The Environmental Studies Service Learning Program

Hendricks Park Forest Monitoring and Invasive Species Final Report

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Prepared by the Environmental Studies Service Learning Program

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Executive Summary

Hendricks Park is Eugene's oldest city park. Its 78 acres of forest land provides habitat for a wide array of native plant and animal species. It is an important local site for preserving biodiversity. However, there are more than 20 invasive plant species in Hendricks Park that threaten its future. The Hendricks Park Forest Management Plan calls for protection and restoration efforts to maintain the biological integrity of the park.

A team of four students from the Environmental Studies Service Learning Program worked with Hendricks Park staff to complete the following tasks:

Create Hendricks Park plant guide – The plant guide provides botanical information on 28 native species and 8 non-native, invasive species found in the park. The team also created a web-based plant guide as a companion to the paper version.

Re-inventory the Hendricks Park permanent forest monitoring plots – In 1999 Salix & associates installed 24 forest monitoring plots in Hendricks Park. Information collected from the plots was intended to help park staff understand the changes occurring in the park over time. The Service Learning Program team revisited each of the 24 plots to re-inventory them. The data was compared to the 1999 permanent forest plot data. Some basic analysis of the information has been conducted. One interesting change is the increase in secondary invasive species where ivy has been removed. The complete results can be found in chapter one. More sophisticated analysis should be performed in order to fully benefit from this data collection effort.

Design and implement a study aimed at testing the effectiveness of four treatments at controlling the spread of invasive species - The Hendricks park secondary invasive plant control study is designed to evaluate the effectiveness of 4 different treatments - hand pulling, mulching, burning, mulching and burning – to control the spread of herb-Robert and nipplewort. One hundred and twenty five plots were installed and treatments were applied. Six weeks later, the number of stems of nipplewort and herb Robert that had returned to each plot was recorded. Hand pulling turned out to be the least effective control method. A combination of burning and mulching is the most effective control method. The data and results can be found in chapter two.

Design and implement a study to determine how far herb Robert has spread into the forest interior - Herb Robert is an "edge" species, using disturbed areas along roads and paths to travel. The Park is concerned that Herb Robert will migrate into the forest interior and become an interior problem as well. We collected data at three separate sites to determine how far into the park interior herb Robert can be found. Our results show that while herb Robert grows much less densely in the interior, it can be found up to 20 meters into the forest interior. Please read chapter three for the complete results.

Review existing literature concerning effective methods to control four invasive species - The team compiled a list of sources documenting the effects of various treatments on four high priority invasive species. The sources included articles from journals, on-line documented reports on projects conducted in other parks, collective information by other organizations, and interviews with local people experienced with various controlling methods. The annotated bibliography is contained in Appendix B.

Copies of all project related documents – excel data files, plant guide, the final report, project webpage, powerpoint presentation, permanent plot photo database, and project poster – have been given to the Hendricks Park staff and Eugene Parks and Open Spaces Division.

Chapter One: Permanent Forest Monitoring Plots

I. Introduction.

The Hendricks Park team re-inventoried the 24 forest monitoring sites originally established in 1999 by Salix & associates. The team collected data from the main forest monitoring plots and entered the information into a database so that the Hendricks Park staff could see the changes that have occurred in the forest over the past four years. Some basic analysis of the information has been conducted. More sophisticated analysis should be performed in order to fully benefit from this data collection effort.

The following information (history, purpose, site description, inventory zones, methods, and protocols) is taken from the Hendricks Park Management Plan and Supplemental report.

II. History.

Salix & associates was contracted by the City of Eugene to inventory and assess vegetation, wildlife, fungi and habitat in forested areas of Hendricks Park. Although the Rhododendron Garden and picnic areas were included (regarding forest canopy issues) the main emphasis was the natural, forested area of the park. Salix Associates created a report in 1999 containing the methods and findings of the inventory, analysis and recommendations. The Hendricks Park team re-inventoried the 24 plots according to Salix & associates protocols.

III. Purpose.

The SLP team was responsible for completing the field data collection of the 24 main forest monitoring plots. The collection of this information will help aid the Hendricks Park Staff in their analysis of their park management strategies

Purposes of the forest monitoring plots

- Characterize current forest overstory and understory conditions
- Gather information to provide clues to the successional trajectory of the forest
- Provide an information base for developing different management scenarios and outcomes
- Document extent and movement of noxious vegetation (English ivy, herb-Robert, etc.)
- Document presence of snags and coarse woody debris
- Assess forest health and tree vitality
- Provide opportunity for long-term monitoring of forest succession, effects of restoration efforts, forest health, tree mortality, effects of cultural practices

IV. Site Description.

Forest monitoring plots were installed in 24 forested locations in the park, including 3 in the Rhododendron Garden. Plots were sited so as to gather information from all the stand types in the park, and in some cases, information about a gap or other feature. The plots were numbered first using the zone number where they are located, followed by a hyphen and the plot number within the zone. (For example, plot 7-2 is the second plot installed in Zone 7). Each plot

contained a main plot, and a smaller subplot within it where more detained information was recorded.

Plant communities were described following the standard system used in plant ecology: dominant species in each vegetation layer. In most cases, this is: tree/shrub/herb. Occasionally, intermediate layers are added: canopy tree/subcanopy tree/shrub/herb.

Information collected on main plots included the following items:

1. Plot location, percent slope, and aspect.
2. Total tree, shrub and herb cover.
3. Plant community description.
4. Trees: species, canopy class (height class), diameter (breast height), vigor, severity of lean, presence of English ivy, presence of pine conks, and other notes such as breakage or presence of old, cut ivy stems.
5. Snags: decay class, diameter, height, lean, presence of ivy, other notes.
6. Tree and shrub cover classes, by species.
7. Cover class of each invasive herbaceous species.
8. Species and cover class of dominant herbs.
9. Coarse woody debris, number of pieces and percent cover.

Inventory Zones.
The 24 forest monitoring sites were delineated in the park into nine different inventory zones. The nine inventory zones were identified by outlining areas with similar topography, aspect and general forest cover.

Zone	Area of Hendricks Park
1	Small northwest facing slope in northwest corner of park, dominated by Douglas-fir
2	Rhododendron Garden area, dominated by Oregon white oak.
3	Small southeast facing stand in northeast corner, dominated by Douglas-fir.
4	South of Zone 2: includes former picnic shelter, parking lot, restrooms and maintenance area. Dominated by Douglas-fir, with mostly a mowed grass understory.
5	West and northwest facing slopes of major ridge in the park, dominated by Douglas-fir.
6	East –facing slope, from the ridge line eastward down to the east park boundary. Dominated by Doulgas-fir.
7	Steep east-facing slopes at upper part of ridge abutting south park boundary, dominated by Douglas-fir.
8	North-facing slopes comprising most of west end of park, dominated by Douglas-fir.
9	Ridge top along the west half of south boundary of park, dominated by Oregon white oak.

V. Methods.

The SLP team revisited the 24 forest monitoring plots to mark out each plot boundary, collect GPS coordinates for the plot center, establish permanent photo points, and to re-inventory the data originally collected by Salix Associates in 1999. The SLP team revisited the 24 forest monitoring sites to re-inventory and gather data for the main plots only; the subplots were not re-inventoried by the SLP team.

Plot Location Protocol

Equipment needed: map, GPS unit, rope marked with plot radius, flagging tape, compass, digital camera, tripod, data sheets, pencil, and clipboard.

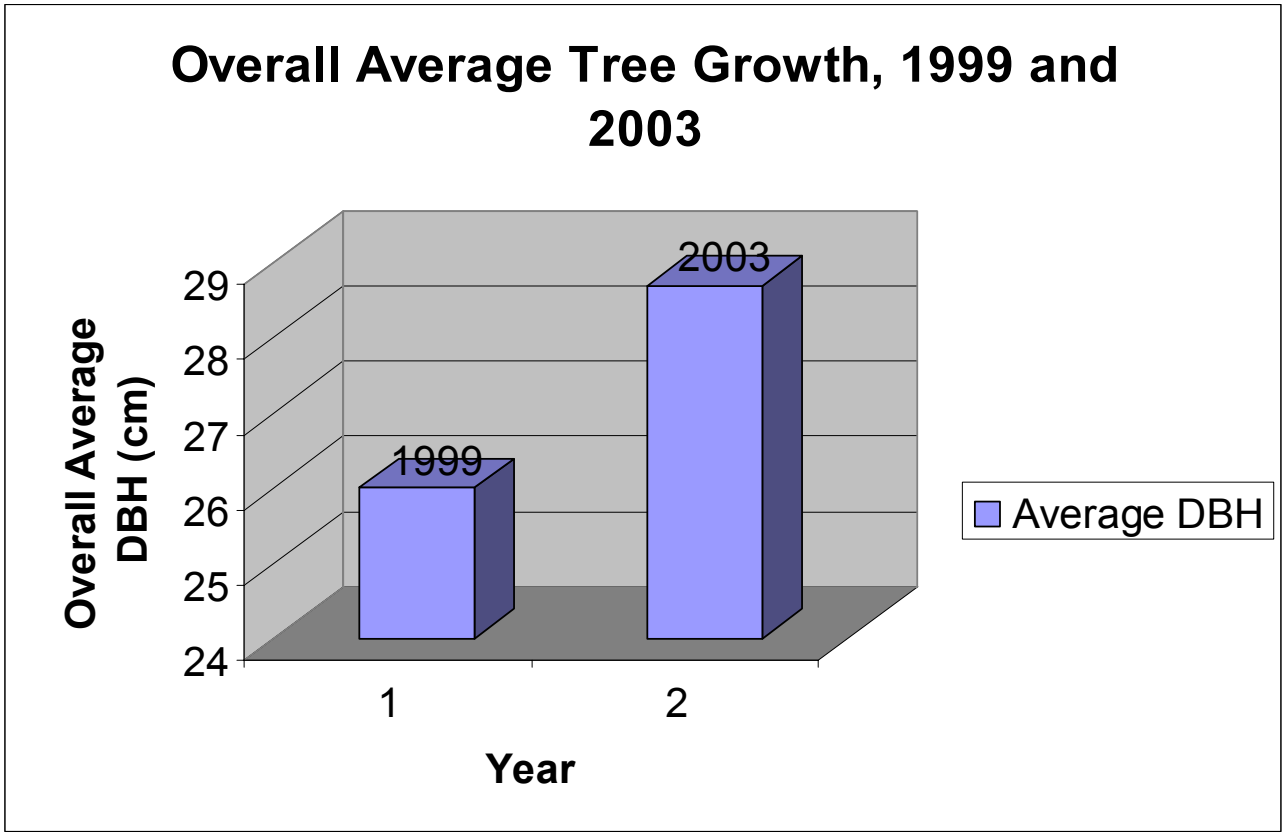
1. Using map, plot location description (on 1999 data sheets), and metal detector find main plot center marked with rebar.
2. Use a GPS unit to mark location and write those coordinates on plot data sheets.
3. Use rope and compass to mark North, East, South, and West corners of plot.
4. Go to South corner of plot and take plot photo. Be sure to mark photo information on data sheet and label photo properly.

Photo Protocol

- Photos should be taken from the southernmost point of each forest monitoring plot.
- To find southernmost point, stand at center of plot and walk south 12.62 meters.
- Mount camera on tripod. Camera should be 1.5 meters from ground level.
- Point camera towards center of plot.
- Camera should be on auto focus.
- Image size should be set to "XGA" and image quality set to "Fine".
- If an object (tree, shrub, etc) is blocking the view of plot center, move 0.5 meters due east and reset tripod. Continue doing this until view is clear. Make sure to re-point camera to center of the plot. Note how far from planned original location the photo is taken.
- Photos should be named for monitoring plot they correspond to (example: winterplot3.1.jpg or springplot3.1.jpg).
- Day, time, location of photo and any other pertinent information should be marked on data sheets.

