
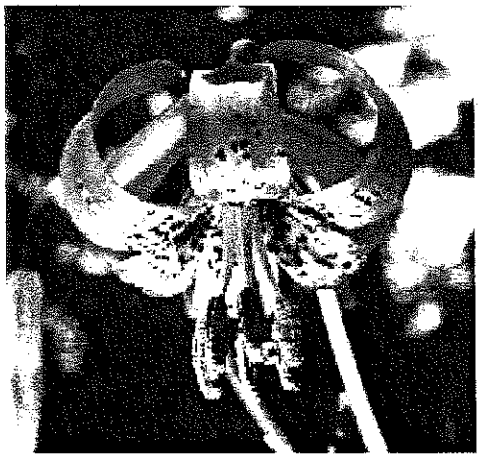

CRESCENT CITY MARSH WILDLIFE AREA

DEL NORTE COUNTY, AND

TABLE BLUFF ECOLOGICAL RESERVE

HUMBOLDT COUNTY, CALIFORNIA

CALIFORNIA DEPARTMENT OF FISH AND GAME

1998-1999 STATUS REPORT
WESTERN LILY VEGETATION STRATEGY

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Prepared Under Interagency Agreement
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1.0 INTRODUCTION

This report includes a compilation of first year results, summarized previously by Imper and Sawyer (1998), and 2nd year results for all tasks included in the Western Lily (*Lilium occidentale*) Vegetation Strategy Project, implemented in June 1998. Current funding (through Section 6 Endangered Species Act) for this project has been extended through March 2002. Since many elements of the study involve long term processes (e.g., western lily recruitment, gradual modification of habitat), extended monitoring will be necessary in order to achieve meaningful results. As a result, the study was designed to continue well beyond the current schedule, perhaps for a decade or more.

Tasks completed over the past 2 years include data collection from previously established sample plots and transects, as well as a new sample protocol intended to further our understanding of the ecology of the western lily, and assess the efficacy of manual treatment and cattle grazing for maintaining its habitat at the Table Bluff Ecological Reserve (TBER) and Crescent City Marsh Wildlife Area (CCMWA). Data files generated as part of this report are included as Attachment 7.

2.0 BACKGROUND AND STUDY OBJECTIVES

2.1 TABLE BLUFF ECOLOGICAL RESERVE

Formal monitoring of the western lily population at the TBER began in 1987 (Map 1). Annual monitoring at this and other sites on Table Bluff documented often severe browsing by deer or small mammals, resulting in loss of 50% or more of the reproductive effort in some years. Although no quantitative data are available, natural browsing may be a factor affecting mortality of the lily. With the exception of limited monitoring at the Christensen and Barry sites in the early 1990's, and monitoring conducted by The Nature Conservancy at their Bastendorf Reserve near Coos Bay, Oregon, there has been no intensive effort to determine the actual annual loss to deer and small mammals, or to investigate methods for discouraging mammal depredation. The ability of this plant to remain dormant for one or more years complicates investigation of browsing impacts. As a result, investigation intended to model the population demographics and various external factors affecting survival must necessarily track the life history of a large number of seedlings throughout the growing season, and over multiple years.

The monitoring at TBER since 1987 also documented an increasing threat to the lily as a result of plant growth following removal of cattle. At the same time, removal of approximately 50% of the spruce forest encouraged plant growth on the forest floor, exacerbating the need for vegetation management. Although the removal of spruce allowed many juvenile lily plants to mature, the release caused by tree canopy removal also appeared to eliminate many preexisting lily seedlings.

We also do not know whether current recruitment at the TBER is adequate to replace the existing stand of mature lilies. Seed plots established in fall 1993 as part of the Experimental Habitat Manipulation Project exhibited virtually no survival of seedlings in the *Coastal prairie*, and

relatively low survival in the *Spruce forest*. In contrast, abundant seedlings have been documented growing in pedestrian and cattle trails at the reserve (Imper and Sawyer, 1996), and in old cattle trails at another site on Table Bluff. We do not know if these seedlings eventually will mature. There is evidence, however, that exclusion of cattle from the lily habitat between 1987 and 1996 negatively impacted both lily recruitment and the longevity of mature plants. Passive cattle grazing has been introduced into the entire lily habitat at TBER for the past 3 years. Other than vegetation transect data collected prior to reintroduction of grazing, and data collected in this study, there has been no quantitative study of the impacts of cattle grazing on vegetation, soils compaction or lily recruitment.

The investigation at TBER is generally aimed at quantifying both the beneficial and negative impacts of cattle grazing applied at varying intensities and duration, as a method for maintenance of vegetation in western lily habitat. That information is critical to development of a formal grazing plan for the TBER, and should be applicable to many other western lily sites throughout the range. The principle study objectives at the TBER are 1) assess the impacts of cattle grazing applied at different intensities and durations upon vegetation composition and structure, soil compaction, and recruitment by the lily, and 2) determine quantitative impacts of natural browsing on the western lily, and the effect of deer and small mammal fencing and chemical inhibitors in reducing natural browsing. Secondary objectives include further definition of the life history of the lily, and determination of whether cattle ingestion of the lily seed, under controlled conditions, is a successful mode of recruitment.

2.2 CRESCENT CITY MARSH WILDLIFE AREA

Formal monitoring of the western lily population in the north part of the CCMWA ("North" and "South" marshes, Map 2; Imper and Sawyer, 1992, 1997) was implemented in 1997. The CCMWA population is unquestionably the largest population known, containing more than 5,000 plants, yet is one of the least studied. There has been no detailed study of the life history, recruitment or population demographics of western lily at this site.

Past monitoring at sites on Table Bluff and in southern Oregon indicates the principal threat to the western lily is encroachment by trees and shrubs (Guerrant et al. 1997). The majority of tree and shrub encroachment into lily habitat at the CCMWA appears to date to the early 1980's, apparently coinciding with removal of cattle from the area. Although the current growth rate for alder, crabapple, spruce, willow, and other potentially aggressive species in this habitat seems slow compared to other sites (perhaps due to the high water table), no quantitative growth estimates have been made. Our experience elsewhere indicates encroachment by these plants will eventually negatively impact the lily. Even a slow growth rate may be cause for alarm, due to the exponential relationship between lateral growth and aerial cover, particularly in light of the literally 1000's of expanding "islands" (seedlings and saplings) of shrubs and trees now scattered throughout the marsh.

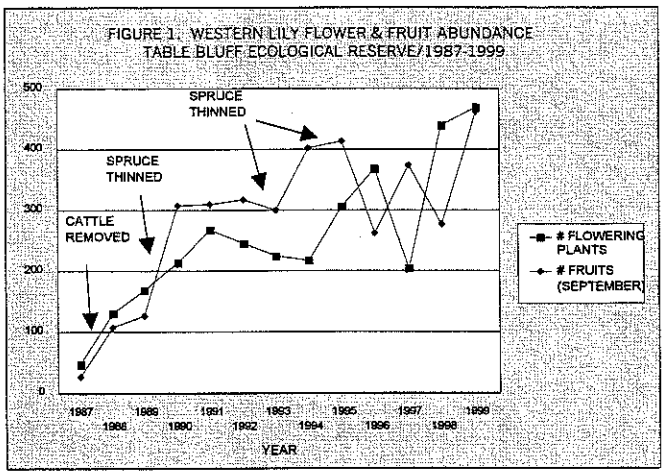
The limited available data indicate the main CCMWA population is not subject to severe natural browsing pressure; however, the critical importance of this population to this species (50% or more of all known flowering plants) warrants a greater understanding of natural browsing impacts, as well as the general life history of this population.

The principal objectives of the investigation at CCMWA are to 1) characterize the current state of the western lily population and its habitat, 2) monitor the rate of vegetation encroachment and its impact on the lily, 3) determine the efficacy of manual vegetation for maintaining the habitat in a suitable condition for the lily, 4) assess the historical impact of cattle grazing in western lily habitat on the reserve, and 5) determine the relative impacts of natural browsing and the effect of deer and small mammal fencing in reducing natural browsing. A secondary objective is to increase our knowledge of the life history of the largest known population of western lily, and develop a quantitative estimate of current recruitment.

3.0 TABLE BLUFF ECOLOGICAL RESERVE

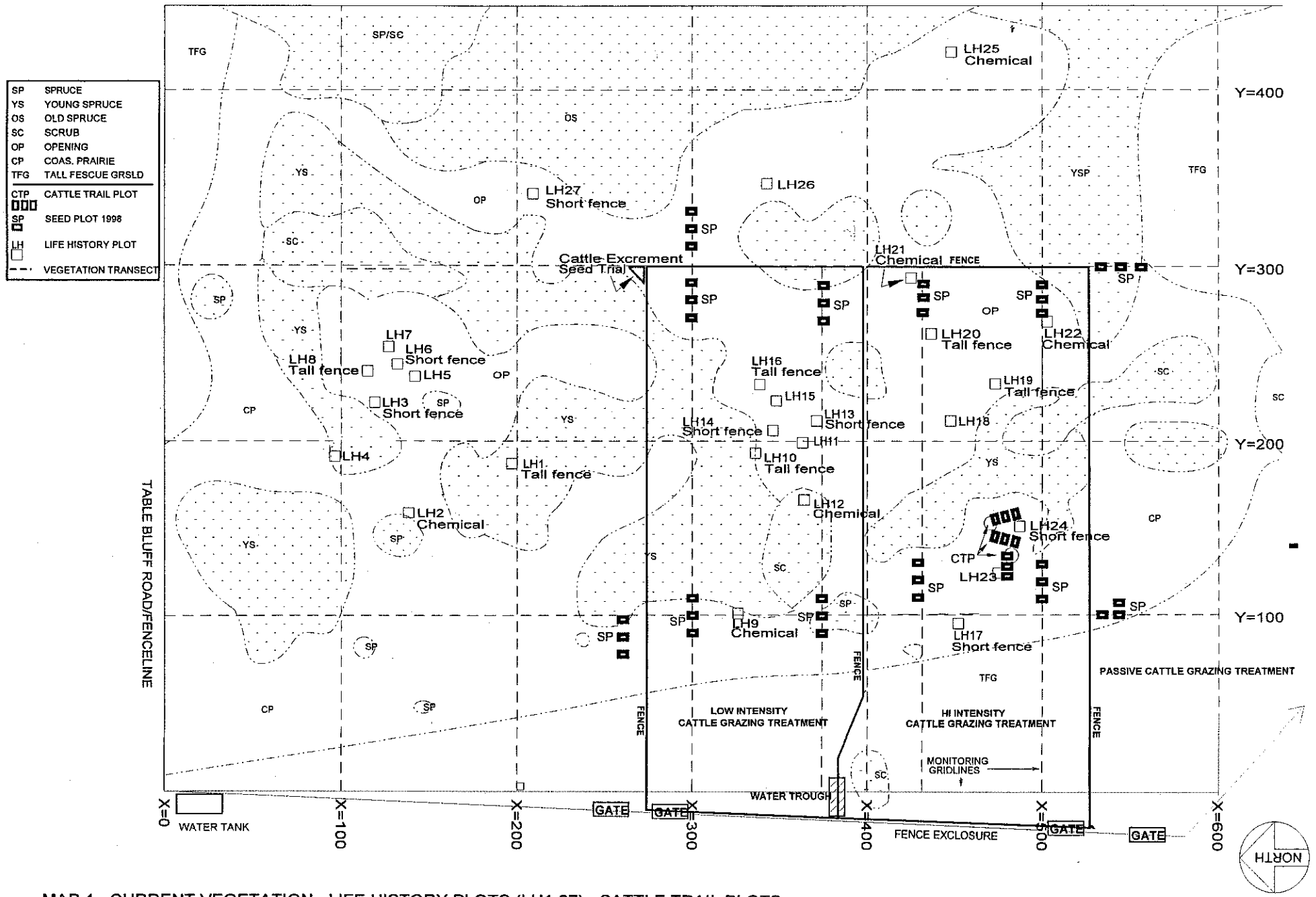
3.1 Western Lily Population Status

A census of the population was conducted at the TBER between 1987 and 1992, after which the annual census has generally been limited to flowering plants (Imper and Sawyer, 1999). The number of flowering plants at the reserve has increased from about 50 in 1987 to 470 in 1999 (Figure 1). The principal factors responsible are removal of cattle during the growing season, and removal of approximately 50% of the spruce stand, which had shaded much of the population. While the total population has not been censused recently, nearly 1,000 plants were mapped and recorded in this study occupying only 970 square feet (sf) of the 5 acres of habitat. Although the sample plots were subjectively located in high density areas for the plant, we can assume the total population easily exceeds 5,000. However, nearly half of the plants recorded in the sample plots were single leaf seedlings, which evidence to date indicates suffer high mortality. At least 160 additional plants have been established at 4 colonies located elsewhere on the reserve, using bulbs propagated in the greenhouse (Imper and Sawyer, 1999).



3.2 Experimental Restrictions on Natural Browsing and Seasonal Cattle Grazing

Fencing and Browsing Inhibitor Treatments: In June, 1998, twenty seven 6ft^2 plots, referred to as "Life History (LH) Plots", were permanently marked, allocated equally among the 3 seasonal cattle grazing treatment areas described below (Table 1, Map 1). The southwest and northeast corner of each plot was staked with rebar; plot identification, grazing treatment and grid coordinates of the southwest corner are indicated in Table 1. In order to coincide with the overall grid coordinate system for the reserve, the X/Y coordinates recorded on the data sheets for each plot (Attachment 1) utilized the northwest corner as the origin. Within each grazing treatment, the plots were located so as to maximize the number of mature (i.e., multi-leaved) lilies and seedlings (single leaf), and still provide representation throughout the treatment areas. In March 1999, prior to emergence of the lily, the 27 plots were treated as follows:



MAP 1. CURRENT VEGETATION, LIFE HISTORY PLOTS (LH1-27), CATTLE TRAIL PLOTS, SEED PLOTS, SEASONAL GRAZING TREATMENTS, LH PLOT TREATMENTS, AND VEGETATION TRANSECTS, TBER 1999.

SCALE: 1" = 80'

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TABLE 1. LOCATIONAL COORDINATES OF LIFE HISTORY PLOTS (LH), CATTLE TRAIL PLOTS, SEED PLOTS AND VEGETATION TRANSECT (MAP 1) AND PHOTOPOINTS, TBER.

Location	Plot ID	Cattle grazing treatment	LH Plot treatment	X/Y Coordinates		
Life	1	passive	Tall fence	200/184		
History	2	passive	Chemical	141/156		
Plots	3	passive	Short fence	122/219		
(SW corner)	4	passive	Tall fence	99/188		
	5	passive		145/234		
	6	passive	Short fence	135/241		
	7	passive		130/251		
	8	passive	Tall fence	118/237		
	9	no. enclosure	Chemical	329/98		
	10	no. enclosure	Tall fence	339/190		
	11	no. enclosure		366/196		
	12	no. enclosure	Chemical	367/163.5		
	13	no. enclosure	Short fence	374/208.5		
	14	no. enclosure	Short fence	349/203		
	15	no. enclosure		351/220		
	16	no. enclosure	Tall fence	341.5/229.5		
	17	so. enclosure	Short fence	455/92		
	18	so. enclosure		450.5/208.5		
	19	so. enclosure	Tall fence	476/230		
	20	so. enclosure	Tall fence	439.5/258.5		
	21	so. enclosure	Chemical	428/290		
	22	so. enclosure	Chemical	505.5/265.5		
	23	so. enclosure		477.5/121		
	24	so. enclosure	Short fence	490/148		
	25	passive	Chemical	451/418.5		
	26	passive		345.5/344		
	27	passive	Short fence	212/338		
Location	**Plot ID**	**Cattle Grazing Treatment**		**X/Y Coordinates**		
Seed Plots						
(NW corner)		so. enclosure		430/110	430/120	430/130
		so. enclosure		430/280	430/285	430/290
		so. enclosure		500/110	500/120	500/130
		so. enclosure		500/274	500/280	500/288
		no. enclosure		300/90	300/100	300/110
		no. enclosure		300/270	300/279	300/290
		no. enclosure		375/90	375/100	375/110
		no. enclosure		375/270	375/282	375/290
		passive		260/80	260/90	260/100
		passive		300/310	300/320	300/330
		passive		535/300	540/300	550/300
		passive		535/100	540/100	540/105
Cattle Trail	#1	so. enclosure		479/130		
Plots	#2	so. enclosure		477/142		
(SW corner)	#3	so. enclosure		478/155		

Notes: Coordinates fo Life History Plots = SW corner (rebar @ diag. corners); for Cattle Trail Plots = SW corner (rebar @ diag. corners) of center 3' x 3' plot; lateral 3' x 3' plots are oriented relative to center plot as follows:#1-90d;#2-20d;#3-356d.

Coordinates for Seed Plots = NW corner (rebar stake) of 12" x 12" plot, 50 seed planted ea. plot 10/6/98.

