CONSERVATION ISSUES

Characterizing Illegal Harvest of the Venus' fly trap (*Dionaea muscipula* Ellis) at Lewis Ocean Bay Heritage Preserve, South Carolina, USA

James O. Luken

Department of Biology
P.O. Box 261954
Coastal Carolina University
Conway, SC 29528-6054, USA

Corresponding author:
joluken@coastal.edu

Natural Areas Journal 25:295–299

ABSTRACT: The Venus' fly trap (*Dionaea muscipula* Ellis) is a unique carnivorous plant listed as a Species of Concern within the native range of southeastern North Carolina and northeastern South Carolina. Although several large nature preserves support Venus' fly trap populations, illegal harvest is considered a factor in long-term population declines. Few data exist on the impacts of illegal harvest. While monitoring Venus' fly trap populations at Lewis Ocean Bay Heritage Preserve (LOBHP), South Carolina, an illegal harvest occurred during summer, 2003. This allowed an assessment of harvest impacts. Most documented populations of Venus fly traps at LOBHP had less than 50 plants. I estimated that harvesters removed 136 plants from two populations. This harvest was roughly half of the plants in both populations and represented 5.5% of the documented adult Venus' fly traps at LOBHP. Harvesters preferentially took plants with relatively larger petioles and/or relatively larger traps and overlooked smaller plants. The shift in size class distribution to smaller plants may affect future mortality and seed production. Because most human interactions with Venus' fly traps growing in nature preserves are negative, the dual goals of conservation and public access may be difficult to achieve with a single management approach. Future management for Venus' fly traps and other unique species might include high-use areas where human impacts (i.e., trampling, collecting, harvesting) are concentrated and remote low-use areas where populations are managed for long-term viability.

Index terms: carnivorous plant, Carolina Bay, collection, *Dionaea*, plant harvest, Venus' fly trap

INTRODUCTION

Even when growing in protected areas, rare and endangered plants face many threats that contribute to long-term population declines (Bratton and White 1981). Of these threats, direct use by humans (e.g., collecting, digging, and harvesting) is perhaps least understood because it is clandestine activity varying in frequency, extent, and intensity. Research on commercially valuable wild plants such as American ginseng *(Panax quinquefolium)* and wild leek (*Allium tricoccum)* suggests that even small levels of utilization may reduce populations below the extinction thresholds (Nantal et al. 1996, Van Der Voort et al. 2003). Furthermore, development and the associated habitat destruction may compound the problem of use as fewer and smaller plant populations are brought into closer proximity with humans. Thus, when use occurs, it should be studied in tandem with other factors that affect long-term population trends and should be considered as a part of the overall management approach (Lawler et al. 2002)

Schemske et al. (1994) proposed that efforts to understand conservation threats to plants must include demographic monitoring, analyses of life history stages, and the causes of variation in these stages. Plant use can potentially influence demography by removing adult plants that produce seed, by altering mortality rates, by creating soil disturbances that allow seedling establishment, by modifying plant density that in turn affects plant growth, and by reducing population size that leads to changes in genetic diversity (Freese 1997). However, it is difficult to study effects of use in the context of field experiments or demographic monitoring because low population sizes of many rare species preclude controlled removals. The human strategy of plant use and thus the demographic impact are likely determined by market forces, by population characteristics of the target species, and by the conservation status of the target species. Legal use of unprotected species can follow strict protocols for ensuring long-term population viability (Vance et al. 2001). In contrast, illegal use of protected species may involve large-scale removals with little or no consideration of long-term impacts. Impacts of plant use have been inferred by broad field surveys (McGraw et al. 2003), by post-harvest assessment (Van Der Voort et al. 2003), by examining size class distributions of confiscated plants (Nantel et al. 1996), or by estimating the size of the plant trade (Robbins 2000)

Most carnivorous plants of the Southeastern Coastal Plain have been removed from the wild by humans (Schnell 2002). These removals can generally be categorized as collections or harvests. Collections involve removal of single specimen plants that will later be propagated in gardens or greenhouses. As long as many collectors do not repeat collection through time in the same area, and as long as collectors do not focus their efforts on genetic variants, it is generally assumed that population impacts are minimal (Schnell 2002). In contrast, harvest involves large-scale removals of plants that are later placed on the market. Because of the large potential for negative change in population size and structure, harvest of carnivorous plants is generally considered a serious conservation threat (Schnell 2002).