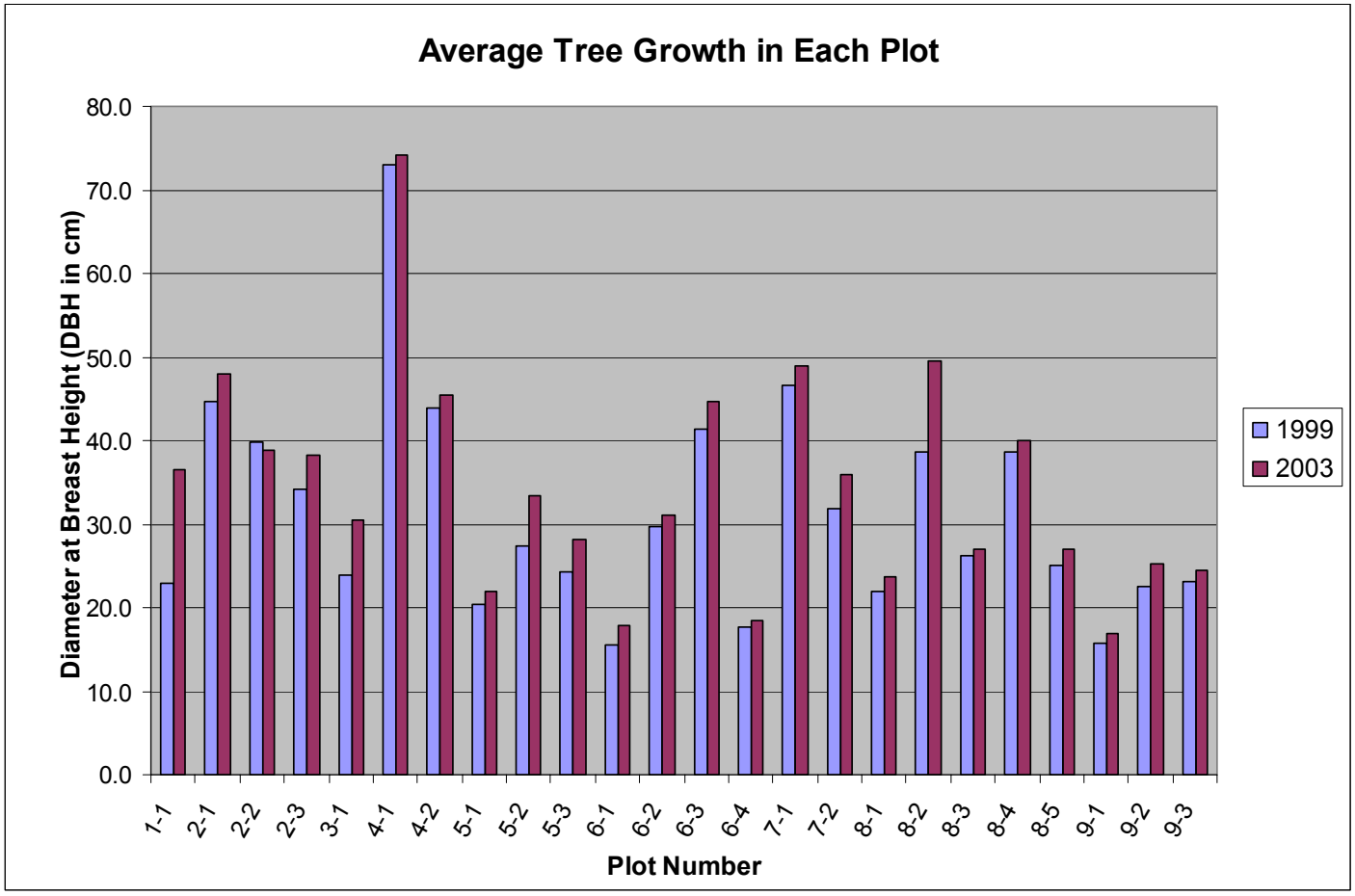
Permanent forest plot data protocols can be found in the Hendricks Park Management Plan and Supplemental report

VI. Findings


Overall Average Tree Growth, 1999 and 2003
Overall Average DBH (cm)
29
28
27
26
25
24
1999
2003
1
2
Year
Average DBH

Average size of trees by plot (diameter at breast height measured in centimeters)

Plots	1999	2003	Difference	Percent change%
1-1	22.8	36.5	13.7	59.8
2-1	44.7	47.9	3.2	7.2
2-2	39.7	38.8	-0.9	-2.4
2-3	34.1	38.3	4.2	12.3
3-1	23.9	30.5	6.6	27.6
4-1	73.1	74.1	1.0	1.4
4-2	43.8	45.5	1.7	3.9
5-1	20.3	21.9	1.6	7.9
5-2	27.4	33.4	6.0	21.9
5-3	24.3	28.1	3.8	15.6
6-1	15.5	17.9	2.4	15.5
6-2	29.7	31.1	1.4	4.7
6-3	41.4	44.7	3.3	8.0
6-4	17.7	18.4	0.7	4.0
7-1	46.6	49.0	2.4	5.2
7-2	31.8	36	4.2	13.2
8-1	21.9	23.6	1.7	7.8
8-2	38.6	49.6	11.0	28.5
8-3	26.3	27	0.7	2.7
8-4	38.7	40.0	1.3	3.4
8-5	25.1	26.9	1.8	7.2
9-1	15.7	16.8	1.1	7.0
9-2	22.5	25.2	2.7	12.0
9-3	23.2	24.4	1.2	5.2

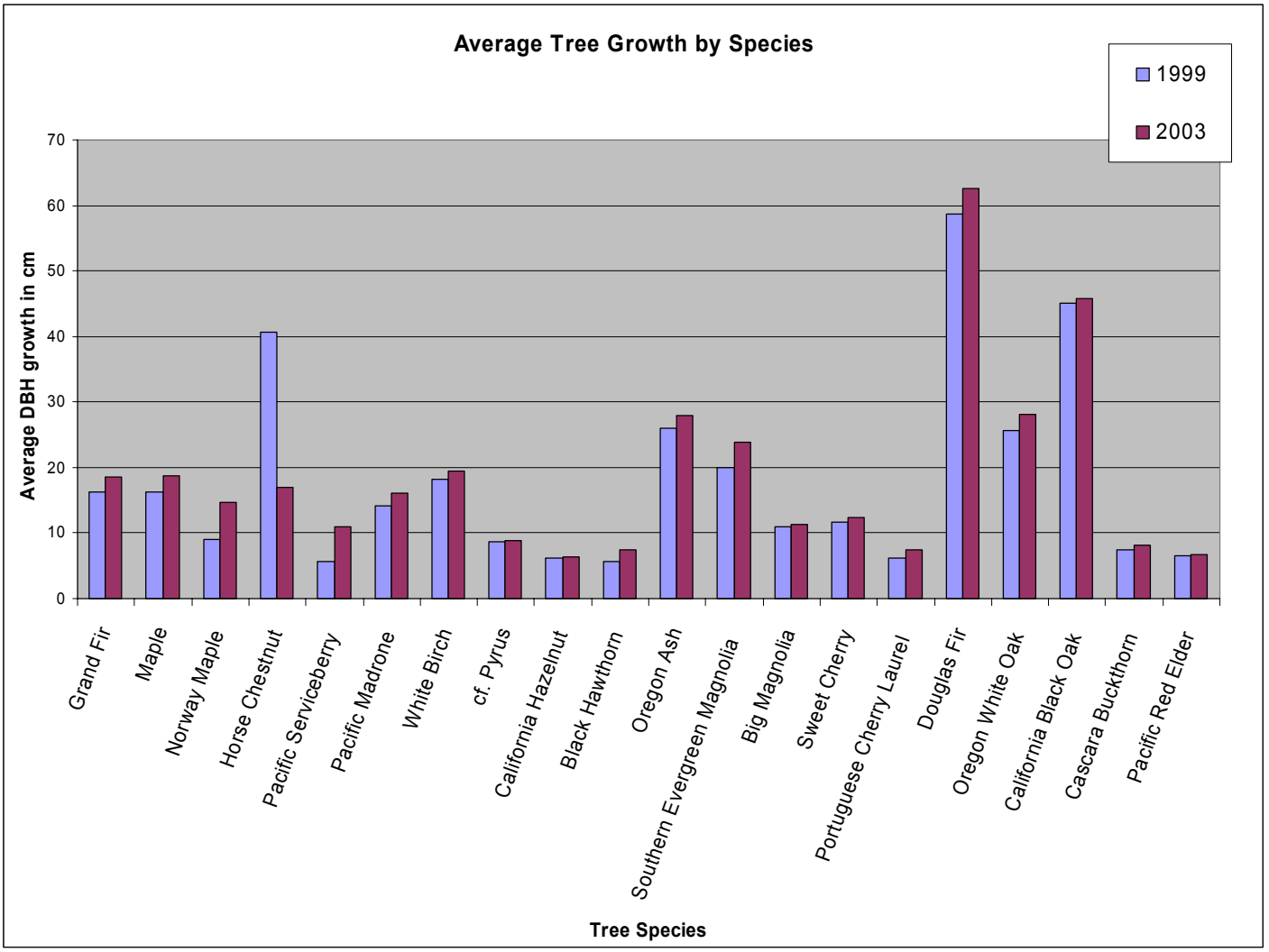


All plots show growth, except plot 2-2. Many large trees were cut there which reduced the average size of trees in that plot. The most notable changes occurred in plot 1-1 with a 59.8% increase, plot 3-1 at 27.6% increase and plot 8-2 with 28.5% increase.

Average size of trees by species (diameter at breast height measured in centimeters)

Average DBH for species

	Plant Species	1999	2003	Difference in DBH
ABIGRA	Grand Fir	16.2	18.5	2.3
ACEMAC	Maple	16.3	18.4	2.1
ACEPLA	Norway Maple	9.1	14.6	5.5
AESHIP	Horse Chestnut	40.7	17	-23.7
AMEALN	Pacific Serviceberry	5.7	11	5.3
ARBMEN	Pacific Madrone	14.1	16	1.9
BETPAP	White Birch	18.2	19.5	1.3
cf. Pyrus	cf. Pyrus	8.7	8.8	0.1
CORCOR	California Hazelnut	6.2	6.3	0.1
CRADOU	Black Hawthorn	5.7	7.4	1.7
FRALAT	Oregon Ash	26	28	2
MAGGRA	Southern Evergreen Magnolia	19.9	23.9	4
MAGSTE	Big Magnolia	10.9	11.4	0.5
PRUAVI	Sweet Cherry	11.6	12.3	0.7
PRULUS	Portuguese Cherry Laurel	6.2	7.5	1.3
PSEMEN	Douglas Fir	58.6	61.2	2.6
QUEGAR	Oregon White Oak	25.7	26.6	0.9
QUEKEL	California Black Oak	45.1	45.8	0.7
RHAPUR	Cascara Buckthorn	7.5	8.39	0.89
SAMCAL	Pacific Red Elder	6.6	6.5	-0.1



Overall, the largest growth among the 20 different tree species was the Grand Fir, Norway Maple, Pacific Serviceberry, Southern Evergreen Magnolia and the Douglas Fir. Our data shows that the lone Horse chestnut found in the plots shrank in size. We assume there was a mistake when its measurement was taken in 1999.

Number of Live Stems in Each Plot

LIVE	STAND	PLOT NO	Frequency		Frequency
			1999	2003	Change
LIVE	DOUG-FIR	1-1	17	16	-1
LIVE	DOUG-FIR	3-1	45	36	-9
LIVE	DOUG-FIR	5-1	55	55	0
LIVE	DOUG-FIR	5-2	29	27	-2
LIVE	DOUG-FIR	5-3	36	33	-3
LIVE	DOUG-FIR	6-1	49	48	-1
LIVE	DOUG-FIR	6-2	42	37	-5
LIVE	DOUG-FIR	6-3	27	26	-1
LIVE	DOUG-FIR	6-4	21	18	-3
LIVE	DOUG-FIR	7-1	16	16	0
LIVE	DOUG-FIR	7-2	16	15	-1
LIVE	DOUG-FIR	8-1	26	26	0
LIVE	DOUG-FIR	8-2	8	8	0
LIVE	DOUG-FIR	8-3	28	25	-3
LIVE	DOUG-FIR	8-4	12	12	0
LIVE	DOUG-FIR	8-5	27	27	0
LIVE	SADDLE	4-1	7	7	0
LIVE	SADDLE	4-2	20	20	0
LIVE	OAK	9-1	38	33	-5
LIVE	OAK	9-2	38	36	-2
LIVE	OAK	9-3	47	47	0
LIVE	RHODODEN	2-1	10	9	-1
LIVE	RHODODEN	2-2	14	11	-3
LIVE	RHODODEN	2-3	9	7	-2
Total			637	595	-42

The table shows that there are 42 fewer live trees noted in the 2003 data than in 1999 data. Eleven trees were cut – nine of them in plot 3-1. Six trees were determined to have fallen. For example, a large Douglas-Fir fell and knocked down another tree during a storm in plot 6-4. Due to missing tags, 21 trees could not be located. Four trees were determined to be dead and still standing.

