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August 30, 2005

Mr. Paul Vehlow
Director, Federal Aid and Special Funds
Wildlife Preservation Fund
Illinois Department of Natural Resources
Office of Natural Resources Conservation/Operations
One Natural Resources Way
Springfield, IL 62702-1271

Dear Mr. Vehlow:

On behalf of the Chicago Botanic Garden, I am pleased to present with you with this report on *Plants of Concern: A Volunteer-Based, Regional, Standardized Monitoring Program for Rare Plants*. Through its unique combination of hands-on volunteer work and major cross-agency partnerships, Plants of Concern is helping preserve the unique flora and fauna of northeastern Illinois. With the 2005 season well underway, data on more rare plants is being gathered and we look forward to updating the Wildlife Preservation Fund after the season's completion.

We are deeply grateful to the Fund for your continued partnership in these efforts. If you have questions regarding this report, please contact the project director, Susanne Masi, at 847/835-8269. Again, thank you for your support.

Sincerely,

Christopher Dunn, Ph.D.
Executive Director of Research Programs

CD: tv

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Report to the Illinois Department of Natural Resources Wildlife Preservation Fund On Plants of Concern: A Volunteer-Based, Regional, Standardized Monitoring Program for Rare Plants Contract # RCO5LOIW Covering Activities from August 1, 2004 to July 31, 2005

Submitted by:
Susanne Masi, Manager of Regional Floristics, Coordinator of Plants of Concern, Chicago Botanic Garden

Developed in 2001, Plants of Concern is a rare plant monitoring program that gathers long-term standardized, regional monitoring data in northeastern Illinois. This effort combines the census of rare plant populations with the documentation of population trends in relation to specific threats and management practices. Now in its fifth year, the project relies heavily on trained volunteers and works in close partnership with both land managers and scientists throughout the Chicago Wilderness region

Planning and implementation of each year's program begins around January and culminates at the end of the calendar year, with data analysis and reporting taking place during the first quarter of the following year. As the Wildlife Preservation Fund grant for Plants of Concern began more than halfway into the 2004 monitoring season, this report will focus on activities that have occurred in 2005. A copy of the final report on the 2004 monitoring season submitted to Chicago Wilderness is attached. It provides a comprehensive overview of all 2004 activities, including program planning, structure, monitoring activity utilizing trained volunteers, and analysis of Level 1 and Level 2 monitoring.

Personnel

From January 1, 2005 to July 31, 2005, the following personnel changes occurred:

- On May 13, 2005, Plants of Concern intern Becky Mann completed her year of internship. Her replacement, Andrew Bishop, began his internship on June 13, 2005.

- Early in the year, program assistant Mary Stupen completed her contracted duties and now works on an as-needed basis to cover the time-gap between interns and fulfill other needs as they arise. The new program assistant, Emily Hudson, began work on February 1, 2005.

Planning the 2005 Monitoring Season

To prepare for the 2005 monitoring season, Plants of Concern program staff met with representatives of Lake, Kane, Will, McHenry, and DuPage Forest Preserve Districts to discuss the 2005 season. Plants of Concern staff also communicated by phone and email with Cook County staff and Deb Nelson of the Illinois Department of Natural Resources regarding their assignments.

Volunteer recruitment efforts began early in the year. Program assistant Emily Hudson designed a brochure, a copy of which is attached, that described the program and advertised upcoming training sessions and was used throughout the recruitment process. To solicit volunteers, Plants of Concern staff manned an information table and held a panel discussion at the Wild Things Conference at Northeastern Illinois University on February 26, 2005, and attended the Volunteer Recruitment Fair at the Chicago Botanic Garden. Recruitment also included an article in the spring 2005 issue of *Chicago Wilderness Magazine*, "Rare Plants Rise Up," which featured POC (a copy of this article is also attached). Also, various stewardship newsletters, including the *Habitat Herald*, ran notices of the training workshops.

Concurrent with recruitment activities, former volunteers were contacted to confirm their participation and provide them with their 2005 assignments. These volunteers also assisted with four workshops held in April, 2005 to train new Plants of Concern volunteers. Conducted as a joint effort between current Plants of Concern volunteers and the Forest Preserve Districts, these sessions introduced new volunteers to the program's history, gave overviews of common invasive species, explicated the monitoring protocols, and provided an opportunity for volunteers to practice monitoring tasks. These workshops were conducted at the following locations (a sample agenda is attached):

- April 2: Ryerson Woods, Lake County for 24 volunteers
- April 10: Blackwell Forest Preserve, DuPage County for 21 volunteers
- April 17: Sand Ridge Nature Center, Cook County for 14 volunteers
- May 1: Glacial Park, McHenry County for 22 volunteers.

In addition to the workshops, volunteers received additional training from program staff. Emily Hudson provided copies of 2004 monitoring reports to all volunteers with active assignments to help guide them in their 2005 work and, along with Susanne Masi and Andrew Bishop, assisted new volunteers in the field as an extension of volunteer training. Andrew Bishop revised the GPS unit instruction sheet and continues to aid volunteers and staff with GPS/GIS needs of the program.

Plants of Concern.org: Website Development

Bianca Rosenbaum, Plants of Concern's website manager, upgraded and expanded the program's website as a recruitment and information tool. She worked with volunteer Peter Jacobs to install the on-line monitoring submission form, which is now being successfully implemented. Volunteer Mary Borecki recruited seven volunteers to trouble-shoot the on-line form before it was officially launched. Program assistant Emily Hudson prepared a list of bloom times for Plants of Concern species. This list was posted on the website and guides volunteers in their monitoring dates.

Monitoring Activity in 2005

The vast majority of project monitoring occurs during the growing season and usually lasts from April until the end of September. Monitoring forms are submitted throughout this time frame; therefore, significantly more monitoring activity will take place before the season's end. As of July 31, 2005, monitoring reports on 99 Element Occurrences, including on-line submissions, were received, representing 206 reports on separate subpopulations of

rare plants. Fifty-seven volunteers participated in these reports (some as lead monitors, some as partners), logging in 331 field hours.

Several guided monitoring events have taken place this year. Ken Klick of the Lake County Forest Preserve District held an *Oenothera perennis* "foray" at a Lake County site on June 28 involving eight volunteers who searched and monitored all the locations of that species. Susanne Masi held a *Geranium bicknelli* foray at a Lake County site on July 7 involving six volunteers. On July 6, volunteer Barb Wilson held a monitoring foray on a rare, although widespread at this site, species at Lake in the Hills Fen for eight interns who work with the Lake Forest Open Lands Association.

Other Activities

The following program activities also occurred during the reporting timeframe:

- In 2004, a study was begun to assess the validity of volunteer-collected Plants of Concern data. Intern Andrew Bishop, Susanne Masi, and Forest Preserve District staff Beth Jarvis, Scott Kobal, Cindy Hedges, and Chris Hauser are continuing this part of the project. In 2005, 30 random Element Occurrences will be monitored as part of this study in 2005.

- Volunteers assisted with data entry, website development, and other office work. Volunteer hours, including training workshops, field work, and office work, totaled 892 from January 1 to July 31, 2005, with 505 hours from May 1 to July 31, 2005.

- Emily Hudson sent two email news updates to volunteers to maintain ongoing communication, to recruit for forays, and to remind volunteers to submit reports.

- Susanne Masi and Rebecca Mann's powerpoint presentation, "Plants of Concern," was accepted for presentation at the Society for Ecological Restoration Annual Conference in September at Zaragoza, Spain.

Conclusion

With the assistance of 217 volunteers, Plants of Concern has monitored more than 121 species throughout northeastern Illinois since the program's beginning. These figures reflect Plants of Concern's success in unifying concerned agencies, organizations, and private citizens towards the common goal of ensuring the stability of the region's rarest plants. We are proud to partner with the Illinois Department of Natural Resources' Wildlife Preservation Fund in these important endeavors and offer our sincerest thanks for your generous support.

Report to the Illinois Department of Natural Resources
Wildlife Preservation Fund
On Plants of Concern

Attachment List

- Report to Chicago Wilderness: *Plants of Concern: Training Volunteers to Conduct Rare Plant Monitoring on a Regional Scale*, April 30, 2005.
- Plants of Concern Brochure
- Plants of Concern Workshop Agenda
- "Rare Plants Rise Up" from *Chicago Wilderness Magazine*

Chicago Botanic Garden

Final Report to Chicago Wilderness and
the Illinois Conservation Foundation
Grant FWS 0313

Plants of Concern: Training Volunteers to Conduct Rare Plant Monitoring on a Regional Scale

April 30, 2005

Covering the period from January 1, 2004 to December 31, 2005.

Submitted by:
Susanne Masi
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Principal Investigator

Co-authors

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Conservation Scientist, Plant Demography
Chicago Botanic Garden

Rebecca Mann, Intern
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Kathryn Theiss, Intern
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Megan Dunning, Graduate Student, UIC
Chicago Botanic Garden Volunteer

Contributors

Bianca Rosenbaum, Database Technician
Chicago Botanic Garden

Mary Stupen, Program Assistant (2004)
Chicago Botanic Garden

Plants of Concern:
Training Volunteers to Conduct Rare Plant Monitoring on a Regional Scale

Report Contents:

- Plants of Concern: Concept and Objectives
- Summary: Monitoring Results 2001 -2004
- Level 1 Monitoring Data: Database; Data Submission, Storage, and Reporting
- Analysis and Discussion: Level 1 Monitoring (Rebecca Mann)
- Analysis: Level 2 Species (Includes Seed Viability Studies) (Kathryn Theiss, Megan Dunning, and Pati Vitt)
- Reproductive Patterns in *Tomanthera auriculata* (P. Vitt)
- Conclusion: Level 2 Monitoring After Four Years (P. Vitt)
- The Volunteer Component, Including the Monitor Evaluation Survey Results
- Program Evaluation
- Recommendations for 2005 and Beyond
- Appendices

Plants of Concern: Concept and Objectives

Plants of Concern (POC) 2001 was the pilot year of a long-term rare plant monitoring program, unique to the region in its use of standardized monitoring protocols. The program has now completed four years of monitoring and has accumulated a substantial base for gathering long-term data on a significant number of species and Element Occurrences.

POC addresses the following needs, as presented in the Chicago Wilderness (CW) *Biodiversity Recovery Plan:* to document the locations of rare species, to provide long-term monitoring of the status of rare species populations, and to track their response to management. This information, which provides managers with the scientifically-acquired data needed to address management problems on their sites, can be used to understand the status of individual Element Occurrences (EOs), as well as multiple populations of a species across the region. On a regional scale it builds the basis for collaboration in adapting, developing, and implementing management strategies that will ensure the presence of these species on a sustainable and stable basis. Long-term monitoring of this sort will allow CW to determine at regular intervals the status of rare plant populations in relation to a monitoring baseline and management practices. After the first five-year phase, which will be reached in the 2005 monitoring season, POC will have generated adequate data for evaluating the program and determining future directions for rare species monitoring within Chicago Wilderness.

Species monitored by POC have been selected from the 1999 *Chicago Wilderness Biodiversity Recovery Plan*'s species priority list because they are listed by the state as endangered or threatened and also if they are considered by regional land managers and ecologists to be rare and significant within the CW region (see Appendix 2). The non-listed species POC monitors comprise an unofficial "species of concern" list which requires a consensus within CW, and should be submitted to appropriate CW participants for review, expansion, and acceptance. Another group, indicator plant species that are not necessarily rare, may be added to the program through the CW Report Card process.

The POC program incorporates the following five interrelated elements, all equally important to its success and through which POC is becoming recognized as a unique, viable, long-term monitoring program:

- Monitoring rare plants, particularly state-listed species, over time to discern population trends within a community context (Level 1), with selected species targeted for more intensive demographic monitoring (Level 2) (Level 2 monitoring was completed in 2004 and is reported below);
- Monitoring rare species in relation to management activities to form a feedback loop for adaptive management, leading to both short-term and long-term responses;
- Using, for the first time, standardized protocols throughout the region to gain uniform data on a regional basis;
- Training volunteers as citizen scientists in order to significantly leverage agency resources for monitoring rare species, while creating an informed conservation constituency; and,
- Working collaboratively with public and private landowners, land managers, and agencies through an Advisory Group to generate a shared approach to regional monitoring (Appendix 1).

Summary: Cumulative Monitoring Results 2001 - 2004

In 2004, the project's fourth year, POC again saw increases in volunteer participation, the number of species and sites monitored, and landowner involvement. The element occurrences (EOs) of the 89 listed species monitored by POC in the six northeast Illinois counties represent approximately 25% of the EOs in the region, as recorded by the Natural Heritage Database. The following overview is detailed in the remainder of the report and in Appendices 2-5:

2004 results

94 species monitored*
- 66 listed species
- 28 non-listed species

236 EOs monitored in 423 subpopulations**
- 194 listed EOs monitored in 367 subpopulations
- 42 non-listed EOs monitored in 57 subpopulations

118 sites in 6 counties
41 participating landowners
150 volunteer monitors
38 staff and interns involved in monitoring

Cumulative results, 2001-2004

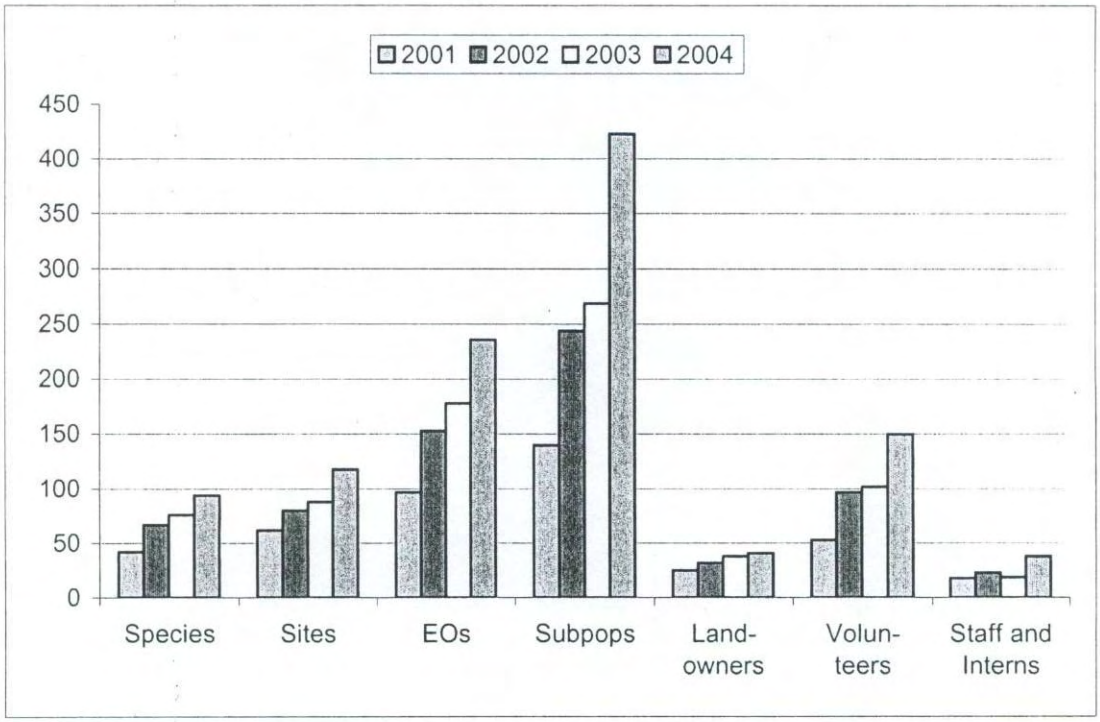
121 species monitored (89 listed, 32 unlisted)*
330 EOs monitored in 564 subpopulations
- 273 listed EOs in 482 subpopulations
- 57 non-listed EOs in 83 subpopulations**

148 sites in 11 counties
217 volunteers
57 participating landowners

**An additional 34 non-listed species were monitored from 2001-2004 using POC protocols. They have been placed in an "inactive" file and removed from the POC program because they were delisted from the State's Endangered and Threatened Species list, or they were considered too common to be monitored on a region-wide basis. Because they are considered rare within certain counties, a majority of these inactive species will continue to be monitored by individual counties for their own records. A regional consensus is needed on which non-listed species should be part of the regional program, and POC will work with the Advisory Group and others to develop such a list.*

***A subpopulation is defined as a grouping of a species within the same EO that is that is tracked separately because it is located more than 50 meters from another grouping or because the grouping is within a different management unit or habitat.*

Figure 1: POC Coverage and Participation



	2001	2002	2003	2004	Cumulative
Species	42	67	76	94	121
Sites	62	80	88	118	148
EOs	97	153	178	236	330
Subpops	140	244	269	424	565
Landowners	25	32	38	41	57
Volunteers	52	97	102	150	217
Staff and Interns	23	30	24	55	93

Numbers in this chart may differ from the 2003 report because a number of non-listed species were removed from the program as "inactive."

Listed Species monitored in multiple counties (see Appendix 4 for a breakdown of these species and number of EOs monitored for each). The numbers of species monitored across multiple counties are the basis for a regional assessment of species status.

1 species monitored in 6 counties
6 species monitored in 4 counties
8 species monitored in 3 counties
24 species monitored in 2 counties
80 species monitored in 1 county

Number of volunteers by county (cumulative): 2001-2004

Cook:	65	Lake:	69
DuPage:	30	McHenry:	17
Kane:	30	Will:	21

Volunteers monitoring for 4 years: 23
Volunteers monitoring for 3 years: 38
Volunteers monitoring for 2 years: 39
Volunteers monitoring for 1 year: 117 (64 new recruits in 2004).

Volunteer retention from 2003 to 2004: 75.49%
Volunteer retention from 2001 to 2004: 53.8%
(over 50% of monitors who began participating in 2001 are still active monitors)

Volunteer hours in the field in 2004: 1265
Volunteer hours in training in 2004: 350
Volunteer hours in lab seed study: ~330

Discussion

In 2004, gains were made in most areas of coverage and participation. The numbers of species monitored, Element Occurrences, and volunteers all increased over 2003 levels (Figure 1). Retention of Element Occurrences was high, with 70% of EOs monitored in 2003 also monitored in 2004. This represents 56% of the 2001 EOs. In 2004, 85 new EOs were monitored, meaning that 36% of all 2004 EOs represented new monitoring locations. The 150 volunteers in 2004 represented a 183% increase from 2001, with 75.5% volunteer retention from 2003-2004 and 53.8% volunteer retention from 2001 to 2004.

Level 1 Monitoring Data: Database; Data Submission, Storage, and Reporting

All Level 1 monitoring data is entered into the CBG-housed Access database developed and managed by Database Technician Bianca Rosenbaum. Volunteers must submit field/paper copies of their monitoring forms, but also have the option of submitting reports through an online from on a secure POC website. Piloted in 2004, this option will save hours of manual data entry. The online form was developed by Bianca Rosenbaum, with the assistance of volunteer Peter Jacobs, and volunteers have assisted in testing and troubleshooting the online process. These reports are reviewed both by landowners, who have access to their own site reports, and POC staff for accuracy. At the end of the season, after data entry and analysis are completed, Access-based reports are submitted to the Illinois Natural Heritage Database, to landowners for their sites, and to the Nature Preserves Commission for Nature Preserve sites.

Because of the sensitive nature of the data on listed species, the Access database is restricted to a few personnel and volunteers. Individual volunteers can access their own monitoring reports only by means of a password. The POC database is listed, but not linked, on the CW Database Inventory that is being set up by The Illinois Natural History Survey. We will continue to make our data compatible with the Illinois Natural Heritage Database.

Data Analysis: Level 1

Monitoring Data

Level 1 protocols were essentially finalized by 2002, having been evaluated by the Advisory Group after the first year of monitoring. In 2003 and 2004, minor changes were introduced to make questions and answers more precise, for example, distinguishing between brush encroachment greater than or less than 1m in height.

At a basic level, POC is gathering census data about the status of individual populations, such as numbers of individuals and area covered by populations, as well as a record of the threats and invasives impacting populations. Monitors record observable management activities that have taken place within the previous year; some monitors are also volunteer stewards or land managers and can provide management information from their own records. By pooling and analyzing this data for all monitored populations across the region, we can begin to form a picture of the common trends within the region, for both individual species and, in general, for rare populations. After four years, we can see population trends, particularly in the 16% of EOs that have been recorded for all four years. This can be demonstrated in the analysis of the Level 1 data for the four target species, *Cirsium hillii, Cypripedium candidum, Tomanthera auriculata, Viola conspersa*, which will be completed in an Addendum to follow this report. Each species monitored in sequential years can be subjected to this type of analysis both across the region and by site.

Land Management Data

A Land Management form, to be completed by the land manager or steward, was introduced in 2002. The form is designed to provide more detailed information than volunteers can be expected to provide about current and past management of the specific areas where populations occur. While land managers report about activities in the area or management unit where the populations occur, they may or may not know precisely how management affects specific population areas; therefore, the two reports serve to complement each other. General site management information and land use history are also requested on the Land Management form.

Due to delays in the submission of Land Management forms and follow-up analysis, a discussion of data from these forms has not been included in this report. For the December 2003 Advisory Group meeting and in the 2003 CW report, Karen Glennemeier documented the detailed information gained from 2002 Land Management forms as a basis for relating population changes with management activities. Using this document as a model, POC will provide an analysis for the 2003 and 2004 Land Management reports at the earliest opportunity.

Management implications of POC monitoring are already becoming apparent. At both individual population locations and region-wide, POC is recording the types and levels of threats, including invasives, that impact populations. This information has value for long-term planning on a regional basis; for example, the response of certain species to fire may help determine fire management for those species. It also has a short-term problem-solving benefit; for example, one monitor was able to get a small population of rare orchids caged to prevent deer browse which had been damaging the plants. After they had reported high levels of brush encroachment, three other monitors were hired to do brush clearing and herbiciding within a population of *Viola conspersa* they were monitoring.

Level 1 Analysis

The Level 1 analysis below reflects information from the monitoring forms. The figures are based on subpopulation reports, which were separated out in the Access database for the first time in 2003 for all years of monitoring. Each EO may have one or multiple subpopulations, defined as separate groupings of plants spaced at least 50m apart from each other, or distinguished from each other by habitat, management applications, or other factors. Monitors reported 423 subpopulations in 2004 in this analysis and a cumulative 564 subpopulations since 2001.

By the fourth year of POC monitoring, temporal trends can be seen developing for levels of disturbance and management that populations are receiving cumulatively. Changes in specific species or populations over time can also be followed. While strong conclusions about trends cannot yet be defined, hypotheses can be formulated about the underlying causes of perceived trends and about the likely directions these trends will head in the future: for example, the hypothesis that overall increase in management activity will be correlated with decrease in the prevalence of ecological threats to populations and increased average percent of populations with juveniles.

It is important to note that in the analyses presented below, data is not based each year on the equivalent set of populations monitored. Each year new populations and subpopulations are added to the program, and each year previously monitored populations/subpopulations may not be monitored again the following year. Increases and decreases in values do not reflect the changes within the same set of populations. The overall value of the data is to show general levels of threats, management activity and recruitment. Real change will be documented when the analysis is applied to the same group of populations over time.

Juvenile Recruitment

Monitors recorded the presence or absence of juveniles for all subpopulations, indicating successful reproduction, for non-annuals, in this or prior years. In 2001, juveniles were present in 72.2% of analyzed populations, while in 2002 populations with juveniles dropped to 65.8%. The value rose slightly in 2003 to 66.7% and again in 2004, up to 70.1% of all analyzed subpopulations contained juveniles (Figures 1 and 2).