Of the various carnivorous plants of the Southeastern Coastal Plain, the Venus' fly trap (*Dionaea muscipula*; Dionaeaceae) has perhaps been most affected by both collection and harvest (Koopowitz and Kaye 1984). Removals from the wild have been significant even though tissue culture methods allow mass propagation (Schnell 2002). There is anecdotal information regarding historical rates of Venus' fly trap harvest in North Carolina (Stolzenburg 1993). However, little information is available on the characteristics of harvest or on the demographic impacts of harvest.

This paper describes a single illegal harvest of Venus' fly traps from Lewis Ocean Bay Heritage Preserve (LOBHP) in South Carolina. Data collected prior to harvest allowed me to address the following questions. How many plants were taken relative to the total known population? Was the harvest selective in terms of plant size? And finally, how might human impacts to rare plants in nature preserves be better managed in the future?

METHODS

The Species

The Venus' fly trap is widely known around the world as a carnivorous species deriving nutrition from the capture of insects in leaves specialized as snap traps. Recent research suggests that this adaptation provides up to 75% of the nitrogen requirements (Schulze et al. 2001). The native range is a relatively small area of southeastern North Carolina and northeastern South Carolina. Within this range, the landscape is characterized by a mosaic of shrub bogs (pocosins and Carolina bays) and pine savannas and woodlands. The Venus' fly trap generally occurs at the ecotone between shrub bog and wet pine forest. It requires frequent fire to reduce the stature of the shrub canopy (Roberts and Oosting 1958).

The Venus' fly trap is not federally protected but it is a Species of Concern in North Carolina and South Carolina due to long-term population declines and development pressures on the plant's habitat. Collection and sale of the species is regulated by a permit system in North Carolina. Collection on public lands in South Carolina is illegal, but is legal on private lands. Due to recent demand in Europe spurred by purported medicinal value, the Venus' fly trap was listed as a CITES Appendix II species. Finally, the species with its snap traps is a botanical novelty and is universally in demand for educational projects and as a specimen plant in bog gardens.

The Setting

Lewis Ocean Bay Heritage Preserve in South Carolina is a 3640-ha tract of land that includes 22 Carolina bays in a matrix of pine savanna. This preserve and the Green Swamp Preserve in North Carolina are important public areas for conserving the Venus' fly trap and its associated species. Lewis Ocean Bay Heritage Preserve is located adjacent to the Grand Strand, a popular coastal tourist destination. Commercial and residential development pressures along the Grand Strand are intense and are now encroaching on all sides of LOBHP. Prescribed fire occurs in LOBHP, although frequent burning is becoming more difficult due to the proximity of residential areas. Although visitation rates to LOBHP have been historically low due to poor access, recent road improvements and zoning changes will likely bring more visitors to the preserve in the future.

Data Collection

During late July 2003, Venus' fly traps were illegally harvested from two sites, hereafter referred to as the Shrub Site and the Track Site. Prior to harvest, small permanent plots (0.25 m^2) were established at the Shrub Site where plants were mapped and placed in size categories based on petiole length. The Track Site included one of the largest Venus' fly trap populations at LOBHP. Prior to the harvest, this site was photographed in an effort to document changes in coverage of *Sphagnum* mosses. Harvest at the Shrub Site affected four adjacent plots. Harvest at the Track Site affected the entire population.