Live trees that could not be located			
Plot	No.	Species	Notes:
2-1	8	QUEGAR	CANNOT LOCATE
2-2	2	QUEGAR	No Tag--cannot locate
2-2	4	QUEGAR	No Tag--cannot locate
2-3	6	SORAUC	Cannot Locate Tree :(
2-3	9	QUEGAR	Cannot Locate Tree :(
5-2	21	ACEMAC	Couldn't locate, may be on ground
5-3	9	ACEMAC	Cannot locate tree :(
6-2	6	PRUAVI	CANNOT LOCATE
6-2	15	ACEMAC	CANNOT LOCATE
6-2	32	PRUAVI	CANNOT LOCATE

6-2	38	ACEMAC	CANNOT LOCATE
9-1	4	QUEGAR	CANNOT LOCATE
9-1	5	QUEGAR	CANNOT LOCATE
9-1	6	QUEGAR	CANNOT LOCATE
9-1	11	QUEGAR	CANNOT LOCATE
9-1	26	QUEGAR	CANNOT LOCATE
9-3	47	ACEPLA	Cannot locate
8-3	15	PRUAVI	
8-3	16	PRUAVI	
9-2	8	CRADOU	Could not locate (1/31/03)
9-2	28	PRUMAH	Could not locate (1/31/03)

Live trees turned dead due to "fall"

Plot	No.	Species	Notes:
1-1	11	SAMCAL	Fell~~small tree
5-2	2	ACEMAC	Dead on ground
6-1	38	ACEMAC	Dead on ground
7-2	8	ACEMAC	DEAD
5-3	27	ACEMAC	Tree fell--we located tag on tree
6-4	13	PSEMEN	Ivy @ base; huge old cut ivy stems. Sp:Fell! By windstorm.

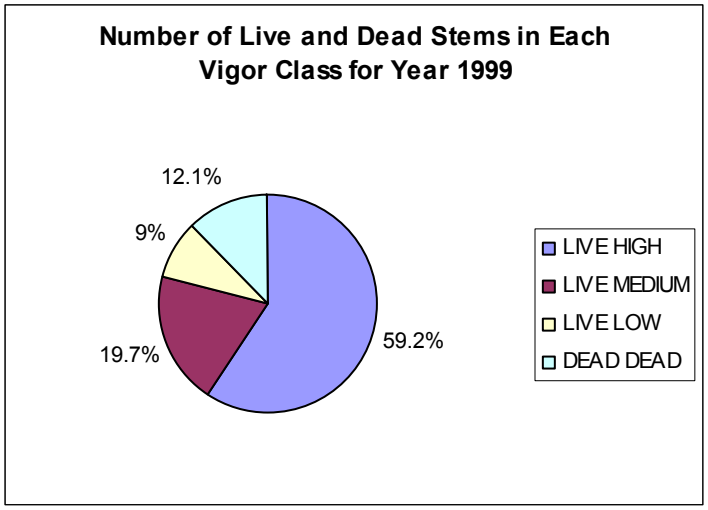
Live trees turned dead due to recently cut

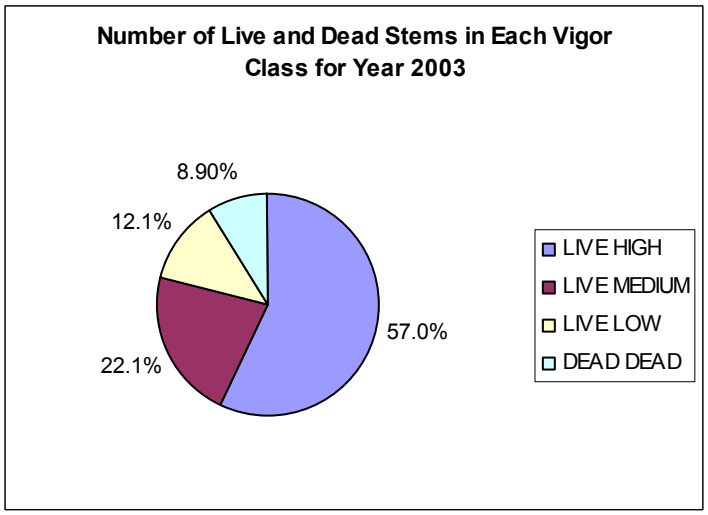
Plot	No.	Species	Notes:
3-1	18	PRUAVI	Trees #18 - #20 have been cut down, leaving 1 m stumps each
3-1	19	PRUAVI	
3-1	20	PRUAVI	
3-1	24	ARBMEN	Recently cut; stump at 1.5 m; missing tag
3-1	25	ACEMAC	Recently cut; missing tag
3-1	26	PRUAVI	Recently cut; missing tag
3-1	27	PRUAVI	Recently cut; missing tag
3-1	43	PRUAVI	Recently cut, lying on ground
3-1	45	PRUAVI	Recently cut, lying on ground
6-3	22	PRUAVI	Recently cut down, stump 1m high
8-3	23	PSEMEN	(assume 23) Cut off at 3 m high; huge log on ground next to it

Number of Live Stems in each tree species

LIVE	TREESP	Frequency		Frequency Change
		1999	2003	
LIVE	ABIGRA	1	1	0
LIVE	ACEMAC	189	179	-10
LIVE	ACEPLA	2	1	-1
LIVE	AESHIP	1	1	0
LIVE	AMEALN	2	2	0
LIVE	ARBMEN	24	23	-1
LIVE	BETPAP	3	3	0
LIVE	cf. Pyrus	1	1	0
LIVE	CORCOR	13	13	0
LIVE	CRADOU	4	3	-1
LIVE	FRALAT	1	1	0
LIVE	MAGGRA	1	1	0
LIVE	MAGSTE	2	2	0
LIVE	PRUAVI	113	100	-13
LIVE	PRULUS	2	2	0
LIVE	PRUMAH	1	0	-1
LIVE	PSEMEN	152	149	-3
LIVE	QUEGAR	108	100	-8
LIVE	QUEKEL	1	1	0
LIVE	RHAPUR	9	8	-1
LIVE	SAMCAL	6	4	-2
LIVE	SORAUC	1	0	-1
Total		637	595	-42

Vigor



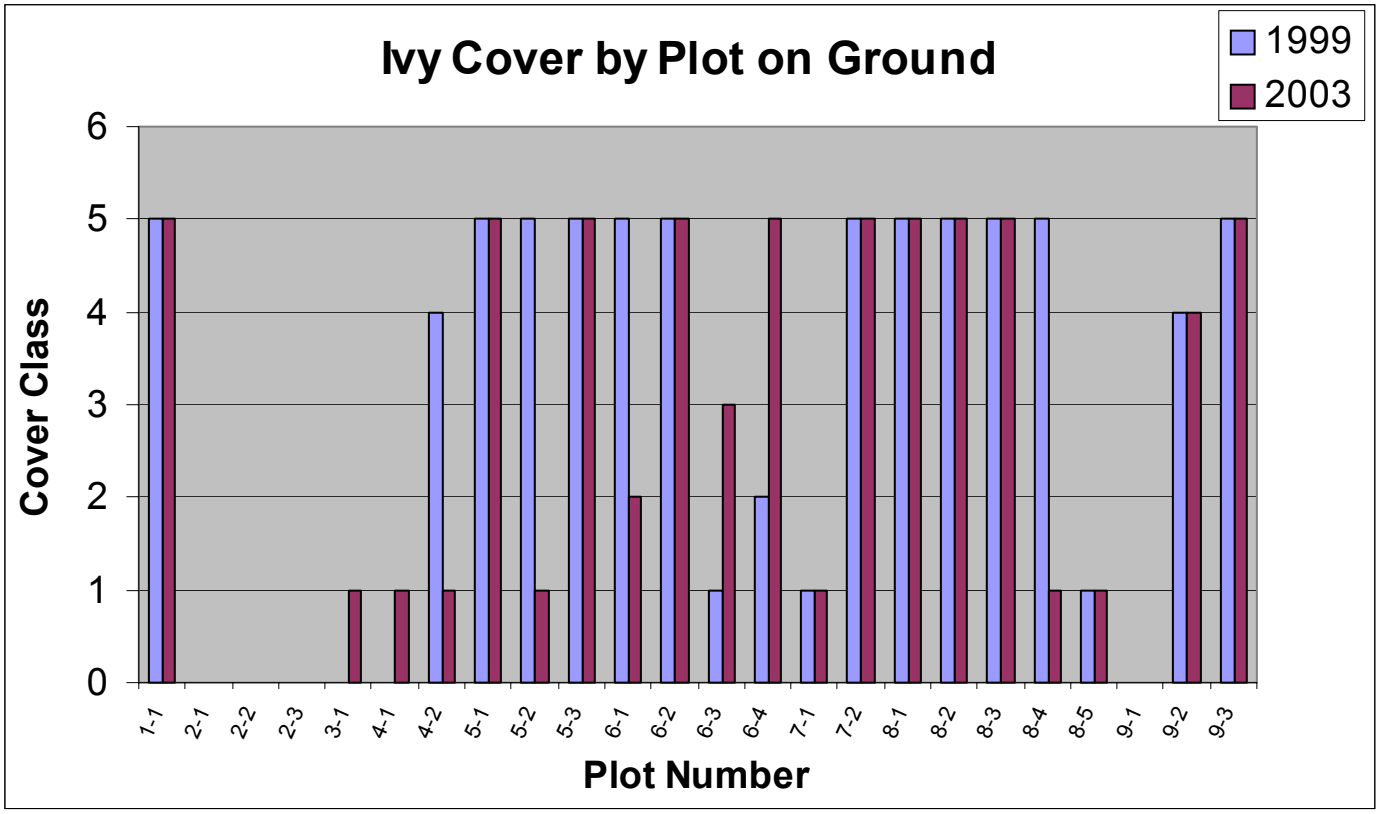


The pie graphs for vigor shows a great reduction in the number of live stems for High vigor because there are quite a few trees that have been recently cut and many trees throughout the 24 plots could not be located (due to missing tags, recently fallen).

IVY COVER

Presence of ivy on trees

LIVE	IVY	Frequency		Percent%	
		1999	2003	1999	2003
LIVE	PRESENT	303	387	41.8%	62.1%
LIVE	ABSENT	334	193	46.1%	31.0%
DEAD	PRESENT	53	33	7.3%	5.3%
DEAD	ABSENT	35	10	4.8%	1.6%



Plots 4-2, 5-2, 6-1 and 8-4 have an obvious decrease in the amount of ivy cover class on the ground. This is due to the ivy removal activities that have taken place in the park. 3-1, 4-1, 6-3, and 6-4 all showed increases in ivy cover. The remaining plots show no changes in ivy cover.

Change in plots where Ivy has been removed.

Plots 4-2, 5-2, 6-1 & 8-4 all show a decrease in ivy cover from 1999-2003. This did not have much effect on the changes in native plant diversity or growth of trees—they either remained the same or grew at a similar pace with the rest of the plots. Unfortunately, in places where ivy was removed, other invasive species increased in cover class and new invasive species appeared altogether.

PLOT 4-2

1999		2003	
Species	Cover cl.	HEDHEL	1
IVY	4	IVY	1
Blackberry	3	Blackberry	1
Herb Robert	3	Herb Robert	2
		Nipplewort	2

PLOT 5-2

1999		2003	
Species	Cover cl.	Species	Cover cl.
IVY	5	IVY	1
ILEAQU	1	ILEAQU	1
		Herb Robert	1
		SMISTE	3

PLOT 6-1

1999		2003	
Species	Cover cl.	Species	Cover cl.
IVY	5	IVY	2
Herb Robert	1	Herb Robert	1
		Blackberry	2

PLOT 8-4

1999		2003	
Species	Cover cl.	Species	Cover cl.
IVY	5	IVY	1
Blackberry	1	Blackberry	2
ILEAQU	1	ILEAQU	1

Notable Changes in plots based on notes.