Analyzed subpopulations are those which contained a "Yes" or "No" response for juvenile presence. Not included in the analysis were subpopulations for which no information was recorded (12% of 2004 subpops), and those which indicated uncertainty in juvenile identification (31% in 2004) or annual subpopulations (13% in 2004). Thus, 50% of the 2004 subpopulations were included in the 2004 analysis. The species with the greatest number of reports of unidentifiable juveniles were *Carex* species, *Viola conspersa*, *Cypripedium candidum*, and *Triglochin* species.

Ecological Threats

Over time, correlation of changes in management activity and/or population status with changes in levels or prevalence of ecological threats can be made. It appears that total brush encroachment has remained fairly stable over the four-year period, although in the past two years for which brush has been differentiated, it can be seen that while the brush less than 1 meter tall is decreasing, brush over 1 meter tall is increasing. Erosion levels appear to be declining in the area of the subpopulations monitored. Trails, especially authorized trails, in the vicinity of the subpopulations monitored appear to be increasing (Figure 3).
Note that we can only report threats for which monitors found physical evidence; actual prevalence of threats may be somewhat varied than that reported here.

In 2004, 84.1% of subpopulations showed some level of ecological threat, higher than the 80.6% noted in 2003.

Figure 1
Percent of reproductive subpopulations 2001-2004. Based on presence of juveniles at monitored subpopulations (50% of monitored subpopulations in 2004).

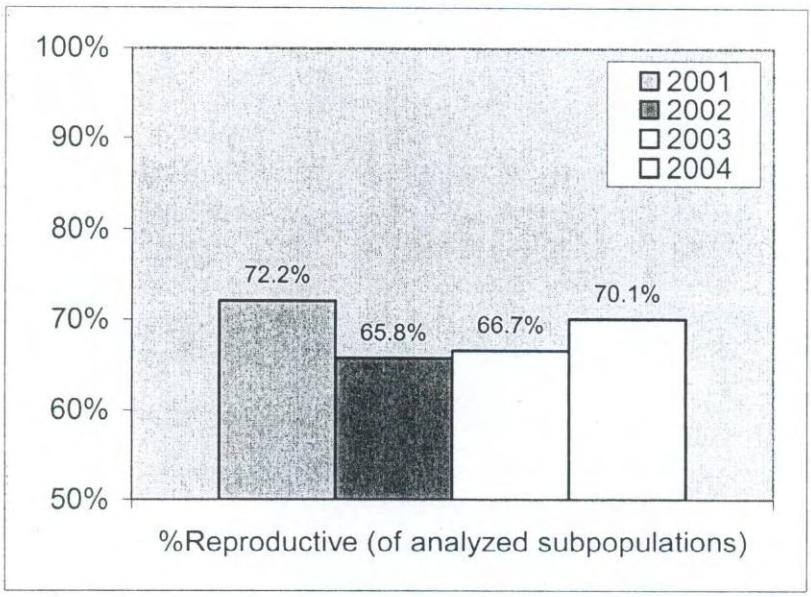


Figure 2
Percent subpopulations included in analysis, and percent subpopulations not included (Annuals, no answers, unidentifiable juveniles).

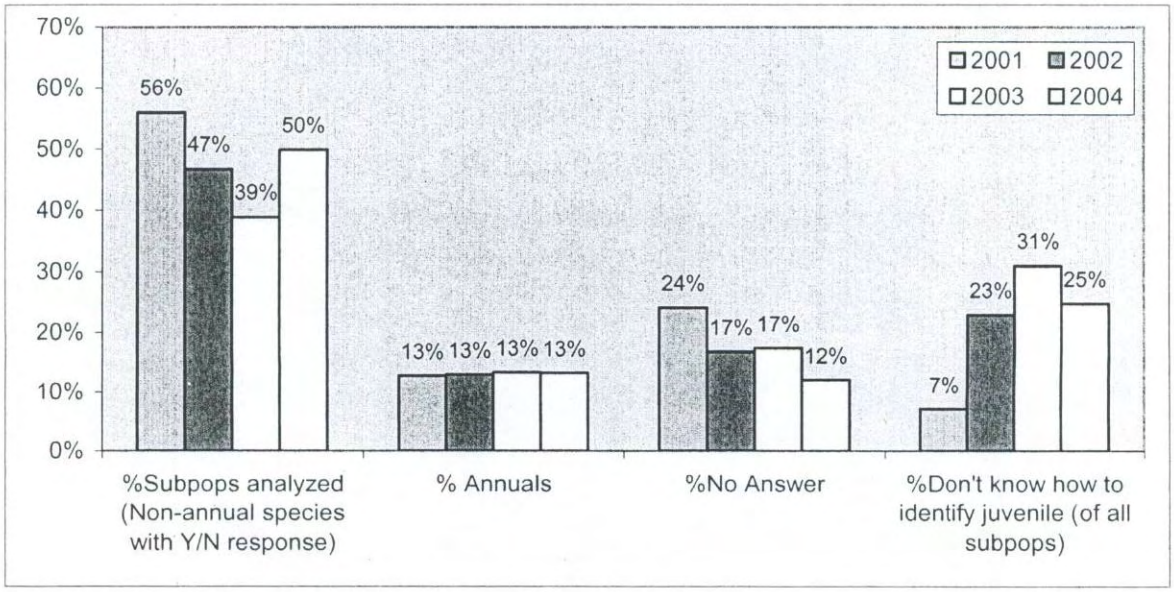
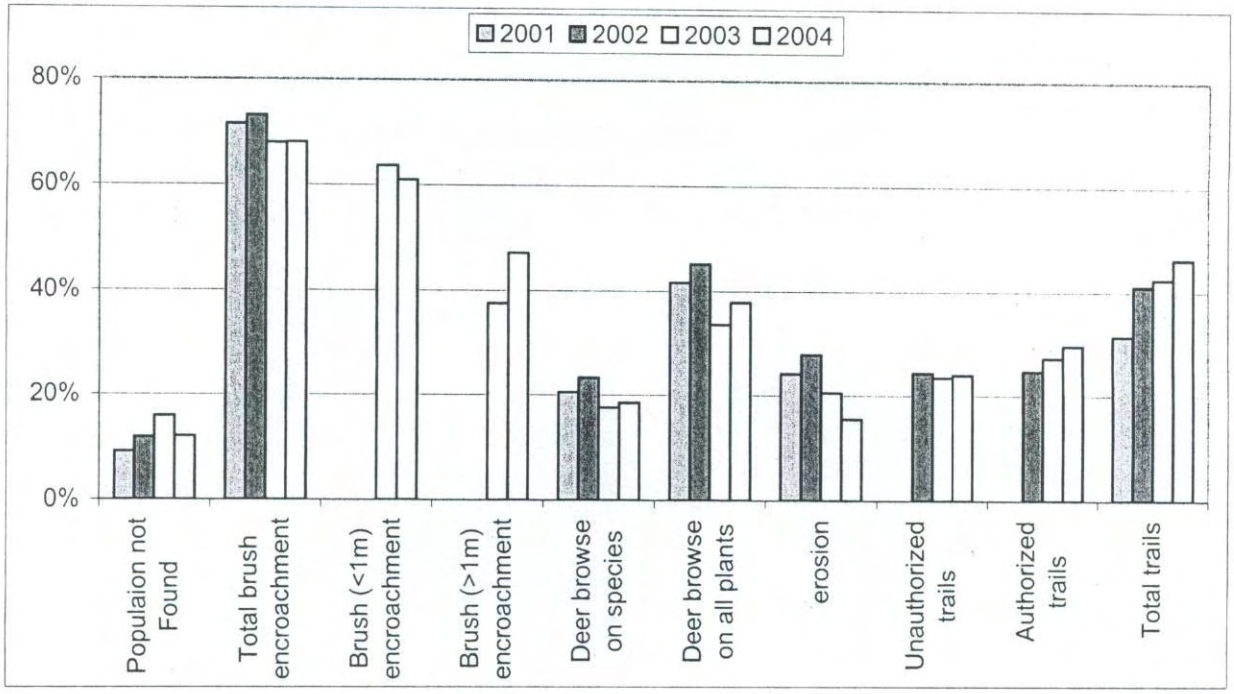


Figure 3
Percent of subpopulations with threats reported on 2001-2004 monitoring reports.



*Only *un*authorized trails were noted in 2001. There is no value for authorized trails in 2001. Because some 2001 responses were ambiguous, they are lumped in total trails. In 2001 and 2002, no distinction was made for brush encroachment less than or greater than 1 meter.

Invasive Species (Figures 4 and 5)
Monitors identified 96 different species of invasive plants in 2004; cumulatively, 139 have been identified. Of all monitored subpopulations, 73% had at least one invasive species present in 2004. Forty-four percent of those subpopulations with invasives listed three or more.

The most commonly cited invasive species in 2004 was again *Rhamnus cathartica*, cited in 31% of the subpopulations, which is up from 25.3% of subpops with citations in 2003, but less than the 36% subpops noting it in 2002. *Alliaria petiolata* is the second most cited invasive at 9.9%, followed by *Cornus racemosa* (9/7%), *Rosa multiflora* (8.7%), *Phalaris arundinacea* (5.9%), Lythrum salicaria (4.5%), and *Rhamnus frangula* (4.5%). When invasive species were lumped together by genus, the most commonly cited genus was *Rhamnus*, cited in 38.8% of all subpopulations. *Cornus* (10.6%) is the second most cited genus, followed by *Lonicera* (9.5%), and *Melilotus* (9.2%). Because these data are based on subpopulations rather than the percent citations analyzed in the 2003 report, the percentages have shifted significantly from that report.

Figure 4
Invasive species cited in 4% or more of 2004 subpopulation records. Total refers to all species within the genus.

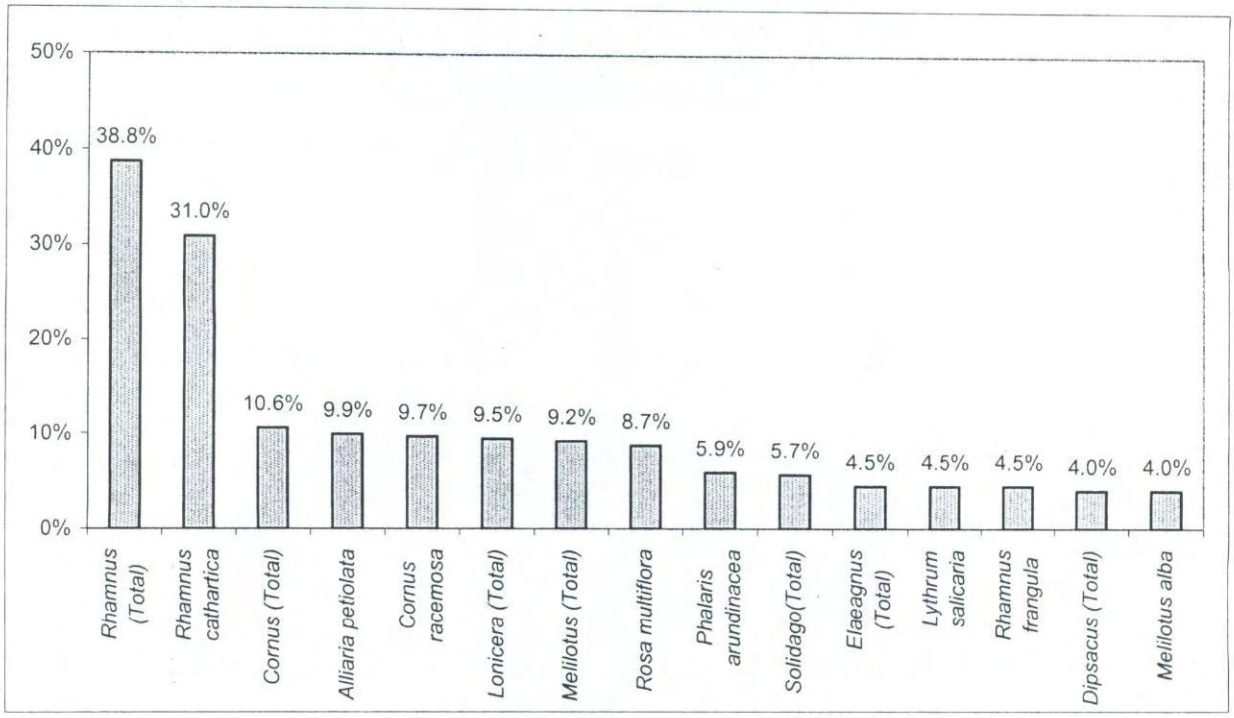
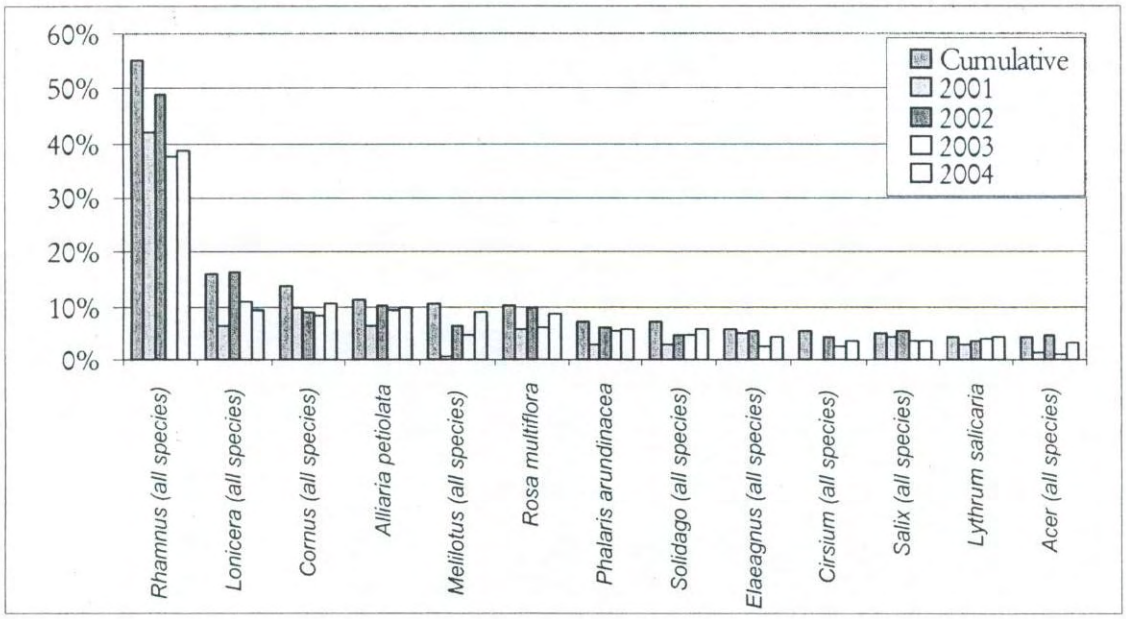


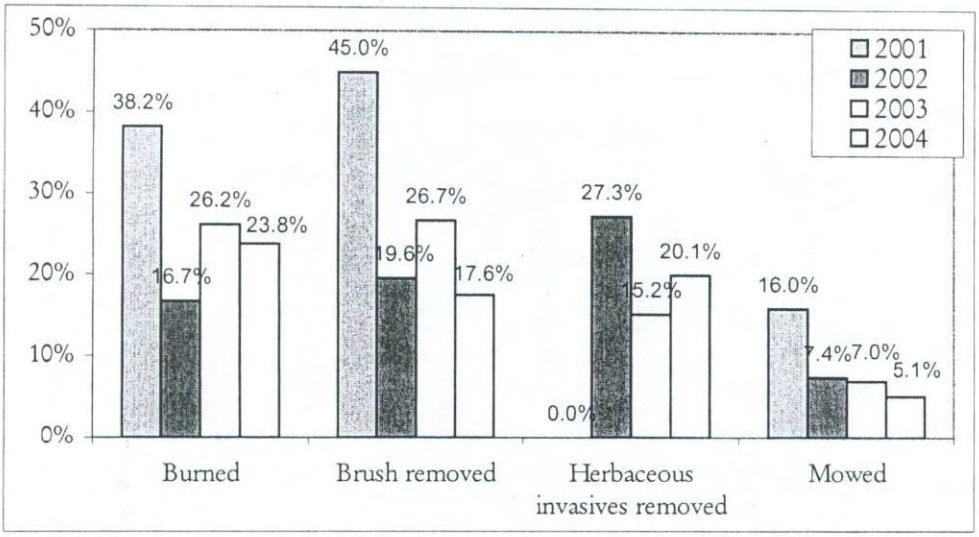
Figure 5
Top 13 overall invasive species citations from 2001-2004



Evidence of Management

The reported percent of subpopulations with invasive herbaceous removal increased from 2003 to 2004, whereas the reported percent of brush removal decreased (Figure 6). Observed burning and mowing activity also slightly decreased. Data analysis from land managers' reports will provide more accurate information about actual management within monitored populations. Based on monitors' observations, 43% of POC populations showed evidence of management activity in 2004, down from 48% in 2003.

Figure 6. Observed management in POC subpopulations 2001-2004



Species-specific Information

Four species are the focus of both Level 1 monitoring and the more intensive Level 2 monitoring. Tables 1a. and 1b. show the Level 1 results for *Cirsium hilli*, *Cyprepedium candidum*, *Tomanthera auriculata*, and *Viola conspersa* for 2001-2004.

Table 1a (*Cirsium hillii* and *Cypripedium candidum*)

Percent of analyzed subpopulations* affected by given threat (or with juvenile recruitment).

	Cirsium hillii								Cypripedium candidum							
	2001		2002		2003		2004		2001		2002		2003		2004	
# Subpops*	21		14		15		13		13		22		27		41	
Authorized Trails**	na	na	50.0%	12	42.9%	14	30.8%	13	na	na	11.8%	17	11.5%	26	21.9%	32
Unauthorized Trails	23.1%	13	25.0%	12	16.7%	12	7.7%	13	30.8%	13	17.6%	17	23.1%	26	18.8%	32
Deer Browse on Species	1.5%	9	1.3%	12	1.4%	13	1.3%	13	0%	10	2.1%	26	2.5%	24	3.6%	34
General Deer Browse	22.2%	9	8.3%	12	7.7%	13	0.0%	12	0%	10	31.6%	19	30.8%	26	11.4%	35
Erosion	0.0%	10	16.7%	12	9.1%	11	15.4%	13	10.0%	10	5.3%	19	0.0%	23	0.0%	35
Brush (<1m) Encroachment	60.0%	10	54.5%	11	61.5%	13	53.8%	13	54.5%	11	80.0%	20	68.0%	25	62.9%	35
Brush/Tree (>1m) Encroachment**	na	na	na	na	33.3%	12	53.8%	13	na	na	na	na	40.9%	22	60.0%	35
Juvenile Recruitment	100.0%	13	91.7%	12	100.0%	12	76.9%	13	70.0%	10	77.8%	18	60.0%	25	51.5%	33

Table 1b (*Tomanthera auriculata* and *Viola conspersa*)
Percent of analyzed subpopulations* affected by given threat (or with juvenile recruitment).

	Tomanthera auriculata								Viola conspersa							
	2001		2002		2003		2004		2001		2002		2003		2004	
# Subpops*	10		12		13		18		14		36		32		34	
Authorized Trails**	na	na	27.3%	11	23.1%	13	25.0%	12	na	na	26.7%	30	32.3%	31	35.7%	28
Unauthorized Trails	40.0%	10	36.4%	11	23.1%	13	16.7%	12	25.0%	14	18.5%	27	20.0%	30	20.0%	25
Deer Browse on Species	0.7%	5	1.2%	12	1.2%	12	1.7%	16	0%	7	2.8%	21	2.5%	20	2.7%	21
General Deer Browse	20.0%	5	27.3%	11	38.5%	13	50.0%	16	0%	7	4.8%	21	0.0%	21	4.5%	22
Erosion	16.7%	6	9.1%	11	23.1%	13	0.0%	16	14.3%	7	6.1%	33	3.3%	30	6.5%	31
Brush (<1m) Encroachment	57.1%	7	72.7%	12	53.8%	13	31.3%	16	0%	7	69.7%	33	45.2%	31	54.8%	31
Brush/Tree (>1m) Encroachment**	na	na	na	na	38.5%	13	31.3%	16	na	na	na	na	32.3%	31	43.3%	30
Juvenile Recruitment	annual	na	annual	na	annual	na	annual	na	75.0%	8	27.3%	33	37.9%	29	48.4%	31

*Percentages calculated from set of subpopulations that contained some response for the given category; subpops with no response were not included in the analysis. The number of subpopulations used for calculations is reported in the column to the right of the percentage.
**Authorized and unauthorized trails were not distinguished in 2001, and all general trails noted on the data forms in this year are reported in the Unauthorized Trail row. Similarly, encroachment by brush over vs. under 1 meter was not distinguished in 2001 and 2002; all brush encroachment for these years is reported in the Brush (<1m) Encroachment row.

Selected Discussion of Level 1A nalysis

The graphs showing threats are relatively consistent across the years. This consistency of pattern, regardless of the different populations being monitored, shows the relative significance of the individual threats. In 2004 brush encroachment remains consistently high at 68.1%, with encroachment from smaller brush (61%) much higher than larger brush (47.2%). Managers may wish to look specifically at monitored populations to implement brush removal. Deer browse on all plants within populations in 2004 is 37.9%, with the monitored species, at 18.6%, suffering less than the communities. Although there are some exceptions, as when an orchid or *A melandrier* needs caging against deer, if deer management is to be considered, it is best seen as a community-level management approach. It should be noted that unauthorized trails are often created by deer, which increase the impact on species and communities even when browse is not reported.

Invasive impact on 73% of all subpopulations monitored can be considered a serious threat. Much effort is put into invasives control as a community management strategy, but these rare populations are individually at risk and a combination of community invasive and population invasive controls seems called for to prevent the further decline of populations of rare plants. Authorized trails impacted 29.7% of 2004 subpopulations and these may need to be reviewed for remediation in individual cases. Erosion impacted 15.56% of 2004 populations and should be reviewed for possible remediation.

Management, specifically burning and brush removal, as reported by monitors has declined somewhat. This may reflect the fact that new populations and volunteers were incorporated into the program in 2004 and some original populations were not monitored

in 2004, shifting the percentages. We also know that burns are not needed each year in most areas and that initial brush removal, if effective, may not need to be repeated. Without further analysis, however, it appears that the general trend being in monitored rare plant populations is that less management is being observed.

Volunteer Data Validation Study

In 2004, a monitoring validation project was initiated that compares Level 1 monitoring data collected by POC volunteers to data collected by POC and county staff biologists. The two primary goals of this project are to determine accuracy and consistency of data collected by volunteers, and to determine if there are any areas on the monitoring form where there are general, persistent discrepancies between two sets of records.

The fieldwork for the validation study occurred between 7/12/04 and 9/30/04. Of 423 subpopulations monitored by POC volunteers in 2004, 110 pertained to species that had a bloom date or could be monitored late in the season. Thirty-seven (37) of these subpopulations were randomly selected for data validation and 28 subpopulations were successfully monitored for validation. POC or county staff monitored these 28 subpopulations at approximately the same date as the POC volunteer. According to POC Level 1 monitoring guidelines, the staff recorded all data that is required of the volunteer, with the exception of GPS coordinates, directions to the subpopulation, and associate species. No contact was made between the staff and the volunteers other than to clarify directions to the site and subpopulation.

A total of 22 species were monitored as part of the 2004 validation study, representing 26 element occurrences (EOs) and 28 subpopulations. These occurred at 16 sites in 6 counties (see table below for distribution of EOs and subpopulations). Four lead staff collected validation data, with assistance from 9 helpers. A variety of species were included in the validation study, including 3 annual species (*Cakile edentula, Chamaesyce polygonifolia, Tomanthera auriculata*), an aquatic species (*Utricularia intermedia*), a creeping vine (*Rubus pubescens*), and several sedges and other graminoids (*Juncus alpinus var. rariflorus, Carex woodii, Scirpus hattorianus, S. palodosus, Triglochin maritima, T. paulustris*).