I estimated total harvest in the following ways. At the Shrub Site, number of plants removed was measured by searching for previously mapped plants. Because each plant was assigned to a size category based on petiole length, I was able to construct size class distributions for plants removed and plants remaining. At the Track Site, I counted gaps in the *Sphagnum* carpet created by plant removal. Because each gap potentially represented more than one plant, two photographed areas within the site were relocated and examined to determine whether gap number was a reliable indicator of plant number. Plants remaining at the Track Site were counted and measured in terms of leaf number, petiole length, and trap length. Characteristics of these plants were compared to plants in four reference populations not affected by harvest.

RESULTS

Of the 53 documented populations of Venus' fly traps at LOBHP, 75% are comprised of less than 50 plants. The Track Site was one of three documented populations comprised of more than 150 plants. The significance of this illegal harvest event can be cast in several ways: effects on number of populations, effects on number of plants, or effects on size-class distribution of plants. The number of populations was not affected because harvesters overlooked roughly half of the plants at each site. However, at the beginning of summer 2003, there were 2486 documented adult plants at LOBHP and this harvest reduced the known total number of plants by 5.5%.

Twenty plants were removed from plots at the Shrub Site; 25 plants were overlooked. At the Track Site, there were 103 gaps in the *Sphagnum* carpet. Examination of two photographs suggested that the number of gaps underestimated the number of plants by 11%. Thus, I estimated that 116 plants were taken from the Track Site; 111 plants were overlooked. Harvesters preferentially removed large plants from the Shrub Site, shifting the size class distribution of remaining plants to the small size classes (Figure 1). A similar impact was noted at the Track Site where remaining plants had significantly ($P<0.05$, rank sum test) smaller traps than plants from reference populations (12.1 ± 0.5 mm, n=111 for remaining plants vs. 16.0 ± 0.3 mm, n=353 for reference plants, means ± se).

DISCUSSION

Potential Impacts of Harvest

This assessment of a single illegal harvest of Venus' fly traps from LOBHP indicated that the harvester(s) focused on larger plants and left behind mostly smaller plants. Impacts of this harvest must be understood in terms of critical life history stages of the species (Schemske et al. 1994). Carnivorous plants such as the Venus' fly trap are adapted to low resource environments (Chapin et al. 1993, Brewer 2003) and have inherently slow rates of growth. It may take seedlings 3 yr. to reach the flowering stage (Roberts and Oosting 1958). Survivorship and flowering of Venus' fly traps are closely linked to plants achieving a critical trap size that allows capture of larger insects such as grasshoppers (Schulze et al. 2001). Venus' fly traps at LOBHP do not generally flower unless mean trap size exceeds 12 mm and only 30% of plants with mean trap size exceeding 12 mm produce flowers (Luken, unpubl. data). Because of illegal harvest, 80% of plants remaining at the Track Site had mean trap size less then this minimum. Assuming that mean trap size does not increase appreciably by the next growing season, it was predicted that only six plants would flower in the subsequent year (2004). Monitoring in 2004 indicated that 18 plants (16%) actually flowered at the Track Site. However, this is still a lower flowering percentage than that observed in populations not affected by harvest (Roberts and Oosting 1958; Luken, unpubl. data).