Plot 1-1 shows lots of celandine growth and quite a few deer trails cutting through the plot.
Plot 2-1 has a very large uprooted Doug fir tree very close to plot center. This plot contained a lot of ornamental plants that were difficult to distinguish and seem to be growing just fine.
Plot 2-3 has many cut logs on the ground and most of the celandine is located in the western half of the plot.
Plot 4-1 shows a fair amount of ivy just starting to creep up the Doug fir trees by Spring 2003.
Plot 4-2 shows 5 herbaceous invasive species verses only 3 invasive species recorded in 1999.
Plot 5-3 has a large snag that fell and is now leaning on tree #31. Also a large snag next to tree #31 has fallen over.
Tree #27 is lying on the ground—tag is still noted on tree.
Plot 6-4 Large Doug fir tree #13 has fallen to the North due to a recent winter storm knocking down tree #14 and other smaller trees in its path.
Plot 8-3 This plot has many new fallen trees due to a recent winter storm. The course woody debris has 7 additional pieces compared to the 1999 data. A few new growing Maple seedlings growing near the Eastern end of the plot near tree #7.
Plot 8-4 The center of the plot moved down slope – 6 m due to erosion.
Plot 9-1 New plot center installed in Winter 2003. Plot herbaceous layer is very well mixed with varieties of plants (i.e. Cucumber, Camas, Bedstraw, Red Dead Nettle, Rye Grass and other species).
Plot 9-3 This plot underwent a lot of changes since 1999. A large Doug-fir fell during winter storm 2003. A recent path was cleared through the middle of the plot marking the center stake of the plot in a depression just off the side of the pathway. The entire plot has scattered tags and missing trees; therefore, the vigor for Spring 2003 was not collected.

Chapter Two: Edge Plot Experimental Treatments

I. Introduction

The Hendricks Park forest under-story has been significantly impacted by a number of invasive and ornamental species. These non-native plants have been introduced from nearby residential landscaping, by birds in their droppings, by squirrels as food caches, by wind blown seeds, and a few have likely been carried unknowingly by park visitors and their pets. Road-cuts and trails through the park provide conditions favoring the spread of introduced species as soils on the edges are often disturbed and exposed by foot-traffic. Of the 198 native and naturalized vascular plant species inventoried in Hendricks Park, about 60% are native, and 40% have been introduced (i.e., escaped, naturalized, non-native species). In this latter category, 20 species are considered "invasive." In a study conducted in 1999, invasive English Ivy was dominant in nearly 90% of the park.

In recent years an enormous effort has been undertaken to remove English Ivy from Hendricks Park, and as a result a number of other invasive plants appear to be quickly filling in the freshly exposed areas. As a result park staff would like to study management options to deal with secondary invasive species. The following paragraphs describe the secondary invasive plant management study.

II. Purpose

The Hendricks Park secondary invasive plant control study is designed to evaluate the effectiveness of 4 different management strategies for controlling the spread of herb-Robert and nipplewort.

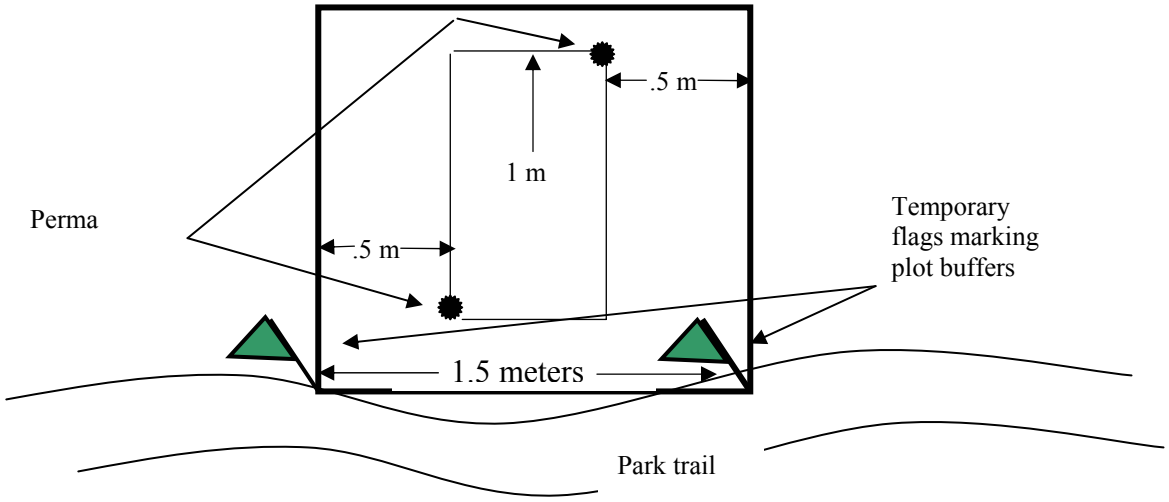
Description of experiment

One hundred and twenty five plots were installed and treatments were applied. Six weeks later we returned to count the number of stems of nipplewort and herb Robert in each plot. Each plot is 1.5 meters wide and 1.5 meters long. Each of the 4 treatments - hand pulling, mulching, burning, mulching and burning – and the control are replicated 25 times and were randomly distributed.

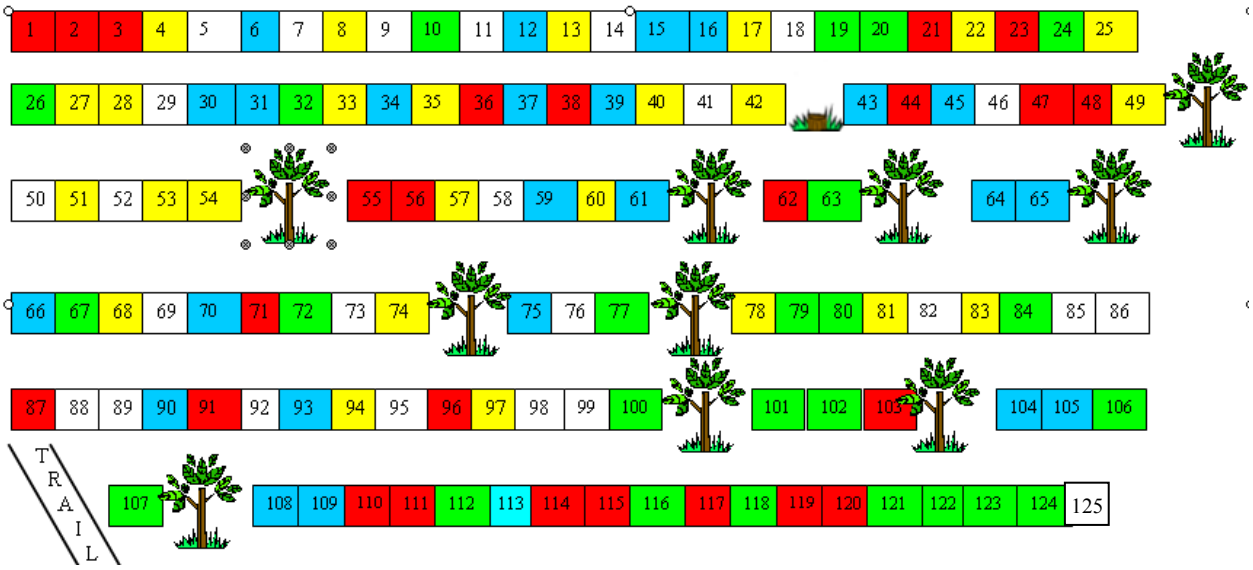
III. Site Description

Two sections were chosen in the park where Herb Robert and Nipplewort are present - a 25 plot section alongside a closed road within the park's forested area and 100 plots along a nearby intersecting trail. The diagram below details the layout for each plot. The map shows the random distribution of the treatments.

Plot Detail



Treatment Mapping



Legend	
Burn	
Burn & Mulch	
Control	
Hand-pull	
Mulch	

IV. Treatment protocols:

Mulch – Mulch is spread evenly over the entire plot approximately 1 inch deep.

Burn – All invasive species are burned with a portable torch. Attempts are made to burn around any native species in the plot. Note: The park staff plans to modify the treatment protocols in the Fall. They will place 2-3 inches of mulch on each plot.

Hand-pull – All herb Robert and nipplewort is pulled by hand from the plot.

Burn/mulch – Burn first, then mulch. Both burning and mulching is done according to the above descriptions/

All treatments were applied over a two day period.

V. Results and Analysis

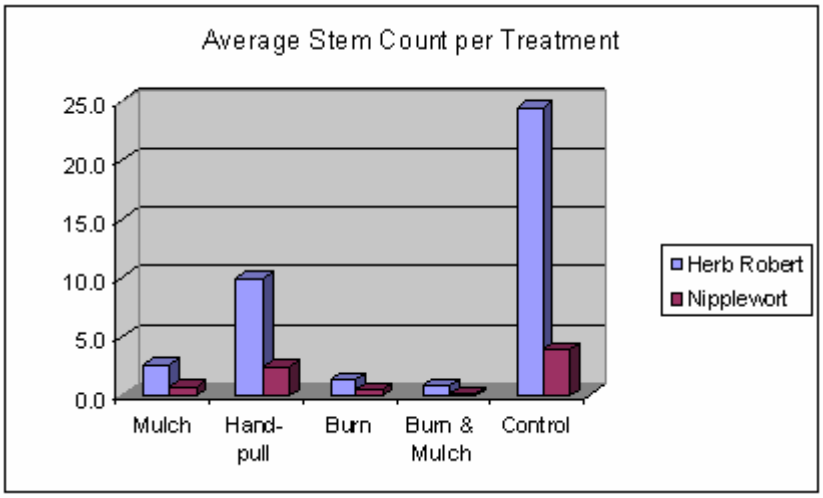
After six weeks the treatment plots were visited by the project group to collect initial stem counts. The graph and tables 1 and 2 below illustrate our preliminary results and provide some interesting statistics. Further treatments and stem counts will hopefully provide enough quantitative data to provide park staff with the information needed to make appropriate management decisions.

Table 1: Stem Counts per Treatment for GERROB

	Num Plots	Avg	Max	Min	Deviation	Median	Total
Mulch	25	2.5	27.0	0.0	5.7	0	63
Hand-pull	25	9.9	50.0	0.0	11.1	6	247
Burn Only	25	1.2	6.0	0.0	1.8	0	31
Burn & Mulch	25	0.8	5.0	0.0	1.3	0	21
Control	25	23.4	50.0	0.0	17.9	29	586

Table 2: Stem Counts per Treatment for LAPCOM

	Num Plots	Avg	Max	Min	Deviation	Median	Total
Mulch	25	0.6	12.0	0.0	2.4	0	16
Hand-pull	25	2.4	15.0	0.0	4.2	1	60
Burn Only	25	0.4	3.0	0.0	0.9	0	11
Burn & Mulch	25	0.1	1.0	0.0	0.3	0	2
Control	25	3.7	22.0	0.0	6.0	1	92



Native Plant Growth – Another consideration for treatment effectiveness is the success of native plant growth. Native plants within the boundary of the treatment plots were estimated using a cover class scale. Native plants with stems rooting from the buffered zone are ignored. Cover class is scaled in percentage of plot cover as seen looking from above. Cover class scale: **0** = 0%; **1** = 1 - 5%; **2** = 6 - 20%; **3** = 21 - 50%; **4** = 51 - 75%; **5** = 76 - 100%

Table 3 below shows the native cover class statistics from the first data collection.

Table 3: Native Cover Class

					Number of plots in each cover class					
	Num Plots	**Avg**	**Max**	**Min**	**0**	**1**	**2**	**3**	**4**	**5**
Mulch	25	1.0	3	0	7	13	3	2	0	0
Hand-pull	25	1.4	4	0	3	14	4	2	2	0
Burn Only	25	0.7	1	0	7	18	0	0	0	0
Burn & Mulch	25	0.6	1	0	11	14	0	0	0	0
Control	25	1.0	3	0	4	17	3	1	0	0

Initial Findings

The data above, collected six weeks after applying treatments, shows that burn or combination of burn and mulch were more successful at removing Herb Robert and Nipplewort. The data also indicates that hand-pulling is the least successful. This second observation was expected since both invasive species have higher germination rates in disturbed soil. It's important to note that more data needs to be collected to substantiate the initial findings. It is also too early in the study to determine the impact the various treatments have on native species. Initial data suggests hand-pulling is more beneficial for natives, but the high stem counts for both invasive species in these plots may make it difficult to support this management strategy.

VI. Future Research:

As a result of our work we learned a few things that may be useful for future data collection, as well as, some suggestions for additional information that may make the study more effective. Further research will need to be conducted to substantiate results.

In addition to the suggestions for collection methods, several other observations were noted. The slopes of the plots are not consistent and soil composition varies significantly since the majority of the plots are located along a managed trail and some sections have a slight gravel layer. It may be necessary to increase the number of monitoring plots to account for these factors, and it may be beneficial to note the slope and soil condition when collecting data.

VII. Hints for improved data collection:

To improve data collection it is easier to locate the monitoring plots with the use of a metal detector as the plot corners get buried by mulching and forest debris. It is also beneficial to locate a number of plots before beginning stem counts. Data collection should be conducted by teams of two working with other teams to conduct stem counts. One person per team should work on down-slope side of plot to minimize disturbance around plots and damage to native plants.