Because 2004 was a pilot year for validation and site visits only occurred during late summer, the data will not be analyzed but pooled with a full season of validation data collected during the 2005 monitoring season. As part of the analysis in 2005, we will report the precision and similarity between the staff and volunteer records for each of the following fields: date monitored, juvenile presence, soil condition, number of individuals, reproductive state and percent reproductives, plant distribution, degree of threats, invasive species and percent invasion, and evidence of management. We will also summarize any fields that show consistent discrepancies.

In 2005, we hope to broaden the validation study by completing validation of at least five new EOs per county for a total of 30 additional reports. We also plan to conduct the validation fieldwork throughout the growing season of 2005, and to further diversify the species included in the study.

Data Analysis: Level 2

A fundamental goal of POC is to relate rare species' population trends with management activities. A focused means of accomplishing this objective was to train volunteers to collect demographic data on individual plants in several populations of four species chosen by the

Advisory Group (*Cirsium hillii, Cypripedium candidum, Tomanthera auriculata*, and *Viola conspersa)* and then to overlay this data over management practices being conducted within the populations. Demographic data has been collected from these populations for four years to determine their stability, overall reproductive patterns, survival and recruitment, and response to management over the long-term. In 2004, fruits were collected from each population in order to determine seed viability rates of the populations. Descriptions of each species, its life history and habitat, and the standardized protocols used for monitoring each of them were submitted in former reports to CW.

POC has monitored 28 demographic plots at 23 sites (EOs) over four years. All Level 2 populations were also monitored at Level 1. An additional 40 EOs of these target species have been monitored only at Level 1. These combined 63 EOs represent 65% of all the EOs in the region of these target species. The cumulative data provided by Level 2 demographic trends and Level 1 population trends provide a significant body of information about the status of these species in the region and their response to management activities.

Species	# EOs in NE IL (based on 2004 NHD data)	*Level 2 EOs* monitored	Level 1 EOs only monitored	% EOs monitored in NE IL
Cirsium hillii	21*	6 (7 plots)	8	67
Cypripdedium candidum	39*	8 (10 plots)	17	64
Tomanthera auriculata	16	5 (5 plots)	6	69
Viola conspersa	21	4 (6 plots)	9	62

**some Cirsium and Cypripedium populations may be introduced as a result of past rescue efforts. All Level 2 populations are spontaneous, but not all Level 1 only populations are spontaneous.*

All Figures and Graphs referred to in the Data Analysis Section will be found in Appendix 6a and 6b. Note that site names are encoded to protect location information of listed species. Species are listed in chronological order.

Cirsium hillii

The full Level 2 analysis of *Cirsium hillii*, including the seed viability study, will be submitted as an addendum to this report.

Cypripedium candidum

The monitoring protocols for *Cypripedium candidum* were not changed for 2004. However, this year many of the sites flowered much earlier that in previous years and at least one site (GP) was flooded during some of this flowering period. This may have affected both the flower production and reproductive success of many of these populations.

We used an analysis of variance (ANOVA) with a Tukey HSD multiple comparisons post-hoc to analyze differences between years and between sites. For analyses with only two sets of data, a Student's t-test was used to assess significance. Significance was established at $p < 0.05$.

Flower production

The percentage of stems at each population producing flowers varied greatly for 2004. CRP1 and 2 had the highest flower production at 57.5 and 53.8%, respectively. BSF, GP, and RP all had very low flower production (14.7, 17.1 and 18.3%). Average flower production per clump ranged from 3.3 (GCP) to 0.5 (BSF). There was a general trend of increased flower production for all sites except for GP and RP.

Fruit production

Overall, total fruit production from 2003 to 2004 decreased. The one exception to this was BP, which showed a slight increase. The reproductive success (percentage of flowers maturing into fruits) decreased at all sites except for RP where there was a slight increase, even though total flower number was down. Many of the sites had a drop of over 50% in reproductive success (BSF, CRP2, GLP, GCP, PP1 and 2).

Plant size

Due to protocol changes in 2003, we were only able to compare plant size between 2003 and 2004. Mean total stem number per clump did not change significantly from 2003 to 2004, except at RP where the mean decreased from 7.6 to 6.0. GLP and GCP had the highest numbers of stems per clump while BSF had the lowest. GLP also had the highest clump diameter with CRP1, CRP2 and RP also having high clump diameters. BSF was the only population to show a significant decrease in clump size.

Survivorship

Survivorship was high: all sites had at least a 90% survivorship rate except for BP (78.7%) and BSF (86.8%). BP has shown the largest decrease for two years in a row and this year did not have any recruits. New recruits were found at CRP2, GCP, PP1 and 2 and RP.

Discussion

While overall flower production increased for 2004, the fruit production greatly decreased. This could be due to the relatively early emergence of the flowers-the earliest ever noted at CRP-which could change the balance between floral availability and pollination availability. In general, many of the populations seem to be relatively stable with high survivorship even with low fecundity and low recruitment. However, we may see the effects of some of these stochastic events, such as flooding, much later in regards to the current underground protocorms.

Further analysis

During 2005, we are going to perform an in-depth analysis of the Level 2 data to look at the relationships between the vegetative and reproductive components of *Cypripedium candidum*. We will also analyze the effects of different management regimes at each site. Pending funding, we will also conduct a genetic analysis of the populations to evaluate the genetic diversity between populations. This will potentially allow us to elucidate any genetic basis for population differences between sites.

Seed Viability Study

To assess the seed viability for *Cypripedium candidum*, we randomly collected up to 12 fruits considered to be intact from each of the Level 2 monitoring sites. We combined the CRP and PP plots to minimize our impact at these sites. We measured the length and width, and then weighed each fruit. We then scraped the seed out of the fruit and reweighed the husk to determine the seed weight. A small sub-sample of seed (~500) was removed from each fruit to assess the viability. These were examined under a light microscope to determine if they had a viable (plump, visible) embryo or an unviable (desiccated, undeveloped) embryo (Figure 1). We tried to examine at least 300 seeds per fruit, although some fruit had suffered insect damage so we were not always able to reach this goal. Our results are summarized in Tables 1 and 2.

We detected no difference between sites in any of the fruit characters measured. We then tested for correlations between the various characters and seed viability. No correlations were found which means that none of the characters measured (fruit length, fruit width, fruit weight or seed weight) can be used to predict seed viability. The relatively high seed viability of those fruits tested indicates that the plants are probably not resource limited and, although rare, pollination events are very effective. However, herbivory by insects can be very detrimental to those fruits attacked. Although we tried to be careful about which fruits we gathered, we did end up collecting some that had small holes in them indicating insect herbivory. This resulted in some apparently mature fruits having very low seed viability, as low as zero (see Table 2).

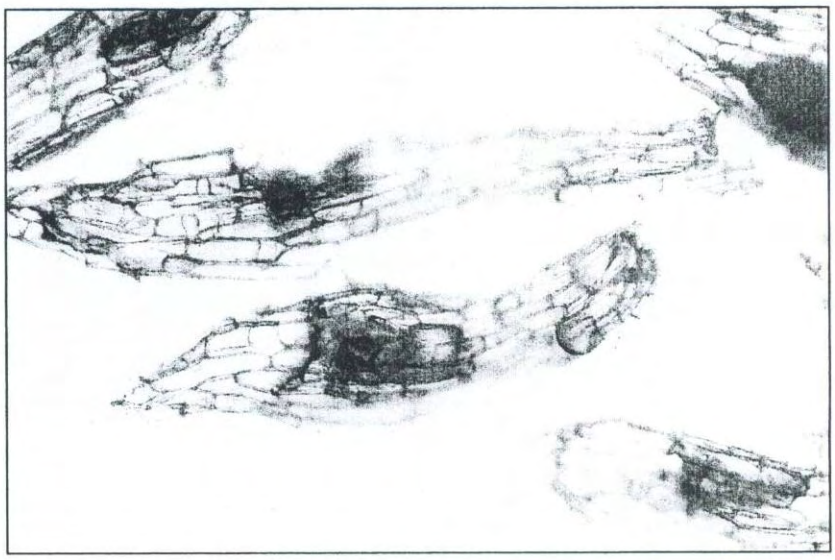


Figure 1. Photo of *Cypripedium candium* taken using a light microscope.

Upper seed is considered unviable due to the small embryo, while the lower seed is considered viable with its large embryo.

Table 1. Average fruit and seed measurements with standard errors in parentheses.

Site	# of fruits	Fruit length (cm)	Fruit width (mm)	Fruit weight (g)	Seed weight (g)
BP	10	2.70 (0.12)	7.75 (0.64)	1.5815 (0.0169)	0.0221 (0.0045)
BSF	11	2.69 (0.08)	6.11 (0.44)	1.6049 (0.0186)	0.0196 (0.0042)
CRP	10	2.40 (0.09)	6.67 (0.42)	1.4501 (0.0161)	0.0204 (0.0045)
GP	8	2.44 (0.08)	6.90 (0.59	0.9937 (0.0123)	0.0110 (0.0044)
GCP	10	2.50 (0.08)	6.94 (0.43)	1.3546 (0.0136)	0.0225 (0.0044)
GLP	12	2.55 (0.08)	6.35 (0.32)	1.3820 (0.0125)	0.0198 (0.0038)
PP	10	2.57 (0.12)	5.85 (0.30)	1.0866 (0.0102)	0.0150 (0.0036)
RP	10	2.57 (0.09)	6.24 (0.30)	1.1047 (0.0119)	0.0121 (0.0021)

Table 2. Seed viability data with standard errors in parentheses.
The average viability is for the site while the minimum and maximum viabilities show the full range of variation.

Site	# of fruits analyzed	Average viability	Minimum viability	Maximum viability
BP	9	86.2 (6.99)	74.8	96
BSF	11	59.7 (26.77)	0	94.6
CRP	10	76.9 (28.17)	0	96.5
GP	6	66.6 (33.75)	22.6	94.7
GCP	10	82.5 (11.23)	63	94.8
GLP	10	79.5 (17.38)	46.8	95.1
PP	10	68.0 (13.57)	45.9	91.4
RP	10	66.9 (25.65)	0	86.7

Tomanthera auriculata

The full Level 2 analysis of *Tomanthera auriculata* will come as an addendum. What is presented here is an analysis of *T. auriculata* reproductive patterns and a seed viability study.

Reproductive Patterns in *Tomanthera auriculata*
A continuation of Level 2 analysis

As a general rule, plant size affects reproductive output. This is thought to be particularly true among annual plant species, such as *Tomanthera auriculata*. Annual plants as individuals have only a single opportunity to reproduce in their lifetime, as opposed to perennial species, which may have multiple opportunities. A perennial species that experiences an unproductive year has the opportunity to "cut its losses" and try again in a subsequent year. An annual plant does not have this luxury. Therefore, as a general reproductive strategy, annual plants will attempt to maximize their reproductive output by producing as many fruits and seeds as they can, given available resources. These resources are generally thought to be such things as carbohydrates, either as stored carbohydrates (starch) or directly

available photosynthate, soil nutrients, water, and light. Though not commonly considered to limit reproduction, pollen availability may also affect reproductive output in annual plants.

While reproductive output may be limited by any of these factors, there is a general trade-off between limiting resources, such as carbon and pollen availability. Most plants are either resource-limited or pollen-limited. Although plants may experience pollen-limitation in the short term, they are generally considered to be resource limited over their lifetimes. As a result of their short lifetime and limited opportunity for reproduction, it is generally thought that annual plant reproduction is limited primarily by carbon availability in the form of either stored sugars (starch) or by sugar as an immediate product of photosynthesis.

There is a direct relationship between plant size of any measure and photosynthetic productivity. The strongest relationship between a measure of plant size and photosynthetic productivity will be found with leaf area. However, it is an onerous task to measure the total leaf area of an individual plant, and an even greater task to measure total leaf area of all plants in a study population. Usually, then, some other measure of plant size is used as a general proxy for leaf area (and, thus, for photosynthetic productivity). In this study of *Tomanthera auriculata*, we have used stem height as our measure of overall plant size. The exact relationship between plant size and total leaf area remains unexplored, but we expect a close correlation between these parameters.

Plant size, by whatever measure, does not simply serve as a proxy for photosynthetic capacity alone. There is strong empirical evidence that plant size may effectively be used as a proxy for understanding many, if not all, of the factors that limit reproductive output. For example, nitrogen is essential for the production of proteins, without which many biochemical processes cannot occur. In the face of limited nitrogen availability, plant growth slows and may even cease. Reproductive activity may take place in the face of nitrogen limitation, however, especially in an annual species. The plant will usually opt to translocate nitrogen from the leaves into the developing embryos, seeds, and fruits. Thus, the total plant body can serve as a repository for essential resources, and, the larger the plant, the larger the stored resource pool of any essential nutrient. Even light availability is greater for a larger plant, not just because of greater photosynthetic surface, but also because large plants tend to overtop smaller plants, effectively blocking out the available light.

The only resource for which plant size may not be a proxy is pollen. While there is an empirical relationship between plant size and both pollen production and pollen deposition, insect behavior and population size play an important role in determining whether or not pollen is a resource that limits reproductive output for any particular plant species. The number of flowers a plant produces governs pollen production, and larger plants tend to produce greater numbers of flowers. When we look at the total number of flowers that a large plant produces, relative to a small plant, insect-mediated pollen deposition is also affected by plant size. Optimal foraging theory suggests that insects will be attracted to larger floral displays because they represent a greater resource pool for the foraging insect. Empirical studies bear this out. Display size generally has a positive correlation with pollen deposition. As both plant and floral display size increase, pollen deposition also increases.

Reproductive output in an annual plant species is critical to population persistence. While an individual plant needs to only replace itself to "win" the fitness race, population growth necessitates that plants produce more offspring than just replacements. While successful seed set is only one factor in ensuring representation in the next generation, setting abundant seed is necessary because finding a safe site for germination of that seed, and from there

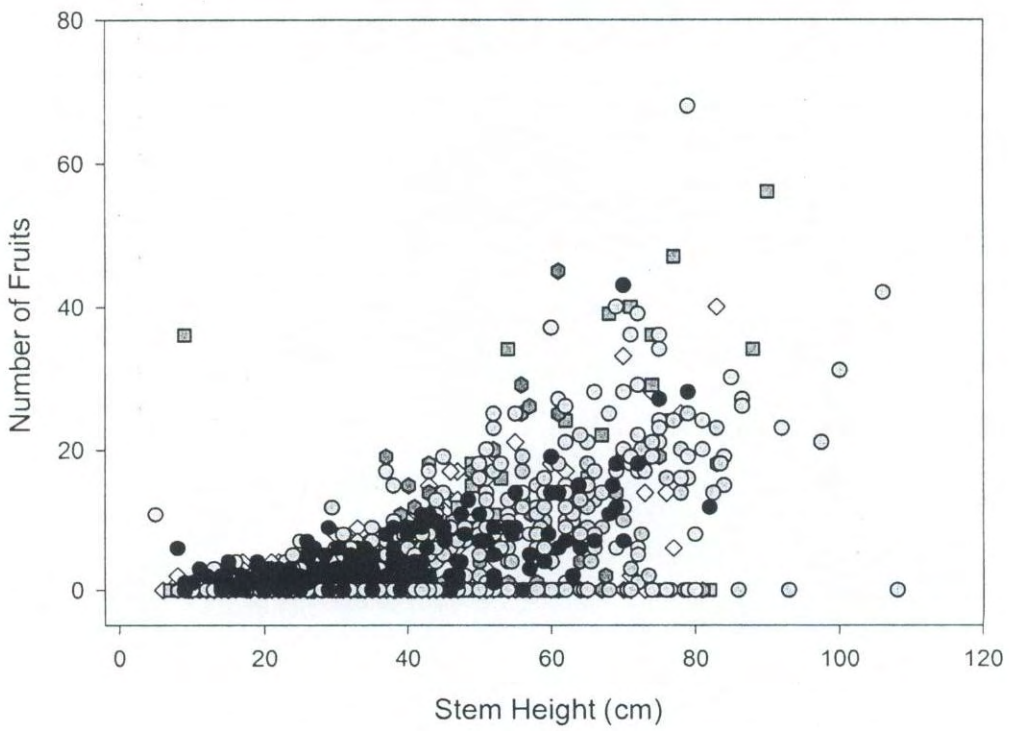
recruitment into a population, are all fraught with danger and the probability of success is fairly low. Generally speaking, a larger plant will have a greater seed output than a smaller plant, and therefore will have a greater probability of having at least one offspring represent them in the next generation. Indeed, a larger plant will stand an even greater chance than a small plant that its offspring will have more than just "replacement" value.

In a very real way, current population size and long-term persistence of annual species is entirely dependent upon prior episodes of reproduction. This is why so many studies in population biology focus on the stages of reproduction, as well as the factors that limit reproductive output. This is the first step in uncovering the underlying dynamics of a population.

Determining Size Classes for Tornanthera auriculata

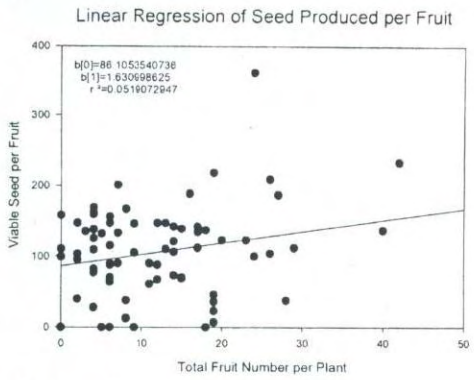
Because of the strong correlation between size and reproductive output, plant population studies usually are stage-based, as opposed to age-based, and the stages are founded upon size and fecundity. In order to assign stages to the plants in the *Tornanthera auriculata* populations monitored through the Plants of Concern program for the past four years, we wanted to explore the overall relationship between plant size and fecundity, using fruit number as our measure of fecundity. As we were looking for stages that would be comparable across all the populations, data for the initial analysis was pooled across all populations and all years and plotted in a scatter plot (Figure 1). This graph shows all individuals monitored in the context of the Plants of Concern program, including those that were deer browsed, which is why there are so many data points at 0 along the x-axis.

Figure 1



Examination of this scatter plot showed an exponentially increasing relationship between size and fecundity. The scatterplot shows that the slope of this relationship changes most visibly at two places: approximately 30cm and approximately 50cm. The two places where the visual relationship between size and fecundity changed in the scatterplot was determined to reflect biologically meaningful changes in the relationship between size and fecundity. In other words, individuals falling within these areas on the curve behave similarly to each other. These became our defacto size classes. We then wanted to determine if these size classes could be considered legitimate at the population level by analyzing plant size within each population. Data collected across years in each population may be pooled for further analysis if there is no significant year effect on plant size. Variables that had similar means and variances (by means of conducting ANOVAs and Tukeys Tests) were pooled across years, within populations. These data were subsequently used to graph scatterplots using the same axes as Figure 1 for each population. Visual inspection of these plots showed a similar relationship between plant size (Stem Height) and fecundity (Fruit Number) within populations.

Figure 2

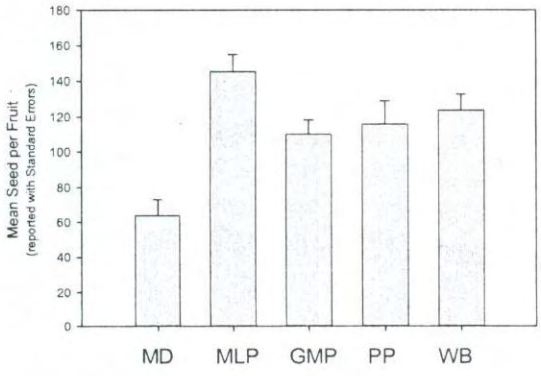


The 3 size classes determined from the method outlined above are small (0-30cm), medium (31-50cm), and large (greater than 50cm). Subsequent data analysis and demographic modeling will be based upon these size classes.

The Relationship Between Plant Size and Seed Output

Thirty randomly selected fruits were collected from individual plants chosen at random from each monitored population. Each fruit was selected from a different plant, with not more than one pod collected from each plant. In some cases, the population was smaller than 30, so two fruits were collected from some individuals. Fruits were randomly selected from the top third of the infructescence, the middle third, or the bottom third. In order to estimate the number of seeds per plant, the number of seeds per pod was determined. Seeds were returned to the site after counting.

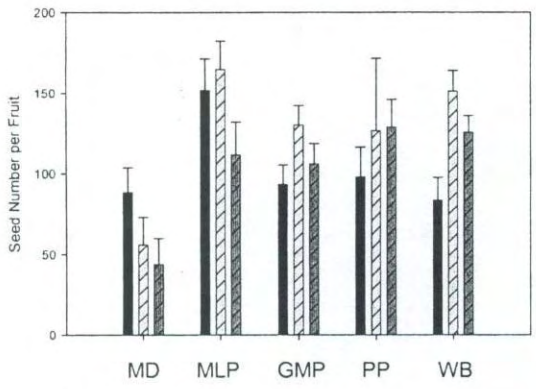
Figure 3



There is a significant difference in the mean number of seeds per fruit between two of the populations (Figure 2). MD has significantly fewer seeds per fruit than all other populations, while MLP has significantly more seeds per fruit than all the other populations. Overall, data pooled across populations and analyzed for an effect of size class on viable seed produced per fruit reveals that there is no significant effect of size class on seed produced (data not shown).

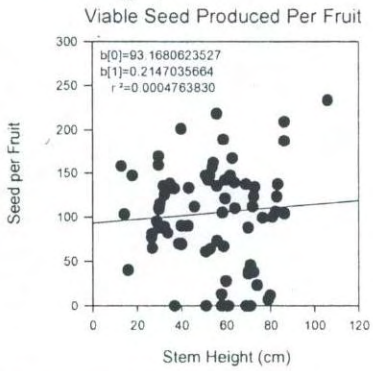
Fruit position within an infructescence may play a role in the number of seed matured at the whole plant level. A maternal plant may adjust the number of ovules she provisions in any given fruit based upon available resources, as well as upon the number of maturing embryos in fruits positioned above and below that fruit. This serial adjustment of resources may happen at either or both the fruit level (wherein a whole fruit is aborted), or at the seed level (wherein individual ovules are aborted). Data collected by the POC volunteers was analyzed to determine if we could detect serial adjustment of resources.

Figure 4



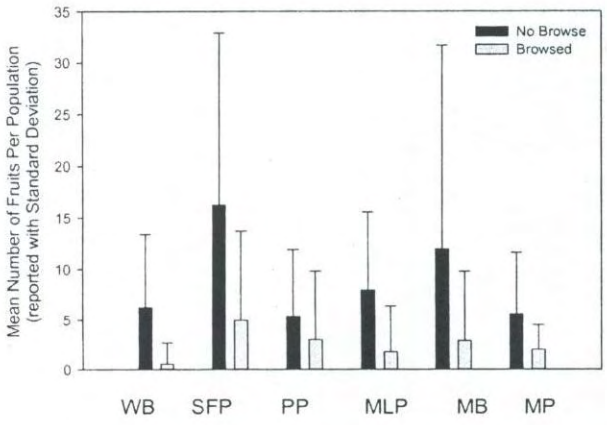
Four of the populations analyzed by ANOVA showed no significant effect of fruit position within the infructescence. There is, however, tremendous variation in the number of seeds per fruit within the categories analyzed (Figure 3: Top - black bars; Middle - gray hatched bars; Bottom - dark hatched bars). No consistent pattern of seed maturation can be seen. In the WB population, however, fruit position does significantly effect the number of seed produced. It is likely that if all fruits within a plant were collected and analyzed across populations, this pattern would be clearer. Many plants will provision older, more developed embryos at the expense of newly formed zygotes, so the pattern of floral bud opening is important. In *Tornanthera auriculata*, the inflorescence opens from bottom to top; however, in our study plants, direction of floral maturation doesn't seem to affect total seed set across populations.

