997, Pywell et al. 1997). Similarly, it is unlikely that dormant rhizomes persisted belowground during many years of cultivation. Although dormancy periods as long as seven years have been reported for this species (Shefferson 2006), Shefferson et al. (2001) reported that the functional dormancy length for mature plants of this species in Illinois was about 1 to 2 years, after which the probability of regrowth became minute.

A more plausible explanation for the rapid establishment of this population is seed dispersal followed by successful colonization. Individual plants of *C. parviflorum* can produce thousands of dust-like seeds that have the potential to travel long distances via wind or water and establish new populations (Light and MacConaill 1998, Mergen 2006). Successful dispersal is dependent on distance from the seed source as well as the condition of the site for colonization. The suitability of this CRP field for germination and growth can be inferred from the large population present in some years. For example, *Cypripedium* orchids exhibit high mycorrhizae specificity (Shefferson et al. 2005). Soil mycorrhizae are necessary for successful germination, seedling nutrition and development, and possibly adult dormancy (Shefferson et al. 2001, 2005; Mergen 2006). Although we do not know the location of the nearest population of yellow lady's slipper, there is no reason to assume that the distance to the nearest population is far. Many small patches of undisturbed vegetation (including wetlands) occur near this CRP field, and short-distance dispersal also is plausible.

This population of yellow lady's slipper has been protected, to a certain extent, by temporary enrollment in the CRP. Although this field has been idle for 20 years, changes in habitat over time (e.g., thatch buildup, increased competition, etc.) might necessitate some type of management to improve survival or increase numbers. Management activities and natural disturbances that benefit this species are currently unknown (Mergen 2006). Moreover, given that this is a recently established population of a rare plant species, management should proceed with caution. Anthropogenic and natural disturbances can have dramatic consequences on the population growth and dynamics of small or isolated populations of rare plant species (Coates et al. 2006). However, some management activities that might be potential threats to yellow lady's slipper also might provide a change in its environment (e.g., remove competing vegetation) that might be beneficial, up to some threshold, for plant growth, reproduction, and seedling establishment (Mergen 2006). Potential management options in this field include some activities that are permitted under the CRP, including weed control, haying, and grazing activities. Strategies to sustain or increase the number of orchids or their survival in this field also might include avoiding these management activities or disturbances during periods when orchid growth or reproduction might be affected. A greater potential threat to the persistence of this population of yellow lady's slipper is returning this field to crop production after the current CRP contract expires.

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