Chapter Three: Spread of Herb Robert to Park Interior

I. Introduction

Invasive species are of primary concern when considering the ecological health of the Hendricks's Park urban forest. With a large and increasing percentage of the park experiencing invasion by english ivy (*Hedera helix*), armenian blackberry (*Rubus discolor*), nipplewort (*Labsana communis*) and sweet cherry (*Prunus avium*), the Park has witnessed a decline in native species diversity and abundance as invasive monocultures dominate the forest under-story. Additionally, the extent to which the ground cover is dominated by these species has led to a decline in the regeneration of coniferous species.

The Forest Management Plan calls for comprehensive eradication of all invasive species by 2010. *Hedera helix*, which had spread to cover 45 of Hendrick's Park's 78 acres, is the Park's most aggressive invader, and as such became the primary focus of immediate removal efforts**.** Herb Robert (*Geranium robertianu)m,* a secondary invasive species, began to appear in the open space vacated by *Hedera helix* shortly after the first extensive removal efforts. The greatest density of these plants was observed in the disturbed areas along roads and paths.

II. Purpose

Concern over the spread of Herb Robert led to the collaboration with SLP, and the development of this experiment. Herb Robert is known to be an "edge" species, using disturbed areas along roads and paths to travel. The Park is concerned that Herb Robert will migrate into the forest interior and become an interior problem as well. In this experiment, we set out to determine how far and how fast species of Herb Robert migrate into the forest interior. By displaying the distances at which Herb Robert is located from the path/edge we hope to determine what factors, i.e. site characteristics, density, foot traffic, encourage movement into the urban forest. The experiment is designed to be replicated annually to show the rate at which Herb Robert is moving into the forest in Hendricks's Park, if at all.

III. Site Description

Three sets of transects were established in Hendricks Park. A map is provided in this report that shows all three site locations.

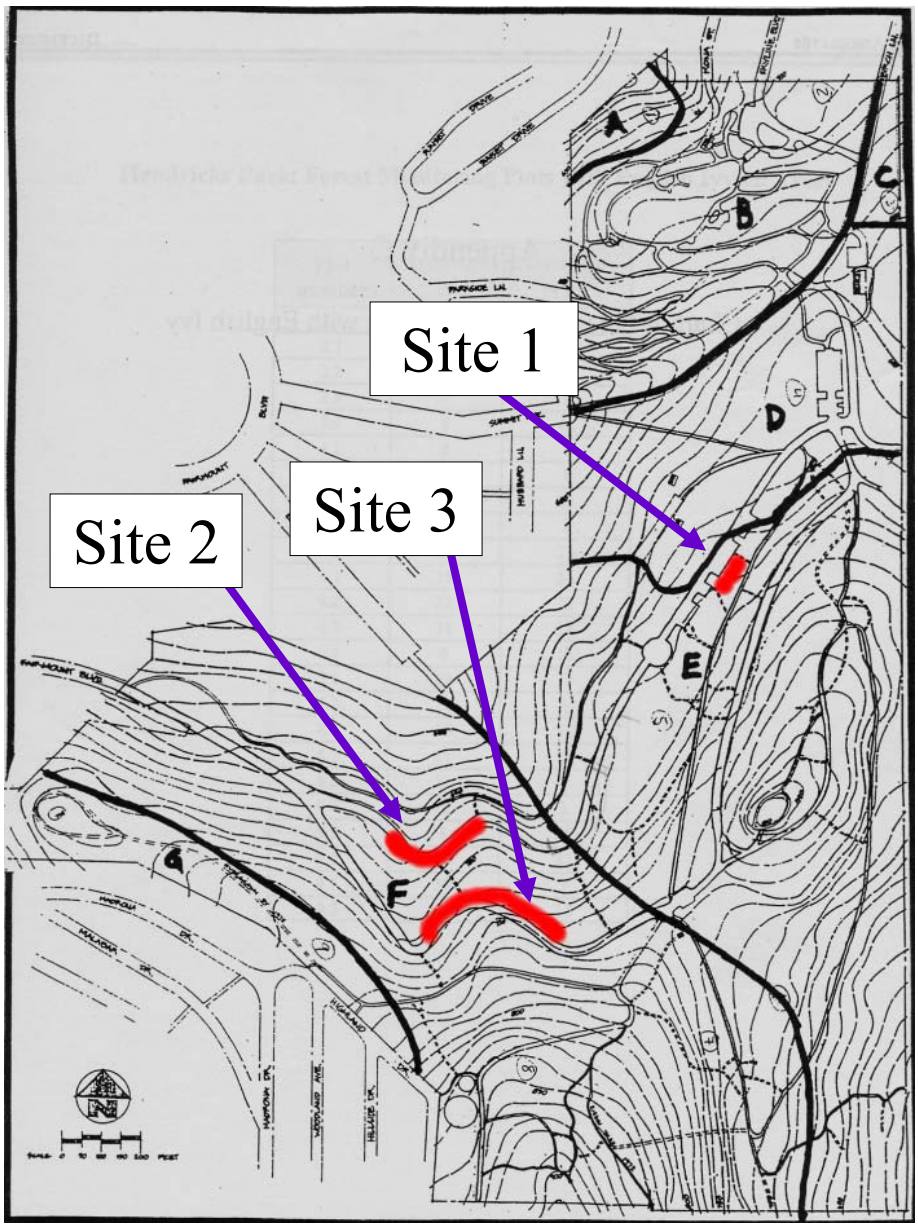
Site 1 and 2 transects were located along the east side of Fairmont, which climbs the west-facing slope of the hill. Site 1 is 25 meters long. To find site 1, walk southwest from the intersection of Summit avenue and Fairmont blvd, following Fairmont until you reach the second parking outlet on the on the east side of the street. Standing at the Northeast corner of the small parking outlet, look for a base plate mounted on the bottom of a nearby tree that provides precise directions to the starting point of site 1. All sites are marked with a nail and washer pounded into the ground.

Site 2 is 75 meters long. It begins approximately 150 meters further south along Fairmont on the east side of the street. Look for a base plate mounted on a nearby tree on the west side of the road for precise directions to site 2. Sites 1 and 2 receive dappled sunlight throughout the afternoon. Due to their westerly direction it does not receive direct sunlight on the forest floor in the morning.

Site 3 is 100 meters long. The transects are located along the west side of the upper road (closed to public traffic) east of Fairmont. Walk down the closed road. Just after the road crosses a culvert look for the base plate on a tree on the west side of the road for precise directions to site beginning. Site 3 follows turns along the road, varying between West and North facing downhill slopes.

All the sites are primarily Douglas Fir *(Pseudotsuga* menziesii*)* forest with an intermediate canopy of Big Leaf Maple (*Acer macorphyllum),* Sweet Cherry (*Prunus avium)* and Oso Berry (*Oemlaria cerasiformis)*. Site 3 also receives limited sunlight as a result of its west and north facing slopes. Native plant species found in the experimental areas are: Trailing blackberry (*Rubus ursinus)*, Hooker's fairybells (*Disporum hooker)*, Big leaf maple *(Acer macrophyllum)*, Yellow wood violet *(Viola glabella)*, Oso berry *(Oemlaria cerasiformis)*, Pathfinder *(Adenocaulon bicolor)*, Common snowberry *(Symphoricarpus albus)*, Wild lettuce *(Lactuca virosa)*, Fragrant bedstraw *(Galium triflorum)*, Pacific mountain ash *(Sorbus sitchensis)*, Sword fern *(Polystichum munitum)*, Miner's lettuce *(Claytonia perfoliata)*. Non-native species found in the experimental area are as follows: English Ivy *(Hedera helix)*, Sweet Cherry *(Prunus avium)*, Armenian blackberry *(Rubus discolor)*, Nipplewort *(Lapsana communis)*, and our test subject Herb Robert, *(Geranium robertianum)*.

IV. Map



V. Methods

Transects were selected and randomized by using a roll dice method. Students walked the combined 200 meters of roadside in sites 1, 2, and 3 stopping each meter to roll the dice. Results of rolls are as follows:

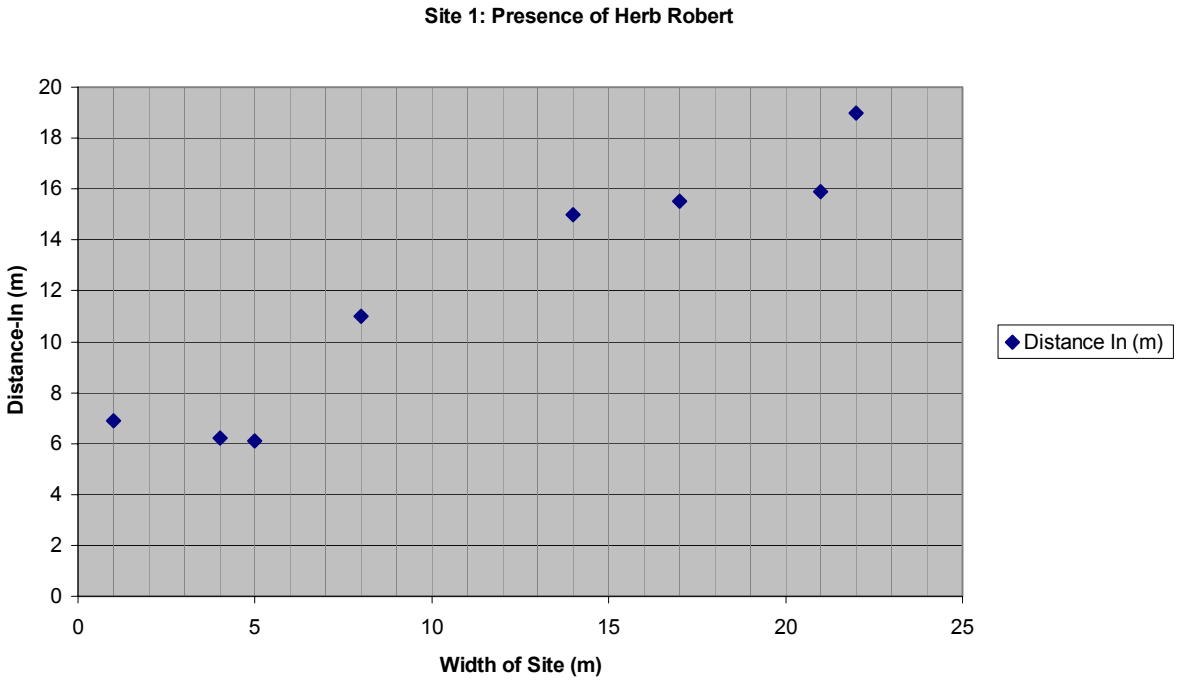
1	Skip
2	Transect
3	Skip
4	Skip
5	Roll again
6	Roll again

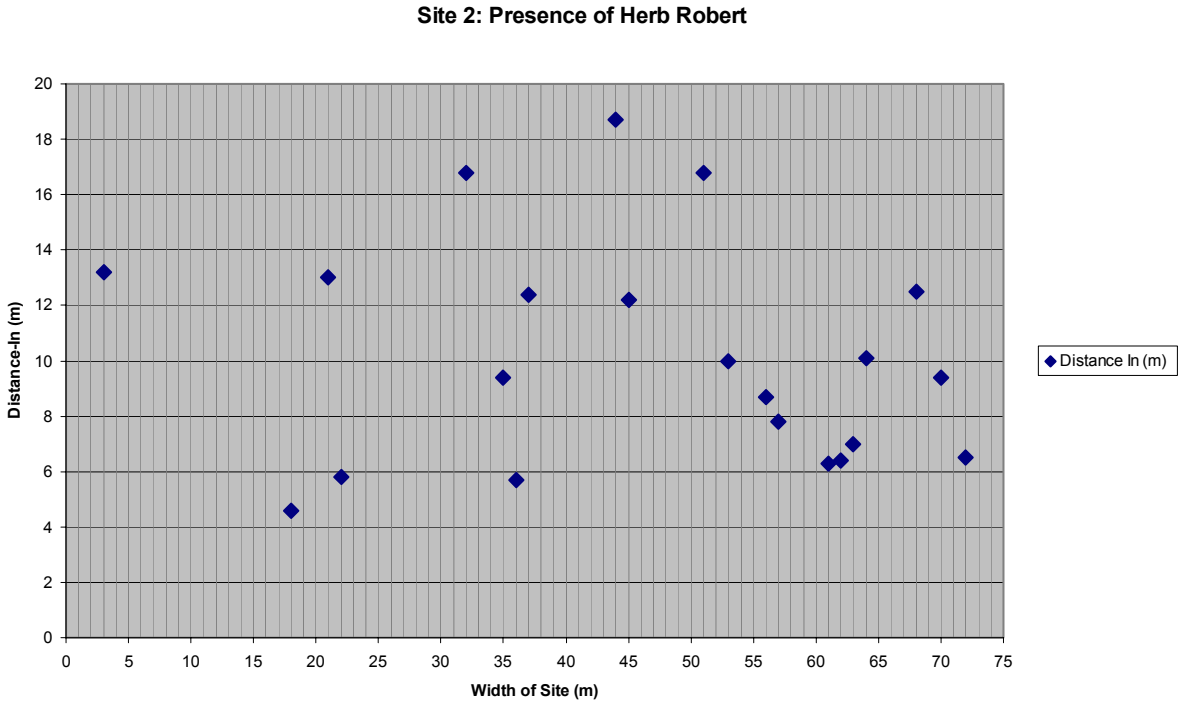
When a 2 was rolled, a 20 meter transect line was installed. Transects began at the road edge and headed directly into the forest. A compass was used to ensure that the 20m transect line was precisely 90 degrees perpendicular to the roadside edge.