Figure 5



There is no relationship between stem height (plant size) and the number of seeds produced per capsule (Figure 4). This indicates that seed set is independent of plant size. There may be an effect of pollinator activity on fruit set, but our data do not allow for that level of interpretation. However, there is a significant effect of the total number of fruit a plant produces on seed set per fruit (Figure 5). The relationship between total fruit and viable seed per fruit is increasing, which means that the percent viable seed per fruit increases with an increase in fruit number. As plant size does not significantly effect seed number, but fruit number does, this is likely an effect of pollinator visitation, reflecting the foraging patterns of the pollinator. The longer the pollinator forages on the same plant, the greater the fruit number and the greater the number of viable seed. One additional analysis that has yet to be conducted would look at the effect of flower number on seed set. If this relationship proves to be positive, it would indicate that floral display size positively effects pollinator behavior, leading to longer visits and greater fruit and seed set.

Figure 6



The Effect of Deer Browse on Reproductive Output

Deer browse has the potential to decrease reproductive success by one of two means. First, the deer may simply remove the floral axis partly or entirely, thereby constraining the plant to re-initiate flowers, if possible. They may also secondarily inhibit reproduction by removing enough photosynthetic surface that plants simply do not have the resource reserves to produce flowers. Removal of the reproductive axis may also occur too late in the growing season for the plant to compensate. Some empirical studies suggest that browsed plants can recover from, and even overcompensate for, deer browsing by converting vegetative meristems held in reserve along the shoot into

reproductive shoots. This conversion is stimulated by browsing and may result in an even greater reproductive output by allowing the plant to produce multiple reproductive branches. Plants that are not browsed may not be able to convert meristems in this manner, and therefore reproductive output is greater in over-compensating plants relative to unbrowsed individuals.

On a population basis, browsing in our study plots significantly reduced the number of fruits produced. All t-tests performed on the number of fruits produced in browsed versus unbrowsed plants show significant reduction in the number of fruits produced as a result of deer browse (Figure 6). For the whole study population (Fruit Number pooled across all years and populations) the mean number of fruits produced when plants are browsed is 2.2 ($\pm$ 5.6 s.d.), while the mean number of fruits produced by plants that did not experience browsing is 8.6 ($\pm$ 13.1 s.d.). The maximum number of fruits a browsed plant produced was 45, while the maximum number of fruits an unbrowsed plant produced was 199.

As we found no differences in plant height as a result of browsing, regardless of population, we concluded that, although browsing affected overall fruit production, it did so by removal of reproductive tissue (flowers and developing fruits) rather than decreasing the photosynthetic capacity of the individual plants. As Plant Height is significantly correlated with fruit production in this species, if the plants compensate for the removal of the reproductive axis by producing multiple branches and converting these to reproduction, we should see an increase in both the number of branches and the number of fruit in these individuals. Browsing is significantly correlated with the number of branches a plant produces across all populations ($F=16.808$, $N=1080$; d.f. = 3; $p=0.000$). Indeed, there is a statistically significant increase in the number of branches at PP ($F=11.499$; $N=167$; d.f. = 1; $p=0.001$), MLP ($F=4.909$; $N=225$; d.f.=1; $p=0.028$), and GMP ($F=36.265$; $N=157$; d.f.=1; $p=0.000$) correlated with browsing.

At the population level, a primary effect found in all populations is that the variance in the number of branches is increased as a result of browsing, resulting from some plants not producing any branches in response to browsing, to a few plants responding to deer browse by significantly increasing the number of branches produced. The variance in the number of fruits produced also increased with browsing at each population. It is difficult to tease apart the confounding effects of plant size, branch number, and deer browse on fruit set. The ideal way to do this would be to visit populations of *Tomanthera auriculata* on a weekly basis to determine the exact timing of deer browse relative to fruit set, and to couple this with an exclosure study that would look at how plants branch in the absence of deer browse.

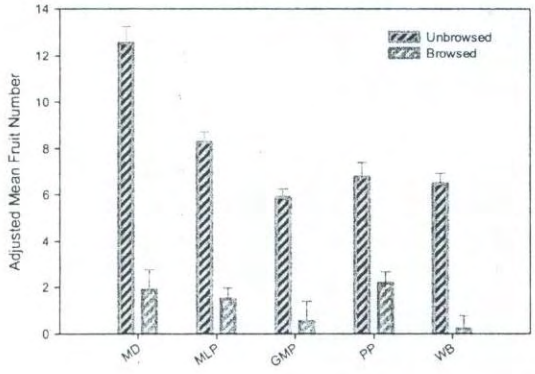
Given that site visits took place at fruiting, and deer browse measures were conducted during the second visit, elucidating cause and effect is difficult. There is a correlation between branch number and deer browse. Branch number could increase with deer browse because either the plants compensate for browsing by producing additional branches; or deer prefer highly branched plants. The latter seems most likely, given the timing of the visits. Additionally, the increase in variance in both the number of branches and the number of fruit in plants that are browsed seems a strong indication that browsing results in the removal of branches in large, highly branched plants. This would account for the increase in variance.

In any event, we are not interested in deer browse itself. We are more interested in the effect browse has on the reproductive potential of plants, and the further effect of decreasing population growth rates as fecundity is significantly decreased by browsing.

Indeed, browsing significantly reduces the probability of reproducing (ie: producing even a single fruit), as found in logistic regression for each population. Logistic regression looks at the probability distribution of a variable with two outcomes. In this instance, we were interested in determining the effect of deer browse on the probability of reproducing. In this model, plants were scored either as reproductive or not reproductive, so the amount of reproductive output is not considered here. When seen in this light, plants that were browsed have a significantly lower probability of reproducing than plants that were not browsed.

If we want to determine the overall effect of browse on fruit set, the best method given our data is an analysis of covariance (ANCOVA). While plant height has a significant effect on fruit set, as does branch number, we want to determine the effect of deer browse independent of plant size measures, which ANCOVA will allow. Analysis of covariance can separate out the confounding effects of stem height and branch number, and allow us to see the effect of deer browse alone on Fruit Number in each population. To increase the statistical power of this analysis, data have been pooled across years for each population. Even controlling for the confounding effects of size, deer browse significantly decreases the mean number of fruits produced in each of our study populations. Figure 3 shows how dramatically fruit number is reduced in plants that were browsed relative to those that were unbrowsed. The output for ANCOVA includes an adjusted Least Squares Mean, which is basically the mean of fruit number produced in browsed versus unbrowsed plants, after controlling (adjusting) for the overall effects of stem height and branch number (Figure 7).

Figure 7



These findings are important because although plant size is not significantly affected by deer browse, reproductive output is strongly affected by deer browse. Therefore, understanding reproductive output for each population, and building population viability models for each population, requires that we fully explore the effect of deer browse on within season growth and survivorship patterns as well as reproductive patterns.

Overall Patterns of Reproductive Success

To determine if reproductive output (reproductive effort) in terms of fruit set is proportional to plant size, we can use linear regression to explore the relationship between plant size and fruit number. Usually, we would use flower number; however, the percentage of flowers that form fruits is very high in this species, above 95%, so we are looking at fruit set instead. The mean reproductive effort equals the slope of the regression line, while a line that intersects the y-axis above the origin (positive value) shows a decreasing relationship between reproductive effort with increasing vegetative size. The opposite effect, when the line intersects below the origin (negative y value), reveals a relationship where reproductive effort increases with increasing plant size. When a population shows a decreasing relationship between size (a proxy for how much energy is available for reproduction) and actual reproduction, this is an indication that overall reproductive levels have the potential to be higher than observed. In an effort to explore limits to reproductive output, we applied this approach to *Tomanthera auriculata* to determine patterns of reproductive effort (allocation) across our study populations. Overall, the regressions in Figure 6 show that our study populations allocate resources to reproduction in an increasing fashion (Figure 8). This implies that allocation to reproduction, relative to vegetative

growth, is balanced in the direction that maximizes reproductive output. This is generally the pattern we expect to find in an annual species. The one rather surprising exception is MLP, which shows the opposite pattern. Although mean reproductive effort increases with increasing size, implied by the positive slope of the regression line, the proportional investment across the population shows a decreasing trend (the line intersects the y-axis below the origin). At the population level, the overall pattern of reproductive allocation to fruit does not increase with increasing size.

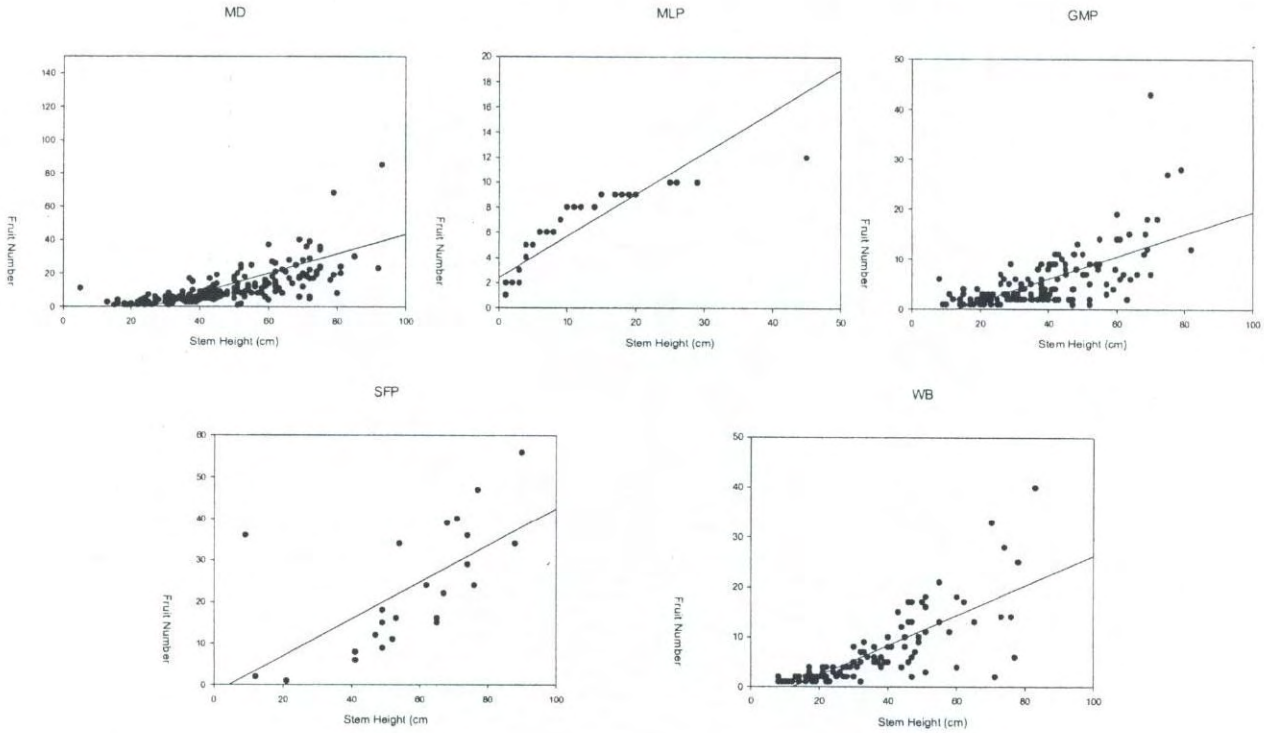


Figure 8. Proportional investment in reproduction versus vegetative growth usually varies with factors such as density, competition, resource availability and successional stage of the habitat. This is a graphic regression approach to exploring patterns of reproductive allocation in *Tomanthera auriculata*.

There is a possibility that reproduction is pollen limited in this population, as actual fruit set seems limited given the observed relationship between plant size and investment in reproductive structures. This is offset, however, by the fact that MLP also had the greatest seed production per fruit than any other population. Rather than producing more fruit with fewer seeds, we see an apparent allocation strategy that produces more seed per fruit, but fewer fruit. MD shows the extreme of the opposing allocation strategy; here, seed set is fairly low and reproductive effort in terms of fruit set is quite high (the linear regression for this population shows the most negative y-intercept of all our study populations). In addition, adjusted fruit set is significantly higher at MD than at all other populations (Figure 9).

Overall, data pooled across populations shows that resources allocated to fecundity (fruit number as a function of plant size) are very similar to patterns of allocation to reproductive effort (flowers produced as a function of plant size). The regression lines are very

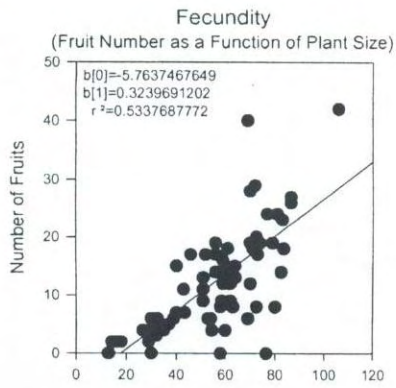
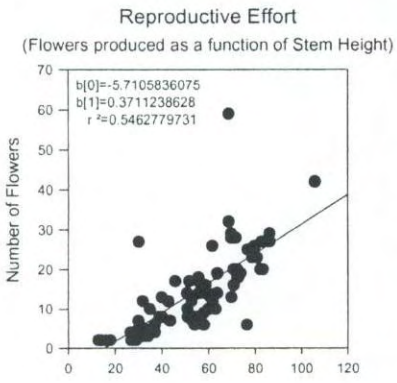


Figure 9

Figure 10



similar: they have nearly the same slope and similar intercepts (Figures 9 and 10). This pattern of reproductive allocation is expected in a species with such a high percentage of fruit set, usually about 95%. It is an indication that plants overall are allocating similar amounts of resources to fruiting as they do to flowering, and that reproductive allocation increases with increasing plant size. Although we expect this to be the case for most plants, it is particularly important for an annual plant to allocate as many resources to reproduction as they can. Because the allocation pattern to reproductive effort matches that of fruiting, we have strong evidence that individuals are maximizing their reproductive potential in terms of allocation and are not experiencing low pollinator visitation or other extrinsic limits to reproduction. However, only plants that were not browsed were included in this analysis. As a result, for those plants (and by extension, populations) that are heavily browsed, reproductive success is limited by herbivory.

Conclusions and Recommendations

In-depth analysis of the reproductive patterns in *Tomanthera auriculata* reveals some very interesting patterns. First, plant size matters: as expected, large plants produce more fruits than small plants. One way to put this finding into practice in terms of management is to ensure that *T. auriculata* populations are not competing with shrubby species, particularly invasive ones. Limiting competition would allow individual plants to optimize growth during the early part of the growing season, leading to a higher probability of reproductive success. Addtionally, reproduction success is severely limited in plants that are browsed. Deer browse dramatically reduces the number of fruits within populations, and those populations that experience heavy browse may therefore have limited growth potential. Deer browse is not easy to limit, but any management activity that would discourage deer would likely lead to positive growth rates in these populations.

Although seed set does not appear to be particularly pollen limited in our study populations, it is clear that foraging patterns influence fruit and seed set. Management activities that would increase pollinator activity or pollinator populations should also be encouraged. Depending upon which of a suite of pollinators prove to affect this species (published reports indicate that the primary floral visitors were *Bombus impatiens* (Apidae) and *Melissodes bimaculata* (Anthophoridae)), these management activities could include allowing smallscale honey producers to place hives near the populations, and/or providing additional on-site nesting sites for the pollinators. This type of management activity would encourage outcrossing in this species and might have the additional benefit of increasing the genetic diversity in these populations. Given that seed set does not appear to be limiting, since this species self-pollinates and is self-compatible even when pollinators do not visit, increasing levels of outcrossing may produce offspring with higher fitness and lead to greater success in seedling establishment.

An additional analysis to look at the effect that one year of deer browse has on the following year's population size is necessary to determine the extent of deer browse's effect, and we will undertake this analysis in the near future. In addition, we are in the process of recoding the data for a matrix projection analysis that will also allow us to simulate the effect of deer browse on the population growth rates for each of our study populations. We will report on the results of this analysis in a forthcoming addendum to this report.

Seed Viability Study

Tomanthera auriculata fruits were randomly collected using standardized protocols from five populations located in Northeast Illinois. Approximately an equal number of pods were collected from the top, middle, and bottom parts of the inflorescence to ensure that placement on the plant did not bias the results. The seeds of these populations were counted and examined under the microscope. It was observed that the seeds generally appeared to be either plump or desiccated. The seeds that were plump were classified as "Assumed Viable," while the seeds that were not plump or desiccated were classified as "Non-Viable." The percentage of seeds classified as "Assumed Viable" was high, while the "Non-Viable" percentages were very low.

Seed Viability Summary tables

	Total # seeds	Total # pods collected	Average # seeds/pod	Total # plump seeds	Average # plump seeds/pod	Total # desiccated seeds	Average # desiccated seeds/pod
MLP (10/6)	4215	30	155.11	4081	153.00	134	2.11
MD (10/6)	1922	30	64.07	1844	61.47	78	2.60
WB (10/6)	3710	30	123.67	3592	119.73	118	3.93
GMP (10/8)	4188	38	110.21	4009	105.50	179	4.71
PP (10/8)	1928	16	122.00	1784	111.50	168	10.50
Overall Total	**15963**	**144**	**575.06**	**15310**	**551.2**	**677**	**23.85**
Overall Mean	**3197.40**	**28.80**	**115.01**	**3062.00**	**110.24**	**135.40**	**4.77**

Percentages comparing seed viability to pod location +/- 1-2%	**MLP**	**MD**	**WB**	**GMP**	**PP**
% Of plump seed in T	32%	49%	13%	28%	29%
% Of plump seed in M	43%	26%	35%	39%	7%
% Of plump seed in B	21%	21%	51%	28%	58%
% of Overall plump seed	**96%**	**99%**	**97%**	**95%**	**94%**

% Of desiccated seed T	1%	1%	0%	1%	2%
% Of desiccated seed M	1%	0%	2%	1%	0%
% Of desiccated seed B	1%	2%	1%	2%	4%
% Of overall desiccated seed	**3%**	**3%**	**3%**	**4%**	**6%**

Percentages of overall plump seeds were above 90% in all five populations. This is not surprising, as *T. auriculata* is an annual and annuals need to have a high percentage of viable seed to survive. In total, 144 pods were collected and almost 16,000 seeds were counted. On average, there were 115 seeds per pod; of those, 110 seeds were assumed viable or plump and 5 were desiccated. There was no significant difference in whether the seed came from the top, middle, or bottom part of the inflorescence.

All five populations differ in number, with population numbers ranging from 30 to 150 individuals. From our demographic measurements, we know deer browsing is a definite factor in determining plant height and flower number. It seems that what flowers are left are eventually producing viable seeds. Why then are the numbers of individuals at some of the

populations so low and at others so high? Seed data seem to indicate that environmental conditions rather than seed viability may control population size.

Tomanthera seed under microscope for viability Study (2/7/2005, M. Stupen)

Viola conspersa

The monitoring protocols remained essentially the same for 2004 with only the following minor changes: the volunteers used small wire tags to mark the chasmogamous flowers on Visit 1 to distinguish these fruits from cleistogamous fruits during Visit 2. This helps us to form a more accurate picture of the contribution of the chasmogamous flowers to the overall reproductive success of the populations. Also this year, due to time constraints, we decreased the number of plants monitored in the MN population in half by randomly selecting 50% of the tags.

We used an analysis of variance (ANOVA) with a Tukey HSD multiple comparisons post-hoc to analyze differences between years and between sites, with significance established at $p < 0.05$.

Flower Production (Chasmogamous)
The mean chasmogamous (CH) flower production varied throughout the populations, with FW, GW, and WW having the highest numbers of CH flowers (Figure 1A, Appendix 6b). FW, MF, and MN all had significantly higher numbers of CH flowers than in 2003, while the other three populations did not have significant changes. Overall, FW had significantly higher CH flower production (1.9 per plant) when compared to the other populations (all less that 1 per plant).

Flower Production (Cleistogamous)
There was greater variation in cleistogamous (CL) flower production in 2004 when compared to 2003 (Figure 1B, Appendix 6b). While most sites did not show significant changes from 2003 to 2004, FL showed an increase and MN showed a decrease. Only FL and GW have shown consistently increasing trends in CL flower production while all other sites have varied among years. FL also had significantly higher CL flower production than all of the other sites.

Fruit Production
FL had significantly higher fruit production than all other sites in 2004 (Figure 2C, Appendix 6b). The overall trends for fruit production were similar to CL flower production. Except for WW, most sites did not have any significant changes from 2003 to 2004. WW had one of the highest fruit productions in 2003, but it dropped considerably in 2004 to its lowest fruit production across all the years studied.

Plant Size
We compared leaf counts of corresponding visits for all sites across years (for example Visit 1 2003 was compared to Visit 1 2004; Figure 2D, Appendix 6b). MF and FW showed large increases, indicating a trend towards mature plants rather than juveniles. All of the other sites remained about the same.

Survivorship
Survivorship varied greatly among the sites (Table 1, Appendix 6b). At 35.3%, FW had the lowest survivorship, although this might reflect continuing damage from the invasive removal in 2003. MN had the highest survivorship with 83.7% of the plants surviving. Recruitment was generally stable for those plots measured. Since we decreased the number of plants surveyed at MN, we did not look at recruits at this site. No new recruits were observed for FW.

Discussion (2004)
Each of the populations of *Viola conspersa* seems to respond differently to the changes in their environment. FL had a decrease in CH flower production, but increases in both CL and fruit production. FW and MN showed the opposite trend with an increase in CH flower production but decreases in both CL and fruit production. GW was the only population showing increases in all aspects of reproduction. MF showed an overall decrease in reproduction, while WW had similar numbers of flowers but a decrease in fruit production.

Further analysis, Viola conspersa

To understand the population dynamics of *Viola conspersa*, we have begun an in-depth analysis of the data collected from 2001-2004. Below is a preliminary report of our findings.

Relationship between vegetative growth and flower production
In order to establish size classes for the life stage analysis, we asked how the different measures of vegetative growth were related to fecundity. Multiple regression analysis was used to estimate the relative effects of different vegetative growth characters (number of leaves, number of reproductive stems and number of basal rosettes) on total flower production over all years. This analysis showed that, in each population, the number of reproductive stems was the strongest determinant of flower number, while the number of basal rosettes was the weakest (illustrated in Figure 3, Appendix 6b; with the exception of chasmogamous flower number in the FW population).

We asked how the combined vegetative growth characters contributed to the variance in fecundity in these populations, using an analysis of covariance (Table 2, Appendix 6b). In the FW population, and at the GW site, vegetative growth is a reasonable predictor of total flower production. At the FW site, and in WW, vegetative growth is an intermediate indicator of flower production, while at both MF and MN, the vegetative growth is a poor predictor of total flower production (Table 4, Appendix 6b).

Additionally, measures of vegetative growth are not equally useful in explaining the variance in chasmogamous and cleistogamous flowers. In most populations, vegetative characters show stronger effects on cleistogamous flower production, although relationships between any subset of flowers are usually weaker than relationships with total number of flowers (Table 2, Appendix 6b). The exception to this rule is FW, where vegetative growth explains more of the variance in chasmogamous flowers than in cleistogamous flowers.

Population dynamics

In all populations, the variation in selfing effort, as measured by cleistogamous flower production, explains most of the variation in total flower number (Figures 1 and 4, Appendix 6b). The exceptions to this trend in 2004 are explained by corresponding changes in outbreeding effort (Figure 1, Appendix 6b), and are worthy of further investigation. Flower production varied from year to year, and population to population and, with the exception of FP, all populations saw the greatest total flower production in 2001 (Figure 1, Appendix 6b).