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TABLE 1. CONTINUED

Vegetation Transects	Cattle Grazing Treatment		X/Y Coordinates
(General habitat	passive		Y=100; X=0-270, 530-600
and grazing trtmt	passive		Y=200; X=0-270, 530-600
characterization)	passive		Y=300; X=0-270, 530-600
	passive		Y=400; X=0-600
	passive		X=100; Y=0-450
	passive		X=200; Y=0-450
	passive		X=300; Y=300-450
	passive		X=400; Y=300-450
	passive		X=500; Y=300-450
	no. enclosure		Y=100; X=270-400
	no. enclosure		Y=200; X=270-400
	no. enclosure		X=300; Y=0-300
	no. enclosure		X=375; Y=0-300
	so. enclosure		Y=100; X=400-530
	so. enclosure		Y=200; X=400-530
	so. enclosure		X=400; Y=0-300
	so. enclosure		X=430; Y=0-300

Photopoints	Cattle Grazing Treatment	Orientation	X/Y Coordinates	
General habitat		S	00/00	
(historical photopts)		S	00/50	
		E,S	200/100	
		S,W	400/100	
		E,N	470/100	
		E	125/200	(north glade)
		E,S,N	200/200	
		E,S	200/300	
		S,W	400/200	
		S,W	400/300	
		S,W	200/400	
		S,W,N	400/400	
		E,W	350/200	(south glade)
		E	170/35	994 mow trtmt)
		E	235/30	994 grzg trtmt)
		E	305/40	burn trtmt-unburned)
Grazing treatments	no. enclosure	S	270/100	
(added 10/8/98)	no. enclosure	S	270/200	
	no. enclosure	W	300/300	
	no. enclosure	W	360/300	
	no./so. enclos.	N,S	400/200	
	no./so. enclos.	N,S	400/100	
	no. enclosure	E	330/0	
	so. enclosure	E	460/0	
	so. enclosure	N	530/100	
	so. enclosure	N	530/200	
	so. enclosure	W	470/300	

#Plots	Name	Treatment
7	Deer exclosure	60 inch chickenwire, corner staked
7	Small mammal exclosure	18 inch x 0.5 inch mesh fence, corner staked
6	Deer chemical inhibitor	Coyote urine vial placed at one corner, recharged 30 day intervals
7	Control	No treatment

The fencing and chemical vials were removed in September, 1999, and will continue to be installed in March, and removed each fall to avoid interfering with the cattle grazing treatments.

The LH plots were initially monitored in June, 1998, and were monitored on 4 dates between March 2 and June 16, 1999. All mature lilies were inventoried and mapped. For single-leaf seedlings, subunits of each plot were successively inventoried until not less than 20 single-leaf were recorded; for the purpose of seedling inventories, the sample plot is considered to be the portion of the original $6ft^2$ plot sampled to achieve 20 or more seedlings (or the total present in the 6 foot square plot, whichever is less), as indicated in the population maps for each plot (Appendix B). All mature lilies were characterized as to height, extent of browsing or disease, and flowering status. Cover and height of all associated species were also described.

Seasonal Cattle Grazing Applications: All the occupied western lily habitat (~5 acres) at the reserve was opened to passive winter grazing by cattle in 1997. Cattle were able to freely enter the ~35 acre rare plant exclosure generally between November and early March. Actual grazing impact, however, has been minimal due to the intermittent, or limited periods during which cattle have been available on the reserve for introduction into the rare plant exclosure.

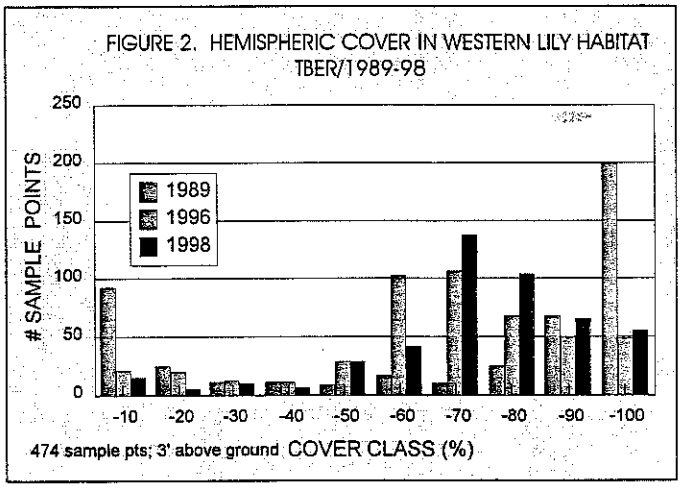
As part of this study, 2 active grazing treatments were implemented in winter 1998-99. In coordination with California Department of Fish and Game (CDFG) personnel, and based on advice from the Humboldt County Agricultural Extension Office, a tentative experimental grazing program was developed. The 2 cattle enclosures were constructed (referred to as the northern, or "low intensity-long duration" treatment cell, and southern, or "high intensity-low duration" treatment cell), each measuring 130 feet by 300 feet (~1 acre), in the west portion of the habitat (Map 1). A 1,000 gallon water tank, and a float-controlled water trough serving the 2 enclosures were installed by CDFG personnel in November 1998. Based on a facilities and habitat monitoring schedule developed by CDFG, the enclosures, water supply, and habitat are to be inspected on a 2-3 day basis throughout the period in which cattle are enclosed. The grazing periods to date have been flexible, and based on the following subjective measures: maximum reduction of shrub cover and establishment of cattle trails within shrub canopies; reduction of the majority of *Calamagrostis nutkaensis* culms to between 6 and 12 inches height; minimal disruption of soil more than one inch deep, particularly in areas known to support the lily.

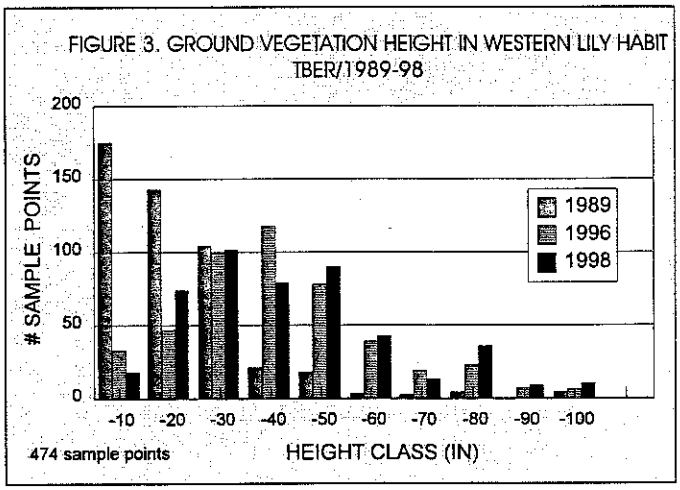
1998: Although opened to cattle on December 1, the passive-grazed habitat was only utilized by cattle between about January 21 and March 7, 1999 due to scheduling problems with the former grazing lessee. Overall, the intensity of use was less than desired, but was substantial in some areas, particularly along the fences where the cattle created mud trails. Two cows were confined in the north enclosure for 20 days, beginning January 4, and 11 cows were confined in the south enclosure for 5 days, beginning January 21, 1999. Additional grazing would have been beneficial, but the cattle were removed at the request of the lessee.

1999: This winter, the new grazing lessee (Clint Victorine) confined his entire herd of 68 cows within the passive-treated habitat for 3 days, beginning on February 12, 2000. The herd was then allowed to enter the habitat passively. The gates are scheduled to be closed on about March 1. Two cows were enclosed in the low intensity treatment cell for 28 days (total 56 animal days), and 12 adults and 13 calves were held in the high intensity treatment area for 6 days (total 72 adult days; 78 calf days), both treatments beginning January 18, 2000.

3.3 Vegetation Characterization and Results of Seasonal Grazing

Overall Habitat: General habitat monitoring was conducted across the entire monitoring grid (4650' transect) in October, 1998, following the standard protocol (Imper *et al.*, 1987), in order to compare pre-experimental grazing conditions with data collected in 1989, 1993 and 1996. The average cover values for dominant vegetation types, species or groups of species (based on transect intervals), and comparisons among the sampled years are included in Table 2A (1998 field data sheets submitted with 1998 status report; Imper and Sawyer, 1998). Cover by typical *Coastal prairie* increased significantly after removal of cattle in 1987, but has since stabilized. The *Sweet vernal grassland*, dominated by *Holcus lanatus* and various other "pasture" species decreased soon after removal of grazing (i.e., converted to *Coastal prairie* or blackberry) but increased since 1993 in response to thinning of the spruce stand. The *Young spruce forest* (i.e., the dense spruce vegetation type, as opposed to individual trees) declined from 32% cover to 7% in 1998 as a result of thinning (largely converted to *Sweet vernal grassland*).





In some cases, changes in individual species cover (i.e., transect intercepts) have been dramatic. Combined cover of *Rubus ursinus* and *R. spectabilis* increased from 13% to 31% by 1998, one of the principal reasons for implementing this study. *Calamagrostis nutkaensis* cover rose from 4% to 18%, while *Erechtites minima* cover peaked at 11% in 1996 and within 2 years fell to 2%. The amount of barren forest floor declined from 26% to 4% by 1998. All of these changes resulted from cattle removal in 1988, and repeated thinning of spruce. Average hemispheric cover (estimated at 3 feet above ground, 10 foot intervals along the transects) has remained virtually the same throughout, but the distribution among cover classes has changed dramatically (Figure 2). Canopy cover was initially weighted heavily in the 0-10%, and 90-100% classes, due to the contrasting habitats - open grazed pasture versus dense spruce. By 1998, the frequency distribution formed an approximate bell shape centered at 60-80% cover.

TABLE 2A. SUMMARY STATISTICS FOR GENERAL HABITAT MONITORING
TABLE BLUFF ECOLOGICAL RESERVE
SAMPLED BY DAVID IMPER, JOHN MCRAE, OCT 89, AUG 93, AUG 96, OCT 98

	1989	1993	1996	1998
% OF GRID WITH SPRUCE DIRECTLY OVERHEAD				
(Based on 4650 ft line intercept data;veg types)	63	51	52	50
% HEMISPHERIC COVER AT 3 ft A.G. (474 pts; 10 ft intervals):	65	69	64	70
Standard deviation	37	25	22	20
GROUND VEGETATION HEIGHT:				
Avg. wtd. hght. [in] (per/ft basis; 4650 ft transect)	16	37	43	37
Standard deviation		19	17	21
GENERAL HABITAT TYPE (% sample grid based on 4650 ft line transect)				
Tall fescue grassland	7	8	8	8
Coastal prairie	0	26	27	27
Sweet vernal grassland	33	24	37	36
Willow scrub	8	9	8	8
Spruce/maianthemum forest				
Young spruce	32	19	7	7
Old spruce	16	12	11	11
Spruce/salmonberry woodland	1	2	2	2
DETAILED VEGETATION COVER (% sample grid based on 4650 ft line transect):				
Tall fescue grassland (typical)	6.4	5.5	3.2	4.3
Sweet vernal grassland (typical)	31.0	29.2	19.3	16.5
Coastal prairie (typical)	0.0	8.0	6.7	7.3
Willow scrub (typical)	7.0	2.6	1.3	2.6
Rubus ursinus	13.0	15.0	21.9	17.3
Rubus spectabilis	0.0	0.0	1.9	13.9
Rubus discolor (himalaya)	0.2	0.1	0.6	0.2
Gaultheria shallon	0.0	0.3	0.6	0.9
Baccharis pilularis	0.9	2.2	3.6	3.7
Polystichum munitum	1.4	3.4	6.1	4.0
Calamagrostis nutkaensis	4.1	11.5	12.7	18.2
Maianthemum dilatatum (incl. Carex obnupta/Iris Douglasiana)	1.2	4.3	7.3	4.3
Sambucus callicarpa	1.5	3.6	2.9	0.4
Erechtites minima	0.0	5.8	11.2	1.8
Barren understory	25.7	6.1	2	3.9

NOTE: Includes all vegetation transects indicated in Table 1, except X=375 and X=430; overall sample grid not sampled 1999..

TABLE 2B. SUMMARY STATISTICS FOR VEGETATION CHARACTERIZATION OF THE 3 GRAZING TREATMENT AREAS
TABLE BLUFF ECOLOGICAL RESERVE
SAMPLED BY DAVID IMPER, JOHN MCRAE, OCT 98 AND SEP 99

GRAZING TREATMENT:	PASSIVE	NORTH (LO INTENSITY)		SOUTH (HI INTENSITY)	
	1998	1998	1999	1998	1999
% OF GRID WITH SPRUCE DIRECTLY OVERHEAD					
(Based on 3230', 860' and 860' of line intercept respectively)	50	53		37	
% HEMISPHERIC COVER AT 3' above ground:					
(based on 337, 90 and 90 pts, respectively; 10' intervals):	72	64	63	69	62
Standard deviation	18	24	24	28	29
GROUND VEGETATION HEIGHT:					
Avg. wtd. hght. ["] (per/ft basis; 3230', 860' and 860' transect respectively)	34	36	34	46	36
Standard deviation	21	16	18	22	17
GENERAL HABITAT TYPE:					
(% sample grid based on 3230 ft, 860 ft and 860 ft line transect respectively)					
Tall fescue grassland	6	16	15	13	13
Coastal prairie	26	23	25	34	35
Sweet vernal grassland	35	44	45	30	30
Willow scrub	6	10	9	16	15
Spruce/maianthemum forest .	7	6	6	7	8
Young spruce	16	0	0	0	0
Old spruce	3	0	0	0	0
Spruce/salmonberry woodland					
DETAILED VEGETATION COVER:					
(% sample grid based on 3230', 860' and 860' line transect respectively)					
Tall fescue grassland (typical)	3.5	1.9	4.1	5.6	4.7
Sweet vernal grassland (typical)	19.1	13.4	18.7	10.5	13.8
Coastal prairie (typical)	6.7	10.1	8.8	14.3	19.7
Willow scrub (typical)	2.4	3.5	4.0	1.0	1.0
Rubus ursinus	15.9	23.1	31.4	26.6	25.7
Rubus spectabilis	14.2	13.0	4.7	8.3	8.0
Rubus discolor (himalaya)	0.3	1.2	0.6	3.0	2.4
Gaultheria shallon	1.1	0.0	0.0	0.0	0.0
Baccharis pilularis	5.0	0.5	0.9	0.0	0.0
Polystichum munitum	4.9	0.9	2.3	2.8	2.1
Calamagrostis nutkaensis	13.4	27.8	13.3	22.3	9.9
Maianthemum dilatatum (incl. Carex obnupta/Iris Douglasiana)	5.3	2.4	9.8	1.7	3.8
Sambucus callicarpa	0.6	0.0	0.8	0.0	0.0
Erechtites minima	2.5	0.2	0.0	0.0	0.0
Barren understory	4.7	0.6	0.7	3.8	8.5

NOTE: See Table 1 for transect segments included in each grazing treatment characterization.

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Average height of the herbaceous and shrub layers increased from 16 to 43 inches by 1996, and then dropped to 37 inches 2 years later, after grazing was reintroduced (Table 2A). Again the frequency distribution for vegetation height was initially weighted in the lower size classes, but now forms an approximate bell shaped distribution centered at 30-40 inches (Figure 3).

Effects of Seasonal Grazing on Vegetation: Both of the confined grazing treatment areas were well impacted by the cattle. Informal observation over the past 2 years has indicated that impacts produced by a large number of cattle confined for a short period (high intensity-short duration treatment) are more evenly distributed, and result in fewer trails created and less severe soil disruption than in the low intensity area. The two cows in the low intensity treatment have tended to use the same pathways repeatedly, and concentrate grazing impacts in smaller areas, resulting in rather extensive soils disruption within the "south glade" lily habitat in the north enclosure (Map 1). An attempt to quantify the relative intensity-related impacts on soil disturbance was made on February 19, 2000, by estimating the total length of trail segments exhibiting bare soil within the 2 enclosures. Within the low intensity treatment, not less than 420 feet of trail was impacted to the degree that bare soil was exposed, compared to about 170 lineal feet (less than half) in the high intensity treatment. The degree of soil disturbance in the low intensity treatment was much higher, often reaching 3-4 inches in depth or more, compared to only minor surface exposure in a majority of the high intensity area. This rather informal survey suggests that, assuming vegetation objectives are met, the high intensity grazing probably attains the goals for western lily habitat maintenance with less impact on the western lily.

In order to provide better sample coverage of the north and south cattle enclosures, two additional vegetation transects were added to the existing network in October 1998 (i.e., X=375/Y=0-300 - north enclosure; X=430/Y=0-300 - south enclosure), and the resulting data for all transects were segregated according to grazing treatment (transect segments allocated to each treatment indicated in Table 1). These transects were resampled in 1999 (field data - Attachment 2).

The species or species group cover values, and cover and height characteristics for the 3 grazing treatment areas are indicated in Table 2B. The south enclosure has the lowest spruce cover (37% cover compared to 50-53% for the passive and north enclosure), and initially exhibited the tallest average vegetation height (46 inches) and canopy cover (69%). Following the high intensity grazing treatment in 1998, those indicators are now equivalent or lower (36 inches height; 62% cover) than the other treatments, suggesting the more intensive-lower duration grazing, combined with manual removal of salmonberry in winter 1998-99, was effective at restoring a more desirable structure. Notable changes within the 2 active grazing treatments included an increase in *Sweet vernal grassland* and/or typical *Coastal prairie*, which was balanced by a decline in *Calamagrostis* cover. *Rubus spectabilis* declined in the north enclosure, but was offset by an increase in *R. ursinus*. Overall, both the active treatments appeared to stimulate an increase in pasture grasses, commonly associated with reintroduction of cattle. The decline in *Calamagrostis* did not necessarily indicate a reduction in density, but rather reduced crown cover due to the removal of old foliage.