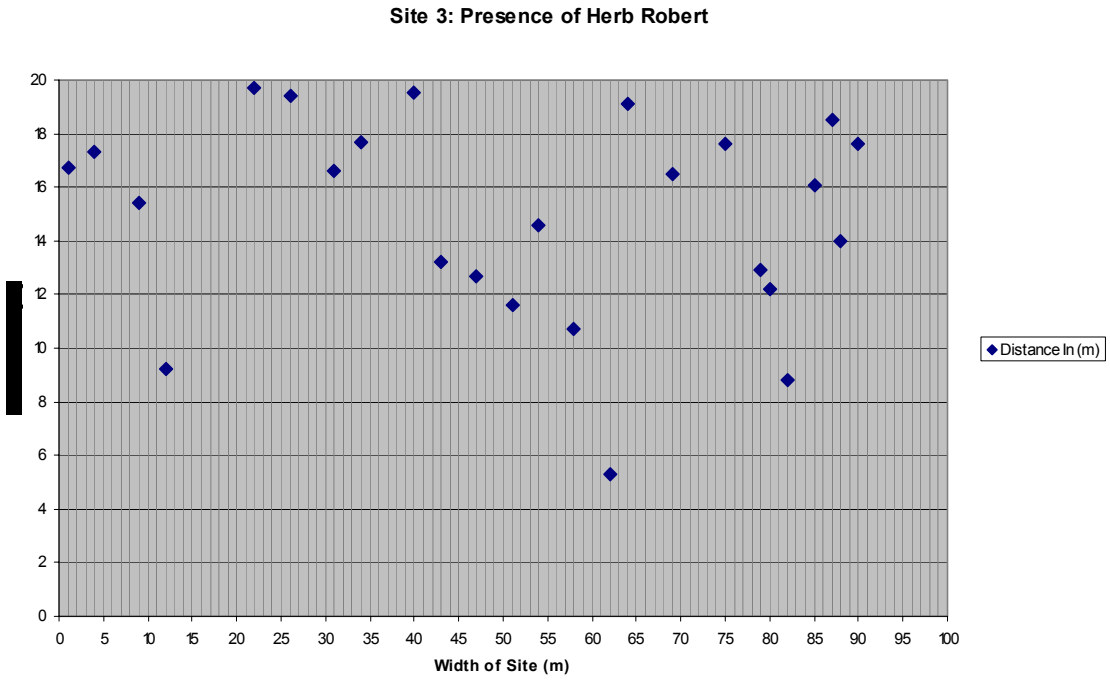
Transects in site 1 and site 2 will be re-randomized when this experiment is repeated next year. Transects in site 3 are permanent. The same transects can be walked in Site 3 when the experiment is repeated next year.

Students then checked for presence of herb Robert .5 meters to either side of the transect line. The greatest distance from the road at which Herb Robert was found within the one-meter wide swath was recorded. Seedlings of *Geranium robertanium* with three distinguishable leaflets at ¼ centimeter height or more were counted. Species of *Geranium robertanium* smaller that ¼ centimeter or without 3 distinguishable leaflets were not counted in the experiment.

VI. Findings/Analysis







Transects Statistics

Distance-In Herb Rober Found

	Avg	Max	Min	Median	Deviation
Site 1	11.95	19.00	6.10	13.00	5.08
Site 2	10.16	18.70	4.60	9.40	4.03
Site 3	14.92	19.70	5.30	16.10	3.79
Combined	12.63	19.70	4.60	12.80	4.58

The measures for central tendency show variations among the three sites. The sites are located in-line and at differing slope locations. Site 2 has the lowest average of 10.16 meters from the edge that *Geranium robertanium* was found. The range in which *Geranium robertanium* was found in site 2 was varying as well between 4.6 meters to 18.7 meters. Site 1 shows a general uphill increase along its 25 meters, Herb Robert was found around 6 meters in transect 1 at meter 1, then found at 19 meters at meter 22. Site 3 shows an overwhelming amount of Herb Robert 15 to 20 meters from the edge of the path. Interestingly, about 10 meters farther from the edge of the 20-meter mark in Site 3 is another path. This may lend some reasoning to the abundance of Herb Robert so deep into the forest at site 3.

Although Herb Robert was found in surprising amounts around 20 meters into the forest, especially in site 3, the species found were isolated seedlings. Students reported that the majority of plants found deep into the interior of the forest, at 15m to 20m, were very small seedlings. The larger patches of *Geranium robertanium* were still found along the edges of the road. Along the edge of

site 1, Herb Robert was also dense. Site 2, contrastingly, had sparse amounts of Herb Robert species along its edge. Species in Site 2 were also noted as "mature" species, found up to 8 inches in height, and some had flowers.

This trend suggests that Herb Robert is both an edge and interior invader. However, it appears to do much better along edges. In general, Herb Robert was found in dense patches along the edge of the road, and in sparse patches between 15- 20 meters from the road.

VII. Future Research

This experiment was very helpful in showing how far Herb Robert has migrated into the interior of the forest. Another study should run transects parallel to the road at various distances from the road and conduct density counts to get an idea of the density as you move further and further away from the edge. It would also be good to know if the sites where Herb Robert was found maturing and in thick patches, occurs where English Ivy has been removed. Further research would indicate if there is a correlation between disturbed ivy removed areas and the presence (in density measurements) of Herb Robert.

Appendix A

Scope of Work

I. Background

Over the last few decades biologists, park managers, and concerned citizens have begun to recognize the serious threat that non-native, invasive species pose to our to ecosystems. Non-native, invasive plants are exotic species that arrive - accidentally or intentionally - and spread over large areas. This happens because the invading plants have no natural control mechanisms to keep their numbers in check. As a result, native species get crowded out. This in turn can affect other species in the ecosystem that depend on the natives for their food and habitat. In a relatively short period of time, invasive species can reduce the biodiversity of a given area and threaten its stability.

Hendricks Park is Eugene's oldest city park. Its 78 acres of forest land provides habitat for a wide array of native plant and animal species. It is an important local site for preserving biodiversity. However, there are more than 20 invasive plant species in Hendricks Park that threaten its future. The Hendricks Park Forest Management Plan calls for protection and restoration efforts to maintain the biological integrity of the park. The City of Eugene Parks and Open Spaces Division (POS) wants to research several invasive species management protocols (including burning, hand pulling, and mulching) to discover which are most successful at keeping invasive species in check. POS staff are particularly concerned about the spread of English Ivy (Hedera helix) and Herb-Robert (Geranium robertianum).

This work program describes how the University of Oregon's Environmental Studies Service Learning Program (SLP) will work with the POS staff to research the effectiveness of invasive species management options and educate the public about its efforts and methods to control invasive species.

II. Proposed Work Program

Sarah Medary, Landscape & Medians Supervisor, will be the Contract Administrator for the City. Kevin Foerstler, Tree Maintenance Supervisor, will be back up Contract Administrator for the City. Michael Robert, Head Gardener, will be the onsite project coordinator. The Environmental Studies Service Learning Program will be responsible for completing requested research and field data collection for the project. A team of 4 Environmental Studies juniors and seniors will work over the course of the academic year to complete the work. The SLP research team will be supervised by Steve Mital, the Service Learning Program Coordinator. Steve is the co-principal investigator and project manager and will handle all day-to-day operations. Dr. Alan Dickman, a senior instructor in the Biology Department, will be the principal investigator on this project.

Description of Tasks

We propose to conduct this project in 3 phases:

I. Start-up,
II. Plot monitoring and data collection
III. Analysis and report writing.

The project work will begin in mid-November of 2002 and conclude by June 15, 2003. The specific tasks are described below.

Phase I: Startup

Task 1 Review existing background material

The SLP team members will read all pertinent chapters (as assigned by the project manager) of the Hendricks Park Forest Management Plan.

Schedule: November - December

Task 2 - Create Plant Identification booklet

SLP members will work with POS staff to develop a plant identification booklet on key native and invasive species that are found in Hendricks park.

Schedule: December
Product: Electronic copy of plant identification booklet

Task 3 - Establish permanent photo points

The SLP coordinator will work with POS staff to establish several permanent photo points. SLP will gather GPS data for each permanent photo point to the extent feasible given limitations on the accuracy of available equipment when working under the forest canopy. Photos will be taken quarterly to monitor and record changes at the permanent forest monitoring plots and at several additional test sites where invasive species removal will be conducted.
Schedule: January
Product: 30 permanent photo points

Task 4 - Install test plots

The SLP team will work with POS staff to install Five 12' by 12' test plots. The installation of these test plots will help refine the methodology, installation technique, and maintenance protocols for the test plots. Plant data will also be gathered during pre-tests.
Schedule: January Product: 5 test plots built and installed

Phase 2: Data Collection

Task 5 - Finalize protocol for test plots

The SLP coordinator will work with POS staff and university faculty project advisor and statistician to finalize number, size, location, and specific management protocol for each test plot. The number of test plots will not be less than 21.
Schedule: January
Product:: Written test plot research plan

Task 6 - Update Hendricks Park forest inventory

The SLP team will revisit the 24 permanent forest monitoring sites established by Salix Associates and re-inventory plant species.
Schedule: January – April
Product: Updated Hendricks Park permanent forest monitoring plots database

Task 7 - Invasive species literature search

The SLP team will search for and review existing information (documented and anecdotal) on effective management protocols for each invasive plant species that threatens Hendricks Park. This list will be provided by Michael Robert, Hendricks Park Head Gardener. The team will summarize this information for the Contract Administrator and POS staff.

Schedule: January - April
Product: Written report

Task 8 - Visit permanent photo points

The SLP team will collect series of photos (wide angle, medium and close-up) from each established photo point. Team members will visit each permanent forest monitoring plot photo point once and each test plot photo point quarterly.

Schedule: January - May
Product: Digital photos database

Task 9 -Build and install test plots

The SLP team will build and install all test plots according to the test plot research plan described in task 6. In order to perform sound scientific analysis, the test plots will remain in place for several years.

Schedule: January
Product: Test plots built and installed

Task 10 - Design field data record sheets and spreadsheet

The SLP team will design a field record sheet to record data collected from the test plots. The team will also design a spreadsheet to record and analyze data over time.

Schedule: January
Product: Field data record sheet and data spreadsheet

Task 11 - Apply prescribed treatments to each plot

The SLP team will hand-pull, mulch, and burn (with POS supervision) all invasives within the test plots according to the test plot research plan.

Schedule: Not later than February
Product: All test plots cleared of invasive species as described in test plot research plan.

Task 12 - Test plot monitoring

The SLP team will visit plots weekly to monitor the test plots, inventory plants within each plot and re-apply treatments as required in the test plot research plan. The SLP team will submit a Monthly report to the City identifying personnel and hours spent monitoring the test plots. The report will also detail findings and any re-treatments for each test plot.

Schedule: February - May
Product: Database updated weekly reporting personnel hours and test plot findings.

Phase 3: Analysis and Reporting

Task 13 - Monthly reporting

SLP coordinator will prepare a monthly report for the contract administrator and POS staff. The repot will include all student and SLP coordinator hours spent on the project. It will also summarize the work completed. The information will be collected weekly, but reported monthly**.**

Task 14 - Create educational posters

The SLP team will create a series of educational posters that will explain to the public the Hendricks Park invasive plant species research, monitoring, and management project. These posters will be used by POS staff during educational workshops.