Both vegetative growth and fecundity in *V. conspersa* are heavily dependent on environment. When analyzing factors that contribute to fecundity, we found that vegetative growth's contribution to total flower number varied by population. In more open populations (higher light; FP and GW), vegetative growth was a good predictor of total flower number (Table 2, Appendix 6b). However, in populations with more dense cover (lower light; MF and MN), we found that vegetative growth was a fairly poor predictor of total flower number (Table 2, Appendix 6b). FW would seem to be an exception to this rule; however, this population was heavily thinned during the third year of the study. It is interesting to note that while in other populations, vegetative growth explains more of the variance in the selfed reproductive effort (cleistogamous flowers), under this dramatic change in cover, vegetative growth explains more of the variation in outbreeding effort (chasmogamous flowers). These populations with variable cover (FW, WW) are also the populations that show stronger chasmogamous (outbreeding) contributions to total flower number in 2004. Although these are preliminary results, it seems that the type of cover may be a critical factor in determining which variables contribute to *V. conspersa* fecundity.

Life stage analysis

In order to understand how different environments and management regimes affect growth and reproduction over the *V. conspersa* lifetime, we are working on developing a transition matrix from this data set. At the moment, we are using the available data to determine how to define the state variables for this species. Given the result that, in all populations, reproductive stems are most strongly correlated with fecundity (above; Table 2, Appendix 6b), we feel that size classes based on leaves alone are inappropriate predictors for this species.

Seed viability

We did not collect fruit from the populations of *Viola conspersa* in 2004 because there was insufficient fruit production when we visited the sites. We are going to collect fruit in 2005 using the following protocols: first, we will mark chasmogamous flowers at each site early in the season with wire tags. Approximately three weeks later we will return to each site and randomly collect 30 of these fruits. We will also return to the sites in July and August and collect 30 cleistogamous fruits from each population. The fruits will be stored at Chicago Botanic Garden and we will count the number of viable and unviable seeds found in each fruit. We will report on this data in the 2006 report.

Conclusion: Level 2 Monitoring After Four Years

Patterns in plant populations are difficult to discern. Spatial as well as stochastic variation in the environment have profound effects on individual plants, and year to year variation can invalidate generalizations made in any given year. To overcome these difficulties requires the kind of high statistical power only found in large sample sizes accumulated over several

years. Applying this effort to Threatened and Endangered Species is expensive, and therefore has been done only to a limited extent; however, the patterns that emerge from larger and longer sampling are profitably applied to managing these species. Sometimes this management even leads to the species rebounding and its subsequent removal from lists of plants of special concern. This happens all too infrequently, however, given the number of species that could be or should be monitored. There is no doubt that using volunteer labor in this effort has value. However, there has been great concern about whether volunteers, even highly trained citizen scientists, are able to gather truly viable data in this regard. It is clear from the results reported at the end of the data gathering phase of our Level 2 Plants of Concern program that volunteer data is highly useful. It is also clear that this data provides enough statistical power to uncover patterns in population dynamics that are amenable to management. In particular, the analysis of the data collected from several populations of *Tomanthera auriculata*, though still incompletely analyzed, has yielded highly applicable results. We find it remarkable that patterns in *T. auriculata* were uncovered simply with monitoring data, without controlled experiments. We have every reason to expect that data collected on our other species, still in various stages of analysis, will also provide insights into the populations of these species which we are privileged to monitor.

The Volunteer Component

The role of the volunteers in POC cannot be overstated. They are the backbone of the program and it could not function without them. Good volunteer recruitment and training is training is critical to the successful implementation of the program. All the counties also recognize the importance of volunteers in their work, including monitoring. At this point, each county has one or two staff persons, either volunteer coordinator or ecologist, assigned to work with Plants of Concern in recruitment, training, and other forms of assistance.

Recruitment
Volunteers were recruited through word of mouth; articles in stewardship newsletters, Chicago Botanic Garden's Garden Talk, and the Habitat Herald; staff talks and information booths at stewardship conferences; and agency volunteer coordinators. The workshops were listed on the POC website.

Training
Volunteer training occurred in two different formats: 5.5 hour training workshops and in-field training.

Training Workshops
Three workshops were offered, one each in Lake, DuPage, and McHenry counties. 70 new and returning volunteers were introduced to POC program objectives and trained in field monitoring techniques for Level 1 protocols. Representatives from county agencies presented information about rare plants to be monitored in their counties; discussed the relationships between monitoring and management, and the benefits of POC to their work; and guided volunteer assignments. The sensitivity and confidentiality of rare plant locations was stressed in all the training, and new volunteers were required to sign a Confidentiality Form.

In-field Training
Program staff, interns, land managers, site stewards or experienced volunteer monitors all provided new monitors with additional field assistance on protocols and an orientation to sites and populations. Again in 2004, program staff and several land managers devoted substantial amounts of time in the field, but it is hoped that this time outlay, although it will always be a

component of the program, will decrease as volunteers become more self-sufficient and begin to mentor each other.

Volunteer retention is important because it ensures continuity of monitoring and consistent application of protocols. Retention rates from year to year have held fairly high, as reported in the first section. Agency and POC staff who participate in monitoring training and field work also contribute to continuity and consistency. Since 2001, POC has worked with many of the same staff from the major agencies. It is clear there will continue to be a high level of staff involvement working with the volunteers, as each year new volunteers need support in the field. As they are trained they become more self-sufficient and also can mentor recruits.

Monitor Evaluation Survey

In October, POC distributed a monitor survey (see Appendix 7 for the Monitoring Survey Form) for the purpose of evaluating the program from their viewpoint. It was geared mainly to volunteers, but staff monitors in the agencies were copied and several of them responded.

POC staff members maintain year-round communication with volunteers and land managers, adapting the program to make data collection more efficient and useful, and to make the monitoring experience informative and enjoyable for the volunteers. To further evaluate the overall reception of POC by monitors, an anonymous survey was sent out (via regular mail or e-mail) to over 200 volunteer monitors and land managers involved in the program in 2004.

Twenty-two surveys were returned, representing each of the six core counties and 16% of the total 2004 monitor pool. Questions on the survey assessed five areas: monitoring form and field equipment, interaction with staff and landowners, landowner and management issues, training, and the POC website. Questions either required a Yes/No response, a ranking on a scale of 1-5 (5 highest), or asked for comments relating to a particular subject. General comments were also welcomed (See Appendix 7 for the monitoring survey form).

Survey results are as follows. All ranks are based on a scale of 1 to 5, with 5 being the highest score. They are expressed below as an average of responses.

Background Information:
Of those who returned the form, 84% were primarily monitors and 16% were primarily landowners. The number of respondents that were active in DuPage County was 6; Cook County: 6, Will County: 3; McHenry County: 1; Kane County: 3; Lake County: 6. The average number of years with the program was reported as 2.55 years and 100% of respondents are planning to return next year.

Overall POC Experience:
90% said they had benefited from the program.
100% had communicated their general POC experience with others.
Overall monitoring experience ranked 4.3.
90% feel their contributions as a monitor have been adequately recognized.

Influence:
How informative and influential POC monitoring has appeared to be for managers ranked 3.5.
46% have seen positive changes in management.

Monitoring form and field equipment:
95% feel that questions on the monitoring form are clear.
Maps and direction clarity ranked 3.8.
Equipment availability ranked 3.7.

Training:
68.18% attended a training session in 2004.
66.7% felt that the location was adequate.
88.9% felt that the training provided was adequate.
71% were assisted in the field: 71%;
(58% assisted by POC staff, 29% by land managers or land owners, 47% by other monitors; 5 individuals assisted by 1 or more type of person).
Quality of training course ranked 4.1.
Quality of field assistance ranked 4.8.

Interactions:
POC staff accessibility ranked 4.5, and helpfulness ranked 4.55.
Landowner accessibility ranked 4.1, and helpfulness ranked 4.15.

POC Website:
Typical website visitation:
0 times: 33%; 1-10 times: 62%; 10+ times: 5%.
The website received a rank of 2.8 for overall presentation.
55.5% used the POC website web to download forms.
5.6% used the web to enter data.

Many suggestions and comments were also made. Some of these are listed here:

- "Some volunteers have difficulty determining how to count stems of *Juncus* and *Carex* species."
- "I think that there could be better training for how to solve problems when conditions don't match the forms."
- "Liked the hands-on experience with the tools, even as a review from year to year. I would definitely like more workshops on plant ID, since some of the areas I monitor in are very diverse and high quality. Don't want to step on really rare plants!"
- "Don't know if comments made to management had effect or if herbicide and brush removal were already part of management plan."
- "More management of invasives needs to be done."
- "In one case I was the most knowledgeable person there and felt like the blind leading the blind. In others, there were, in each case, someone who had great plant ID skills."
- "The assistance of the management staff was the best training."
- "POC program is great fun!"
- "Have I told other people that I've monitored for POC - Yes - I'm thrilled to do it!"
- "I thoroughly enjoy being a plant monitor. Great people to work with, great job, great experience to be outdoors checking up on these important and special plants."
- "I think they should hold a volunteer appreciation party (even if it's a potluck - at CBG) at the end of the year just for all the POC people so we can get to know who they all are."

Another fourth-year volunteer emailed us at the end of her season and said "I feel this has probably been the most growthful POC year for me in terms of what I have learned

botanically and about myself, as a steward and volunteer coordinator. Each year this work seems to become deeper and more important, and I thank you again for the privilege of doing it."

The POC program continues to adapt its methods in response to this survey and other suggestions and comments received throughout the year. Monitoring forms and protocols are seasonally clarified to make them easier to interpret and more widely applicable to the diverse field conditions encountered by monitors. A fourth training workshop in South Holland (southern Cook County) was added in spring of 2005 to accommodate a wider audience. Many additional projects are anticipated for the website. POC is also making plans for a volunteer appreciation event in conjunction with the Habitat Project for the end of the 2005 monitoring season to recognize volunteer involvement and dedication and to mark the completion of the fifth year of the program.

Program Evaluation: Meeting 2004 Goals and Projected Products

POC met nearly all of the evaluation criteria and delivery of products as outlined in the grant proposal and listed below. Many of these have already been discussed in detail in the preceding text.

Evaluation Criteria

** Element Occurrences monitored at Level 1 are maintained at current levels or moderately increased, with attention to proportionally equalizing sites, species and occurrences among counties. Cumulative monitoring for 2001-2004 will reach up to 30% of EOs in NE Illinois.*

POC monitored an increase of 58 occurrences (a 32.6% increase) from 2003, with increases in all counties. Cumulative monitoring of listed EOs in NE Illinois is about 25%. A revised Endangered and Threatened Species list was published in 2004 and the exact percentage of EO monitoring needs to be researched.

** Retention of former volunteers is greater than 50%.*

Retention rate of volunteers from 2003 to 2004 was 75%

** Five volunteers from each collaborating county are recruited and trained for participation.*

New volunteers by county: Cook, 23; DuPage, 5; Kane, 6; Lake, 11; McHenry, 2; Will, 12

POC recruited 69 new volunteer monitors in 2004, for an average of 11.5 per county. The program met its minimal goals overall, and for all but one county.

** Field data and land management forms are completed and all data is entered into the POC Access database.*

All 2004 submitted monitoring and management forms have been entered into the database. We are still lacking a number of Land Management forms from the landowners and will continue to request them.

** Level 1 monitoring is evaluated by submitting questionnaires to participating staff, volunteers and recipient agencies.*

An evaluation survey was distributed by mail and/or email to all volunteers (see Appendix 7) and is discussed in this report. Staff and agencies provided more informal feedback and suggestions through the Advisory Group meeting and frequent communication with POC staff during the planning and implementation of the monitoring season, and POC incorporates their concerns and input into the program. POC collaborators from five county agencies and IDNR spoke at the training workshops of the tremendous support POC monitoring provides to their own monitoring programs and management decisions. Specific comments on the program's benefits are communicated in their letters of support submitted with this grant proposal. There were two major factors in the decision not to survey staff and agencies more formally: the reluctance to require additional paperwork from overburdened agency staff; and POC staff time limitations, due to the planning, implementing, and data-recording demands of this rapidly expanding program.

** Level 2 monitoring is evaluated by submitting questionnaires to participating staff, volunteers and recipient agencies.*

At the Advisory Group meeting in December 2004, the decision was made to discontinue Level 2 demographic monitoring through the POC program at the four-year mark in 2004, rather than continue a fifth year as initially planned. The major reason for this decision was that the seed collection made possible viability analyses and fecundity studies for our target species and we were able to complete a critical demographic monitoring cycle. This, combined with the other demographic data gathered over four years on these species, suggested a natural end point to this process. The demanding and time-consuming nature of demographic monitoring also played a part in this decision. Results of this work are presented in this report and data will continue to be analyzed in 2005. Because of the decision to discontinue Level 2 monitoring, it was not felt necessary to conduct a formal evaluation of it for the purpose of determining whether this expenditure of time and resources should continue.

Program Products

All five products listed in the 2003 Chicago Wilderness proposal have been delivered:

1. Monitoring results: Level 1 and Level 2 monitoring complete and all field data entered and analyzed on the Access database.

Monitoring data for all Level 1 occurrences, in the form of an Access report for each occurrence and data from Level 2 demographic plots, are being reported simultaneously with this report to collaborating Forest Preserve Districts, other landowners, the Natural Heritage Database, and the Nature Preserves Commission. This summary report to CW, which analyzes the data, is also being shared with them.

Field data from Level 1 and Level 2 monitoring have been entered into the Access database and subsequently analyzed.

2. Three field training workshops.

Three workshops were held on April 3 and 17, and May 2, 2004 for 70 participants.

3. Advisory Group meetings: two held in March and November/December.

Partner landowners and agencies participate in diverse ways, and perhaps this goal of Advisory Group meetings should be set in a broader context of regular and extensive communication with all POC partners. The Advisory Group itself comprises project collaborators and representatives from all the major landholding agencies, volunteer groups, and scientists (See Appendix 1). The additional 40-plus landowners communicate with POC on an individual basis for their particular sites and species. It should be noted that most of these smaller landowners do not have resources to monitor rare plants, and POC has become their vehicle for monitoring.

One Advisory Group meeting was held on December 9 at the Chicago Botanic Garden (See Appendix 11 for minutes). It was agreed by the Advisory Group that, in 2004, it would be more effective and efficient for POC staff to meet or communicate with individual agencies to plan the specifics of their 2004 monitoring program, rather than hold another full group meeting. In winter 2004, POC staff began a series of meetings that continued into 2005 with five forest preserve districts and the Illinois Department of Natural Resources. Extensive communication with landowners was ongoing before, during, and after the season. The major landowners also participated by providing maps and aerial photos, reviewing monitoring reports, completing Land Management forms, and providing volunteer communication and field assistance. Eight major agencies assisted with the training workshops.

The Natural Heritage Database representative on the AG advised us on making POC data compatible with Natural Heritage Database formats. The Nature Preserves Commission representative worked closely with POC to provide monitoring permits in nature preserves.

Overall, one of the greatest benefits of POC is the level of collaboration between the many agencies and their volunteers in monitoring the region's rare species. In addition to six forest preserve districts, 49 other landowners have been involved in the program, many of whom would not be able to engage in rare plant monitoring. The IDNR's strong support and involvement in POC strengthens the program's regional identity. Listed here are the active links POC has to other CW projects and research:

- The Habitat Project
- Early Detection and Rapid Response
- Wild Things Conference, February 26, 2005 (booth and panel)
- Regional Monitoring Task Force
- CW Report Card
- Chicago Wilderness Science Agenda
- Endangered Species Photography Project (Carol Freeman)
- Chicago Botanic Garden staff research projects developed through or as a direct offshoot of Plants of Concern: Cirsium hillii genetic research (Jeremie Fant, with Marlin Bowles and Tim Bell of the Morton Arboretum); Viola conspersa population research (Pati Vitt); Ammophila breviligulata genetic research (Jeremie Fant); Cypripedium candidum genetic research (Kathryn Theiss).

4. Public Communication. The broader public will be made aware of the importance of monitoring, the Plants of Concern project and the training workshops through promotion in various vehicles and formats.

Some highlights of the extensive public communication and outreach for Plants of Concern are presented here, including a discussion of the POC website. Several of them are included as an appendix. Other promotion and outreach efforts included mailings and announcements and articles in newsletters.

Plants of Concern Website

The Plants of Concern website (www.plantsofconcern.org) was created in late 2003. Database Technician Diana Rosenbaum manages the website design and content, while volunteer Peter Jacobs is in charge of the web database programming. They have worked together to create a website to benefit current and prospective volunteers, POC staff, and land managers. The intent of the website is many-fold. It is a way to get the word out about rare plants and the POC program, recruit new volunteers, and provide news, information, and monitoring resources.

There are six major sections on the website: home page, news, contact information, links, download forms, and submission forms. The home page lists background information about POC as well as statistics from previous years. There is also a news section that posts newspaper articles about the program or any announcements of events. The contact information section lists phone numbers and email addresses for POC staff, while the links section lists links to partners' websites and various plant resources. From the download forms section, monitors can download up-to-date monitoring forms, land management forms, and guidelines and instructions on GPS usage. The website is also extremely beneficial to POC in that it allows monitors to submit their monitoring forms on-line, saving hundreds of hours of data entry. It also instantly provides land manager with current and past data forms, giving them up-to-date knowledge on the status of their sites' rare plants.

Currently we are assembling a team of volunteers to troubleshoot the data-entry process, as well as critique other aspects of the website, such as the look and feel of the site. Once suggested changes are incorporated we will add new features. Our goals for future development include species pages for POC-monitored plants, which would include pictures for identification as well as links to reference materials, and a volunteers' corner where we will post a calendar of upcoming events, articles, projects, stories and pictures submitted by POC volunteers. Further resources that we will create for the website are a table of species' bloom times, a look-up table for scientific names of associate and invasive species and information and pictures of common invasive species.

Publications/Presentations

"Plants of Concern." Presentation by Susanne Masi at the Morton Arboretum Stewardship Forum, March 13, 2004.

"Eyes on the Prized Plans." Article by Mary Cannon in *The Habitat Herald.* Vol. 5, Issue 2, April 2004. (See Appendix 11)

"Plants of Concern: Volunteers Monitor Rare Species in a Standardized Regional Program (Northeast Illinois)." Poster by Susanne Masi and Lailah Reich published in *Proceedings of the 16th International Conference, Society for Ecological Restoration, August 24-26, 2004.* Victoria, B.C.

This poster was also presented at the Natural Areas Conference in Chicago in October, 2004 and the Janet Meakin Poor Research Symposium at the Chicago Botanic Garden in October.

"Learning to See." Article by Victor Cassidy (POC volunteer and writer/editor) in *The Habitat Herald* Vol. 5, Issue 3: October 24, 2004 (See Appendix 10)

"Plants of Concern." Prairie Fest, sponsored by the Unitarian Univeralist Church, Elgin. POC booth staffed by Susanne Masi, Becky Mann and Mary Supen.

"Keeping Watch over Local Nature." Article in *Chicago Wilderness 2003 Annual Report*, November 2004. Plants of Concern was featured in this article.

5. *Final Project Report.*

Hereby submitted.

Other goals defined within the proposal as recommended by the Steering Committee for this grant proposal:

Continued Funding
Chicago Wilderness expressed concern that, while it recognizes and supports the importance of regional monitoring, all the regional monitoring programs, including Plants of Concern, should look to securing additional sources of funding.

We agree that, to reach its full potential as a systematic, comprehensive rare plant monitoring program for northeast Illinois, long-term funding issues need to be addressed. The current funding, including four years of grants from CW and substantial matching funds from the Chicago Botanic Garden, is inadequate to meet all the needs of POC, much less to support its full potential for expansion. Therefore, POC, with the assistance of the CBG development staff, has been aggressive in seeking additional funding. In 2004, we received a $20,000 contract from CorLands to monitor work in the Lower Des Plaines River Watershed in Cook and Will Counties, which significantly expanded our efforts there. Also in 2004, we received a two-year grant for $20,000 from the IDNR Wildlife Protection Fund. We have applied three times to C2000, and received the highest ranking from Chicago Wilderness for this grant, but fund cuts at the state level have so far prevented us from receiving an award. Midewin National Tallgrass Prairie (US Forest Service) contracts POC to do monitoring each year for $5,000. POC continues to pursue other private and public sources of funding.

Although these other types of support are crucial, a base source of funding is needed to keep the program alive. Embedding POC within Chicago Wilderness' long-term Work Plan will help ensure its continuation. There are many ways to keep this work integrated within CW's broader goals, such as linking POC with the Regional Report Card process, the CW Research Agenda, the Regional Monitoring Task Force, and the Regional Scientific Database. POC currently participates in all these efforts, and several are likewise seeking additional funds.

Regional Monitoring
Chicago Wilderness recommended a closer unity and integration among the various regional monitoring efforts. POC has made many efforts to fulfill this suggestion. During the past year, POC has participated in the Regional Monitoring Task Force and attended its planning

and priority setting workshop in January 2005. We also participated in the Regional Report Card process and contributed data to its August 2004 rare species workshop, and we are prepared to incorporate any species designated by these larger groups as key indicators of community health into POC monitoring. In 2005, we have joined forces with the CW-funded Early Detection and Rapid Response Program to incorporate the new target invasive species list into our training and protocols. Finally, the POC database is listed on the Regional Scientific Database developed by the Illinois Natural History Survey for CW.

Recommendations for 2005 and beyond

Based on the CW grant for this current year, we are already working in 2005 to expand and improve the POC program. Our volunteer recruitment and training is working well and should be continued and expanded using current practices. The following section discusses some of the areas needing further attention and improvement.

Data Management and analysis

Managing increased amounts of data and the need to analyze additional years of data are both exciting developments and challenges for limited time and resources. In 2005, we are committed to further analyzing Level 2 data, particularly to a population matrix analysis for each of the target species. We will also seek to expand the analysis of Level 1 data, perhaps in partnership with graduate students and researchers within the region. There is still a wealth of POC data to be analyzed in response to specific scientific questions that CW may wish to explore. It is our hope to attract researchers, including graduate students, to further utilize the data already collected. We also plan to continue the volunteer data validation study in 2005, using POC staff and agency professionals to test for reliability of volunteer data.

Species selection

POC wants to ensure that it monitors those species and element occurrences most beneficial to the region and devotes its resources to regional priorities. The region needs to revisit the priority list of endangered and threatened species to determine which species not currently in the program need monitoring. POC is monitoring about 25% of the listed species occurrences in northeast Illinois, and an ultimate goal would be to monitor 70-80% of the region's EOs on a rotational basis, a significant program expansion.

We also recognize that some of the species that should be monitored for regional importance are not listed as endangered or threatened. In conjunction land management agencies, we have begun developing a "special concern" species list, 32 of which we have begun monitoring. However, we must be cautious that the list doesn't become too large for us to monitor all included species. POC will take the lead in developing such a regional list, starting with surveys that will lead to a meeting among agencies and botanists during 2006. Any species chosen as regional indicators through the regional monitoring task force and the report card process can be brought into the POC program immediately.

Program Expansion to Wisconsin and Indiana

It is regularly suggested that the time has come to move POC into other areas of Chicago Wilderness, for example northwest Indiana and southeast Wisconsin, as well as other Illinois counties. Additional funding for area coordinators– who would work with all the various agencies involved in other states, develop an advisory board in each area to select species for monitoring, organize volunteer recruitment, and perform other important administrative functions of the program– would help meet that excellent goal. The current POC can share common elements such as protocols, database, and volunteer training.