Effects of Seasonal Grazing on Western Lily: The number of seedlings and mature plants increased in all cattle grazing treatments from 1998-99 (Table 3), even subtracting lilies that had been browsed or died back by the time of the 1999 final census. The increase in mature lilies and flowering was greatest in the low intensity grazed plots (~80% increase in mature lilies; 60% increase in flowering). However, mean height of mature lilies declined in 1999, with the

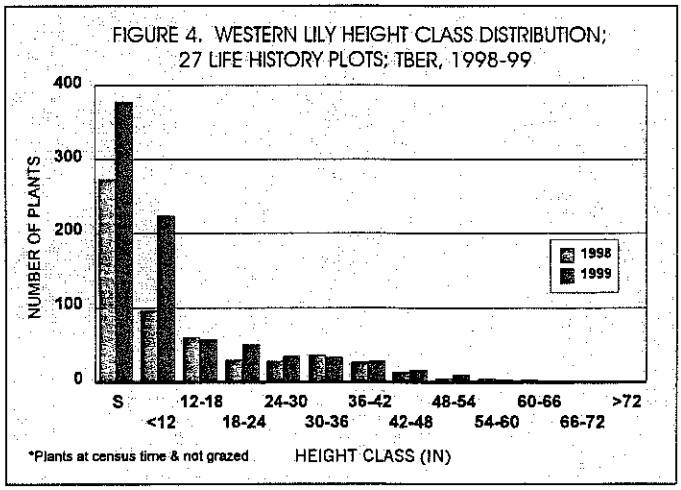
exception of the high intensity grazed plots (16 to 21 inches). However, it is undoubtedly too early to detect meaningful difference in the response of the lily to the grazing intensity treatments.

Photomonitoring: Photomonitoring has been conducted during the annual flowering plant census at 25 permanent photopoints since 1987; an additional 3 photopoints were established in 1994, focused on the 3 vegetation treatment areas included in the Experimental Habitat Restoration Study (one slide set submitted with Imper and Sawyer, 1999). In 1998, 13 additional photopoints were established to monitor the impact of cattle grazing in the north and south cattle enclosures (locational coordinates and declinations indicated in Table 1). Photographs were taken in October, 1998, prior to introduction of cattle, and in July 1999 (Attachment 5). Photodocumentation of the cattle enclosures will continue to be conducted annually, during the annual plant census.

3.4 Western Lily Life History/Browsing Inhibitor Plot Results

Plant density and growth: Various growth characteristics of the sample populations are compared for the 2 years in Table 3; maps of all plants emerging in 1999 are included as Appendix B. The 1999 field data sheets are included as Attachment 1.

Some 274 seedlings and 314 mature lilies were recorded in 1998, compared to 467 seedlings and 496 mature plants, respectively, this year, (58-74% increase). Of those plants, 106 flowered in 1998, and 131 flowered this year. As expected, seedlings comprised the largest size class during both years (Figure 4). There was a significant increase in the abundance of seedlings and plants <12 inches in 1999, in part explained by the multiple sample dates as opposed to the single census made in 1998. However, based on the rate of disappearance of plants in 1999 prior to the final June census (19% seedlings, 2% mature plants), the affects of early season browsing probably did not explain the entire increase in sampled population, indicating a high rate of full-year dormancy in 1998. No incidence of disease was observed.



Emergence: The majority of plants in 1999 emerged between April 2 and May 7, although 24% of the mature plants emerged after May 7 (Table 3, Figure 8). Overall, the seedlings tended to emerge prior to mature plants. Based on monitoring of flowering plant phenology over the past 13 years, 1999 was a late year due to relatively cool spring temperatures. Emergence may have been delayed several weeks behind normal.

Natural Browsing Impacts and Results of LH Plot Treatments: Based on the LH plot data, wildlife grazing impacts in 1999 appeared relatively minor compared to previous years. The large loss in lily seedlings prior to the final June census date reported for the short fence and tall fence treated plots (Table 3) was largely due to 2 plots in which many seedlings were buried

TABLE 3. SUMMARY STATISTICS FOR WESTERN LILY IN 27 LIFE HISTORY PLOTS
TABLE BLUFF ECOLOGICAL RESERVE
SAMPLED BY DAVID IMPER, JOHN MCRAE, JUNE 16-18, 1998, and JUNE 12-15, 1999

OVERALL LIFE HISTORY (LH) PLOTS (27-6' sq.; 972 sf))		1998	1999
Total LIOC seedlings sampled (single leaf)		274	467
#LIOC seedlings sampled per sf*		0.3	0.5
Total non-seedling plants sampled		314	496
Mean ht non-seedling (non-grazed) plants (in)		21	17
% incidence mammal grazing (plts still visible at census)		3	4
% incidence insect/slug grazing (plts still visible at census)		4	0
% incidence disease (plts still visible at census)		0	0
Total %plants missing at census time			11
#Seedlings missing at census			91
%Seedlings missing at census			19
#Mature plants missing at census			12
%Mature plants missing at census			2
1999 Emergence	%Seedlings emerge 3/20-4/2		0
	%Seedlings emerge 4/2-4/16		52
	%Seedlings emerge 4/16-5/7		39
	%Seedlings emerge 5/7-6/18		9
	%mature plts emerge 3/20-4/2		1
	%mature plts emerge 4/2-4/16		35
	%mature plts emerge 4/16-5/7		41
	%mature plts emerge 5/7-6/18		24

FLOWERING PLANTS ALL LH PLOTS			
Total LIOC flowering		106	131
Mean #flowers		2.3	4.0
Maximum #flwrs		13	12
Maximum ht (in)		66	61
	DATE	6/18/98	7/8/99
Phenology	Bud	93	53
(from complete population census data)	Flower	6	41
#plants	Fruit	0	6

COMPARISON AMONG FENCING/INHIBITOR TREATMENTS (LH PLOTS)

Treatment	*Tall fence*	*Short fence*	*Chemical*	*Control*
1998 (pre-treatment)				
#seedling (present at census)	65	71	64	67
#mature plants (present at census)	77	102	42	91
#mature plants mammal grazed	1	10	4	3
1999				
#seedling (present at census)	57	87	87	145
#seedling (total emerging)	105	127	90	145
#mature plants (present at census)	110	149	48	177
#mature plants (total emerging)	113	150	50	183
#mature plants mammal grazed	3	16	8	18
#mature plants missing at census time or grazed	6	17	10	24

COMPARISON AMONG GRAZING TREATMENTS (~1 acre cells)

Treatment	*Passive grazing*	*Lo Intensity*	*Hi Intensity*
1998 (treatments not yet implemented)			
#seedling (present at census)	100	65	109
#mature plants (present at census)	116	122	89
#flowering plants	41	25	40
Mean ht mature plants (not grazed)	22.8	17.5	16.2
1999			
#seedling (present at census)	162	88	126
#seedling (total emerging)	167	89	211
#mature plants (present at census)	160	207	117
#mature plants (total emerging)	163	212	121
#flowering plants	47	40	44
Mean ht mature plants (not grazed)	20.1	14.6	21.3

under a gopher mound, or otherwise eliminated. Only 12 mature plants out of 496 were missing by the final June census, with half of those missing from the control plots. The best indication of the relative protection afforded by the treatments (perhaps indicating the browsing agent) was comparison of the total missing, and total visibly browsed (but still visible in June). Based on that measure, 24 plants were impacted in the control plots, followed by 17 in the short fence, 10 in the chemically treated (coyote urine), and 6 in the tall fence plots. Based on these rather inconclusive results, the principal browsing agent in 1999 appears to have been deer, and the tall fence, followed by chemical treatment were most effective at discouraging browsing. Based on the small number of plants browsed, statistical comparisons among treatments did not appear warranted.

3.5 Western Lily Recruitment Studies

3.51 Western Lily 1993 Seed Plots

One hundred western lily seed were planted in each of 48 - 3ft^2 plots split between the *Spruce forest* and *Coastal prairie* on the reserve in fall 1993, as part of the Experimental Habitat Manipulation Project implemented that year (Imper and Sawyer, 1994a). Vegetation cover, and survival and growth of the resulting lilies were monitored in 1993, 1996, and on June 12, 1999 (data summary - Table 4; field data - Appendix A). The results indicate substantially greater survival rates in the *Spruce forest* after 6 growing seasons (overall 92 seedlings and 109 mature plants this year, of which 13 flowered), compared to the *Coastal prairie* (27 seedlings, 3 mature plants). The resulting recruitment rate after 6 years was 8.4% for the *Spruce forest*, and 1.2% for the *Coastal prairie*. Average and maximum height of the *Spruce forest* plants were 7 and 44 inches, respectively, while the tallest new lily in the *Coastal prairie* was 8 inches. Available moisture and pH were measured in the upper 6 inches of soil at several *Spruce forest* seed plots in June 1999, with a hand-held meter (Appendix A). Available moisture ranged 40-100%, and pH ranged from 5.7-6.8. There was no obvious relationship between soil moisture, or pH and recruitment. Among the variables sampled (species cover, ground cover, spruce cover, etc.), the total number of lily plants present in the plots was best correlated with *Rubus spectabilis* cover (correlation coefficient $r = 0.6$). The linear regression equation predicting number of lilies based on *Rubus spectabilis* cover was statistically significant ($R^2 = 0.36$; $F = 11.9$; $P = 0.002$). The explanation for that correlation is not clear, but there may be a co-preference for some aspect of the habitat, such as abundant fog drip.

Over the 6 year period, average hemispheric canopy cover increased from 27 to 49% in the *Coastal prairie* plots, due to increasing height and density of vegetation (Table 2A). The changes in species abundance in this habitat reflects primarily the impact of cattle exclusion between 1988 and 1997, although cattle were reintroduced back into the "grazing" treatment cell (1/4th of the seed plots) in fall 1993. *Baccharis pilularis, Heracleum lanatum, Maianthemum dilatatum, Pteridium aquilinum*, and *Rubus spectabilis* showed the greatest increase over the 6 years, while *Carex obnupta, Rubus ursinus*, and *Holcus lanatus* declined in cover and frequency. The sum of the individual cover values for exotic species peaked in 1996 compared to 1993 and 1999, but overall never constituted more than 10% of the summed cover values for both exotic and native species (Table 2).

In the *Spruce forest*, average hemispheric cover declined from 82 to 62%, while average ground cover increased from 47 to 94%; both changes were the result of spruce thinning in

1989, 1992 and 1994. Species that increased in abundance over the 6 years included *Juncus* spp., *Heracleum lanatum, Rubus discolor*, and especially *Rubus spectabilis, Rubus ursinus, Maianthemum dilatatum*, and *Anthoxanthum dilatatum*. Species that declined included *Carex obnupta, Cirsium* spp., and particularly *Erectites minima*. The summed cover values for exotic species in this habitat also peaked in 1996, rising from 68 to 85% of the summed cover values for all species, but then dropped to 58% of the total by 1999.

3.52 Western Lily 1998 Seed Plots

As part of the current study, 12 - 1ft^2 seed plots were established in each of the 3 grazing treatment areas (Map 1). A short rebar stake was placed at the northwest corner of each plot. Locational coordinates and grazing treatment for each seed plot are indicated in Table 1. On October 6, 1998, 50 visibly healthy lily seed were planted in each test plot prior to introduction of cattle.

Numerous seedlings were observed growing in several of the plots in July, 1999. No attempt was made to count the very small seedlings this year. The seed plots will be monitored annually hereafter for number and growth of seedlings.

3.53 Western Lily Seed (Cow) Ingestion Study

On January 18, 1999, 500 healthy western lily seed were fed to a cow (Holstein-Guernsey cross) provided by Fred Fearrian (grazing lessee), confined in a pen at his ranch near Loleta. The cow was initially deprived of food for 24 hours in order to encourage consumption of the grain. The seed was then added to several pounds of grain, and fed to the cow (confined by a stanchion). The excrement was collected every 12 hours thereafter for 36 hours, and transported to TBER, where it was placed in a fenced area near grid coordinates 270/300 (Map 1).

Approximately a third of the excrement was disturbed by deer (through the surrounding barbed wire), which may compromise the results. No seedlings emerged in 1999. The lack of germination in seed planted in January or later is not surprising. Of 1,000 seed planted at Freshwater Farms nursery on February 22, 1999, only 7 seedlings emerged this year. In addition, results for western lily seed planted in the greenhouse on January 18 and January 27, 1993 showed as high as 42% 1st-year germination during the first year for the seed planted on January 18, but <1% germination for seed planted only 9 days later (Imper, 1999).

The excrement will be monitored annually hereafter for seedling germination, growth and survival.

3.54 Western Lily Recruitment in Cattle Trails

Three 3ft^2 plots (CTP #1-3; Map 1) were permanently marked in existing cattle trails located in the south enclosure in June 1998, in order to monitor lily seedling density and fate, and soil compaction in trails created during the past 2 years of passive winter cattle grazing (and likely impacted by human traffic). Location coordinates are indicated in Table 1. For each plot, a rebar stake was placed at the southwest and northwest corners. In June 1998, and July 1999, all western lilies were recorded and mapped within the plot (centered on the cattle

TABLE 4. SUMMARY OF VEGETATION AND WESTERN LILY SURVIVAL AND GROWTH IN 48 SEED PLOTS PLANTED IN FALL 1993, TBER (SEE APPENDIX A).

COASTAL PRAIRIE PLOTS

WESTERN LILY ESTABLISHMENT	1996 OVERALL avg#	1996 OVERALL tot#	1996 MOW avg#	1996 MOW tot#	1996 GRAZE avg#	1996 GRAZE tot#	1996 BURN	1996 CONTROL avg#	1996 CONTROL tot#	1999 OVERALL avg#	1999 OVERALL tot#	1999 MOW avg#	1999 MOW tot#	1999 GRAZE avg#	1999 GRAZE tot#	1999 BURN avg#	1999 BURN tot#	1999 CONTROL avg#	1999 CONTROL tot#
BULB REMAIN (NW/4)**		1	0	0	0	0		0	1	0	0	0	0	0	0	0	0	0	0
#LIOC SDLING (FROM SEED)	0	4	0	0	0	0		1	4	1	27	2	11	1	6	1	4	1	6
#LIOC PLTS MULT. LVES		0		0		0			0		3		3		0		0		0
LIOC MAX HT	0		0		0			1			8		8		2		2		2
LIOC MEAN HT	0		0		0			1		3		4		2		2		2	

TREATMENT	1993 OVERALL AC*	1993 OVERALL FR*	1993 MOW AC	1993 MOW FR	1993 GRAZE AC	1993 GRAZE FR	1993 BURN AC	1993 BURN FR	1993 CONTROL AC	1993 CONTROL FR	1996 OVERALL AC*	1996 OVERALL FR*	1996 MOW AC	1996 MOW FR	1996 GRAZE AC	1996 GRAZE FR	1996 BURN AC	1996 BURN FR	1996 CONTRO AC	1996 CONTRO FR	1999 OVERALL AC*	1999 OVERALL FR*	1999 MOW AC	1999 MOW FR	1999 GRAZE AC	1999 GRAZE FR	1999 BURN AC	1999 BURN FR	1999 CONTROL AC	1999 CONTROL FR
Canopy cover (hemispheric)	27		16		31		30		20		24		17		31		NOT		17		49		43		48		53		52	
Spruce cover	13		0		18		22		0		9		0		18		YET		0		10		0		16		22		1	
Total ground cover	100		100		100		100		100		100		100		100		BURNED		100		100		100		100		100		100	
NATIVE SPECIES (%/in)																														
Baccharis pilularis	0	4	0	0	1	17	0	0	0	0	3	17	0	0	6	33			0	17	4	21	0	0	5	33	7	17	3	33
Calamagrostis nutkaensis	17	67	6	50	6	33	29	100	28	83	22	67	8	67	40	83			19	50	15	71	9	67	16	67	18	83	16	67
Carex obnupta	26	96	36	100	44	100	8	83	14	100	15	61	9	50	14	33			21	100	6	79	5	83	8	67	2	67	7	100
Corylus cornuta	3	17	0	0	0	0	8	50	2	17	0	6	0	0	0	0			1	17	2	17	0	0	0	0	5	50	3	17
Gaultheria shallon	0	4	2	17	0	0	0	0	0	0	1	11	3	17	0	0			1	17	0	0	0	0	0	0	0	0	0	0
Heracleum lanatum	0	4	0	0	0	0	0	0	1	17	3	22	3	17	3	17			3	33	4	42	5	50	1	33	6	33	4	50
Iris douglasiana	10	71	13	83	2	33	5	67	20	100	22	100	32	100	16	100			19	100	9	88	20	100	6	67	4	67	6	100
Maianthemum dilatatum	1	21	0	0	3	17	2	67	0	0	10	44	0	0	12	67			18	67	10	54	0	0	13	83	15	67	12	67
Polystichum munitum	7	25	4	17	3	17	20	67	0	0	1	11	3	17	2	17			0	0	4	21	1	17	0	0	16	67	0	0
Pteridium aquilinum	10	83	8	83	15	100	4	67	12	83	33	94	30	100	34	83			36	100	16	92	25	100	14	67	8	100	18	100
Rosa nutkana	0	8	0	0	0	0	0	33	0	0	0	11	0	0	0	0			1	33	0	4	0	0	1	17	0	0	0	0
Rubus parviflorus	4	25	0	0	12	50	3	33	1	17	6	28	0	0	13	50			5	33	6	33	0	0	6	50	14	50	3	33
Rubus spectabilus	1	4	5	17	0	0	0	0	0	0	3	6	10	17	0	0			0	0	3	13	11	17	1	17	0	17	0	0
Rubus ursinus	56	96	68	100	52	83	31	100	72	100	69	94	79	100	48	83			80	100	35	92	56	100	22	83	16	83	47	100
Solidago spathulata	0	17	0	0	0	17	1	50	0	0	0	6	0	0	1	17			0	0	0	0	0	0	0	0	0	0	0	0
Spiraea douglasii	1	4	0	0	0	0	0	0	3	17	2	6	0	0	0	0			7	17	0	0	0	0	0	0	0	0	0	0
Stachys rigida	1	17	0	0	1	17	0	33	1	17	0	6	0	0	1	17			0	0	0	0	0	0	0	0	0	0	0	0
Subtotal - native cover	136		148		139		112		152		193		176		192				210		113		131		91		111		117	
EXOTIC SPECIES																														
Achillea millefolium	1	33	2	50	0	0	3	67	0	17	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0
Anthoxanthum odoratum	0										10	0	13	0	12	0			5	0	3	58	4	50	6	100	2	67	0	17
Aster chilensis	1	25	0	0	0	17	1	17	2	67	1	17	0	0	1	17			2	33	0	17	0	17	0	17	0	0	1	33
Cirsium vulgare + C. arvense	1	13	2	17	0	17	0	17	0	0	0	17	0	0	2	50			0	0	0	13	0	0	0	17	0	17	0	17
Holcus lanatus	11	83	8	100	2	33	26	100	6	100	21	83	29	100	28	100			7	50	7	75	16	100	4	100	2	50	5	50
Subtotal - exotic cover	12		10		2		31		6		21		29		28				7		14		20		11		4		6	
Total sum cover(%)	148		153		140		142		158		214		205		220				217		164		152		102		115		123	
Wtd mean height vegetation(")	37	(H	35		38		37		40		40	(HT)	37		40				44											