Schedule: February - March
Product: 4 posters

Task 15 - Analyze data

The SLP team will conduct preliminary statistical analysis on test plot data. The goal of this effort is to begin assessing the effectiveness of the experimental design as well as the effectiveness of treatment protocols.
Schedule: April - May
Product: Written report

Task 16 - Prepare final written report

The SLP team will produce a comprehensive written report that includes background information, methodology, results from inventory work, test plot data, photos, hours spent on project, and recommendations.

Schedule: May - June
Product: Final report

Task 17 - Prepare final oral report

The SLP team will prepare a comprehensive oral report and slide show to be delivered to the contract administrator and POS staff. This report will highlight the contents of the written report.

Schedule: May - June
Product: Powerpoint presentation

Task 18 - Prepare web-based reports (to be determined at a later date)

The SLP team will make the written report, powerpoint presentation, and photos available to be placed onto the City of Eugene Parks and Open Spaces Division website.

Schedule: June
Product: CD

Task 19 - Orient summer project continuation team (as necessary)

POS staff plans to continue monitoring the test plots through the summer months. The City may hire SLP team members or others to conduct this work. SLP team members will assist as necessary with the training and orientation for summer project staff.

Schedule: June

III. Schedule

The Environmental Studies Service Learning Program will begin work on this project as soon as an intergovernmental agreement is in place. SLP will submit its final report to the Contract Administrator, City of Eugene Parks and Open Spaces Division on or before June 30, 2002. Figure 1 shows the general project schedule.

Figure 1. General project schedule

Task	Dates
Task 1. Review existing background material	November - December
Task 2 Create Plant Identification Booklet	November - December
Task 3. Establish permanent photo points	January
Task 4. Install test plots	January
Task 5. Finalize protocol for monitoring plots	January
Task 6. Update Hendricks Park forest inventory	January - April
Task 7. Invasive species literature search	January - April
Task 8. Visit permanent photo points	January - May
Task 9. Build and install monitoring test plots	January
Task 10. Design field data record sheets and spreadsheet	January
Task 11. Apply prescribed treatments	February
Task 12. Test plot monitoring	February - May
Task 13. Monthly Reporting	December - May
Task 14. Create educational posters	

	February - March
Task 15. Analyze data	April - May
Task 16. Prepare final written report	May - June
Task 17. Prepare final oral report	May - June
Task 18. Prepare web-based reports	June
Task 19. Orient summer project continuation team	June

IV. Budget

The total cost for this project is estimated at $11,134.00.
The Service Learning Program coordinator will devote 10 hours each week for 36 weeks on this project. The SLP coordinator is responsible for project design, training students, supervising project work, meeting with the contract administrator and POS staff staff, reporting and overall project quality.
The Service Learning Program coordinator will provide the contract administrator with a weekly accounting of actual hours spent on the project. This report will be submitted to the City once per month, together with an invoice for payment for services provided during that month. Hours to be compensated shall not exceed 360 total for the project.
Hours will be compensated as follows
The four SLP student team members are not paid for their work. Instead they receive academic credit and practical experience.
The City will fund 194 hours @ $30.93/hr.
The SLP will fund 166 hours @ $30.93/hr

Appendix B

Invasive Species Literature Review

During winter term 2003, the SLP team searched for sources that described experiments conducted to find out the effectiveness of various treatments, discussed treatments and their results, and discussed other information that was related to methods to control the spread of the particular invasive plant species. The team compiled the list of sources available and summarized the information. The sources included articles from journals, on-line documented reports on projects conducted in other parks, collective information by other organizations, and interviews with real people experienced with various controlling methods. This annotated bibliography will give the park staff a quick reference on the kind of information available on the various controlling methods of the invasive species.

English Ivy (*Hedera helix*)

Best, Rebecca, and Hilary Quinn. "English Ivy in Stanley Park: Effects of Invasion and Implications for Management." Environmental Sciences, University of British Columbia, 2002. <http://www.science.ubc.ca/envsc/quinn_et_al.pdf>.

Abstract: The authors of this study research feasible control methods for controlling English Ivy, considering the cost, manual labor, and site description in Stanley park. This is a very extensive and informative study and seems to draw many similarities (site description, previous control methods, and available resources) to the efforts for controlling English ivy at Hendricks Park in Eugene, Oregon. Their research employs the use of GIS to assess the size and depth of ivy cover and proximity to the road in order to assess the effectiveness of control methods on a certain site. In conclusion, the authors found manual removal combined with chemical herbicides the most effective way to control English ivy.

"Control Assessment," Ivy Removal Project. Forest Park, Portland, Oregon. 16 March 2003. <http://www.noivyleague.com/index.html>.

Abstract: This study was compiled by the members of the NO IVY league as a guide to eradicating English Ivy from yards, homes, and parks. It was not intended to be a research project but has since spurred further research projects. From extensive work with English ivy in Forest Park, located in urban Portland, Oregon, the organization critically evaluated five types of control methods: manual, chemical, genetic, cultural, and biological. The report concludes that although there are many types of control treatments to remove English ivy, the most effective treatments are manual removal or some combination of manual removal with genetic, chemical, or biological treatment methods to ensure long-term suppression of English Ivy.

Derr, Jeffery F. "English ivy (Hedera helix) response to post emergence herbicides." Journal of Environmental Horticulure, 1993; 11 (2) 45-48. <http://sain.nbii.gov/invasives/species31.shtml>

Abstract: This study, conducted by Jeffery Derr examines the effects of herbicides to control the invasive Hedera helix. It was found that one application of *Roundup* at 2.2 or 4.5 kg reduced new shoot growth of English ivy 10 weeks after treatment by 46% to 80%. Roundup at 4.5kg plus non-ionic surfactant in a single application reduced the older shoot growth of English Ivy by 41% after 19 weeks of the treatment. Increasing

applications by 2kg significantly increased the reduction of English ivy, at 74% to 92% with the above listed treatments. Treatments of *Banvel* or *Garlon* were also tested, but were proven less effective than the *Roundup* treatments.

Diedrich, Sandra and Jil M Swearingen. "English Ivy." Plant Conservation Alliance. 16 March 2003. <http://www.nps.gov/plants/alien/fact/hehe1.htm>

Abstract: The authors, Sandra Diedrich, from the NO IVY league, and Jil Swearingen from the National Park Service highlight some of the main descriptive characteristics of English Ivy to provide background information on its threat as an invasive species. They also discuss both manual and mechanical means of treatment. They recommend a mixture of triclopyr amine (*Garlon 3A*) with water applied in lesser amounts to the foliage of English ivy, which is absorbed into plant tissues and carried to the roots, effectively killing the entire plant in place. A higher amount of *Garlon 3A* can be applied to the bark of trees which English Ivy is climbing, although this is recommended only for trees with thicker bark, because trees with thinner bark are susceptible to the toxics of the pesticide *Garlon 3A*. This is a good reference for botanical characteristics of English ivy as well as recommended control treatments.

"Hedera helix," National Park Service, 16 March 2003. <http://www.nps.gov/redw/eivy.htm>

Abstract: This factual web page about English Ivy lists its origin, habitat, characteristics and best methods for removing English Ivy, specifically in the Redwoods region of Northern California. The provided information posits it is best to pull ivy away from trunks, roots, and branches to stop ivy from growing up the tree. It is also recommended that the roots of the ivy must be pulled to avoid re-sprouts. Although this information is very basic, it is nonetheless useful in studying English Ivy.

Morisawa, Tunyalee. Weed notes: *Hedera helix L*. Wildland Weeds Management and Research. 30 June 1999. <http:// tncweeds.ucdavis.edu/moredocs/hedhel01.pdf>

Abstract: The author of this study assessed both chemical and cultural control treatments. First cutting is recommended, followed by supplemental herbicide. Special note is given to being cautious when handling cut ivy. Do not leave it on the ground near an exposed site. It should be placed on a wooden board or concrete to dry, and then transplanted to decompose. Chemical controls of English ivy were then tested with 2, 4-D, (*Weedar 64*) at 1.1 kg/ha and glyphosate (*Roundup*) at 4.5 kg/ha, applied once a month for two months. The plants did re-grow, but with reduced shoot weight in both applications. Many combinations of herbicides and cutting methods were tested, and the most effective treatment was the use of a nylon cord weed eater followed by a 2% solution of 2,4-D (*Weedar 64*). All treatments were evaluated one-year post applications.

Okerman, Anne. "Combating the 'Ivy Desert': The invasion of *Hedera Helix* (English Ivy) in the Pacific Northwest United States." Restoration and Reclamation Review. Dept of Horticultural Science. University of Minnesota. March 2003. <http://www.hort.agri.umn.edu/h5015/00papers/okerman.htm>

Abstract: This report describes the ecological impacts *Hedera helix* has had in forested, riparian, and wetland areas of northwestern United States. The author describes tried control methods of English Ivy including physical, biological, and chemical treatments. The standard pulling method is described as well as new methods such as burning infested sites with a blow torch. It is recommended to immediately plant native species to the burnt site to restrict further invasions from non-native plants. Detailed chemical treatments are also described in the report. Postulated as the most effective chemical treatment is **Round-up** (glyphosate) with a controlled droplet application or electrostatic sprayer. This treatment system would charge the ions of **Round-up** (glyphosate) so that herbicides will more successfully adhere to the stomates on the underside of the plant, avoiding its waxy cuticle and resulting in increased uptake. No applications of biological treatments have been tried, yet there is a fungus (*Phoma hedericol*) known to damage the populations of English Ivy in Italy.

Sardy, Marin. "Control of English Ivy (Hedera helix) in Oregon parks. Thesis. University of Oregon, 1997

Abstract: The author, an undergraduate biology student, analyzes data from treatment methods applied to English ivy in a Eugene park, Skinner's Butte, to test its effectiveness and implications. Hand pulling and flaming were the primary control methods tested. Manual removal was shown to be most effective and more efficient than flaming in eradicating the invasive English ivy and allowing native species to succeed. Sardy concludes that manual removal is the most efficient way to remove English ivy, although it is the most labor intensive.

Herb Robert (*Geranium robertianum*)

Bleekman, Amy. Personal Interview. 12 March 2003

Abstract: Amy Bleekman has lived in the Willamette Valley for the past 12 years. During that time, she has discovered various invasive species including Herb Robert. Amy's trick to killing the majority of the weeds is to start the process on a dry day. She takes a pot of boiling water and pours it over the main stem of the weed. She then waits for about a week to see if the weeds re-grow. If this method does not succeed (it's about a 3/5 chance), then Amy pulls the plant from the root base. Once Herb Robert has been pulled, Amy distributes a semi-thick layer of bark over her flowerbeds to prevent the growth of the weeds. The grow-back rate of Herb Robert is pretty low once the pulling and bark have been applied.

Chapek, Lonnie. Telephone Interview. 05 March 2003.

Abstract: Lonnie Chapek has lived in the Willamette Valley for over 25 years. She has always valued her flowerbeds and was delighted to explain her technique of mulching out the invasive species. Her trick for a perfect flowerbed is to grade the proposed site that she wants to work with. Next she describes how she encloses each flowerbed with wood siding and places a layer of black plastic over the graded soil. Once this is done she covers the bed in a thick layer of bark. She says it's best to let the bark beds sit for at least 1 – 2 weeks before attempting to plant anything—this gives all of the invasive species time to die (however, it does kill off the other plants too).

Earls, John. Personal Interview. 13 March 2003.

Abstract: John Earls has dealt with a fair amount of invasive species throughout his lifetime. One of John's methods of ridding the invasive species Geranium robertianum is to mark out the plot of ground that he wants to control. Next he spreads hay over the area - about 3 inches thick. Because the light cannot penetrate through the hay, the plants begin to die off, and any seeds left are not able to germinate. This process is done over a couple years span in which the hay biodegrades and the layers accumulate creating a really nice thick layer of fragipan soil. When John wants to plant in an area that he has covered with hay, he simply moves some of the hay aside and lets light reacht only the plants that he wants to survive.

The Nature Conservancy. Wildland Invasive Species Team.
<http://tncweeds.ucdavis.edu/methods.html>

Abstract: The staff of The Nature Conservancy address invasive weed problems, strategically and on effective scale. They maintain files on more than 500 invasive plant and animal species, and emphasize controlling them in the most environmentally friendly ways possible. They discuss information of control methods that are most effective against the invasives, while being the least damaging to the ecosystem. They asserted that usually the best way of controlling invasives (*Geranium robertianum*) is by hand pulling, other times by pulling with mechanical tools. However, they suggest that sometimes a pulled weed grows back from the root system, presenting an even worse problem the next season. Other options discussed are controlled burns, flooding, biocontrols or other natural habitat processes.