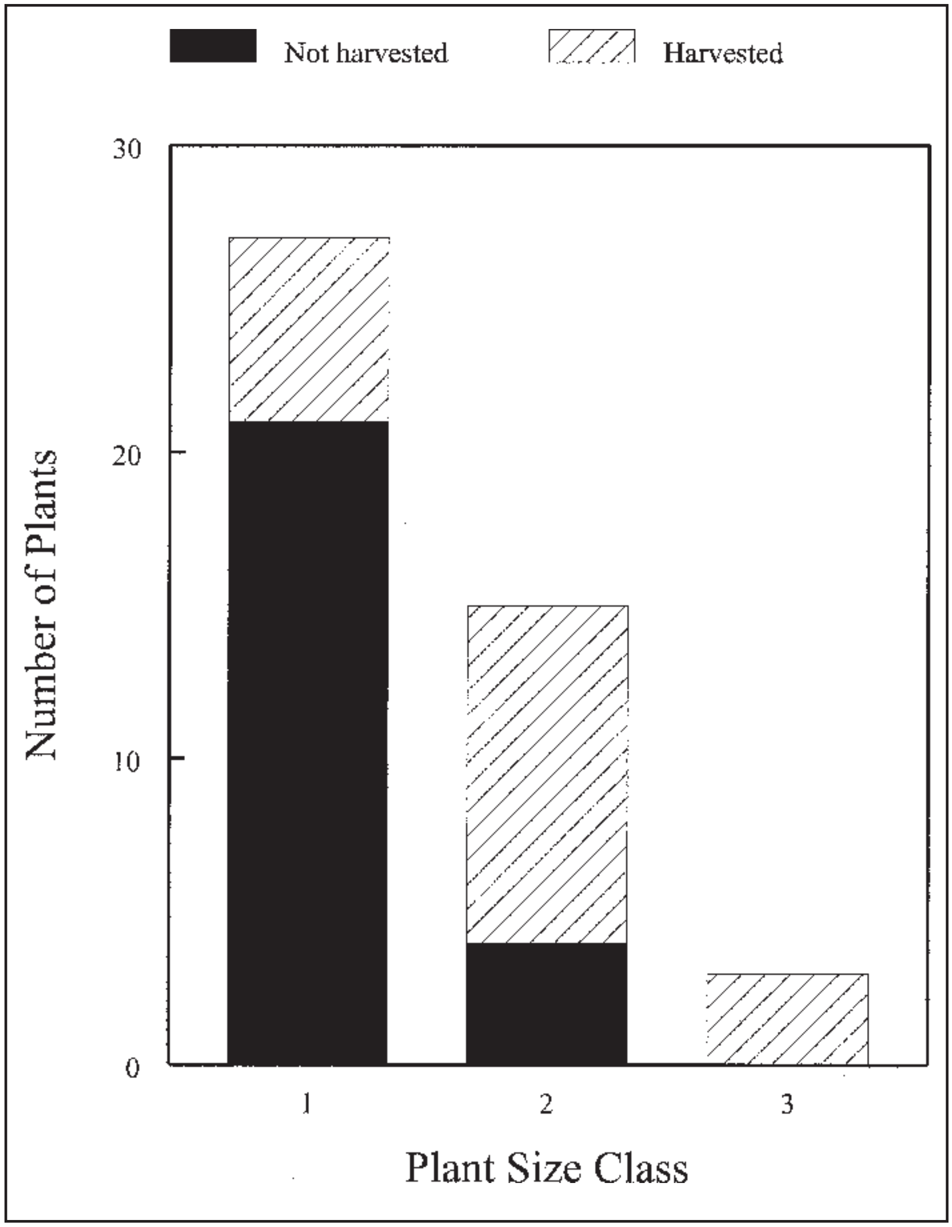

Figure 1. Size class distribution of Venus' fly trap plants measured at the Shrub Site, Lewis Ocean Bay Heritage Preserve, S.C. Plants were either removed by harvesters or not removed. Size classes were based on maximum petiole length. Size classes were as follows: 1 = 11-20 mm, 2 = 21-30 mm, 3 = 31-40 mm.

Illegal harvest of Venus' fly traps may modify population structure so that other threats have greater impacts. For example, lack of frequent fire is considered the major threat to long-term viability of Venus' fly trap populations. In the absence of frequent fire, a dense canopy of shrubs quickly forms and plants experience both light and insect limitation (Schulze et al. 2001). Although a population viability analysis was not done here due to absence of seedling recruitment data, populations comprised of smaller plants are likely to experience higher rates of mortality during times when plants are overtopped by shrubs (Schulze et al. 2001). When fires do occur, populations of smaller plants will likely have lower rates of recruitment due to limited seed availability (Roberts and Oosting 1958). Demographic analysis of another carnivorous species, *Sarracenia alata*, indicated that large reproductive individuals contribute more to population growth than do small individuals under varied fire regimens (Brewer 2001).