SPRUCE FOREST PLOTS

WESTERN LILY ESTABLISHMENT	1996 OVERALL avg#	1996 OVERALL tot#	1996 MOW avg#	1996 MOW tot#	1996 GRAZE avg#	1996 GRAZE tot#	1996 BURN	1996 CONTRO avg#	1996 CONTRO tot#	1999 OVERALL avg#	1999 OVERALL tot#	1999 MOW avg#	1999 MOW tot#	1999 GRAZE avg#	1999 GRAZE tot#	1999 BURN avg#	1999 BURN tot#	1999 CONTROL avg#	1999 CONTROL tot#
#LIOC SDLING (FROM SEED)	7	119	6	33	4	21		11	65	4	92	3	16	1	8	6	35	6	31
#LIOC PLTS MULT. LVES		6		1		0			5		109		11		21		3		74
#PLTS FLOWERING											13		1		6		0		6
LIOC MEAN HT	3		3		2			4		7		2		8		2		9	
LIOC MAX HT	4		4		2			5			44		20		15		3		44

TREATMENT	1993 OVERALL AC*	1993 OVERALL FR*	1993 MOW AC	1993 MOW FR	1993 GRAZE AC	1993 GRAZE FR	1993 BURN AC	1993 BURN FR	1993 CONTROL AC	1993 CONTROL FR	1996 OVERALL AC*	1996 OVERALL FR*	1996 MOW AC	1996 MOW FR	1996 GRAZE AC	1996 GRAZE FR	1996 BURN AC	1996 BURN FR	1996 CONTROL AC	1996 CONTROL FR	1999 OVERALL AC*	1999 OVERALL FR*	1999 MOW AC	1999 MOW FR	1999 GRAZE AC	1999 GRAZE FR	1999 BURN AC	1999 BURN FR	1999 CONTROL AC	1999 CONTROL FR
Canopy cover (hemispheric)	82		64		87		79		81		58		55		60				57		62		59		59		73		55	
Spruce cover	65		47		75		65		59		37		30		26				44		44		42		47		56		36	
Total ground cover	47		68		15		65		40		84		100		78				90		94		98		98		88		92	
NATIVE SPECIES (%/in)																														
Baccharis pilularis	0	8	1	33	0	0	0	0	0	0	0	22	1	50	0	0			0	17	0	0	0	0	0	0	0	0	0	0
Calamagrostis nutkaensis	1	21	2	33	0	0	2	50	0	0	0	0	0	0	0	0			0	0	1	22	0	0	0	17	5	50	1	20
Carex obnupta	6	31	7	75	14	33	2	17	0	0	1	19	2	42	0	17			0	0	1	35	4	67	1	67	0	0	0	0
Festuca subuliflora	1	13	3	17	0	0	0	0	1	33	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0
Juncus spp.	1	4	3	17	0	0	0	0	0	0	0	4	1	17	0	0			0	0	3	35	3	50	0	0	0	0	0	0
Lonicera involucrata	0										1	0	0	0	1	0			1	0	0	0	0	0	0	0	0	0	0	0
Maianthemum dilatatum	0	13	0	0	0	0	2	50	0	0	1	17	1	33	0	0			0	17	9	43	11	50	1	33	18	50	3	40
Polystichum munitum	2	33	1	33	2	50	7	33	0	17	2	33	3	50	2	33			0	17	4	35	3	33	3	50	8	50	0	0
Pteridium aquilinum	1	13	1	17	0	0	5	33	0	0	0	11	0	17	1	17			0	0	0	0	0	0	0	0	0	0	0	0
Ribes sanguineum	1	50	3	67	0	0	1	50	1	83	2	56	1	50	2	33			3	83	2	30	0	17	6	50	0	17	1	40
Rubus spectabilis	0										1	0	0	0	2	0			1	0	14	67	10	83	15	100	8	67	23	100
Rubus ursinus	1	67	3	100	1	50	1	67	1	50	8	100	7	100	5	100			12	100	17	91	11	100	22	83	15	83	18	100
Salix spp.	0	13	1	50	0	0	0	0	0	0	0	0	0	0	0	0			0	0										
Heracleum lanatum																					3	39	1	33	5	67	7	50	0	0
Sambucus racemosa	6	63	3	83	10	100	10	50	2	100	3	33	0	0	8	67			1	33	0	4	0	0	0	0	0	0	0	20
Subtotal - native cover	21		26		26		30		4		18		17		20				18		55		42		52		68		48	
EXOTIC SPECIES																														
Achillea millefolium	0	8	0	17	0	0	1	17	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0
Anthoxanthum odoratum	0										5	0	3	0	1	0			12	0	25	87	26	100	21	83	14	67	44	100
Leucanthemum vulgare	1	21	2	50	0	0	1	17	0	17	0	11	0	0	0	0			1	33	0	0	0	0	0	0	0	0	0	0
Cirsium vulgare + C. arvense	2	50	8	100	0	17	0	33	1	50	2	22	5	33	1	17			0	17	0	13	2	50	0	0	0	0	0	0
Dactylus glomerata	0	8	0	0	0	0	1	33	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0
Erechtites minima	7	71	14	100	0	17	9	67	5	100	32	100	26	100	37	100			31	100	1	17	0	0	5	50	0	17	0	0
Festuca arundinacea	0										1	0	3	0	1	0			0	0	0	4	0	0	1	17	0	0	0	0
Holcus lanatus	31	88	28	100	2	50	66	100	30	100	56	94	79	100	39	83			57	100	31	87	45	100	33	100	17	83	27	60
Hypocheris radicata	1	46	1	33	0	33	1	50	1	67	1	11	0	0	0	0			2	33	0	0	0	0	0	0	0	0	0	0
Rubus discolor (himalaya)	0	8	0	17	0	17	0	0	0	0	1	22	3	50	0	17			0	0	2	17	5	33	4	33	0	0	0	0
Rumex acetosella	0	6	0	17	0	0	0	0	0	17	1	22	1	17	3	50			0	0	0	4	0	0	1	17	0	0	0	0
Stachys rigida	0	4	0	0	0	0	0	17	0	0	0	17	1	33	0	0			1	17	0	0	0	0	0	0	0	0	0	0
Cerastium glomeratum	1	8	0	0	0	0	0	0	4	33	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0
Subtotal - exotic cover	44		54		2		79		41		102		122		81				103		61		78		64		31		71	
Total sum cover(%)	65		80		28		109		46		120		140		100				121		115		120		117		99		128	
Wtd mean height vegetation(")	17	(H	20		11		23		13		33	(HT)	37		36				26											

*Plots = 6' X 6', N = 6 ea. treatment and vegetation type (coa. pr./spruce); AC = average cover; %FRE = % frequency within group specified.
**Note: 100 seed planted SE quarter all plots, and 3-12 bulbs planted NW quarter of indicated plots, fall 1993.
***Sampled 10/93, 7/96 and 6/99 (See Appendix A).

trail) and in two 3ft^2 plots adjoining the central plot on both sides of the trail. Soil core samples were collected between 4 and 10 inches below the ground surface from each center plot and one of the adjacent plots. Samples were retrieved by driving a 1.37 inch diameter x 4 inch thinwall brass tubes, sharpened on the leading edge. Each sample was immediately labeled and sealed with duct tape until weighed to the nearest gram. Samples were then extruded and dried to oven dry weight at 105 degrees C., then reweighed to calculate bulk density and % moisture. Number of lily seedlings and mature plants, and bulk density and moisture results for each plot are reported in Table 5.

Soil Compaction: In 1998, average soil bulk density for the 6 samples (3 trail, 3 adjacent) was 58 pounds per cubic foot (pcf), ranging 52-74 pcf in the trail plots, and 49-58 pcf in the adjacent plots (Table 5). In 1999, the overall average was 56 pcf, ranging 50-61 in the trail and 54-59 in the adjacent plots. Although the sample sizes are too small to enable meaningful statistical comparison, it appears there is no significant difference in soil bulk density associated with proximity to the trails, or between years.

Seedling Fate: In 1998, the trail and adjacent habitat sample plots contained 17-49, and 1-13 seedlings, respectively; totals for 1999 were similar; 6-55 seedlings in the trail plots and 1-17 seedlings in the offset plots. Number of seedlings recorded, and the probabilities that each seedling or mature plant either did not emerge, or returned as a seedling or mature plant in 1999 are shown in Table 5. Overall an estimated 45% of the 1998 seedlings did not emerge, 3% progressed to a mature stage, and the remainder returned as seedlings again in 1999. These data are subject to error due to the difficulty in determining the unique identity of seedlings from year to year (since height often does not change).

Since the cattle have continued to use the sampled trail segments, young lily bulbs located near the surface and undoubtedly some mature plants are eliminated or are setback due to physical disruption. The preponderance of germination within the trails, in contrast to the threat of elimination or chronic disruption from hoof traffic, suggests the majority of adult plants may have developed in trails receiving only modest use, or which were soon abandoned. As a result, we can assume that lily recruitment should be optimized by introducing cattle on a seasonal basis for the minimum period necessary to maintain surrounding vegetation (e.g., 2-4 years), followed by a rest period during which the lily has sufficient time to develop, and withdraw its bulb to a safe depth out of reach of hoof damage (e.g., 3-5 years).

3.6 Soil Compaction Characterization

In October 1998, and September 1999, between 5 and 7 soil cores were sampled at random locations within each of the 3 grazing treatments, in addition to the cattle trail samples described above. Sample methodology and preparation were described above.

In 1998, dry bulk density ranged from 49 to 74 pcf; mean bulk density for all samples, including the 6 samples collected from the cattle trail plots, was 60 pcf, while moisture content was 36% (a light rainfall had occurred the previous week). These results correlated well with the mean density for samples collected in the *Coastal prairie* in 1992 (59 pcf; n = 4) and 1994 (63 pcf; n = 6). For comparison, the mean bulk density measured in nearby *Tall fescue grassland* soils (unsuitable lily habitat) was 70 pcf (n = 4) in 1992 (Imper and Sawyer, 1994).

TABLE 5. SOIL BULK DENSITY AND MOISTURE RESULTS, SEP 99 AND OCT 98, AND LIOC CENSUS RESULTS IN CATTLE TRAIL PLOTS, TBER, JUN 98 AND JUN 99.

		1998			1999		
	Sample	Moisture	Bulk Dens.	Group B.D.	Moisture	Bulk Dens.	Group B.D.
Location	ID	(%)	(#/cf)	Means	(%)	(#/cf)	Means
So. Grazing	1	35	54		26	64	
Trtmnt	2	45	49		28	61	
Cell	3	37	61		30	69	
	4	36	55		28	61	
	5	34	63	56	28	64	
	23				39	51	
	24				30	64	62
							1998-99 P>0.1
No. Grazing	6	36	65		25	66	
Trtmnt	7	46	63		25	63	
Cell	8	26	64		33	60	
	9	42	67		51	50	
	10	33	58	63	26	52	
	22				54	60	
	27				33	63	59
							1998-99 P>0.1
Passive	11	31	65		36	50	
Grazing	12	30	58		22	64	
Trtmnt	13	25	63		30	69	
	14		64		24	74	
	15	21	74	65	24	63	
	26				27	64	64
							1998-99 P>0.1
Cattle Trail	1ctr	46	60		28	61	
Seed	1east	45	49		32	59	
Plots	1west						
	2ctr	21	74		35	55	
	2north	39	58		29	57	
	2south						
	3ctr	46	52		33	50	
	3north	44	52		30	54	
	3south			58			56
Overall Mean		36	60		31	60	*1998-99 P>0.1*

Notes:

Soil bulk density values are dry weight; samples = 1.37" dia. x 4" brass tubes driven into soil between 4 and 10" below surface, oven-dried @ 105d C. to constant weig

Cattle trail plots = 3' x 3', centered on cattle trails in optimum LIOC habitat.

WESTERN LILY FATE ANALYSIS

	1998		1999		Total number plants						
Cattle Trail	#LIOC	#LIOC	#LIOC	#LIOC	no sdlg	sdlg to	sdlg stay	new sdg	mat not	mat to	new
Plots	sdlings*	mature	sdlings	mature	1999	mat 99	sdlg 99	1999	show 99	mat 99	mat 99
1ctr	18	0	6	5	10	3	5	1	0	0	1
1east	2	3	1	2	1	0	1	0	1	2	1
1west	2	0	3	0	1	0	1	2	0	0	0
2ctr	49	10	55	15	17	0	32	23	3	7	8
2north	10	6	4	8	10	0	0	3	1	5	3
2south	13	10	17	10	5	0	8	14	2	8	1
3ctr	17	3	14	4	5	0	10	3	0	3	1
3north	2	2	4	1	2	0	2	2	0	2	1
3south	1	1	5	3	0	0	1	2	1	0	1
Totals	114	35	109	48	51	3	60	50	8	27	17
					Probabilities:						
1ctr					0.56	0.17	0.28		0.00	0.00	
1east					0.50	0.00	0.50		0.00	0.67	
1west					0.50	0.00	0.50		0.00	0.00	
2ctr					0.35	0.00	0.65		0.30	0.70	
2north					1.00	0.00	0.00		0.17	0.83	
2south					0.38	0.00	0.62		0.10	0.80	
3ctr					0.29	0.00	0.59		0.00	1.00	
3north					1.00	0.00	1.00		0.00	1.00	
3south					0.00	0.00	1.00		0.00	0.00	
Total					0.45	0.03	0.53		0.23	0.77	

* Seedlings = single leaf; mature = multi-leaved.

1999 results were very similar to 1998; bulk densities ranged 50-74 pcf, also with a mean of 60 pcf. Statistical comparison between the overall means, and the group means for each grazing treatment for the 2 years showed no significant difference (t test; unpaired; $P>0.1$).

3.7 Year 2000 Vegetation Strategy Task Schedule

1) In mid-March, 2000 and 2001, the fencing and chemical treatments will be replaced, and in September 2000 and 2001, the fencing and chemical treatments will be removed.

2) The 27 LH plots will be monitored on or about the following dates: March 15, April 1, April 15, and June 15, 2000 and 2001. On each monitoring date, all mature lilies within the entire plot, and all single leaf seedlings within the seedling plots will be mapped and characterized for height, extent of browsing or disease, and flowering condition.

3) The cattle trail plots (lily recruitment and soil compaction) located in the south cattle enclosure will be resampled in June (recruitment) and September (soil compaction), 2000 and 2001.

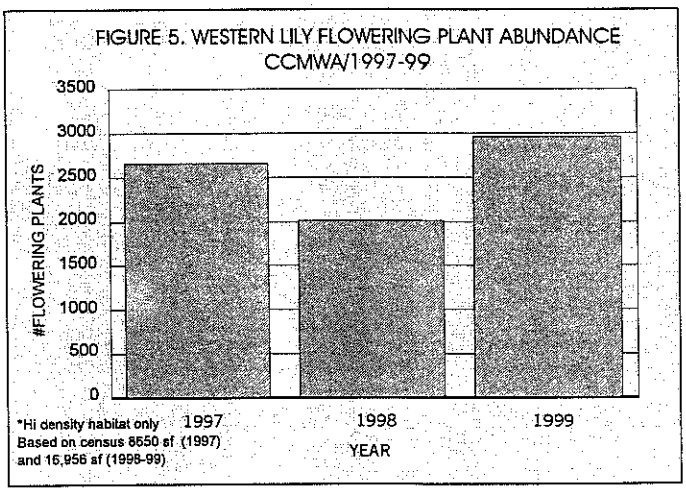
4) The 48 - 3ft^2 seed plots installed in 1994 as part of the Experimental Habitat Manipulation Project (Imper and Sawyer, 1996) will be monitored for lily survival and growth in June 2001.