Concluding Statements

During the projects' fourth year, the POC research project expanded its research efforts in several ways. In 2004, POC monitored 24% more species, 32.5% more Element Occurrences, and 24% more sites. The project had higher volunteer participation rates, with an increase of 47%. Also, volunteers were generally confirmed as valid agents of data collection when, through a more intensive analysis of Level 2 species *Tomanthera auriculata*, we found meaningful patterns revealed as a result of volunteer monitoring.

POC data continues to confirm important information for land managers on the threats to rare plant populations and efforts to address these threats. For example, we found that 84% of all populations monitored showed at least one threat, with brush encroachment and deer browse as the greatest threats. Also, data showed that 73% of all populations monitored had a least one invasive plant species present, with Buckthorn species (*Rhamnus* species) posing by far the greatest invasive threat. Monitors observed management efforts to meet these threats in at least 43% of all populations; however, these observations need to be compared with reports from land managers regarding actual management that occurred.

Our demographic studies showed mixed results of reproductive success in Level 2 species. *Tomanthera auriculata* showed a greater than 90% seed viability, but deer browse was found to significantly decrease reproductive efforts in that species. *Viola conspersa* populations showed great variability in all measures studied - fruit production, survivorship, and plant size: these findings suggest that populations of this species respond differently to different environments and changes within those environments. *Cypripedium candidum* showed an increase of flower production in 2004, but a decrease in fruit production: a possible explanation for these results may be a decrease in pollination levels, due to extremely early flowering dates that year.

With this report, we are submitting the great majority of the work and analysis delineated for this grant. However, we will submit several addenda to complete grant expectations no later than June 3, 2005. These additional reports will include complete Level 2 analyses for *Cirsium hillii* and *Tomanthera auriculata*, a seed viability study for *C. hillii*, and a population matrix analysis for *T. auriculata* that uses current demographic data to predict population growth rates and relates these rates to the impact of deer browse. Meanwhile, work on POC continues, and we look forward to sharing our findings with Chicago Wilderness throughout the coming year.

APPENDIX 1

Plants of Concern Collaborator and Advisory Group Listing, 2004

Rebecca Blazer (Audubon-Chicago Region)*
Scott Kobal (FPD- DuPage County)*
Cindy Hedges (FPD – DuPage County)*
Kenneth Klick (FPD – Lake County)*
Tom Smith (FPD – Lake County)*
Beth Jarvis (CD – McHenry County)*
Debra Nelson (District Natural Heritage Biologist)*
Tara Kieninger (Illinois Natural Heritage Database)*
Chris Hauser (FPD - Kane County)
Rebecca Key (FPD - Will County)
Dan Gooch (Illinois Endangered Species Protection Board)
Glen Kruse (IDNR: Biodiversity Program, Division of Resource Protection & Stewardship)
Ben Dolbeare (IDNR: Biodiversity Program, Division of Resource Protection & Stewardship)
Patti Reilly (IDNR: Natural Areas Program Manager – Acting)
Kelly Neal (Illinois Nature Preserves Commission)
Eric Ulaszek (Midewin National Tallgrass Prairie)
Karen Billo (The Nature Conservancy)
Mary Borecki (Volunteer)
Jane Balaban (Volunteer)

* = official collaborator contributing time and/or in-kind matches in the 2004 Chicago Wilderness Workplan grant

APPENDIX 2

Plants of Concern 2001-2004
Species, County Element Occurrences

Species	Listed	County	2001	2002	2003	2004	Total EOR#
Actaea rubra	Not Listed	Cook				1	1
Adiantum pedatum	Not Listed	Lake			1	1	1
Agalinis skinneriana	Listed	Lake				2	2
Amelanchier interior	Listed	DuPage	2	2	2	2	2
Amelanchier sanguinea	Listed	Cook	1		1	2	2
Amelanchier sanguinea	Listed	Kane		1	1		1
Ammophila breviligulata	Listed	Cook	3	3	4	3	5
Arenaria patula	Listed	Cook				1	1
Arenaria patula	Listed	DuPage	1	1		1	1
Arenaria patula	Listed	Will			1	3	3
Artemisia serrata	Not Listed	Kane				1	1
Asclepias exaltata	Not Listed	Lake			2	1	2
Asclepias lanuginosa	Listed	McHenry		1		1	1
Asclepias meadii	Listed	DuPage		1			1
Asclepias viridiflora	Not Listed	Kane	3			2	4
Aster furcatus	Listed	Cook	2	1	1	1	2
Aster furcatus	Listed	Kane	2	2	1	2	2
Aster furcatus	Listed	Lake		2	2	2	2
Baptisia leucophaea	Not Listed	Lake			1	1	1
Beckmannia syzigachne	Listed	Cook				1	1
Bidens discoidea	Not Listed	DuPage			1	1	1
Cakile edentula	Listed	Cook	3	4	5	4	6
Cakile edentula	Listed	Lake	1	1			1
Calopogon tuberosus	Listed	Cook	1	1	1	1	1
Calopogon tuberosus	Listed	Lake			1	1	1
Calopogon tuberosus	Listed	McHenry			1	1	1
Carex alata	Listed	Will				1	1
Carex aurea	Listed	Cook		2	1	1	2
Carex aurea	Listed	Kane			1	1	1
Carex aurea	Listed	Lake	1	1	4	1	4
Carex bromoides	Listed	Cook				1	1
Carex bromoides	Listed	DuPage			1	1	1
Carex brunnescens	Listed	Lake			1		1
Carex crawei	Not Listed	Cook		1	1	1	1
Carex crawei	Not Listed	Will				3	3
Carex crawfordii	Listed	Will				1	1
Carex crus-corvi	Not Listed	DuPage			1	1	1
Carex crus-corvi	Not Listed	Lake			1		1
Carex cryptolepis	Listed	DuPage	1	1			1
Carex cryptolepis	Listed	Lake			1	1	2
Carex disperma	Listed	Lake			1		1
Carex formosa	Listed	Cook				2	2
Carex intumescens	Listed	Cook	1				1
Carex intumescens	Listed	Lake			1		1
Carex oligosperma	Listed	Kane		1			1
Carex trisperma	Listed	Lake			1		1
Carex tuckermanii	Listed	DuPage	2	4	3	4	4
Carex viridula	Listed	Cook		1		1	2
Carex viridula	Listed	DuPage	4	4	3	2	5
Carex viridula	Listed	Lake			1		1
Carex viridula	Listed	Will			1	1	1

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Plants of Concern 2001-2004
Species, County Element Occurrences

Species	Listed	County	2001	2002	2003	2004	Total EOR#
Carex woodii	Listed	Cook		1		1	1
Carex woodii	Listed	DuPage	3	6	3	5	6
Carex woodii	Listed	Lake			3	4	5
Castilleja sessiflora	Listed	Lake			1		1
Chamaedaphne calyculata	Listed	Kane		1			1
Chamaedaphne calyculata	Listed	Lake			1		1
Chamaesyce polygonifolia	Listed	Cook	2	3	3	5	7
Chamaesyce polygonifolia	Listed	Lake		1			1
Cirsium hillii	Not Listed	DuPage	3	4	3	4	5
Cirsium hillii	Not Listed	Kane	1	1	2	2	2
Cirsium hillii	Not Listed	McDonough	1				1
Cirsium hillii	Not Listed	McHenry	1	1	1	1	1
Cirsium hillii	Not Listed	Peoria	1				1
Cirsium hillii	Not Listed	Pike	1				1
Cirsium hillii	Not Listed	Will	1	2	2	2	2
Cirsium hillii	Not Listed	Winnebago	1				1
Comptonia peregrina	Listed	Kankakee		1			1
Corallorhiza maculata	Listed	Will			1		1
Cypripedium calceolus var parviflorum	Listed	Lake	1	1	1	1	2
Cypripedium candidum	Listed	Cook	5	5	4	6	7
Cypripedium candidum	Listed	DuPage	2	4	2	4	4
Cypripedium candidum	Listed	Kane	3	2	2	3	3
Cypripedium candidum	Listed	Lake	2	2	4	3	4
Cypripedium candidum	Listed	McHenry		2	3	4	6
Cypripedium candidum	Listed	Will		1	1	1	1
Dalea foliosa	Listed	Cook		1			1
Dalea foliosa	Listed	DuPage	1	2		1	2
Delphinium tricorne	Not Listed	Cook				1	1
Diarrhena americana	Not Listed	DuPage			1		1
Dirca palustris	Not Listed	Kane		1	1		1
Drosera intermedia	Listed	Kane		1			1
Drosera rotundifolia	Listed	Lake	1	1	1	1	1
Elymus trachycaulus	Listed	DuPage	1	1	1	1	1
Epilobium strictum	Listed	Will				1	1
Eriophorum angustifolium	Not Listed	Kane	2			1	2
Filipendula rubra	Listed	Lake		1	1	1	1
Geranium bicknellii	Listed	Lake	1	2	2	2	3
Geum rivale	Not Listed	Kane		1	1		1
Geum triflorum	Not Listed	Lake		1			1
Goodyera pubescens	Not Listed	Kane				1	1
Helianthus giganteus	Listed	Cook				1	1
Hydrastis canadensis	Not Listed	Cook				1	1
Hydrocotyle ranunculoides	Listed	Lake		1			1
Hymenoxys herbacea	Listed	DuPage	1	1		1	1
Hypericum kalmianum	Listed	Lake		1	3	2	3
Ilex verticillata	Not Listed	DuPage			1	1	1
Isoetes butleri	Listed	DuPage		1		1	1
Isoetes butleri	Listed	Will			1	2	2
Jeffersonia diphylla	Not Listed	Cook				1	1
Juglans cinerea	Not Listed	DuPage				1	1
Juglans cinerea	Not Listed	Lake			1	1	1

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Plants of Concern 2001-2004
Species, County Element Occurrences

Species	Listed	County	2001	2002	2003	2004	Total EOR#
Juncus alpinus var rariflorus	Listed	DuPage		1	1	1	1
Juncus alpinus var rariflorus	Listed	Lake				1	1
Juniperus communis	Listed	Lake		1			1
Larix laricina	Listed	Lake		1			1
Lathyrus ochroleucus	Listed	Lake	2	4	2	6	7
Lechea intermedia	Listed	Kane		1	1	1	1
Lespedeza leptostachya	Listed	McHenry		1	1	1	2
Liatris scariosa var nieuwlandii	Listed	Cook				2	2
Liatris scariosa var nieuwlandii	Listed	Will				1	1
Lycopodium clavatum	Listed	DuPage	1				1
Lycopodium complanatum flabelliforme	Not Listed	DuPage				1	1
Lycopodium complanatum flabelliforme	Not Listed	Kane				1	1
Malvastrum hispidum	Listed	Will				1	1
Menyanthes trifoliata	Listed	Kane				1	1
Mitella diphylla	Not Listed	Lake			1	1	1
Oenothera perennis	Listed	Cook	1			4	4
Oenothera perennis	Listed	DuPage			1	1	1
Oenothera perennis	Listed	Lake	2	3	5	7	7
Oenothera perennis	Listed	Will				1	1
Orchis spectabilis	Not Listed	McHenry		1	1	1	1
Oryzopsis racemosa	Not Listed	DuPage			1	1	1
Oryzopsis racemosa	Not Listed	Lake			1		1
Penstemon tubaeflorus	Listed	DuPage				2	2
Plantago cordata	Listed	DuPage		1	1	1	1
Platanthera clavellata	Listed	Lake			1	1	1
Platanthera flava var herbiola	Listed	Lake		2	3	3	4
Platanthera hyperborea var huronensis	Not Listed	McHenry		1	1	1	1
Platanthera psycodes	Listed	Lake		2	3	3	3
Poa sylvestris	Not Listed	DuPage			1	1	1
Pogonia ophioglossoides	Listed	Cook	1				1
Pogonia ophioglossoides	Listed	McHenry			1		1
Polygonatum pubescens	Listed	Cook				1	1
Polygonatum pubescens	Listed	Lake		1			1
Populus balsamifera	Listed	Cook				1	1
Potamogeton robbinsii	Listed	Lake		1			1
Psoralea tenuiflora	Not Listed	Kane	1			1	1
Pyrola elliptica	Not Listed	Lake				1	1
Rubus odoratus	Listed	DuPage	1	1	1	1	1
Rubus odoratus	Listed	Kane		1	1	1	1
Rubus odoratus	Listed	Lake		1			1
Rubus pubescens	Listed	Cook			1	1	2
Rubus pubescens	Listed	Lake		1	2	1	2
Rudbeckia fulgida var. sullivantii	Not Listed	Will				1	1
Salix candida	Not Listed	Kane				1	1
Sarracenia purpurea	Listed	McHenry				1	1
Scirpus hattorianus	Listed	DuPage	2	2	1	1	2
Scirpus hattorianus	Listed	Lake		1	1	1	1
Scirpus microcarpus	Listed	Lake				1	1
Shepherdia canadensis	Listed	Lake	1	1	1		1
Silene regia	Listed	Cook		1	1	1	1
Silene regia	Listed	Kane	2			2	2

APPENDIX 2

Plants of Concern 2001-2004
Species, County Element Occurrences

Species	Listed	County	2001	2002	2003	2004	Total EOR#
Sisyrinchium montanum	Listed	Cook			1	2	2
Sisyrinchium montanum	Listed	Lake		1	1		1
Sparganium chlorocarpum	Listed	DuPage	1	2		2	2
Sparganium chlorocarpum	Listed	Kane			1		1
Spiranthes lucida	Listed	Cook	1	2	2	2	2
Symphoricarpos albus	Listed	Kane		1	1		1
Tofieldia glutinosa	Listed	Cook	1	1	1	1	1
Tomanthera auriculata	Listed	Cook	3	3	3	5	5
Tomanthera auriculata	Listed	DuPage	1	1	2	1	2
Tomanthera auriculata	Listed	Will	2	3	3	4	4
Trientalis borealis	Listed	Lake			1		1
Trifolium reflexum	Listed	Will		1	1	1	1
Triglochin maritima	Listed	Lake				1	1
Triglochin maritima	Listed	McHenry				1	1
Triglochin palustris	Listed	Cook	1	1	1	1	1
Triglochin palustris	Listed	Kane			1		1
Triglochin palustris	Listed	Will				1	1
Trillium cernuum	Listed	McHenry				1	1
Trillium sessile	Not Listed	Cook				1	1
Utricularia cornuta	Listed	McHenry		1	1	1	1
Utricularia intermedia	Listed	Cook	1	1	1	2	2
Utricularia intermedia	Listed	Kane			1		1
Utricularia intermedia	Listed	Lake			1	1	1
Utricularia intermedia	Listed	McHenry		1	1	1	1
Utricularia minor	Listed	Cook	1				1
Vaccinium oxycoccus	Listed	Lake			1		1
Valeriana uliginosa	Listed	McHenry		1	1		1
Veronica scutellata	Listed	Cook				1	1
Veronica scutellata	Listed	DuPage	2	4	2	4	5
Veronica scutellata	Listed	Lake		2	3	2	5
Veronica scutellata	Listed	Will			1		1
Viola conspersa	Listed	Cook	1	1	1	2	2
Viola conspersa	Listed	DuPage	1	1	1	1	1
Viola conspersa	Listed	Lake	4	6	8	7	9
Viola conspersa	Listed	McHenry			1		1

	2001	2002	2003	2004	Total EOR#
Totals:	97	153	178	235	329

# Listed Species:	89
# Non-Listed Species:	32
Total # Species:	121

APPENDIX 3

Plants of Concern 2001-2004
Species, County Element Occurrences

County	SiteName	LandOwner	2001	2002	2003	2004	Total EOR#
Cook	Bergman Slough	FPD Cook County				2	2
Cook	Bluff Spring Fen	MWRD and City of Elgin	9	6	7	8	10
Cook	Bunker Hill Prairie and Savanna (Clayton F. Smith Woods)	FPD Cook County				1	1
Cook	Bunker Hill Prairie and Savanna (Sidney R. Yates Flatwoods)	FPD Cook County				1	1
Cook	Camp Sagawau	FPD Cook County				4	4
Cook	Camp Sagawau (CCC Quarry)	FPD Cook County				3	3
Cook	Chicago Ridge Prairie	Oak Lawn Park District	1	1	1	1	1
Cook	Deer Grove	FPD Cook County				1	1
Cook	Dixon Prairie, Chicago Botanic Garden	FPD Cook County/CBG	1	3	2	3	4
Cook	Dropseed Prairie	TNC				1	1
Cook	Edgebrook Woods	FPD Cook County				1	1
Cook	Gensburg Markham Prairie	Northeastern Illinois University	1	1	1	1	1
Cook	Glencoe Botanical Area (Shelton Park)	Glencoe Park District				1	1
Cook	Glenview Naval Air Station Prairie	Village of Glenview		2	3	3	3
Cook	Kennicott's Grove	Glenview Park District	1				1
Cook	Kloempken Prairie and Savanna	FPD Cook County				1	1
Cook	Lake Cook Metra Station (Metra Prairie)	Metra Railroad ?				1	1
Cook	Lloyd Park Beach Boat Launch	Village of Winnetka				1	1
Cook	Loyola Beach (Pratt Beach)	Chicago Park District	1	1	1	2	2
Cook	McDonald Woods East, Chicago Botanic Garden	FPD Cook County/CBG	1	1	2		2
Cook	McDonald Woods West, Chicago Botanic Garden	FPD Cook County/CBG	1			1	1
Cook	McDonald Woods, Chicago Botanic Garden	FPD Cook County/CBG	1	2	1	2	2
Cook	Montrose Beach	Chicago Park District	3	3	3	4	4
Cook	Oakton Community College	Oakton Community College				3	3
Cook	Paintbrush Prairie	TNC	1	1	1	1	1
Cook	Palatine Prairie	Palatine Park District + MWRD	1	1	1	1	1
Cook	Rainbow Beach	Chicago Park District		3	2	3	3
Cook	Sante Fe Prairie	Civic Center Auth of I&M Canal Natl Herit Corridor	1	1	1	1	1
Cook	SEPA Station - Calumet River	MWRD	1				1
Cook	Sheridan Lakeside Condominium Association Beach	Sheridan Lakeside Condominium Association and Owners			1		1
Cook	Sheridan Lakeside Condominium Association Beach/Berger Park	Sheridan Lakeside Condominium Association and Owners/Chicago Park District	1		2		2
Cook	Somme Prairie Grove	FPD Cook County				4	4
Cook	Somme Prairie Nature Preserve	FPD Cook County				2	2

APPENDIX 3

Plants of Concern 2001-2004
Species, County Element Occurrences

County	SiteName	LandOwner	2001	2002	2003	2004	Total EOR#
Cook	Surfside Condominium Beach / Kathy Osterman Beach	Surfside Condominium Association/Chicago Park District	3	3	3		3
Cook	Tower Road Park Beach	Village of Winnetka				3	3
Cook	William Powers Conservation Area (Wolf Lake)	IDNR		3	1	1	3
Cook	Wolf Road Prairie	Village of Westchester	1	1		1	1
DuPage	Belmont Prairie	Downer's Grove Park District	2	2	2	2	2
DuPage	Big Woods Forest Preserve	FPD DuPage County				2	2
DuPage	Blackwell Forest Preserve	FPD DuPage County	1	2	2	3	3
DuPage	Churchill Woods	FPD DuPage County				1	1
DuPage	Des Plaines Riverway	FPD DuPage County				1	1
DuPage	East Branch Marsh (East Branch Forest Preserve)	FPD DuPage County		2	2	2	2
DuPage	Fischer Woods	FPD DuPage County	1	1	7	7	7
DuPage	Fullersburg Woods	FPD DuPage County	3	3	3	3	3
DuPage	Hawk Hollow	FPD DuPage County	1	1	1	1	1
DuPage	Hidden Lake	FPD DuPage County		1		1	1
DuPage	Lyman Woods	FPD DuPage/Downer's Grove Park District/Village of Downer's Grove	3	3	1	1	3
DuPage	Mallard Lake	FPD DuPage County	1	1			1
DuPage	Maple Grove	FPD DuPage County		2	2	2	2
DuPage	Meacham Grove	FPD DuPage County		1		1	1
DuPage	Pratt's Wayne Woods	FPD DuPage County	2	3	2		3
DuPage	Pratt's Wayne Woods (Brewster Creek)	FPD DuPage County	1	1		1	1
DuPage	Swift Prairie (Swift Road Meadow)	FPD DuPage County		1	1	2	3
DuPage	Timber Ridge (Klein Savanna)	FPD DuPage County	1	1	1	1	1
DuPage	Tri-County State Park	IDNR		1		1	1
DuPage	Warrenville Grove Forest Preserve	FPD DuPage County		1	1	1	1
DuPage	Waterfall Glen	FPD DuPage County	4	8	1	7	8
DuPage	Waterfall Glen (Dolomite Prairie)	FPD DuPage County		1			1
DuPage	Waterfall Glen (Signal Hill)	FPD DuPage County	1	1		1	1
DuPage	West Branch Forest Preserve	FPD DuPage County	1	1	1	1	1
DuPage	West Chicago Prairie	FPD DuPage County	2	3	2	3	4
DuPage	West DuPage Woods	FPD DuPage County	2	1	2	1	3
DuPage	West DuPage Woods (Elsen's Hill)	FPD DuPage County	2	1	1	1	2
DuPage	Wood Dale Grove	FPD DuPage County	2	2	2	2	2
Kane	Almon Underwood Forest Preserve	FPD Kane County	1				1
Kane	Bliss Woods Forest Preserve	FPD Kane County				1	1
Kane	Burlington Prairie	FPD Kane County	1	1	1	1	1
Kane	Burnidge Forest Preserve	FPD Kane County				2	2

APPENDIX 3

Plants of Concern 2001-2004
Species, County Element Occurrences

County	SiteName	LandOwner	2001	2002	2003	2004	Total EOR#
Kane	Campton Hills Park	St. Charles Park District	1		1	1	1
Kane	Dixie Fromm Briggs	Dundee Township		1	1	1	1
Kane	Fox River Bike Trail and Trout Park	FPD Kane County/City of Elgin	1	1	1	1	1
Kane	Freeman Kame	FPD Kane County	1			3	3
Kane	Hannaford Forest Preserve	FPD Kane County	1			1	1
Kane	Helm Road Woods (Barrington Hills Botanical Area)	FPD Kane County and ComEd	1	1		1	1
Kane	LeRoy Oakes Forest Preserve	FPD Kane County	2			2	2
Kane	LeRoy Oakes Forest Preserve (Murray Prairie)	FPD Kane County	2			2	2
Kane	Mooseheart Ravine	Loyal Order of Moose		3	3		3
Kane	Nelson Lake Marsh	FPD Kane County			3	1	3
Kane	Pothole Marsh	FPD Kane County			1		1
Kane	Prairie Kame Forest Preserve	FPD Kane County	1				1
Kane	Russell Fen	FPD Kane County	2	1	1	1	2
Kane	Rutland Bog	Chicago Title and Trust		3			3
Kane	Sauer Family Prairie Kame FP	FPD Kane County				1	1
Kane	Sleepy Hollow Ravine	Glen Speigler		1	1	1	1
Kane	Trout Park Nature Preserve	City of Elgin		2	2	1	2
Kankakee	Sweet Fern Savanna	Marianne Hahn		1			1
Lake	Berkeley Prairie	FPD Lake County		2	3	3	3
Lake	Buffalo Grove Prairie	Commonwealth Edison			1	1	1
Lake	Cuba Marsh	FPD Lake County		3			3
Lake	East Skokie Nature Preserve	Lake Forest Open Lands Association		1			1
Lake	Elm Road Forest	FPD Lake County			5	2	6
Lake	Ethel's Woods	FPD Lake County		1		1	1
Lake	Florsheim Park	Village of Lincolnshire	1	1	1	1	1
Lake	Florsheim Park/North Park	Village of Lincolnshire		1	1	2	2
Lake	Fort Sheridan Bluff (Ft. Sheridan Golf Course)	FPD Lake County	2	6	2		6
Lake	Fourth Lake Fen	FPD Lake County			1		1
Lake	Gavin Bog and Prairie	FPD Lake County	2	3	8	3	8
Lake	Grainger Flatwoods	FPD Lake County	1	3	6	3	6
Lake	Grant Woods Forest Preserve	FPD Lake County	1	1	1	3	3
Lake	Greenbelt Forest Preserve	FPD Lake County			2	1	2
Lake	Heller Nature Center	Highland Park/Park District			1	2	2
Lake	Highmoor Prairie	Highland Park/Park District				1	1
Lake	Illinois Beach State Park (North Unit)	IDNR				2	2
Lake	Illinois Beach State Park (North Unit) and Hosah Prairie	IDNR + Zion Park District				2	2
Lake	Illinois Beach State Park (South Unit)	IDNR	2	3	6	6	8
Lake	Independence Grove	FPD Lake County				2	2