Meador, Jessie. Telephone Interview. 03 March 2003.

Abstract: Jessie Meador has lived in the Willamette Valley for over 20 years and is an avid gardener. She has lived at a variety of locations throughout the Springfield area including places with heavy forest canopy (which usually contained more species of Geranium robertianum). At her tender age of 79 years, one of the techniques she discusses to rid the invasive species Geranium robertianum is by hand pulling. However, she brings up the importance of not only pulling the stem, but making sure you pull the entire root ball. If this is not done, the weed will come back again the next season. She also mentioned how she would place just a drop of herbicide on the former root ball location to assure the weed would not come back.

Mathison, Jay. Personal Interview. 12 March 2003

Abstract: Jay Mathison moved from Washington and has lived in the Willamette Valley for the past 8 years. Jay is an avid gardener and despises weeds that like to creep up in his yard. Jay's main method of weed control for the invasive species is hand pulling. He makes sure that he grips the plant from the base so that he does not leave behind any root base. If hand pulling is not effective, he'll sometimes get out the burn torch and "torch the little guys down."—This works for a while too, but, if the root has not been pulled the weeds tend to grow back. He notices that sometimes by applying a small amount of **round-up** or **crossbow** to the problem area (making sure that it is applied on a dry day so that there is no potential run-off) after hand pulling and applying a layer of bark, has also proven to be very effective.

The Washington State Noxious Weed Control Board. 2001.
<http://www.wa.gov/agr/weedboard/weed_info/herbrobert.html>

Abstract: Researchers at the Washington State Control Board use data from Boerner, Falinska, Fries, McAlpine, and Time Life Plant Encyclopedia & Tisch to provide information on the noxious weed: Herb Robert (Geranium robertianum). They discuss the description and variation, economic/environmental importance/detriment, geographic distribution, habitat, history, growth & development, and responses to various treatments to get rid of the species. They find that while herbicides (i.e. *Deurinol*, *Ronstar*, *Treflan*, and *Rout*) work well, it may be difficult to control this species without damaging the plants associated with it. Responses to mechanical methods (i.e. pulling) found that Geranium robertianum has little root structure and pulls from the ground easily at all stages of growth. It may also be controlled using a string trimmer in early to mid summer before fruiting. Bio-control potentials include a specific aphid (Acrythosiphon malvaegarantii) that likes Geranium robertianum as part of its diet.

Youngquist, Harry. Personal Interview. 12 March 2003.

Abstract: Harry Youngquist is a long-time gardener from the Hawaiian Islands. He has lived in the Willamette Valley for over 25 years and has seen a lot of non-native species move in. His method of control is to use a small-scale shovel just pitched enough at the end to dig into the soil and pull the entire plant up from its root base. He then layers his flowerbed with bark and sprinkles **Tordon** over the top (an herbicide designed to kill off plant stems but does not harm woody stems). He says that he uses the **Tardon** in limited amounts in order to minimize any harmful effects to the environment.

Armenian (Himalayan) Blackberry
(*Rubus Armeniacus, syn: Rubus Discolor*)

DiTomaso, J.M.. "UC Pest Management Guidelines , Wild Blackberries, Home & Landscape." University of California Statewide IPM Program. Ed. Ohlendorf, B.. April 2002. University of California. February 2003. <http:// www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7434.html>

Abstract: This is a guideline on integrated pest management by the University of California primarily for home and landscape purposes. Mechanical control like repeated tillage can easily control the blackberries. The rhizomes can be fragmented and will spread by a single cultivation. Bulldozing, mowing, and burning are not effective because they can cause vigorous resprouting. However, mowing and burning can be suitable for short-term canopy reduction. Chemical control will be effective with subsequent treatments. It recommended applying tebuthiuron, which is a nonselective urea herbicide, to be used for total control applied to the soil. During the growing season, an herbicide must be transported within the plant, moving from the phloem with the plant sugars that are produced during photosynthesis, to the rhizomes and new growing points. The timing of this application depends on whether the plants are first-year canes or canes of combined first and second-year. It also gives instructions and recommendations for the application of foliar-applied herbicides, basal bark treatment, and dormant stem and leaf treatment.

Goodwin, Kye, and Burgerjon, Joop. "Invasive Plant Control in Sargeant Bay Provincial Park." January 2003. Sargeant Bay Society. February 2003. <http://www.sargbay.ca/IPC.pdf >.

Abstract: This is a report that gives information on the steps taken by the Sargeant Bay Provincial Park in British Columbia to tackle four invasive plant species in the park area of which Himalayan Blackberry is of the greatest concern. It recorded the number of hours, the methods used, and the specific areas tackled by the volunteers that range from high school student to adult workers from other organizations. The effort to control the invasives began in 1993, and the processes and observations through 2002 were recorded. Detailed descriptions include how strong re-growth occurred on some of the sunny sites into early October 2000, after they had cut the stems of the blackberry to the crowns as many as 5 to 7 times, with a gap between mid-July and late August. The following year, they began to remove the underground parts of the blackberry. Discussions and conclusions were given at the end. It says that by November 2001, blackberries in shadier sites did not come back, but they might re-establish in the sunnier areas. Therefore, immediate control efforts must continue. Assuming that control efforts would begin at the start of the 2002 growing season, the authors estimated that a maximum of 200 person hours might be needed. But, actually only 70 hours were needed. Between 1% and 10% of plants, those removed back in 2001 regenerated. It also discusses how they dealt with old crowns, root shoots, and new seedlings, and the benefits of clipping as compared to digging.

Hoshovsky, Marc. "Element Stewardship Abstract For *Rubus discolor*, (*Rubus procerus*)." Wildland Invasive Species Team. Ed. TunyaLee Martin. August 2001. The Nature Conservancy. February 2003. <http://tncweeds.ucdavis.edu/esadocs/documnts/rubudis.html>.

Abstract: The Element Stewardship Abstract (ESA) for *Rubus Discolor* is prepared for The Nature Conservancy's Stewardship staff and other land managers. The abstract organized and summarized data from multiple sources on the effectiveness of various management techniques. Specific information for each of the four control techniques was discussed: physical, managerial, biological, and chemical. It mentioned that re-growth of the weed may be prevented by planting fast-growing native shrubs or trees, or by grazing sheep, goats, or chickens. It also discussed how some manual methods and hand hoeing would not damage the roots of desirable vegetation, and certain herbicides might not be as effective as cane removal, which can prevent the stimulation of sucker formation on lateral roots. Suggested effective methods with proper management for removing mature plants are mechanical removal or prescribed burning over manual methods, followed by subsequent treatments. The ESA encourages an integrated pest management plan because it is effective, economical, and environmentally sound.

William, Ray D. , Ball, Dan, Miller, Terry L., and et. al..Control of Problem Weeds. Pacific Northwest Weed Management Handbook. Integrated Plant Protection Center of Oregon State University. June 28, 2002. Oregon State University, Washington State University, and University of Idaho. February 2003. <http://ag.ippc.orst.edu/pnw/weeds?33W_PROB02.dat>.

Abstract: This is a section from this management handbook that contains a list of herbicides for the treatment of blackberry vines. The list includes herbicides like picloram, glyphosate, metsulfuron, amitrole, triclopyr ester, triclopyr amine, and triclopyr + 2, 4-D. For each of them, it mentioned the rate of the treatment, the time to apply it, and other caution about the particular herbicide. This basically works as a primary reference list for the various pesticides on controlling the blackberries.

Nipplewort (*Lapsana communis*)

"Exotic Plant Management Plan & Environmental Assessment." The National Park Service, Redwood National Park. March 2003. <http://www.aqd.nps.gov/ >.

Note: Although listed as an exotic species, Lapsana cummunis is considered a low priority and management strategies have not been studied.

Lee Jacobson. March 2003. <http://www.arthurleej.com/a-nipplewort.html>.

Abstract: Nipplewort is an annual plant whose seedlings can sprout any time of year, usually during the wet months. Seeds are dispersed by gravity, they simply drop to the ground below or are tossed as plant is blown in the wind. The nipplewort root system is shallow and can easily be pulled. Germination is more successful in disturbed soil because seedlings that are partially buried get access to moisture more readily leading to flourishing growth.

Per, Milbert, and Lars, Andersson. "Seasonal variation in dormancy and light sensitivity in buried seeds of eight annual weed species." Canadian Journal of Botany 75(11) November 1997: 1998-2004.

Abstract: Germination was recorded in three different light environments (light, dark, and after a short light exposure) and in eight annual weed species. Seeds were buried outdoors at the end of November 1994, and exhumed monthly from March 1995 to April 1996. All species exhibited substantial seasonal changes in dormancy levels; however, *Lapsana communis* was inconsistent over the year showing that the right soil and light conditions were the primary factors in germination.

Skutrud, R, Bjugstad, N, Tyldum, A, and Torresen, K Semb. "Effect of herbicides applied at different times of the day." Norwegian Crop Research Institute, Plant Protection Centre. Crop Protection 17(1) February 1998: 41-46.

Abstract: Spraying with low dose of a mixture of ioxynil, dichlorprop and MCPA early in the morning or in the middle of the day, caused a greater reduction in the biomass of the test plant than spraying in the evening. There was a similar tendency for the biomass of all weeds as well. However, Lapsana communis (Nipplewort) tended to be less susceptible at evening sprayings. The soil was relatively dry during the experimental period. It is concluded that spraying in the early morning or at daytime should be preferred under dry soil conditions with this type of herbicide.

Appendix C
Permanent Forest Plot Maintenance Report

Plot #	Trees with missing or heavily damaged tags	Other maintenance needs
1-1	2, 3, 5, 15, 17	
2-1	2, 8	No plaques found with plot center information. Cannot locate tree 8
2-2	2, 4, 10	No plaques found with plot center information. Cannot find trees 2, 4
2-3	5, 6, 9	Cannot find trees 6, 9
3-1	21, 22, 23, 24, 25, 26, 27, 28	
4-1	No problems reported	
4-2	14	
5-1	16	
5-2	No problems reported	
5-3	19, 21, 24	Cannot locate tree 9
6-1	No problems reported	
6-2	2	Cannot locate Tree 6, 15, 17, 32, 38
6-3	No problems reported	
6-4	7, 11	
7-1	No problems reported	
7-2	7, 13, 15, 16	Cannot locate tree 14
8-1	No problems reported	
8-2	No problems reported	
8-3	No problems reported	
8-4	1	
8-5	23, 24	
9-1	8, 9, 15, 18, 35, 37, 38	No plaques found with plot center information.
9-2	35, 37, 38	Need snag info
9-3	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 32, 42,	Cannot find tree 47

Appendix D

Directions to transects and edge plots

Monuments with the following information are located at the base of a large tree near each of the sites listed below.

Site 1 - begins 3.8 meters. 332 degrees from large douglas fir.

Site 2 – begins 8.3 meters and 80 degrees from large tree across street with sign on it.

Site 3 - begins 4.8 meters and 220 degrees from a cherry tree.

edge plot #1 - begins 3.6 meters and 101 degrees from large douglas fir across the path.

edge plot #26 - begins 4 meters and 68 degrees from a medium sized maple tree.

edge plot #50 - begins .5 meters and 44 degrees from a large douglas fir.

edge plot #107 - begins 5.65 meters and 110 degrees from a large douglas fir.

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Appendix E
Press Release

May 16, 2003

CONTACT:

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FOR IMMEDIATE RELEASE

UO STUDENT RESEARCH AIDES HENDRICKS PARK STAFF

On Tuesday, May 20, and Thursday, May 22, from 8 to 9 a.m., students from the UO Environmental Studies Service Learning Program, the Rachel Carson Environmental classroom and the Northwest Youth Corps will collect data from 125 experimental research plots in Hendricks Park. The results will help Hendricks Park staff determine the best way to control the spread of invasive species in the park.

The UO students have been working with park staff since last fall, researching a variety of methods for controlling aggressive, non-native plants, such as English ivy and Herb Robert, which threaten the biodiversity of Hendricks Park. The effectiveness of four treatments—burning, mulching, hand-pulling, and a combination of mulching and burning—were tested on several test plots. In the follow-up phase of the project, the university students enlisted the help of high school students to help them count all the re-growth that has occurred on the test plots since the treatments were applied several weeks ago.

The UO Environmental Studies Service Learning Program creates student-oriented research and service projects that directly benefit the Eugene–Springfield community. For more information, call 346-0591 or 682-5324 or visit www.uoregon.edu/~ecostudy/slp/.