5) The 3rd year project status report will be submitted by March 31, 2001, summarizing the results of the past 3 years. A comprehensive report will be submitted by March 31, 2002, and include: a) discussion of lily population life history, demographics, phenology, annual dormancy rates, recruitment and seedling fate observed over the 4 years, b) assessment of the positive and negative aspects of cattle grazing in maintaining or expanding the western lily population and its habitat, and c) assessment of the impacts of natural browsing and the efficacy of the various means investigated for its control. Recommendations will be made for further monitoring.

4.0 CRESCENT CITY MARSH WILDLIFE AREA

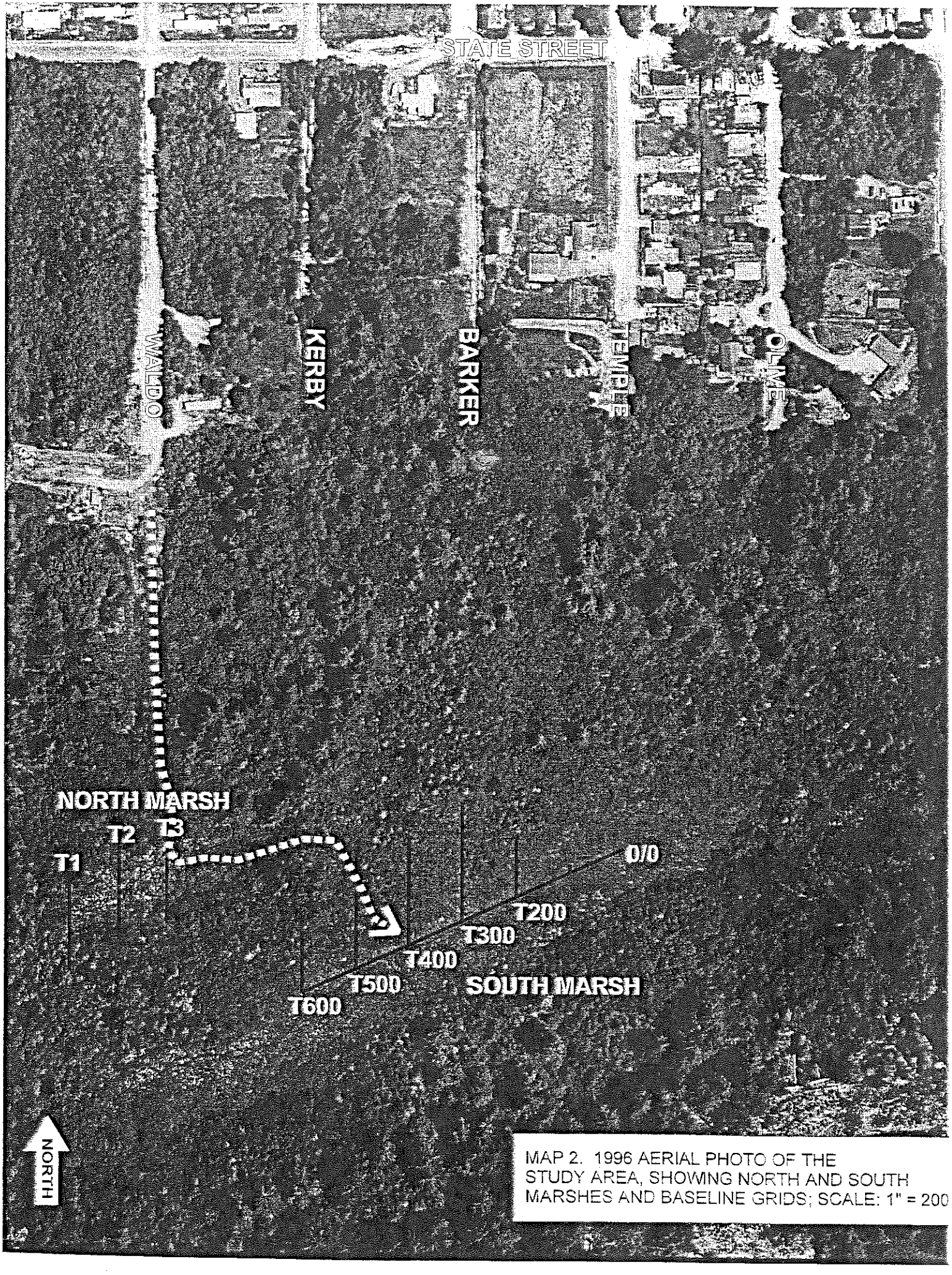
4.1 Western Lily Population Status

Due to the very large and widely distributed western lily population at the CCMWA, no complete census has been conducted to date. The population monitoring protocol implemented in 1997 (Imper and Sawyer, 1997) incorporated a series of 12 foot x 20 foot belt transects in the North Marsh, and 12 foot diameter circular plots in the South Marsh, systematically located and permanently marked for reference each year. All flowering plants and a portion of the vegetative plants were recorded within an area of 8,650 sf. Based on the number of flowering plants counted in the North and South marshes (80 and 130, or 2.2 and 3.0 plants/100 sf, respectively), and the estimated square footage of equivalent high density occupied habitat in each marsh (26,400 and 69,400 sf, respectively), the entire flowering population in 1997 was estimated to be about 2,660 (not counting some 580 flowering and non-flowering plants estimated to occupy "low density" habitat that year).



The revised protocol implemented in 1998 for this study included a flowering census based on 24 - 30 ft diameter circular plots, for a total sample area of 16,956 sf. All flowering lilies within each plot were recorded and mapped in July 1998, and July 1999 (Appendix C). Maps for 1998 were submitted previously (Imper and Sawyer, 1998). Assuming the 8,478 sf sampled in each marsh qualifies as "high density" habitat defined in 1997, the estimated total plants flowering in 1998 and 1999 were 2,016 and 2,996, respectively. This estimate does not include a small number of plants located on private property west of the 2 marshes, and the habitat considered to contain plants at low density. The estimates suggest 1998 was a low year, and 1997 and 1999 were peak years. Alternating peak years, as a result of both non-emergence and browsing during the early part of the season has been shown to occur at 2 sites on Table Bluff (Christensen and Barry sites).

Based on the proportion of flowering plants observed in the LH Plots (88 out of 512 plants), and the total number of plants emerging this year (as opposed to the number observed in July only), the total population probably exceeded the flowering population by a factor of 5-6, resulting in a total estimated 1999 population occupying high density habitat in excess of 17,000.
The western lily in the North Marsh is unevenly distributed, with habitat in the south portion supporting far more plants than the north portion. The difference is exemplified by census counts for vegetation plots #9, 10 and 12, located at the north edge of the marsh (averaged 6 flowering plants in 1999), and plots #1, 3 and 8, located at the south edge of the marsh (averaged 47 flowering plants in 1999). The factors responsible for the uneven distribution are not clear, but may be related to water table depth or degree of exposure.



MAP 2. 1996 AERIAL PHOTO OF THE STUDY AREA, SHOWING NORTH AND SOUTH MARSHES AND BASELINE GRIDS; SCALE: 1" = 200

4.2 Depth to Water Table

Formal monitoring of the water table depth in the North and South marshes was begun in 1997. A portion of the PVC pipe used to mark sample plots that year were modified to serve as informal piezometers, enabling measurement of depth to the water table across the occupied lily habitat. Piezometers were installed at 40 foot intervals along T1 and T3 in the North Marsh, and at 40 foot intervals along transects T200 and T400 in the South Marsh (Maps 3 and 4). The piezometers consisted of 6 foot sections of 3/4 inch PVC pipe, sawcut in the lower half, capped at the bottom, and pushed at least 3 feet into the peat substrate. Measurements made on July 28, 1997 ranged between 9 and 36 inches below the surface in the South Marsh, and from 10 to greater than 35 inches in the North Marsh. The correlation between vegetation type and height, and depth to water was evident in the South Marsh, with an average depth of 12 inches recorded in the *Low Labrador tea marsh* (N = 4), and 29 inches in the *Tall Labrador tea marsh* (N = 4). In particular, measurements in that marsh taken along transect T400 exhibited a sharp drop in water table moving north, corresponding to a sharp increase in height of the *Labrador tea marsh.* Average depth to water is less in both the *Buckbean marsh* and *Carex marsh*, located south of the transect baseline, which often contains standing water. Water table measurements taken in the North Marsh were more varied. Average depth to water measured there in the *Calamagrostis marsh* was 20 inches (N = 5), while the average measurement along the edge or outside of that habitat exceeded 28 inches (N = 3).

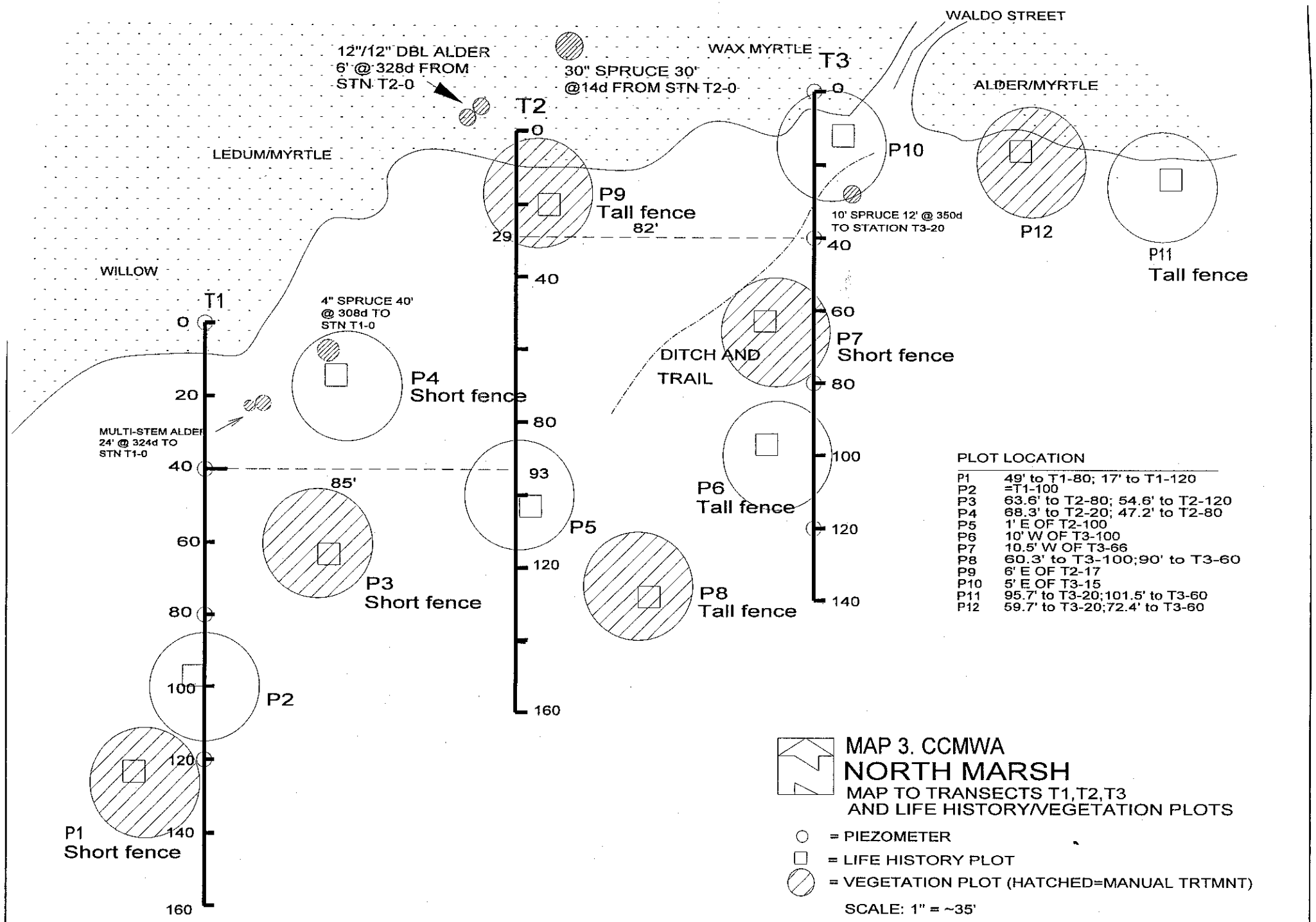
Measurements were made again on July 21, 1999 at the following stations (followed by 1999, then 1997 depth to water): North Marsh: T1-80' (8, 27 inches) and T1-120' (11, 10 inches); South Marsh: T200-40' (6, 9 inches); T400-120' (8, 36 inches); T400-160 (8, 31 inches). The relative measurements indicate on nearly the same date this year, the water table was much higher than in 1997, not surprising given the greater rainfall this past year (City of Eureka rainfall: 12.5 vs. 7.9 inches total from March-June during the respective years).

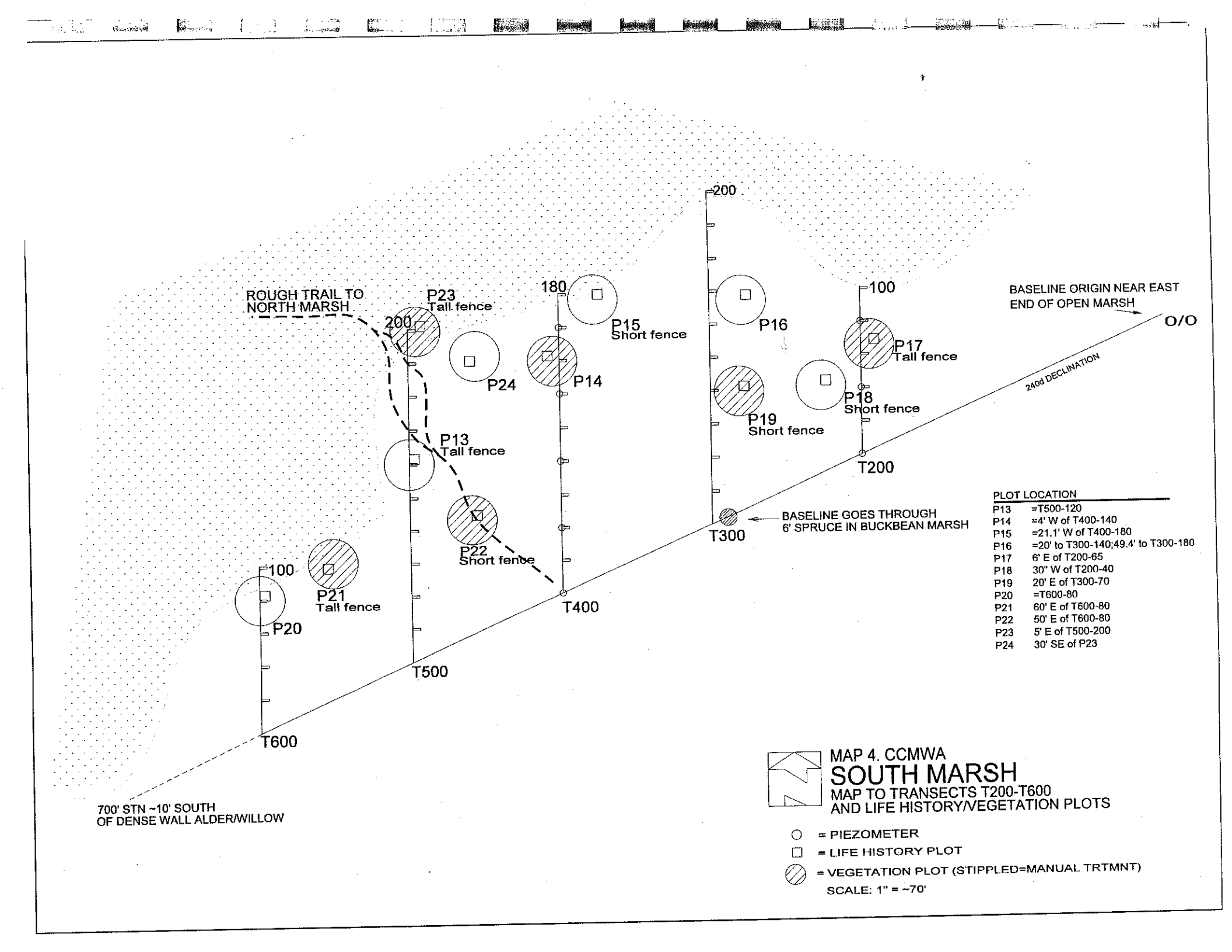
4.3 Manual Vegetation Removal and Fencing Treatments

Twelve 30 foot diameter vegetation plots, each enclosing a $6ft^2$ LH plot, were permanently marked in both the North and South marshes in July 1998 (Maps 2-4). Since a comprehensive grid coordinate system has not been developed for the CCMWA population, the vegetation and LH plots were mapped relative to the existing monitoring framework for the 2 marshes (Maps 3 and 4). The plots were marked as follows: a 4 foot rebar stake was placed at one corner of the square plot, corresponding to the center point for the surrounding 30 ft diameter vegetation plot. A 4 foot PVC pipe marker was placed at the diagonal corner of the LH plot. The plots were subjectively located so as to provide a comparison between manual treatment and no treatment in similar vegetation, as well as contain at least some mature lilies and maximize the number of seedlings in the LH plots, and provide space between adjoining vegetation plots. The manually treated plots are indicated in Maps 3 and 4.

The LH plots were monitored in July 1998, and on 4 dates between March 26 and July, 21, 1999, using the same methodology described above for the LH plots sampled at TBER. Vegetation plots were monitored in July 1998 and 1999.