APPENDIX 3

Plants of Concern 2001-2004
Species, County Element Occurrences

County	SiteName	LandOwner	2001	2002	2003	2004	Total EOR#
Lake	Leonardi Park	Highland Park/Park District			1	1	1
Lake	Lyons Prairie and Marsh	CD McHenry County			1		1
Lake	Lyons Woods	FPD Lake County			2	1	2
Lake	MacArthur Woods	FPD Lake County		4	6	5	6
Lake	Marl Flat Forest Preserve	FPD Lake County				1	1
Lake	Marl Flats Forest Preserve	FPD Lake County				1	1
Lake	Middlefork Savanna	FPD Lake County		2	1		3
Lake	Red Oak Woods	North Shore School District 112				1	1
Lake	Reed-Turner Woodland and Woodland Ridge Lot	Village of Long Grove	1	1	1	1	1
Lake	Rollins Savanna	FPD Lake County			1		1
Lake	Ryerson Conservation Area	FPD Lake County	1	4	8	7	8
Lake	Singing Hills	FPD Lake County			1		1
Lake	Spring Bluff	FPD Lake County		2	4	2	4
Lake	Sun Lake	FPD Lake County		1			1
Lake	Turner Lake	IDNR	1	1	1	1	1
Lake	Wadsworth Prairie	FPD Lake County	1	1	1	1	1
Lake	Wadsworth Prairie	FPD Lake County/RR Right of Way	1	1	1		1
Lake	Wauconda Bog	FPD Lake County	1				1
Lake	Waukegan Beach	City of Waukegan			2	2	2
Lake	Wright Woods	FPD Lake County	1	1	2	3	3
McDonough	Thistle Hills Land and Water Reserve	Privately Owned	1				1
McHenry	ABRAMS/KAN	Privately Owned				1	1
McHenry	Alden Sedge Meadow	CD McHenry County			1	2	2
McHenry	Bailey Easement: Boone Creek	Bailey Family		1	1		1
McHenry	Boone Creek Fen	O'Donnell Family			1		1
McHenry	Frank and Margo Blair Property	Frank and Margo Blair		1	1	1	1
McHenry	Glacial Park	CD McHenry County		1	1	1	1
McHenry	Glacial Park (Delta Kames)	McHenry County CD			1		1
McHenry	HUM 58-59	McHenry County CD				1	1
McHenry	HUM 61	McHenry County CD				2	2
McHenry	HUM Coyne Station East	McHenry County CD				2	2
McHenry	HUM Railroad Prairie West	McHenry County CD		1	1		1
McHenry	Lake in the Hills Fen	IDNR/Village of Lake in the Hills	1	5	5	4	6
McHenry	Tom Burroughs Property	Tom Burroughs		1	1	1	1
Peoria	Wokanda Camp	Peoria Park District	1				1
Pike	Walnut Grove Hill Prairie	Privately Owned	1				1

APPENDIX 3

Plants of Concern 2001-2004
Species, County Element Occurrences

County	SiteName	LandOwner	2001	2002	2003	2004	Total EOR#
Will	Blodgett Road Dolomite Prairie (Des Plaines River Conservation Area)	IDNR		1	1	1	1
Will	Dellwood Park/North Prairie	Lockport Township Park District				3	3
Will	Four Seasons Park	Plainfield Park District			1	1	1
Will	Goodenow Grove Nature Preserve	FPD Will County				2	2
Will	Grant Creek Prairie	IDNR	1	1	1	1	1
Will	Grant Creek Prairie and Midewin National Tallgrass Prairie	IDNR + USFS		1	1	1	1
Will	Hickory Creek Barrens	FPD Will County				1	1
Will	Middle Plum Creek	FPD Will County				1	1
Will	Midewin National Tallgrass Prairie (Blodgett Road)	U.S. Forest Service	1	1	1	1	1
Will	Midewin National Tallgrass Prairie (Drummond Prairie)(Joliet Army Ammunition Plant)	U.S. Forest Service/Exxon/Mobil			2	3	3
Will	Midewin National Tallgrass Prairie (Joliet Army Ammunition Plant)	U.S. Forest Service				2	2
Will	Midewin National Tallgrass Prairie and Des Plaines River Conservation Area: Foxglove Prairie (Joliet Army Ammunition Plant)	U.S. Forest Service/IDNR	1	1	1	1	1
Will	Romeoville Prairie Nature Preserve	FPD Will County		1	1	5	5
Will	Thorn Creek Woods	FPD Will County, IDNR, Villages of Park Forest and University Park			2		2
Will	Thorn Grove Forest Preserve	FPD Will County				1	1
Will	Vermont Cemetery	FPD Will County		1	1	1	1
Winnebago	Sugar River Alder Nature Preserve	FPD Winnebago County	1				1

	2001	2002	2003	2004	Cumulative EOR#
Total # EORs	97	153	178	235	329
Total # Sites (duplicated removed)	62	80	88	118	148
Total # Land Owners (duplicates removed)	25	32	38	41	57

APPENDIX 4

Plants of Concern 2001-2004
Species Monitored by County Frequency - A Regional View

Number of Counties	Species	Cook	DuPage	Kane	Lake	McHenry	Will	# EORs
6	Cypripedium candidum	*	*	*	*	*	*	25
4	Carex viridula	*	*		*		*	9
4	Cirsium hillii		*	*		*	*	14
4	Oenothera perennis	*	*		*		*	13
4	Utricularia intermedia	*		*	*	*		5
4	Veronica scutellata	*	*		*		*	12
4	Viola conspersa	*	*		*	*		13
3	Arenaria patula	*	*				*	5
3	Aster furcatus	*		*	*			6
3	Calopogon tuberosus	*			*	*		3
3	Carex aurea	*		*	*			7
3	Carex woodii	*	*		*			12
3	Rubus odoratus		*	*	*			3
3	Tomanthera auriculata	*	*				*	11
3	Triglochin palustris	*		*			*	3
2	Amelanchier sanguinea	*		*				3
2	Cakile edentula	*			*			7
2	Carex bromoides	*	*					2
2	Carex crawei	*					*	4
2	Carex crus-corvi		*		*			2
2	Carex cryptolepis		*		*			3
2	Carex intumescens	*			*			2
2	Chamaedaphne calyculata			*	*			2
2	Chamaesyce polygonifolia	*			*			8
2	Dalea foliosa	*	*					3
2	Isoetes butleri		*				*	3
2	Juglans cinerea		*		*			2
2	Juncus alpinus var rariflorus		*		*			2
2	Liatris scariosa var nieuwlandii	*					*	3
2	Lycopodium complanatum flabelliforme		*	*				2
2	Oryzopsis racemosa		*		*			2
2	Pogonia ophioglossoides	*				*		2
2	Polygonatum pubescens	*			*			2
2	Rubus pubescens	*			*			4
2	Scirpus hattorianus		*		*			3
2	Silene regia	*		*				3
2	Sisyrinchium montanum	*			*			3
2	Sparganium chlorocarpum		*	*				3
2	Triglochin maritima				*	*		2
1	Actaea rubra	*						1
1	Adiantum pedatum				*			1
1	Agalinis skinneriana				*			2
1	Amelanchier interior		*					2
1	Ammophila breviligulata	*						5
1	Artemisia serrata			*				1

APPENDIX 4

Plants of Concern 2001-2004
Species Monitored by County Frequency - A Regional View

Number of Counties	Species	Cook	DuPage	Kane	Lake	McHenry	Will	# EORs
1	Asclepias exaltata				*			2
1	Asclepias lanuginosa					*		1
1	Asclepias meadii		*					1
1	Asclepias viridiflora			*				4
1	Baptisia leucophaea				*			1
1	Beckmannia syzigachne	*						1
1	Bidens discoidea		*					1
1	Carex alata						*	1
1	Carex brunnescens				*			1
1	Carex crawfordii						*	1
1	Carex disperma				*			1
1	Carex formosa	*						2
1	Carex oligosperma			*				1
1	Carex trisperma				*			1
1	Carex tuckermanii		*					4
1	Castilleja sessiflora				*			1
1	Corallorhiza maculata						*	1
1	Cypripedium calceolus var parviflorum				*			2
1	Delphinium tricorne	*						1
1	Diarrhena americana		*					1
1	Dirca palustris			*				1
1	Drosera intermedia			*				1
1	Drosera rotundifolia				*			1
1	Elymus trachycaulus		*					1
1	Epilobium strictum						*	1
1	Eriophorum angustifolium			*				2
1	Filipendula rubra				*			1
1	Geranium bicknellii				*			3
1	Geum rivale			*				1
1	Geum triflorum				*			1
1	Goodyera pubescens			*				1
1	Helianthus giganteus	*						1
1	Hydrastis canadensis	*						1
1	Hydrocotyle ranunculoides				*			1
1	Hymenoxys herbacea		*					1
1	Hypericum kalmianum				*			3
1	Ilex verticillata		*					1
1	Jeffersonia diphylla	*						1
1	Juniperus communis				*			1
1	Larix laricina				*			1
1	Lathyrus ochroleucus				*			7
1	Lechea intermedia			*				1
1	Lespedeza leptostachya					*		2
1	Lycopodium clavatum		*					1
1	Malvastrum hispidum						*	1
1	Menyanthes trifoliata			*				1
1	Mitella diphylla				*			1
1	Orchis spectabilis					*		1
1	Penstemon tubaeflorus		*					2

APPENDIX 4

Plants of Concern 2001-2004
Species Monitored by County Frequency - A Regional View

Number of Counties	Species	Cook	DuPage	Kane	Lake	McHenry	Will	# EORs
1	Plantago cordata		*					1
1	Platanthera clavellata				*			1
1	Platanthera flava var herbiola				*			4
1	Platanthera hyperborea var huronensis					*		1
1	Platanthera psycodes				*			3
1	Poa sylvestris		*					1
1	Populus balsamifera	*						1
1	Potamogeton robbinsii				*			1
1	Psoralea tenuiflora			*				1
1	Pyrola elliptica				*			1
1	Rudbeckia fulgida var. sullivantii						*	1
1	Salix candida			*				1
1	Sarracenia purpurea					*		1
1	Scirpus microcarpus				*			1
1	Shepherdia canadensis				*			1
1	Spiranthes lucida	*						2
1	Symphoricarpos albus			*				1
1	Tofieldia glutinosa	*						1
1	Trientalis borealis				*			1
1	Trifolium reflexum						*	1
1	Trillium cernuum					*		1
1	Trillium sessile	*						1
1	Utricularia cornuta					*		1
1	Utricularia minor	*						1
1	Vaccinium oxycoccus				*			1
1	Valeriana uliginosa					*		1

	Cook	DuPage	Kane	Lake	McHenry	Will	# EORs
Totals:	39	33	25	53	15	18	328

APPENDIX 5

Cumulative Species Monitored by Plants of Concern
2001-2004

Listed Species
Agalinis skinneriana
Amelanchier interior
Amelanchier sanguinea
Ammophila breviligulata
Arenaria patula (Minuartia patula)
Asclepias lanuginosa
Asclepias meadii
Aster furcatus
Beckmannia syzigachne
Cakile edentula
Calopogon tuberosus
Carex alata
Carex aurea
Carex bromoides
Carex brunnescens
Carex crawfordii
Carex cryptolepis
Carex disperma
Carex formosa
Carex intumescens
Carex oligosperma
Carex trisperma
Carex tuckermanii
Carex viridula
Carex woodii
Castilleja sessiflora
Chamaedaphne calyculata
Chamaesyce polygonifolia
Comptonia peregrina
Corallorhiza maculata
Cypripedium calceolus var. parviflorum (C. parviflorum var. makasin)
Cypripedium candidum
Dalea foliosa
Drosera intermedia
Drosera rotundifolia
Elymus trachycaulus
Epilobium strictum
Filipendula rubra
Geranium bicknellii
Helianthus giganteus
Hydrocotyle ranunculoides
Hymenoxys herbacea (Tetraneuris herbacea)
Hypericum kalmianum
Isoetes butleri
Juncus alpinus var rariflorus (J. alpinoarticulatus)
Juniperus communis
Larix laricina
Lathyrus ochroleucus
Lechea intermedia
Lespedeza leptostachya
Liatris scariosa var nieuwlandii
Lycopodium clavatum
Malvastrum hispidum
Menyanthes trifoliata
Oenothera perennis
Penstemon tubaeflorus
Plantago cordata
Platanthera clavellata
Platanthera flava var herbiola
Platanthera psycodes
Pogonia ophioglossoides
Polygonatum pubescens
Populus balsamifera
Potamogeton robbinsii
Rubus odoratus
Rubus pubescens
Sarracenia purpurea
Scirpus hattorianus
Scirpus microcarpus
Shepherdia canadensis
Silene regia
Sisyrinchium montanum
Sparganium chlorocarpum (S. emersum)
Spiranthes lucida
Symphoricarpos albus (S. albus var. alba)
Tofieldia glutinosa
Tomanthera auriculata
Trientalis borealis
Trifolium reflexum
Triglochin maritima
Triglochin palustris
Trillium cernuum
Utricularia cornuta
Utricularia intermedia
Utricularia minor
Vaccinium oxycoccus
Valeriana uliginosa
Veronica scutellata
Viola conspersa

89 Listed Species Monitored

Not Listed Species
Actaea rubra
Adiantum pedatum
Artemisia serrata
Asclepias exaltata
Asclepias viridiflora
Baptisia leucophaea
Bidens discoidea
Carex crawei
Carex crus-corvi
Cirsium hillii
Delphinium tricorne
Diarrhena americana
Dirca palustris
Eriophorum angustifolium
Geum rivale
Geum triflorum
Goodyera pubescens
Hydrastis canadensis
Ilex verticillata
Jeffersonia diphylla
Juglans cinerea
Lycopodium complanatum flabelliforme
Mitella diphylla
Orchis spectabilis
Oryzopsis racemosa
Platanthera hyperborea var huronensis
Poa sylvestris
Psoralea tenuiflora
Pyrola elliptica
Rudbeckia fulgida var. sullivantii
Salix candida
Trillium sessile

32 Non-Listed Species Monitored

32 Non-Listed + 89 Listed Species:
121 Total Species Monitored from 2001-2004

APPENDIX 5 Cumulative Species Monitored by Plants of Concern
2001-2004

Listed Species
Agalinis skinneriana
Amelanchier interior
Amelanchier sanguinea
Ammophila breviligulata
Arenaria patula (Minuartia patula)
Asclepias lanuginosa
Asclepias meadii
Aster furcatus
Beckmannia syzigachne
Cakile edentula
Calopogon tuberosus
Carex alata
Carex aurea
Carex bromoides
Carex brunnescens
Carex crawfordii
Carex cryptolepis
Carex disperma
Carex formosa
Carex intumescens
Carex oligosperma
Carex trisperma
Carex tuckermanii
Carex viridula
Carex woodii
Castilleja sessiflora
Chamaedaphne calyculata
Chamaesyce polygonifolia
Comptonia peregrina
Corallorhiza maculata
Cypripedium calceolus var. parviflorum (C. parviflorum var. makasin)
Cypripedium candidum
Dalea foliosa
Drosera intermedia
Drosera rotundifolia
Elymus trachycaulus
Epilobium strictum
Filipendula rubra
Geranium bicknellii
Helianthus giganteus
Hydrocotyle ranunculoides
Hymenoxys herbacea (Tetraneuris herbacea)
Hypericum kalmianum
Isoetes butleri
Juncus alpinus var rariflorus (J. alpinoarticulatus)
Juniperus communis
Larix laricina
Lathyrus ochroleucus
Lechea intermedia
Lespedeza leptostachya
Liatris scariosa var nieuwlandii
Lycopodium clavatum
Malvastrum hispidum
Menyanthes trifoliata
Oenothera perennis
Penstemon tubaeflorus
Plantago cordata
Platanthera clavellata
Platanthera flava var herbiola
Platanthera psycodes
Pogonia ophioglossoides
Polygonatum pubescens
Populus balsamifera
Potamogeton robbinsii
Rubus odoratus
Rubus pubescens
Sarracenia purpurea
Scirpus hattorianus
Scirpus microcarpus
Shepherdia canadensis
Silene regia
Sisyrinchium montanum
Sparganium chlorocarpum (S. emersum)
Spiranthes lucida
Symphoricarpos albus (S. albus var. alba)
Tofieldia glutinosa
Tomanthera auriculata
Trientalis borealis
Trifolium reflexum
Triglochin maritima
Triglochin palustris
Trillium cernuum
Utricularia cornuta
Utricularia intermedia
Utricularia minor
Vaccinium oxycoccus
Valeriana uliginosa
Veronica scutellata
Viola conspersa

89 Listed Species Monitored

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Actaea rubra
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Geum rivale
Geum triflorum
Goodyera pubescens
Hydrastis canadensis
Ilex verticillata
Jeffersonia diphylla
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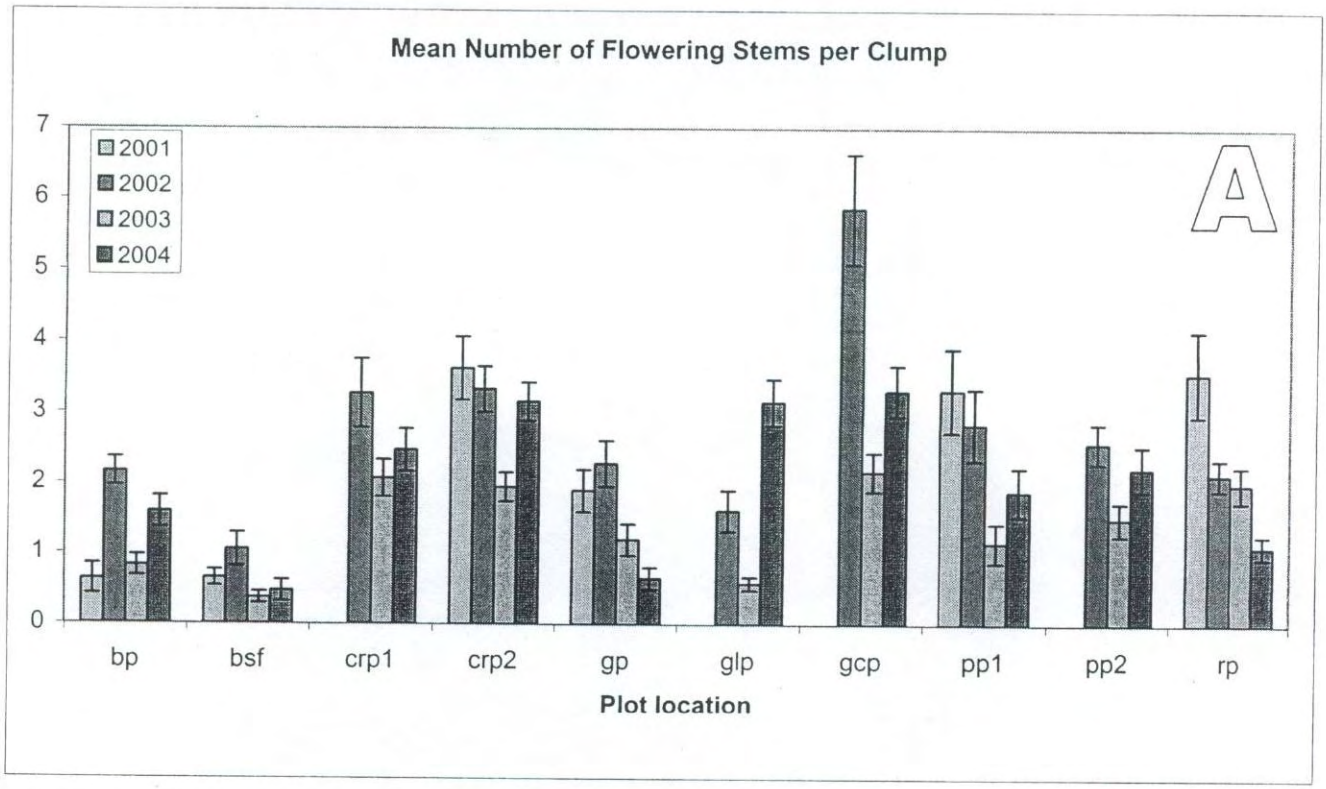
Pyrola elliptica
Rudbeckia fulgida var. sullivantii
Salix candida
Trillium sessile

32 Non-Listed Species Monitored

32 Non-Listed + 89 Listed Species:
121 Total Species Monitored from 2001-2004

APPENDIX 6a. **Figure 1.** *Cypripedium candidum*



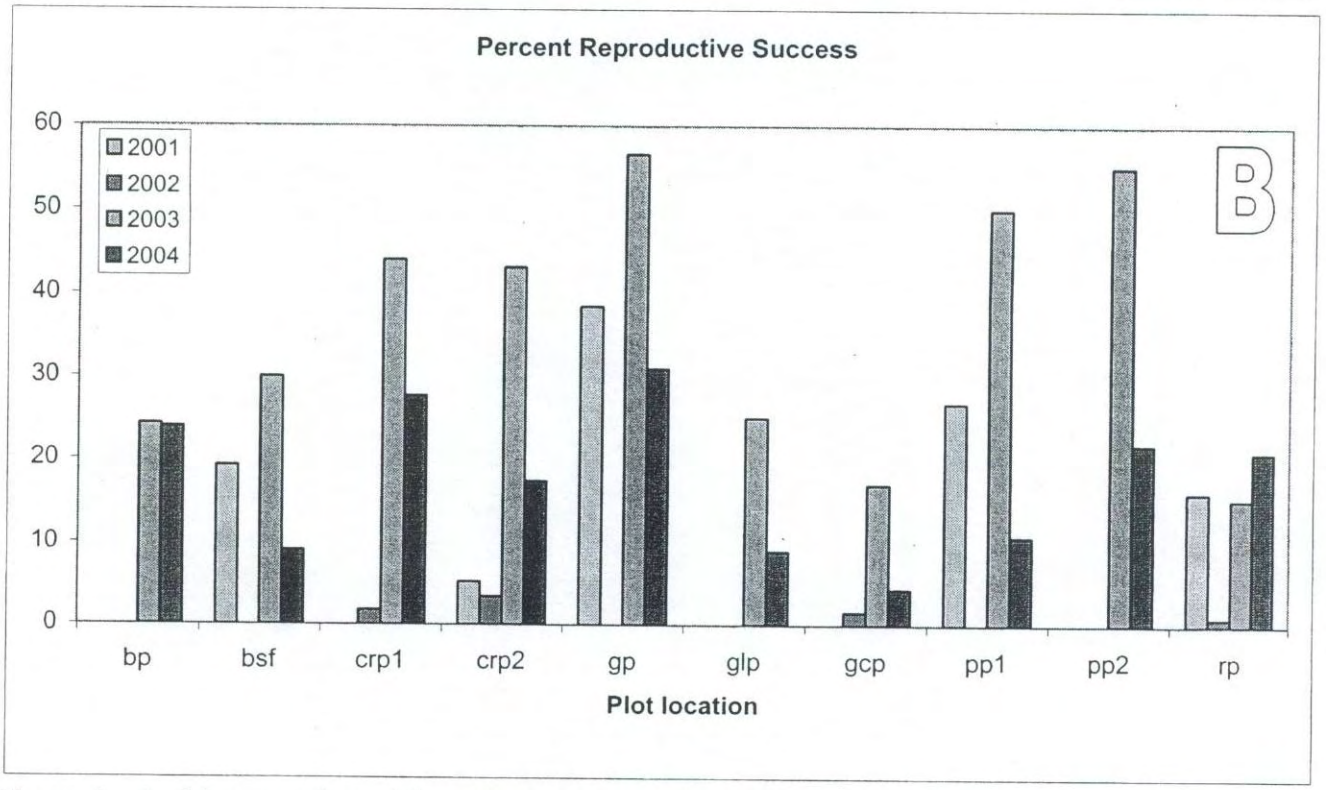


Figure 1. A. Mean number of flowering stems per clump for 2001-2004. **B.** Percent of reproductive success calculated as the percentage of flowers maturing into fruits for 2001-2004. Bars represent standard error.