People and Preserves

The presence of unique species such as the Venus' fly trap poses a dilemma for preserve managers. Heritage Preserves in South Carolina and most other states exist to protect natural features and to provide for the "enjoyment" of people. Public access is maintained and interpretive information is made available. However, in the case of the Venus' fly trap, almost any effort to bring people in contact with the plant will be detrimental. The soil where Venus' fly traps grow has a high organic content and is often saturated. Foot traffic quickly creates compacted areas. The plants are relatively obscure and are susceptible to accidental trampling. When people encounter a Venus' fly trap in the wild, there is an irrepressible urge to trigger the trap. This activity may put plants under stress (Stuhlman 1948). Finally, collection and harvest are constant threats as long as people perceive that Venus' fly traps have high monetary or aesthetic value.

Boundaries of LOBHP are clearly marked and the policy forbidding plant removal is stated on a sign at the edge of the preserve. The site where plants were removed was visible from an access road. Thus, plant harvesters worked under threat of discovery, arrest, and fine. Furthermore, Venus' fly traps are difficult to locate within the matrix of shrubs and herbs. Thus, it is not surprising that harvesters worked inefficiently. Previous efforts to harvest Venus' fly traps from nature preserves involved a variety of tactics to avoid arrest and fine (Stolzenburg 1993). The characteristics of illegal plant harvest will likely vary depending on plant apparency and the perceived risk associated with the illegal activity.

Various strategies exist for managing illegal harvest of Venus' fly traps. However, most of these strategies are impractical and may run counter to preserve goals. Obviously, increased patrolling by preserve managers would lead to better plant protection. However, most state agencies cannot afford this, and it is logistically difficult in a large preserve such as LOBHP. Increased fines for plant removal might work, but this also increases the perception that Venus' fly traps have high monetary value. Closure of areas where large populations of Venus' fly traps grow may keep out people but may also indicate the locations of plants to illegal harvesters.

Considering the difficulties associated with direct management of illegal Venus' fly trap harvest, indirect methods warrant some consideration. For example, enlisting hunters in a program where violations are immediately reported to a central location is a sensible approach to wildlife poaching. This program is well publicized and is based on the idea that sound wildlife management requires universal adherence to game laws. In the case of Venus' fly traps, users of LOBHP (i.e., bird watchers, hunters, and hikers) could be enlisted in a similar program where illegal plant harvest is reported. The same program could be coupled with information regarding negative impacts of plant harvest, market values of Venus' fly trap plants, and potential fines if harvesting is discovered. Educational programs where Venus' fly traps are distributed free-of-charge to the public would also dispel the notion that Venus' fly traps are valuable. Finally, preserve managers might consider two simultaneous strategies for public enjoyment and conservation of Venus fly traps. One strategy would involve development of a high-use area where Venus' fly trap populations are maintained and interpreted within a trail system. Here one assumes that Venus' fly traps will require constant maintenance due to trampling, collecting, and perhaps harvest. The other strategy would involve maintaining existing populations or restoring new populations of Venus' fly traps in remote and relatively inaccessible areas of LOBHP (Luken 2003). These populations would be managed in efforts to increase the number of populations and the number of plants within each population. These two approaches are supportive in that the remote sites could eventually serve as a source of replacement plants at the high-use area. The high-use area would garner positive public opinion regarding management activities (e.g., frequent fire) and off-site effects of management (e.g., smoke).

ACKNOWLEDGMENTS

This project was supported by grants from the National Fish and Wildlife Foundation, Santee Cooper Power, South Carolina Department of Natural Resources, and Coastal Carolina University. Jamie Dozier (SCDNR) and Ken Sott (Santee Cooper) facilitated many parts of the project. Scott Rider, Andy Ferguson, and Nichole Peele helped with plant measurements. Reviews by Rob Sutter and Phil Sheridan greatly improved this paper

---

James Luken is Professor and Chair in the Department of Biology at Coastal Carolina University. His research currently focuses on the ecology and management of wetland communities in coastal South Carolina.