In both the North and South marshes, one half of the vegetation plots were cleared of all tree cover, and selected shrub cover between October 28 and 30, 1998. Trees and shrubs were removed at the base with pruners or a gas powered brush machine. Target species included


WALDO STREET
12"/12" DBL ALDER
6' @ 328d FROM
STN T2-0
30" SPRUCE 30'
@14d FROM STN T2-0
WAX MYRTLE
T3
0
ALDER/MYRTLE
T2
0
P10
LEDUM/MYRTLE
P9
Tall fence
82'
29
10' SPRUCE 12' @ 350d
TO STATION T3-20
40
P12
P11
Tall fence
WILLOW
40
T1
4" SPRUCE 40'
@ 308d TO
STN T1-0
60
P7
Short fence
0
DITCH AND
TRAIL
P4
Short fence
20
80
MULTI-STEM ALDER
24' @ 324d TO
STN T1-0
40
93
85'
100
P6
Tall fence
P5
60
120
P3
Short fence
P8
Tall fence
80
140
100
P2
120
P1
Short fence
140
160
PLOT LOCATION
P1 49' to T1-80; 17' to T1-120
P2 =T1-100
P3 63.6' to T2-80; 54.6' to T2-120
P4 68.3' to T2-20; 47.2' to T2-80
P5 1' E OF T2-100
P6 10' W OF T3-100
P7 10.5' W OF T3-66
P8 60.3' to T3-100;90' to T3-60
P9 6' E OF T2-17
P10 5' E OF T3-15
P11 95.7' to T3-20;101.5' to T3-60
P12 59.7' to T3-20;72.4' to T3-60
MAP 3. CCMWA
NORTH MARSH
MAP TO TRANSECTS T1,T2,T3
AND LIFE HISTORY/VEGETATION PLOTS
= PIEZOMETER
= LIFE HISTORY PLOT
= VEGETATION PLOT (HATCHED=MANUAL TRTMNT)
SCALE: 1" = ~35'


ROUGH TRAIL TO NORTH MARSH
P23 Tall fence
200
180
P15 Short fence
P24
P14
P13 Tall fence
P22 Short fence
P21 Tall fence
100
P20
T500
T400
T600
700' STN ~10' SOUTH OF DENSE WALL ALDER/WILLOW
200
P16
100
P17 Tall fence
P18 Short fence
P19 Short fence
T200
T300
BASELINE ORIGIN NEAR EAST END OF OPEN MARSH
O/O
240d DECLINATION
BASELINE GOES THROUGH 6' SPRUCE IN BUCKBEAN MARSH
PLOT LOCATION
P13 =T500-120
P14 =4' W of T400-140
P15 =21.1' W of T400-180
P16 =20' to T300-140;49.4' to T300-180
P17 6' E of T200-65
P18 30" W of T200-40
P19 20' E of T300-70
P20 =T600-80
P21 60' E of T600-80
P22 50' E of T600-80
P23 5' E of T500-200
P24 30' SE of P23
MAP 4. CCMWA
SOUTH MARSH
MAP TO TRANSECTS T200-T600
AND LIFE HISTORY/VEGETATION PLOTS
= PIEZOMETER
= LIFE HISTORY PLOT
= VEGETATION PLOT (STIPPLED=MANUAL TRTMNT)
SCALE: 1" = ~70'

Alnus rubra, A. viridus Lonicera involucrata, Myrica californica, Picea sitchensis, Rhamnus purshiana, Salix hookeriana, S. lasiolepis, Spiraea densiflorus, and in some cases, *Ledum glandulosum* and *Rubus ursinus. Ledum glandulosum* and *Rubus ursinus* were only removed from a portion of the plots, indicated on the vegetation plot data sheets. Past observation has indicated in most cases the lily is able to tolerate high cover of these species, while the lily rarely occurs in dense stands of *Spiraea.*

An average of 2 people worked for 2 - 10 hour days to treat the plots, for a total labor expenditure of 40 hours to treat 8,500 sf (~200 sf/hour; 200 hrs/acre). Occupied habitat in the 2 marshes is estimated at 260,000 sf, or ~6 acres, not including surrounding private property (Imper and Sawyer, 1997). Approximately 40% of this area is not currently threatened by shrub encroachment (e.g., *Carex marsh, Buckbean marsh*), leaving an estimated 3.5 acres potentially in need of clearing (not counting private property). At that rate, a crew of 4 may be required for 3-4 weeks to adequately clear the habitat. Of course, the labor required will increase rapidly (exponentially?) as the vegetation grows. At the same time, longevity of the effects of manual treatment are potentially short, certainly less than 20 years based on the current age of the predominate woody vegetation in the marsh (discussed below).

4.4 Vegetation Characterization and Results of Manual Vegetation Removal

All woody shrub and tree crown cover was mapped, and cover and height of all species were recorded in the 24 vegetation plots, in July 1998 (prior to manual treatment of 12 plots - October 1998), and in July 1999 (tabulation of pre- and post-treatment field data - Appendix D; 1999 field data sheets - Attachment 4). Average frequency, cover and height are reported for associated species in Table 6. Slide photographs were taken of each vegetation plot prior to and following manual removal of vegetation in October, 1998, and again (treated plots only) in July 1999 (location and declination of each photopoint indicated in Maps 3 and 4). All photodocumentation conducted in 1998 and 1999 is included as Attachment 6.

The species most negatively impacted by the clearing included *Picea sitchensis* (eliminated in the plots), *Alnus viridus, Malus fusca,* and *Myrica californica* (Table 6). Species that were reduced in height, but otherwise were relatively unaffected, included *Spiraea douglasii, Alnus rubra, Lonicera involucrata.* Several species may have been positively influenced by the removal of woody species (8 months prior), including *Veratrum californicum, Equisetum* spp., and *Blechnum spicant.*

Whether the manual treatment impacted the western lily is not clear. Between 1998 and 1999, the number of flowering plants increased by 56% in the cleared plots (difference between the means statistically significant; t test; $P<0.05$), and 72% in the uncleared plots (statistically significant; $P<0.01$), for an overall increase of 62% (Table 8). The number of seedlings encountered in the LH plots increased in both cleared and uncleared plots, but the difference between the means between the 2 years was statistically significant only for the cleared plots ($P=0.01$). When the number of seedlings actually present at the time of the July census were compared, the difference in means between the 2 years was not significant. The number of mature plants also increased in both cleared and uncleared plots from 1998 to 1999, but the difference in means was not statistically significant either for the total encountered, or the number of plants present during the July census. There also was no indication that the clearing significantly impacted the average height of flowering plants in the vegetation plots. The results overall indicated no obvious impact on the lily from the treatment.

TABLE 6. SUMMARY STATISTICS FOR ASSOCIATED SPECIES IN 24 VEGETATION PLOTS, CCMWA, OCT 98 AND JUL 99.

	ALL PLOTS*						MANUAL TREATED PLOTS (TREATED OCT98)*					
	%FRE**		%COV**		HT (in)**		%FRE**		%COV**		HT (in)**	
ASSOCIATED SPECIES	1998	1999	1998	1999	1998	1999	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
Alnus rubra	17	17	2	2	199	77	25	25	1	0	185	22
Alnus viridis	83	71	19	10	83	67	83	58	10	1	83	43
Angelica genuflexa	92	96	5	5	57	51	92	100	2	2	52	42
Athyrium felix-femina	54	54	3	3	41	43	58	58	2	2	37	41
Blechnum spicant	46	54	4	3	38	40	42	58	1	1	34	37
Calamagrostis nutkaensis	100	100	58	58	43	44	100	100	26	26	41	42
Carex obnupta	88	88	21	20	45	43	83	83	10	9	43	39
Carex spp.	0	0	0	0			0	0	0	0		
Cornus sericea	0	0	0	0			0	0	0	0		
Deschampsia caespitosa	4	4	0	0	48	48	0	0	0	0		
Epipactus gigantea	8	8	0	0	18	18	8	8	0	0	24	24
Equisetum spp.	17	21	1	1	27	31	25	33	1	1	24	30
Galium trifidum	0	4	0	0			0	8	0	0		
Gaultheria shallon	0	0	0	0			0	0	0	0		
Gentiana sceptrum	29	25	1	1	26	23	33	25	0	0	27	22
Holcus lanatus	0	8	0	0			0	17	0	0		
Hypericum formosum	17	21	0	0	21	20	8	17	0	0	24	21
Juncus leseurii	25	29	2	1	50	46	17	25	1	0	48	40
Ledum glandulosum	100	100	68	64	50	42	100	100	32	28	50	34
Lonicera involucrata	67	67	7	5	68	56	58	58	4	2	72	45
Lotus formosissimus	0	0	0	0			0	0	0	0		
Lysichiton americanum	96	96	12	13	35	36	100	100	8	8	28	31
Maianthemum dilatatum	4	8	1	1	48	27	0	8	0	0		6
Malus fusca	13	8	1	1	152	87	17	8	1	0	162	42
Menyanthes trifoliata	54	58	3	5	14	14	42	50	2	3	12	12
Myrica californica	46	33	6	5	97	107	33	8	1	0	90	144
Oenanthe sarmentosa	0	0	0	0			0	0	0	0		
Picea sitchensis	50	25	5	2	134	165	50	0	3	0	104	
Rhamnus purshiana	8	8	0	0	36	36	0	0	0	0		
Potentilla palustris	75	79	14	16	32	31	92	100	11	12	34	33
Pteridium aquilinum	4	4	0	0			0	0	0	0		
Rhododendron occidentalis	50	46	2	2	63	58	67	58	2	1	62	53
Rubus ursinus	58	58	18	14	39	35	58	58	8	4	38	30
Salix spp.	29	29	7	5	98	75	25	25	3	1	112	60
Sanguisorba officinalis	100	100	27	28	32	32	100	100	16	18	34	34
Rubus spectabilis	8	8	0	0	54	54	0	0	0	0		
Aster chilensis	42	42	1	1	38	33	42	42	1	0	41	30
Spiraea douglasii	42	42	8	7	60	50	33	33	3	2	63	39
Veratrum californicum	0	21	0	1			0	42	0	1		

*All plots (N=24) and Treated Plots (N=12)

**%FRE = absolute %frequency; %COV = absolute %vertical projection cover;

HT = average weighted height (contribution to ht calculation proportional to rel. cover within plot)

CCM99VEG.wk4

TABLE 7. AGE OF SHRUBS AND TREES SECTIONED DURING MANUAL TREATMENT OF 12 VEGETATION PLOTS, NORTH AND SOUTH MARSHES, CCMWA, OCT 1998.

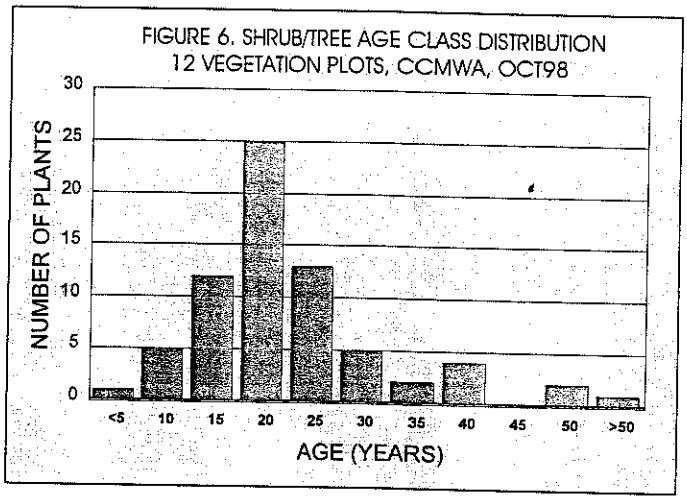
SPECIES CODE	*ALRU*	*ALVI*	*LOIN*	*SPDO*	*MYCA*	*PISI*	*SAL*	*MAFU*
OVERALL N	5	23	9	9	5	8	9	2
VEGETATION PLOT#	AGE---							
1		19	15	9				
		17	17	12				
				18				
3		23		4				
		19		12				
				7				
7		18				19		
		16						
8		18						
		17						
		18						
		18						
9		22	14	17	30			
			20					
			21					
12	23			16	14			16
				12				
14		28	23		23	29		
17	68	11	17		23	9	48	
	49					6		
19	34	7	17			16	29	
						13	21	
							23	
21		15	20				36	
		13					40	
		40					16	
		13					18	
							30	
22	23	24				39		
		16				25		
		14						
23		18			33			18
		24						
BY SPECIES								
Max. Age	68	40	23	18	33	39	48	18
Min. Age	23	7	14	4	14	6	16	16
Mean Age	39	19	18	12	25	20	29	17
NORTH MARSH								
Max. Age	23	23	21	18	30	19		16
Min. Age	23	16	14	4	14	19		16
Mean Age	23	19	17	12	22	19		16
SOUTH MARSH								
Max. Age	68	40	23		33	39	48	18
Min. Age	23	7	17		23	6	16	18
Mean Age	44	19	19		26	20	29	18
OVERALL (all species/all plots)								
Max. Age								68
Min. Age								4
Mean Age								21
Std. Dev.								11

Abbreviations: ALRU = Alnus rubra; ALVI = A. viridus; LOIN = Lonicera involucrata;

SPDO = Spiraea douglasii; MYCA = Myrica californica; PISI = Picea sitchensis; SAL = mixed Salix;

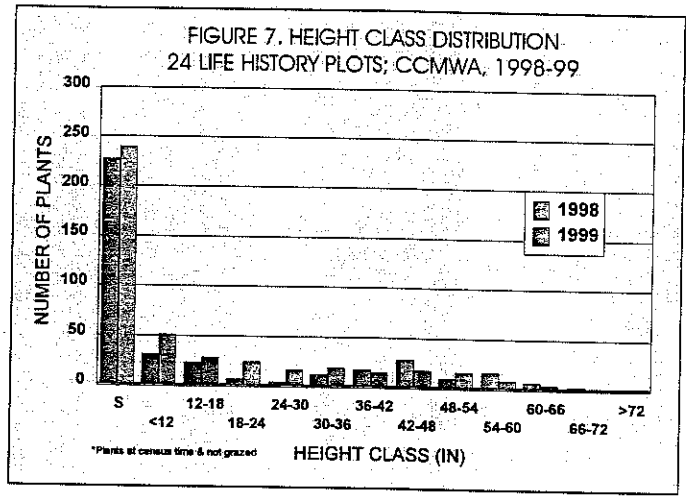
MAFU = Malus fusca.

Shrub and Tree Age: Stem cross-sections were collected from the base of the majority of trees and shrubs removed, and aged under a microscope to document the history of encroachment. The predominant tree sampled was Sitka alder (*Alnus viridus*), for which the occurrence at this elevation is quite unusual. With the exception of 2 individuals (40 and 28 years old), all stems were aged at <25 years old, as were the majority of crabapple (*Malus fusca*), twinberry (*Lonicera involucrata*), spiraea (*Spiraea douglasii*), and wax myrtle (*Myrica californica*) individuals (Table 7). Only willow (*Salix* spp.) and red alder (*Alnus rubra*) generally exceeded 30 years age. Overall, the age class distribution peaked in the 15-20 year age class, regardless of location in the North or South Marsh (Figure 6).



4.5 Western Lily Life History/Browsing Inhibitor Plot Results

Plant density and growth: Various growth characteristics of the sample populations are compared for the 2 years in Table 8; maps of all plants emerging in 1999 are included as Appendix C. The 1999 field data sheets are included as Attachment 3.



Some 222 seedlings and 155 mature lilies were recorded in both marshes in 1998, compared to 296 and 216 plants, respectively, this year, (33-39% increase). Of those plants, 81 flowered in 1998, and 88 flowered this year. Average height of the mature plants overall declined from 34 inches in 1998, to 27 inches this year. The decline in height is unexplained, since phenological development of the population during sampling was equivalent or even more advanced in 1999 compared to 1998. Similar to the TBER, seedlings comprised the largest size class during both years (Figure 7).

The density of seedlings increased from an overall average of 0.26 seedlings/sf in 1998, to 0.34 seedlings/sf this year. The South Marsh continued to exhibit a higher density of seedlings in the LH plots (nearly double this year), even though the density of mature plants was somewhat lower (slightly more than half the density in the North Marsh this year). The increase in the abundance of seedlings and mature plants was only partially explained by the multiple sample dates as opposed to the single census made in 1998, and suggested a high rate of full-year dormancy occurred in 1998 (consistent with the vegetation plot flowering plant totals for the 2 years). No incidence of disease was observed.

TABLE 8. SUMMARY STATISTICS FOR WESTERN LILY IN 24 LIFE HISTORY AND VEGETATION PLOTS, CCMWA, JUL 98 AND JUL 99.