APPENDIX 6a. **Figure 2.** *Cypripedium candidum*

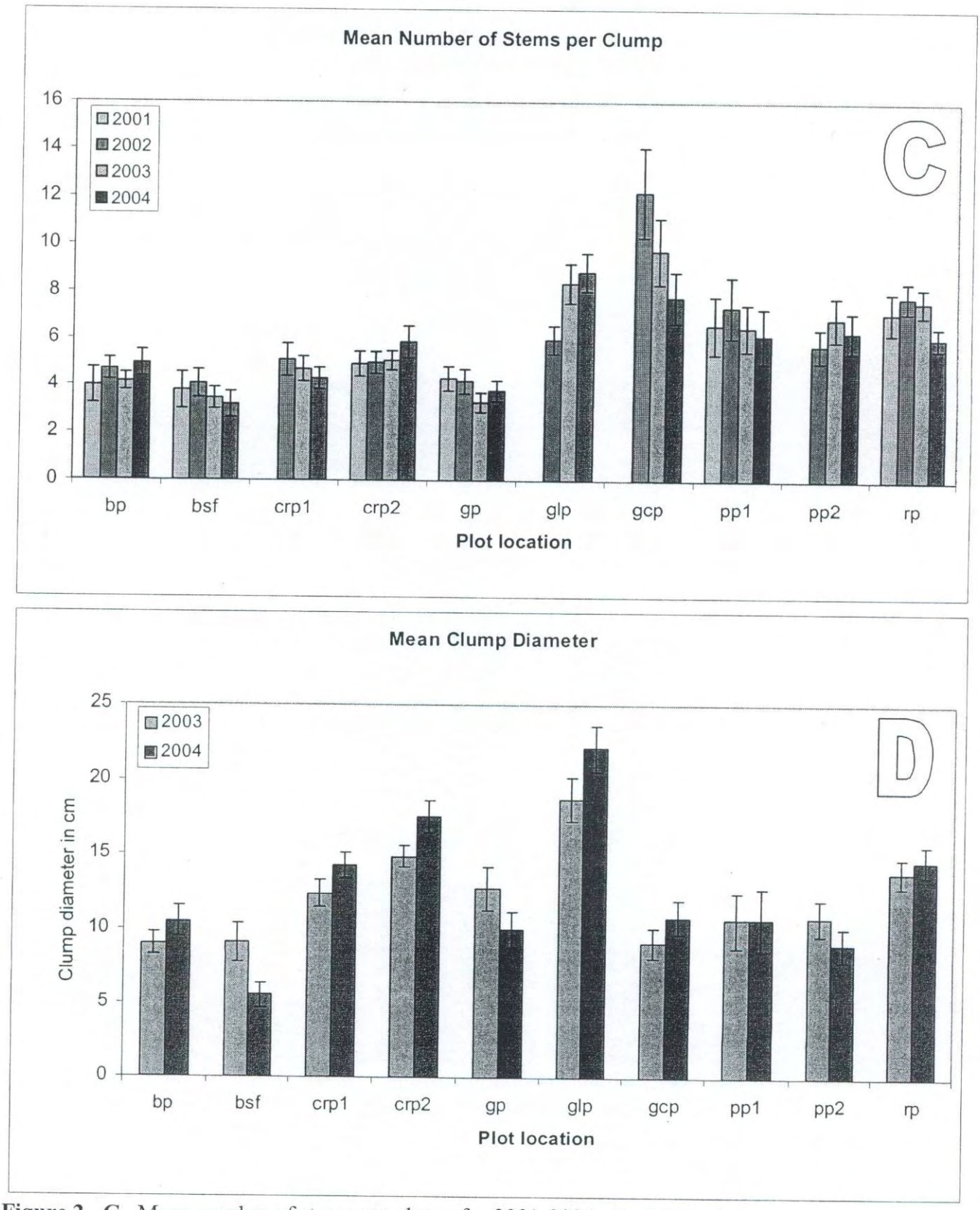


Figure 2. C. Mean number of stems per clump for 2001-2004. **D.** Mean clump diameter for 2003 and 2004. Previous years are not shown due to changes in protocol. Bars represent standard error.

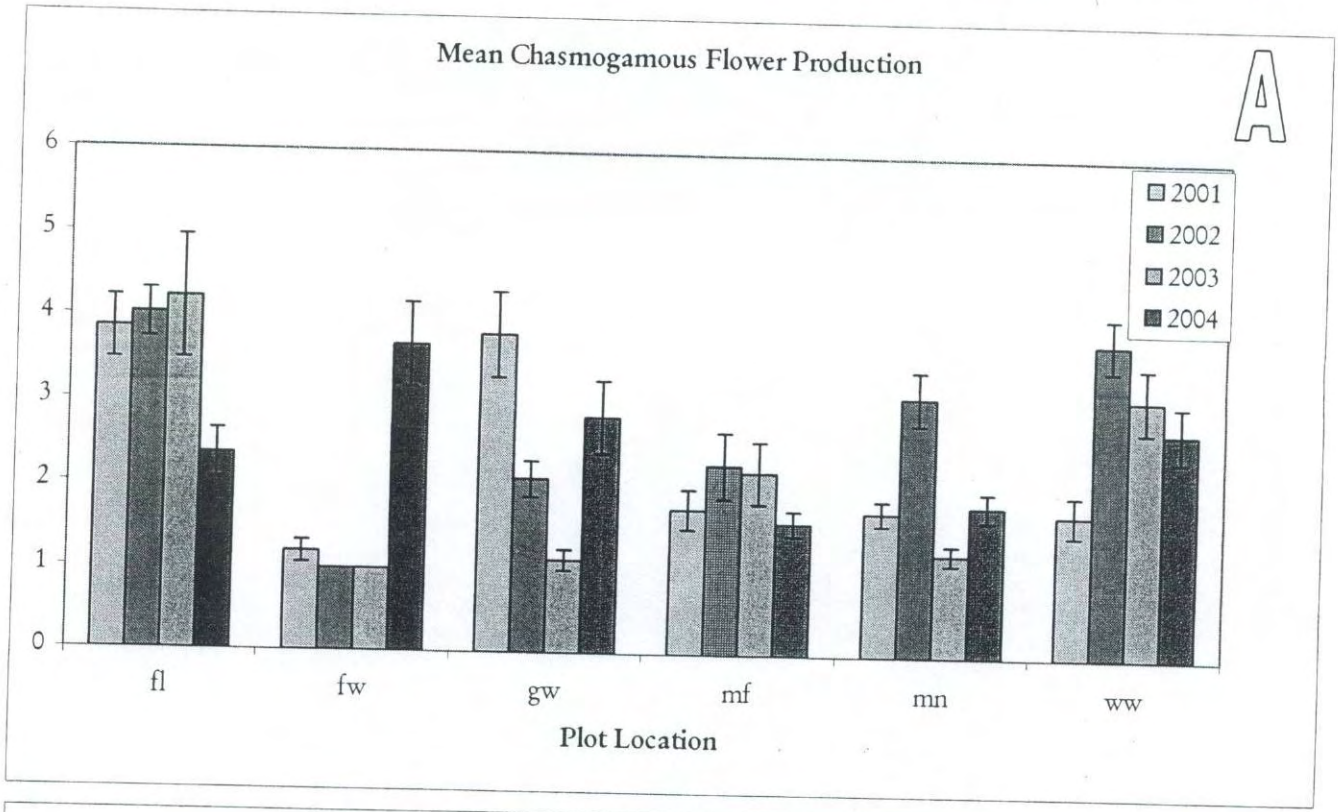
APPENDIX 6a. **Tables 1-2. *Cypripedium candidum***

	Plot Size 2004	% Surviving 2003-2004	New Recruits 2004	% Flowering 2004	Fecundity 2004
bp	155	78.7	0	32.2	23.9
bsf	108	86.8	0	14.7	9.1
crp1	58	100	0	57.5	27.7
crp2	83	98.8	6	53.8	17.4
gp	71	92.5	2	17.1	30.9
glp	93	98.9	0	35.7	8.9
gcp	181	93.8	18	42.6	4.3
pp1	63	96.8	16	30.1	10.8
pp2	63	98.4	9	35.2	21.8
rp	122	100	2	18.3	20.9

Table 1. *Cypripedium candidum* percentages. **Plot size:** Total number of plants from which data were recorded in 2004. **% Surviving**: Percentage of plants within the plot from which data was taken at least once in both 2003 and 2004. **% Flowering**: Percentage of stems in plot producing flowers in 2004. **Fecundity**: Percentage of flowers in plots producing fruit in 2004.

APPENDIX 6b.

Figure 1. *Viola conspersa*



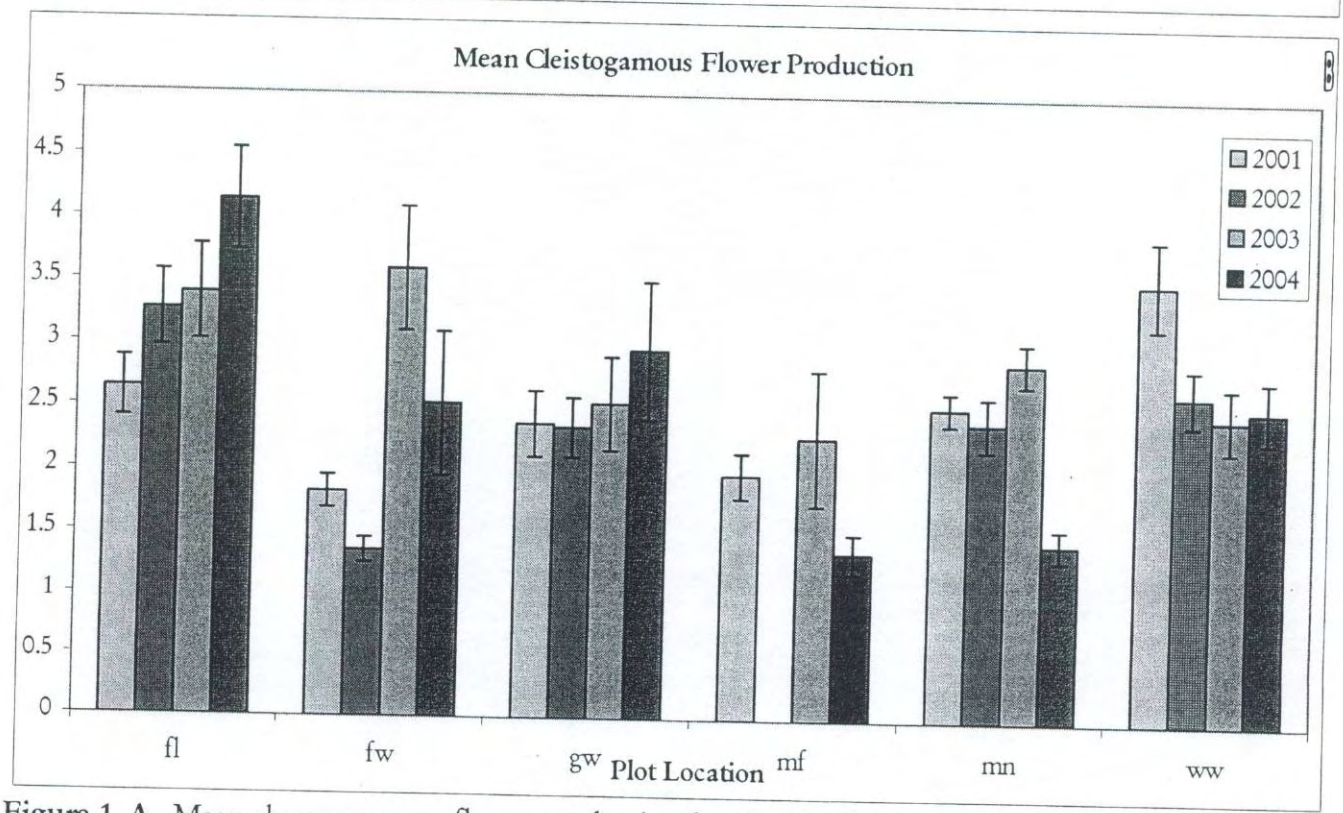


Figure 1. A. Mean chasmogamous flower production for all visits for 2001 through 2004. **B.** Mean cleistogamous flower production for all visits for 2001 through 2004. Bars represent standard error.

Figure 1. *Viola conspersa*

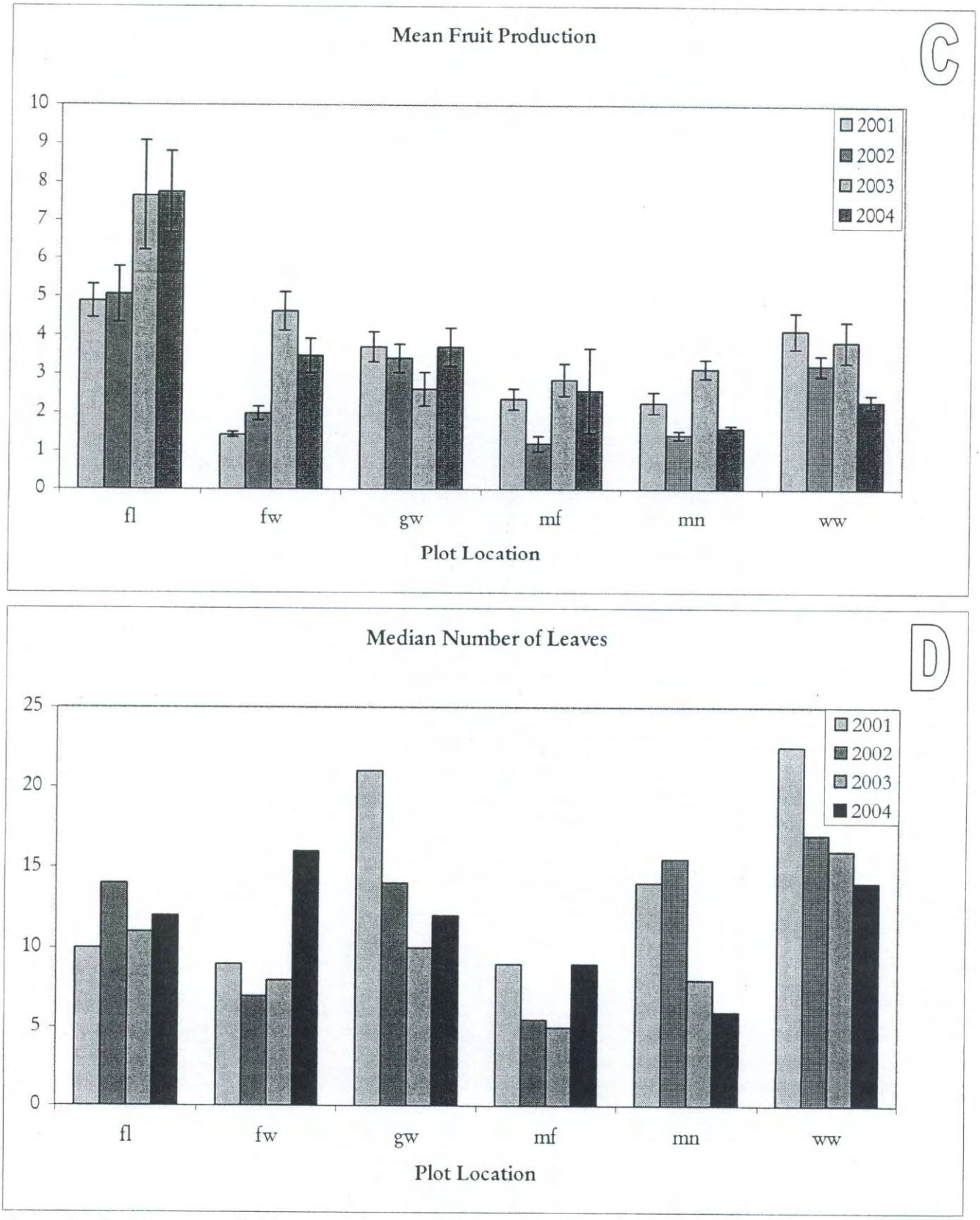


Figure 2. C. Mean overall (chasmogamous and cleistogamous) fruit production for 2001 through 2004. Bars represent standard error. D. Median number of leaves for existing plants from 2001 through 2004.

APPENDIX 6b.

Tables 1-2. *Viola conspersa*

	Plot Size 2004	% Survival 2003-2004	New Recruits 2004	% Reproductive Visit 1	% Reproductive Visit 2	% Reproductive Visit 3
fl	133	50.4	17	30.7	30.2	27.8
fw	187	35.3	0	16.6	3.8	8.6
gw	107	39.3	30	14.8	22.6	26.2
mf	229	46.3	21	14.4	4.9	6.7
mn	178	83.7	N/A	32.6	30.5	28.8
ww	135	44.4	17	17.8	34.8	26.7

Table 1. *Viola conspersa* Summary Statistics. **Plot Size**: Total number of plants from which data were recorded in 2004. % **Survival**: Percentage of plants within the plot from which data was taken at least once in 2003 and 2004. % **Reproductive**: Percentage of plants within the plot that produced chasmogomous (CH) or cleistogomous (CL) flowers or fruit during visits 1, 2, and 3.

Table 2: Analysis of covariance between vegetative characters and flower number for all years. The effects of three vegetative growth characters (number of leaves, number of reproductive stems and number of basal rosettes) on total flower number, chasmogamous flower number and cleistogamous flower number were assessed for all years in each of the six populations. Values listed are R^2.

Population	Total Flowers (R^2)	Chasmogamous Flowers (R^2)	Cleistogamous Flowers (R^2)
FL	0.751	0.591	0.677
FW	0.450	0.413	0.317
GW	0.804	0.757	0.817
MF	0.580	0.369	0.453
MN	0.316	0.153	0.273
WW	0.332	0.235	0.315

APPENDIX 6b.

Figure 3-4. *Viola conspersa*

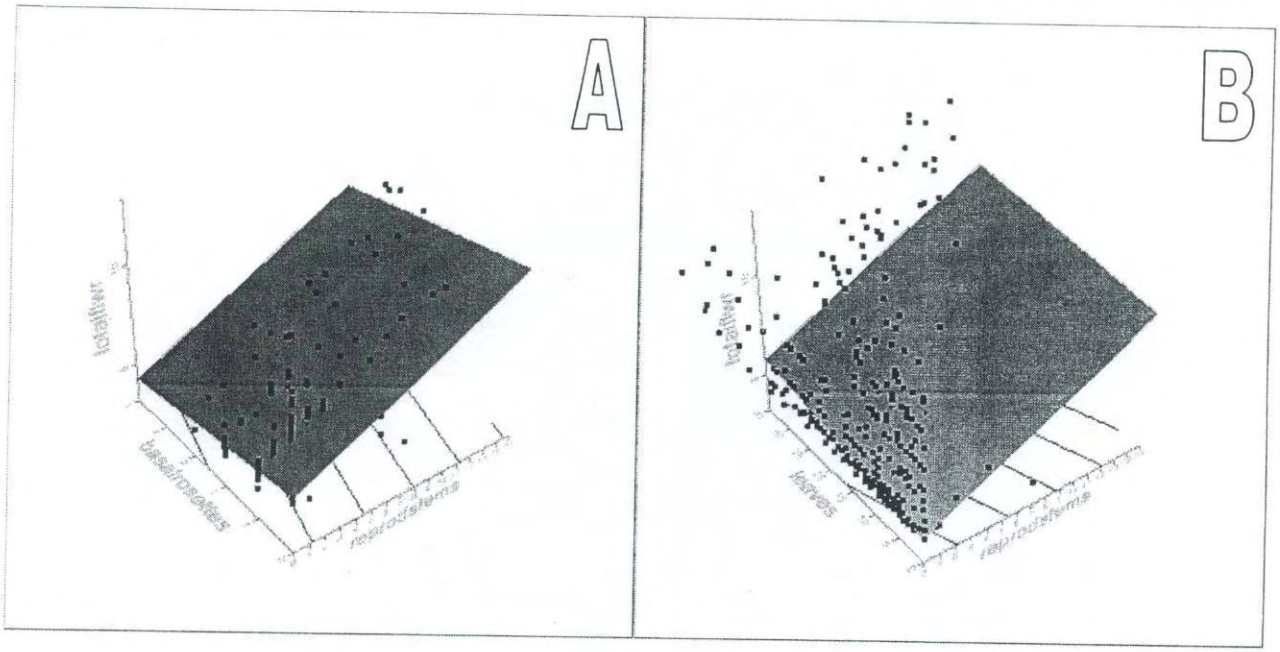


Figure 3. Surface profiles of vegetative effects on total number of flowers for the FL population (all years). Prob(F) < 0.0001 for all effects shown. **A.** Effect of leaves and reproductive stems on total flower number. **B.** Effect of basal rosettes and reproductive stems on total flower number.

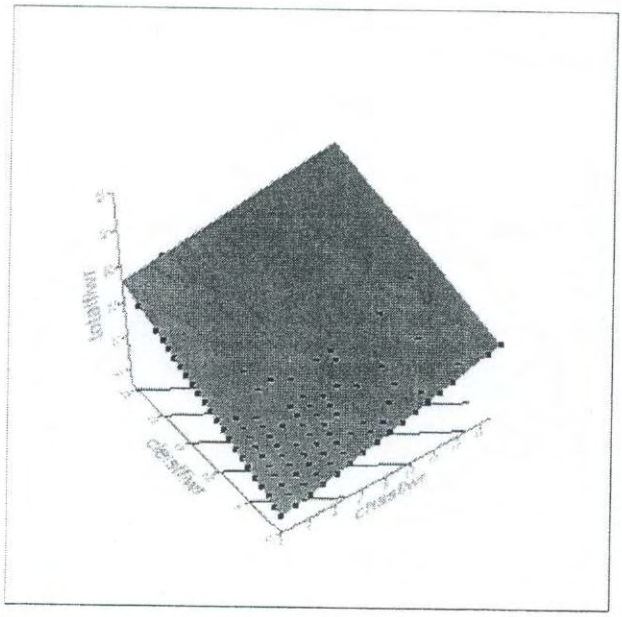


Figure 4. Relative contributions to flower production in *Viola conspersa*. Surface profile from a multiple regression of cleistogamous flower number and chasmogamous flower number on total flower number. Variation in cleistogamous flower production contributes more to the variation in total flower number (Sum of Squares = 30882.3 and 10262.1 for cleistogamous flowers and chasmogamous flowers, respectively).