LITERATURE CITED

Bratton, S.P., and P.S. White. 1981. Rare and endangered plant species management: potential threats and practical problems in US national parks and preserves. Pp. 459-474 *in* H. Synge, ed., The Biological Aspects of Rare Plant Conservation. J. Wiley, Chichester, U.K.

Brewer, J.S. 2001. A demographic analysis of fire-stimulated seedling establishment of *Sarracenia alata* (Sarraceniaceae). American Journal of Botany 88:1250-1257.

Brewer, J.S. 2003. Why don't carnivorous pitcher plants compete with non-carnivorous plants for nutrients? Ecology 84:451-462.

Chapin, F.S., III, K. Autumn, and F. Pugnaire. 1993. Evolution of suites of traits in response to environmental stress. American Naturalist 142:S78-S92.

Freese, C.H. (ed.) 1997. Harvesting Wild Species – implications for Biodiversity and Conservation. Johns Hopkins University Press, Baltimore, Md.

Koopowitz, H., and H. Kaye. 1984. Plant Extinction: a Global Crisis. Stone Wall Press, Washington D.C.

Lawler, J.J., S.P. Campbell, A.D. Guerry, M.B. Kolozsvary, R J. O'Connor, and C.N. Seward. 2002. The scope and treatment of threats in endangered species recovery plans. Ecological Applications 12:663-667.

Luken, J.O. 2003. Cultivating new populations of Venus' fly trap at Lewis Ocean Bay Heritage Preserve (South Carolina). Ecological Restoration 21:225-226.

McGraw, J.B., S.M. Sanders, and M. Van der

Voort. 2003. Distribution and abundance of *Hydrastis canadensis* L. (Ranunculaceae) and *Panax quinquefolius* L. (Araliaceae) in the central Appalachian region. The Journal of the Torrey Botanical Society 130:62-69.

Nantel, P., D. Gagnon, and A. Nault. 1996. Population viability analysis of American ginseng and wild leek harvested in stochastic environments. Conservation Biology 10:608-621.

Robbins, S.C. 2000. Comparative analysis of management regimes and medicinal plant trade monitoring mechanisms for American ginseng and goldenseal. Conservation Biology 14:1422-1434.

Roberts, P.R., and H.J. Oosting. 1958. Responses of venus fly trap (*Dionaea muscipula*) to factors involved in its endemism. Ecological Monographs 28:193-218.

Schemske, D.W., B.C. Husband, M.H. Ruckelshaus, C. Goodwillie, I.M. Parker, and J.G. Bishop. 1994. Evaluating approaches to the conservation of rare and endangered plants. Ecology 75:584-606.

Schnell, D.E. 2002. Carnivorous Plants of the United States and Canada. Timber Press, Portland, Ore.

Schulze, W., E.D. Schulze, I. Schulze, and R. Oren. 2001. Quantification of insect nitrogen utilization by the venus fly trap *Dionaea muscipula* catching prey with highly variable isotope signatures. Journal of Experimental Botany 52:1041-1049.

Stolzenburg, W. 1993. Busting plant poachers. Nature Conservancy 43:16-23

Stuhlman, O. 1948. A physical analysis of the opening and closing movements of the lobes of Venus fly-trap. Bulletin of the Torrey Botanical Club 75:22-44.

Van Der Voort, M.E., B. Bailey, D.E. Samuel, and J.B. McGraw. 2003. Populations of goldenseal (*Hydrastis canadensis* L.) and American ginseng (*Panax quinquefolius* L.) following harvest. American Midland Naturalist 149:282-292.

Vance, N.C., M. Borsting, D. Pilz, and J. Freed. 2001. Special forest products species information guide for the Pacific Northwest. General Technical Report PNW-GTR-513, U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station, Portland, Ore.