OVERALL LIFE HISTORY PLOTS (24-6 ft sq.)		North Marsh		South Marsh	
		1998	1999	1998	1999
Total area sampled (sf):		432	432	432	432
Total LIOC seedlings sampled (single leaf))		43	102	179	194
#LIOC seedlings sampled per sf		0.10	0.24	0.41	0.45
Total LIOC non-seedling sampled		81	137	74	79
Mean ht non-seedling plants (in)		33	23	35	29
% incidence mammal grazing (plts still visible at census)		3	2	1	0
% incidence insect/slug grazing (plts still visible at census)		1	0	0	0
% incidence disease (plts still visible at census)		0	0	0	0
Total %plants missing at census time (7/21/99); both marshes combined					15
#Seedlings missing at census; both marshes combined					57
%Seedlings missing at census; both marshes combined					19
#Mature plants missing at census; both marshes combined					19
%Mature plants missing at census;both marshes combined					9
OVERALL VEGETATION PLOTS (24-30 ft dia.)					
Total area sampled (sf):		8478	8478	8478	8478
Total LIOC flowering		133	268	199	266
#LIOC flowering per sf		0.016	0.032	0.023	0.031
Mean #flowers		1.6	1.7	1.5	1.6
Maximum #flwrs		5	6	7	8
Mean ht (in)		47	46	46	46
Maximum ht (in)		72	88	70	74
Phenology (%plts sampled)	Date:	07/16/98	07/21/99	07/16/98	07/21/99
	Bud (comb. 1998=65; 99=52)	68	56	63	48
	Flower (comb. 1998=31; 99=44)	29	40	32	47
	Fruit (comb. 1998=4; 99=4)	4	4	4	4
	(Infl. Grazed)	0	0	1	0
% incidence mammal grazing (plts still visible at census)		2	0	1	0
% incidence insect/slug grazing (plts still visible at census)		2	0	1	1
% incidence disease (plts still visible at census)		0	0	0	0
Timing of Emergence	%Seedlings emerge 3/26-4/24				62
(both marshes combined)	%Seedlings emerge 4/24-5/22				27
	%Seedlings emerge 5/22-7/21				11
	%mature plts emerge 3/26-4/24				24
	%mature plts emerge 4/24-5/22				48
	%mature plts emerge 5/22-7/21				28

COMPARISON OF CLEARED (OCT98) AND UNCLEARED PLOTS	1998		1999	
	cleared	*uncleared*	*cleared*	*uncleared*
Total sdlgs (LH plots)	122	100	173	123
Total mature plts (LH plots)	83	72	132	84
#flowering plants (veg plots)	208	122	324	210
t test significance results				
LH Plots				
All seedlings 1999: Probability #seedlings differ 1998-99 (paired; 2 tld)	*P* =		0.01	0.36
All mature plts: Probability #mature plts differ 1998-99 (paired; 2 tld)	*P* =		0.07	0.24
Seedlings present at census: P for #seedlings differ 1998-99	*P* =		0.54	0.89
Mature plants present at census: P for #mat plts differ 1998-99	*P* =		0.25	0.34
Vegetation Plots				
Flowering plts present at census: P for #plts differ 1998-99			0.03	0.003

COMPARISON OF FENCING TREATMENTS	*Tall fence*	*Short fence*	*Control*
1998 (pre-treatment)			
#seedling (present at census)	100	70	52
#mature plants (present at census)	56	59	40
#flowering plants	30	29	22
#plants mammal grazed	2	3	2
1999			
#seedling (present at census)	90	92	57
#seedling (total emerging)	102	123	71
#mature plants (present at census)	55	95	47
#mature plants (total emerging)	58	105	53
#flowering plants	31	35	22
#plants mammal grazed	2	2	0
#plants missing at census time or grazed	15	41	20

Emergence: The majority of seedlings (62%) had emerged between March 26 and April 24, 1999, while the majority of mature plants emerged somewhat later (72% by May 22) (Table 8, Figure 8). No plants were observed emerging prior to March 26.

Natural Browsing Impacts and Results of LH Plot Treatments: The impact of browsing on the marsh population was greater than previously thought. Nineteen of the total 216 mature plants (9%), and 57 of the total 296 seedlings (19%) recorded in 1999 were missing by the July census. Over half of the browsed seedlings and mature plants occurred in the short fence treatment plots. Overall 15 plants were browsed in the tall exclosures, followed by 20 plants in the control (no fencing), and 41 plants in the short fence treatment plots. The high rate of loss in the short fence treatment appeared in part due to inadequate fencing. The hummocky terrain combined with the soft peat substrate, and need to step close to the fence in order to monitor, often caused gaps between the fencing and substrate. Not only was the fence ineffective, but the short fenced plots were often the only plots in which visible browsing activity had occurred (including frequent stacking of stem pieces, apparently typical of voles). The data suggest *preferential use of those plots by the animals intended to be excluded,* perhaps for the protection offered from predators.

4.6 Grazing History on the CCMWA

Aerial photographs for the years 1942, 1964 and 1989 were compared to determine the extent of cattle grazing on the CCMWA over the past 60 years (first generation copies included as Appendix E). In addition, interviews were conducted with Helen Ferguson, whose family grazed cattle on a portion of the CCMWA as late as 1986.

The 1942 aerial photograph, flown by the military for wartime security, indicated most or all of the wildlife area was grazed at that time. In particular, the portion of the CCMWA west of US 101 (western lily site US 101 West), north of Sandmine Road (lily sites Humboldt Road, Humboldt Road West), and west of the large spruce stand outside the north end of the wildlife area (2 private western lily sites) appear to have been cattle grazed. What appears to be a fence line is seen extending along the south edge of the large upland area (inholding in the CCMWA facing Humboldt Road) west across the wet marsh to intersect US 101, indicating cattle were allowed into the wettest portion of the marsh, and were segregated between the north and south portions of the CCMWA. In addition, what appear to be fence lines are located at the north boundary of the CCMWA, extending across the north side of the "North Marsh", and along the current west boundary of the wildlife area, which now adjoins the Hambro Lumber property. However, both the North and South marshes extended across the fence lines, appeared quite open, and showed virtually no sign of large shrubs or trees except across the fence to the north. The habitat located north of the "South Marsh" was definitely more scrubby at that time than currently.

The 1964 aerial photograph appears very similar to the 1942 photograph, with a few exceptions. Additional brush or tree vegetation is seen as islands, or extending out from the former brush boundaries, perhaps indicating the intensity of cattle grazing had been reduced in some areas. The North Marsh remained continuous with the open marsh to the west; however, the west boundary of the South Marsh (i.e., west boundary of CCMWA in this area) was by then cut off from the rest of the marsh to the west by a shrub border, which developed along a ditch cut along the west property boundary, and which connected a logpond (to the north) to the creek located at the south border of the South Marsh. Overall, the 1964 photograph provides no evidence that cattle were entirely removed from any occupied western lily habitat, including the North and

South marshes. The west portion of the fence (appearing in 1942) crossing the wet marsh, between US 101 and Humboldt Road is not visible, but replaced by a brushy corridor. The fence line at the north boundary still appeared (remnants of that fence found in 1992), along with suspected cattle trails next to the fence. Of interest are a series of intertwined ditches or pathways visible in this photograph which appear to match with a the existing network of pathways cut into the peat surface. (Since the western lily does not grow in the bottom of these paths, they provide a means to walk through the marshes without crushing the lily.) While these paths could be just drainage channels, their interbraided distribution suggests they may have been created or used by cattle. In addition, the photograph seems to indicate several of the paths coalesced at the fence along the north boundary, also suggestive of cattle trails.

By 1989, both the North and South marshes have shrunk, and are isolated from the rest of the marsh to the west by the dense vegetation strip following the ditch connecting the former logpond (current Hambro property) and the creek. The north property line is more obscure, and patches of scrub now occur south of the former fence line. The network of trails are not visible in the 1:12,000 scale photograph, suggesting they may have become more grown over (they are visible in the 1:2,400 scale 1996 photographs). The Humboldt Road western lily site still appears relatively open, but the scrub border generally appears to be advancing out into the formerly grazed western lily habitat throughout the wildlife area.

Information provided by Helen Ferguson supported the conclusions based on the photographs. Their family ran approximately 250 cows on the current CCMWA, including the portion of the CCMWA west of US 101, until the late 1970's when CDFG purchased the property. By agreement with CDFG, they continued to run cattle in the habitat west of Humboldt Road (Humboldt Road, and Humboldt Road West lily sites) after the transfer of property, until 1986 (5 years prior to discovery of western lily in this habitat). She indicates both areas of the current wildlife area were much more open prior to removal of cattle, and in particular the very dense habitat west of Humboldt Road (within the spruce stand) was previously very open. Unfortunately, she did not have any knowledge as to whether their cattle, or other cattle used the north end of the marsh in the late 1970's (i.e., North and South marshes).

Unfortunately, there is yet no firm evidence of the extent of historical cattle impacts in the north portion of the CCMWA (e.g., North and South marshes). It is not clear what effect reintroduction of cattle into the North and South marshes at the north end of the CCMWA would have on the soft peat soil, and unique plant communities. Occurrence of the western lily is clearly associated with the root mounds, hummocks and upper peat surface, and it does not occur in the bottom of the trails or mud depressions, where species such as skunk cabbage and several woody shrubs are rooted. While it is possible that the raised hummocks were formed by the high water table and accumulation of debris in the developing root masses, it is also feasible that cattle were responsible for creating the depressions and trails cut into the peat surface, which do not support the lily and many other species. Therefore, even though cattle appear to have been critical in maintaining marsh vegetation in a condition suitable for the lily, their potential impact on the microrelief of the peat surface (i.e., the amount of surface area elevated above the water table) is critical in determining the potential impact of cattle on the western lily. Of course there is no guarantee that the main western lily population on the CCMWA was as robust prior to 1980, when it was grazed, than it is now, although our experience elsewhere indicates that substantial increases in population size for this species require many years. Still it is possible that we are now seeing a significant, but short-lived peak in the population triggered by the removal of cattle, and that reintroduction of cattle would negatively impact the lily.

We also do not know how resumption of cattle grazing in the marsh would impact *Trientalis arctica, Sangisorba officinalis, Viola palustris*, and the other sensitive or unusual species present. While presence of these species now suggests they tolerated at least some level of grazing prior to 1980, the potential for impacts on these species, particularly the *Viola* and *Trientalis,* which are relatively rare within the CCMWA, as well as the unique plant communities present, must be considered in planning future management of the wildlife area.

Based on the above concerns, if reintroduction of cattle is considered for the North and South marshes, we recommend the grazing first be implemented on a limited, controlled scale until the impacts on western lily and other sensitive species are determined. Given the rapid successional processes currently active in most of the habitat, an experimental grazing program probably should be implemented soon.

4.7 Year 2000-2001 Task Schedule

1) The 24 LH plots will be monitored on or about the following dates: March 15, April 1, April 15, July 15 of 2000 and 2001. On each monitoring date, all lilies will inventoried as described under life history monitoring for TBER.

2) A census of all flowering lilies within the 24 vegetation plots will be conducted in July 2000. Cover and height of all species present in the plots, and maps of all woody vegetation will be recorded in July 2001, in order to assess the results of manual treatment.

3) The 3rd year project status report will be submitted by March 31, 2001, describing the results of the past 3 years. A comprehensive project report will be submitted by March 31, 2002, and include 1) discussion of lily population life history, demographics, phenology, annual dormancy rates, recruitment and seedling fate observed over the 4 years, 2) assessment of impacts of manual vegetation treatment on vegetation composition and structure, and the lily, 3) assessment of the impacts of natural browsing and the efficacy of the various means investigated for controlling natural browsing. Recommendations will be made for further monitoring, and if warranted, manual treatment or resumption of cattle grazing in the marsh.

5.0 COMPARISONS BETWEEN THE TBER AND CCMWA

The similarity in lily emergence dates for the 2 populations was unexpected, given the somewhat later floral maturation exhibited by the CCMWA and other Oregon populations compared to Table Bluff. In both populations, the majority of seedlings emerged prior to the mature plants (Tables 3 and 8; Figure 8); 52% of the seedlings at TBER had emerged by April 16, compared to 62% of the seedlings at CCMWA by April 24. However, the rate of emergence was less similar later in the season; by May 7, 91% of the seedlings had emerged at TBER compared to 89% at CCMWA by May 22. That delay (greater than 2 weeks) was more representative of the typical difference in phenological development. The data generally indicated a rapid, but short-lived surge in seedling emergence at CCMWA in April. Emergence of mature plants occurred at a more constant rate, and more consistent with floral maturation timing; 35% of the plants at TBER emerged by April 16, compared to 24% at CCMWA by April 24. In both populations, virtually no plants emerged prior to March 20, which at least for the TBER, may have been abnormally late due to the cool spring temperatures this year (Imper and Sawyer, 1999).

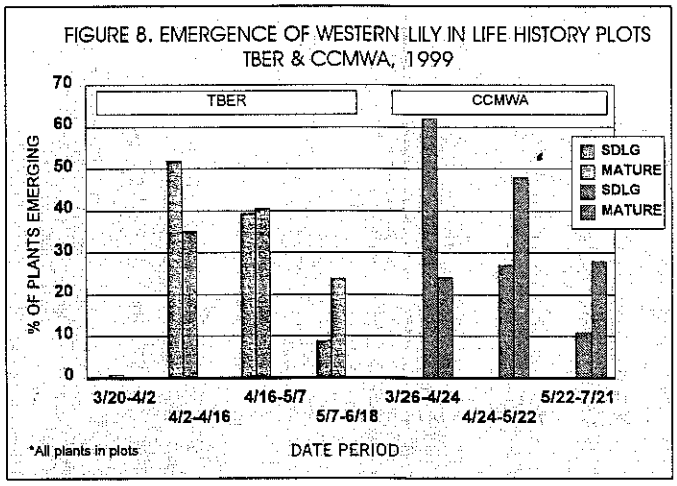


FIGURE 8. EMERGENCE OF WESTERN LILY IN LIFE HISTORY PLOTS TBER & CCMWA, 1999

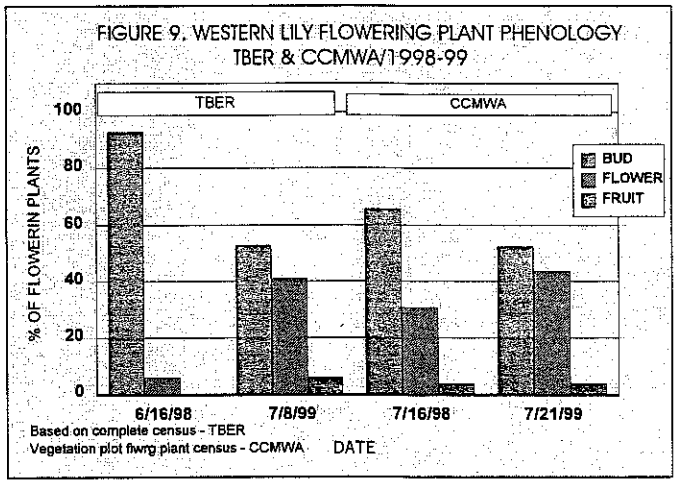


FIGURE 9. WESTERN LILY FLOWERING PLANT PHENOLOGY TBER & CCMWA/1998-99

With respect to floral plant phenology, the CCMWA and many of the populations in Oregon have traditionally been thought to reach peak flower approximately 1 month later than the Table Bluff populations. Our 1998 data indicated floral maturation at TBER was advanced more than a month compared to CCMWA (6% in flower at TBER on 6/18/98 compared to 31% at CCMWA on 7/21/98), but the 1999 data indicated the 2 populations were within 1-2 weeks of each other (41% in flower at TBER on 7/8/99 compared to 44% on 7/21/99 at CCMWA. Past monitoring has indicated the floral development at the TBER is highly correlated with spring air temperature. Perhaps the phenology of the CCMWA population is less plastic, or correlated with fluctuations in soil temperature, presumably moderated by the high water table.

Based on only a single year of full season monitoring, we are unable to assess the rate of full year dormancy. However, the impact of natural browsing (i.e., loss of plants prior to the final census date) was slightly greater at the CCMWA (19% seedling and 9% mature plant loss, compared to

19% seedling and 2% mature plant loss at TBER. Loss to natural browsing at TBER probably was abnormally low in the past year.

Mean height of the mature lilies in 1999 (LH plots) at CCMWA was 26 inches, compared to only 17 inches at TBER. In both populations, the mean height declined from 1998 to 1999 (10 and 4 inches, respectively), even though the populations were more advanced (phenologically) when sampled in 1999 (based on floral development). Reasons for the decline in height are not clear.

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WESTERN LILY VEGETATION STRATEGY

1999 STATUS REPORT

APPENDIX A

VEGETATION AND LILY SURVIVAL DATA
48 SEED PLOTS PLANTED FALL 1993, TBER, 1993-99

APPENDIX A1. 1999 VEGETATION AND LILY SURVIVAL DATA FOR 48 SEED PLOTS PLANTED FALL 1993 (EXPERIMENTAL HABITAT MANIPULATION PROJECT); SAMPLED 6/18/99.

COASTAL PRAIRIE PLOTS

TREATMENT	MOW						CATTLE GRAZE						BURN (not burned)						CONTROL PLOTS					
Transect designation	150			180			220			250			290			320			120			350		
X Coordinate	150	150	150	180	180	180	220	220	220	250	250	250	290	290	290	320	320	320	120	120	120	350	350	350
Y coordinate	60	100	120	80	100	120	80	100	120	80	100	120	80	100	120	75	80	105	60	80	100	80	90	90
WESTERN LILY ESTABLISHMENT																								
BULB REMAIN (NW4)***		0			0					0	0			0					0					
#LIOC SOLING (FROM SEED)	0	3	6	0	0	3	0	0	0	0	6	0	0	0	3	0	0	1	0	0	0	4	0	2
LIOC MEAN HT		2	5		6	1					2				2			2				2		2
LIOC MAX HT		3	8		6	1					2				2			2				2		2
#PLTS MULT. LVES	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GENERAL																								
Canopy cover (hemispheric)	25	25	35	90	20	60	40	40	50	30	80	70	95	30	60	30	45	80	60	80	40	40	45	55
Spruce cover	0	0	0	0	0	0	0	0	0	0	30	75	0	0	60	0	0	50	0	5	0	0	5	0
Total ground cover	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

NATIVE SPECIES (%/in)	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht
Baccharis pilularis											25	3							40															
Calamagrostis nutkaensis			15	35			0	2				40			25	20	10		2	25	50		5		10	3	5	10	10	5				
Carex obnupta	5	10	5				5	5	10	1	25	10							2				5	5	2	10	3	5	10	10	5			
Corylus cornuta																			20	3			5			15								
Gaultheria shallon																																		
Heracleum lanatum	20			5	5					2	2												5	30	2	15	5	2						
Iris douglasiana	10	10	30	20	20	30	2					5	5	25	3	1							3	2		26	3	2	5	5	3			
Melanthemon dilatatum							3			2	5	5	60			40	10	10	30	10									25	20	16			
Polystichum munitum		5													3		25	40	30															
Pteridium aquilinum	50	5	15	20	20	40	20			25	20	20		10	10	1	25	1	1	10	20	20	30	20	5									
Rosa nutkana								5																										
Rubus parviflorus							25	3			10			50			15	20		5			10											
Rubus spectabilis				65							3					2																		
Rubus ursinus	40	50	55	60	70	70	20	25	40	30	15		5	50			10	25	5	50	80	75	20	15	40									
Solidago spathulata																																		
Spiraea douglasii																																		
Stachys rigida																																		
Subtotal - native cover	125	95	145	160	115	147	105	79	94	95	78	95	129	99	124	100	116	98	155	111	114	130	95	99	113		131		91		111		117	

EXOTIC SPECIES																																		
Achillea millefolium																																		
Anthoxanthum odoratum	10	10			5		20	3	6	6	3	1		5	1	2	1					1												
Aster chilensis	2									1									2	3														
Cirsium vulgare + C. arvense										2								1		2														
Holcus lanatus	20	20	10	30	10	5	3	3	2	10	1	5		10	1	2			15			10	2											
Subtotal - exotic cover	32	30	10	30	15	5	23	6	7	18	4	6	0	15	2	4	1	1	17	5	10	3	0	0	14		20		11		4		6	
Total sum cover(%)	157	125	155	190	130	152	128	85	101	113	82	101	129	114	126	104	117	97	172	116	124	133	95	99	164		152		102		115		123	
Wld mean height vegetation(")		NO DATA																																

OVERALL		MOW		GRAZE		BURN		CONTROL	
avg#	tot#	avg#	tot#	avg#	tot#	avg#	tot#	avg#	tot#
0	0	0	0	0	0	0	0	0	0
1	27	2	11	1	8	1	4	1	8
5		4		2		2		2	
	8		8		2		2		2
	3		3		0		0		0

AVERAGE COVER/%FREQUENCY									
AC**	FR**	AC	FR	AC	FR	AC	FR	AC	FR
50		43		46		53		57	
10		0		16		22		2	
100		100		100		100		100	

OVERALL		MOW		GRAZE		BURN		CONTROL	
avg#	tot#	avg#	tot#	avg#	tot#	avg#	tot#	avg#	tot#
4	21	0	0	5	33	7	17	3	33
15	71	8	67	16	67	18	83	15	67
6	79	5	83	6	67	2	67	7	100
2	17	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
4	42	5	50	1	33	8	33	4	50
9	83	20	100	6	67	4	67	6	100
10	54	0	0	13	83	15	67	12	67
4	21	1	17	0	0	16	67	0	0
16	92	25	100	14	67	8	100	18	100
0	4	0	0	1	17	0	0	0	0
8	33	0	0	8	50	14	50	3	33
3	13	11	17	1	17	0	17	0	0
35	92	56	100	22	83	18	83	47	100
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
113		131		91		111		117	

0	0	0	0	0	0	0	0	0	0
3	58	4	50	6	100	2	67	0	17
0	17	0	17	0	17	0	0	1	33
0	13	0	0	0	17	0	17	0	17
7	75	16	100	4	100	2	50	5	50
14		20		11		4		6	
164		152		102		115		123	

SPRUCE FOREST PLOTS

TREATMENT	MOW						CATTLE GRAZE						BURN (not burned)						CONTROL PLOTS					
Transect designation	150			180			220			250			290			320			180		200	340	340	350
X Coordinate	150	150	150	180	180	180	220	220	220	250	250	250	290	290	290	320	320	320	310	320	310	310	320	300
Y coordinate	220	240	260	220	240	270	220	240	260	220	240	260	210	240	260	220	240	260	310	320	310	310	320	300
WESTERN LILY ESTABLISHMENT																								
#LIOC SOLING (FROM SEED)	0	12	4	1	0	1	1	0	2	0	1	4	0	1	10	4	10	10	2	8	6	3	12	no
LIOC MEAN HT		9	2	2		1	12		3		11	22		2	2	2	2	2	8	18	12	6	8	data
LIOC MAX HT		20	3	2		1	24		4		20	42		2	3	3	3	3	12	44	28	10	18	
#PLTS MULT. LVES	0	11	0	0	0	0	3	0	0	0	2	16	0	1	1	0	0	0	2	16	18	24	14	
#PLTS FLOWERING	0	1	0	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	0	3	2	0	1	
GENERAL																								
Canopy cover (hemispheric)	60	55	80	55	55	70	55	75	55	55	55	60	95	55	55	70	95	80	60	60	60	55	55	
Spruce cover	100	0	0	0	50	100	60	0	60	90	0	70	100	50	20	15	50	100	90	50	5	50	10	
Total ground cover	100	100	90	100	100	100	100	95	100	100	100	90	100	100	100	100	90	70	90	100	100	90	100	

NATIVE SPECIES (%/in)	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht
Baccharis pilularis															1		20			5	3								5						
Calamagrostis nutkaensis										2					2																			
Carex obnupta	3				5	10	5																											
Festuca subulifiora																			20	10	15	2			10									
Juncus spp.	2	15	3																															
Lonicera involucrata				6	20				40		3	5			60						20	35			10	10								
Melanthemum dilatatum				10	5					5	5	8			20							10	20											
Polystichum munitum																																		
Pteridium aquilinum																							2	5	2									
Ribes sanguineum	1						2						25	10																				
Rubus spectabilis	3	20	30	5	2		20	5	15	3	10	35							5	50	30	3	50											
Rubus ursinus	5	15	20	10	10	5	10	70	10	20		20	30	15	20	2	20	6	10	35	20	20	5	25										
Heracleum lanatus	2					2	2	10		5	10					10	20		10					2										
Sambucus racemosa																																		
Subtotal - native cover	16	50	68	45	22	52	39	93	40	28	45	68	120	55	27	103	82	42	45	82	50	23	87	0	55		42		52		58		48	

EXOTIC SPECIES																																		
Achillea millefolium																																		
Anthoxanthum odoratum	20	40	25	20	30	20	40			30	5	25	25			10	40	25		10	25	30	20	75	70									
Leucanthemum vulgare																																		
Cirsium vulgare + C. arvense		3	5			2																												
Dactylis glomerata										2		3							2															
Erechtites minima							25																											
Festuca arundinacea							3																											
Holcus lanatus	70	50	30	50	40	30	40	5	60	20	60	25	3	60	30		2	5	45	40	50													
Hypocheris radicata																																		
Rubus discolor (himalaya)		20	10				10	15																										
Rumex acetosella							3																											
Stachys rigida																																		
Cerastium glomeratum																																		
Subtotal - exotic cover	90	113	70	70	76	52	121	20	90	27	75	53	3	70	70	25	2	17	70	70	70	75	70	0	61		78		64		31		71	
Total sum cover(%)	106	163	138	115	92	104	160	113	130	55	120	121	123	125	97	128	84	59	115	152	120	98	157	0	116		120		117		99		128	
Wld mean height vegetation(")		NO DATA																																
pH (0-6" soil, 6/18/99)					6.2	5.7	6.2			6.4		6	6.1	6.4		8		6.4						6.8										
%moisture (0-6" soil, 6/18/99)					70	90	40			60		70	95	90		75		100						60										

OVERALL		MOW		GRAZE		BURN		CONTROL	
avg#	tot#	avg#	tot#	avg#	tot#	avg#	tot#	avg#	tot#
4	92	3	16	1	8	6	35	6	31
7	44	2	8	2	16	3		9	44
	109		11		21		3		74
	13		1		0		0		6

AVERAGE COVER/%FREQUENCY									
AC**	FR**	AC	FR	AC	FR	AC	FR	AC	FR
63		69		53		73		58	
43		42		47		56		29	
95		98		98		88		96	

0	0	0	0	0	0	0	0	0	0
1	22	0	0	0	17	5	50	1	20
1	39	4	67	1	50	0	0	0	0
0	0	0	0	0	0	0	0	0	0
3	35	3	50	0	0	8	67	2	20
0	0	0	0	0	0	0	0	0	0
9	43	11	50	1	33	19	50	3	40
4	35	3	33	3	50	8	50	0	0
0	0	0	0	0	0	0	0	0	0
2	30	0	17	6	50	0	17	1	40
14	87	10	83	15	100	8	67	23	100
17	91	11	100	22	83	15	83	18	100
3	39	1	33	5	67	7	50	0	0
0	4	0	0	0	0	0	0	0	20
55		42		52		58		48	

0	0	0	0	0	0	0	0	0	0
25	87	26	100	21	83	14	67	44	100
0	0	0	0	0	0	0	0	0	0
0	13	2	50	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1	17	0	0	5	50	0	17	0	0
0	4	0	0	1	17	0	0	0	0
31	87	45	100	33	100	17	83	27	60
0	0	0	0	0	0	0	0	0	0
2	17	5	33	4	33	0	0	0	0
0	4	0	0	1	17	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
61		78		64		31		71	
116		120		117		99		128	

*Plot 350/300 too impacted by feneceline and trail to monitor

**AC (average cover) and %FRE (% frequency) based on all plots within group specified.

***Note: 100 seed planted SE quarter all plots, and 3-12 bulbs planted NW quarter of indicated plots, fall 1993.

file Tberseedplots-93-99.wk4

APPENDIX A2. VEGETATION AND WESTERN LILY SURVIVAL AND GROWTH IN 48 SEED PLOTS PLANTED FALL 1993 (EXPERIMENTAL HABITAT MANIPULATION STUDY); SAMPLED 7/13-26/96.

COASTAL PRAIRIE PLOTS

TREATMENT	MOW			CATTLE GRAZE									BURN						CONTROL					
Transect designation	150			180			220			250			290			320			PLOTS					
X Coordinate	150	150	150	180	180	180	220	220	220	250	250	250	280	280	280	320	320	320	120	120	120	350	350	350
Y coordinate	80	100	120	80	100	120	80	100	120	80	100	120	80	100	120	75	90	105	60	80	100	60	90	90
WESTERN LILY ESTABLISHMENT																								
BULB REMAIN (NW/A)**		0			0					0	0								1			1	0	0
#LIOC SDLING (FROM SEED)	0	0	0	0	0	0	0	0	0	0	0	0							0	0	0	0	0	4
LIOC MEAN HT	0	0	0	0	0	0	0	0	0	0	0	0	NOT YET BURNED						0	0	0	0	0	3
LIOC MAX HT	0	0	0	0	0	0	0	0	0	0	0	0	NOT SAMPLED						0	0	0	0	0	4
#PLTS MULT. LVES	0	0	0	0	0	0	0	0	0	0	0	0							0	0	0	0	0	0

	OVERALL		MOW		GRAZE		BURN		CONT	
	avg#	tot#	avg#	tot#	avg#	tot#			avg#	tot#
	1		0	0	0	0			0	1
	0	4	0	0	0	0			1	4
	0		0		0				1	
	0	4	0	0	0	0			1	
	0		0		0				0	

	AVERAGE COVER/%FREQUENCY									
	OVERALL		MOW		GRAZE		BURN		CONT	
	AC**	FR**	AC	FR	AC	FR	AC	FR	AC	FR
GENERAL										
Canopy cover (hemispheric)	10	15	20	20	15	20	20	20	25	15	40	65							15	20	20	15	15	15
Spruce cover	0	0	0	0	0	0	0	0	0	0	10	95							0	0	0	0	0	0
Total ground cover	100	100	100	100	100	100	100	100	100	100	100	100							100	100	100	100	100	100
NATIVE SPECIES (%/in)	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht
Bacchars pilularis											30	72	20	72									2	54								
Calamagrostis nutkaensis			20	54	15	54			5	54	5	60	70	60	5	42	45	60	50	54	70	54										
Carex obnupta	40	36							5	24	10	36	60	24	35	48																
Corylus cornuta																																
Gaultheria shallon					15	24																										
Hemlock tanatum	20	36													15	42																
Iris dongasiana	20	30	25	36	30	30	50	30	35	30	30	30	20	24	5	24	5	24	25	24	10	18	30	24								
Maianthemum dilatatum															15	6			15	10	10	10	30	10								
Polystichum munitum			15	42																	10	36										
Pteridium aquilinum	35	42	25	42	25	42	35	42	20	36	40	42	45	36	50	48	45	42	40	52	25	42										
Rosa nutkana																																
Rubus parviflorus													30	24					25	24	35	42										
Rubus spectabilis							80	60																								
Rubus ursinus	60	36	80	36	85	36	65	42	90	30	95	36	60	24	60	42	80	36	50	30	40	42										
Solidago spathulata																	5	30														
Spirea douglasii																																
Stachys rigida																			5	20												
Subtotal - native cover	175		165		170		210		155		180		235		220		190		205		170		130									
EXOTIC SPECIES																																
Achillea millefolium																																
Anthoxanthum odoratum	10	36	15	42	15	40	15	36	15	30	10	30	20	36	10	30	20	42	10	36	10	36										
Aster chilensis																			5	24												
Cirsium vulgare + C. arvense																	2	24			2	36	5	12								
Holcus lanatus	15	36	35	42	35	40	35	30	35	30	20	36	50	36	15	30	50	48	20	36	10	36	25	30								
Subtotal - exotic cover	15		35		35		35		20		50		15		50		20		10		10		25		0		0		0		10	
Total sum cover(%)	190		200		205		245		190		260		285		235		240		225		180		155		252		190		147		250	
Wtd mean height vegetation(")		36		40		37		42		31		37		33		48		42		38		42		36		48		57		57		39

	AVERAGE COVER/%FREQUENCY									
	OVERALL		MOW		GRAZE		BURN		CONT	
	AC**	FR**	AC	FR	AC	FR	AC	FR	AC	FR
	0	0	0	0	0	0			0	0
	10	0	13	0	12	0			5	0
	1	17	0	0	1	17			2	33
	1	17	0	0	2	50			0	0
	21	83	29	100	28	100			7	50
	21		29		28				7	
	214		205		220				217	
	40	(HT)	37		40				44	

SPRUCE FOREST PLOTS

TREATMENT	MOW												BURN											
Transect designation	150			180			220			250			290			320			PLOTS					
X Coordinate	150	150	150	180	180	180	220	220	220	250	250	250	290	290	290	320	320	320	180	180	200	340	340	350
Y coordinate	220	240	260	220	240	270	220	240	260	220	240	260	210	240	280	220	240	260	310	320	310	310	320	300
WESTERN LILY ESTABLISHMENT																								
#LIOC SDLING (FROM SEED)	3	14	5	5	5	1	2	1	0	2	2	14	NOT YET BURNED						2	14	15	14	17	3
LIOC MEAN HT	2	5	3	2	3	1	2	3	0	1	2	3	NOT SAMPLED						2	5	3	5	4	2
LIOC MAX HT	3	7	5	3	5	1	2	3	0	1.5	3	5							2	7	4	7	6	2
#PLTS MULT. LVES	0	1	0	0	0	0	0	0	0	0	0	0							0	1	0	4	0	0

	avg#	tot#	avg#	tot#	avg#	tot#			avg#	tot#
	7	119	6	33	4	21			11	85
	3		3		2				4	
	4		4		2				5	
	6		1		0				6	

	AVERAGE COVER/%FREQUENCY									
	OVERALL		MOW		GRAZE		BURN		CONT	
	AC**	FR**	AC	FR	AC	FR	AC	FR	AC	FR
GENERAL										
Canopy cover (hemispheric)	60	60	60	60	60	70	55	55	55	70	60	65							60	60	55	55	55	55
Spruce cover	90	0	0	0	0	0	20	0	50	90	0	0							100	50	40	50	30	65
Total ground cover	100	100	100	100	100	100	100	40	100	90	65	90							95	95	100	90	90	70
NATIVE SPECIES (%/in)	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht	cov	ht
Bacchars pilularis	2	20	2	24	3	30															1	12										
Calamagrostis nutkaensis																																
Carex obnupta			3	24							7	12																				
Festuca subulifora																																
Juncus bufonius			8	30																												
Lonicera involucrata					1	12					1	6			1	6	1	6	1	6												
Maianthemum dilatatum							5	8			2	6																				
Polystichum munitum					5	12	8	18			6	24	7	18			4	12														
Pteridium aquilinum							2	24							3	24																
Ribes sanguineum			1	12	1	6	1	10					2	24																		
Rubus spectabilis			2	30											2	30	3	30														
Rubus ursinus	3	8	10	12	15	12	5	10	5	18	5	12	3	12	3	12	5	6	5	6	5	6	5	6	5	6	1	6				
Salix spp.																																
Sambucus racemosa																	1	6	15	36	5	12	25	36								
Subtotal - native cover	5		26		25		21		5		21		12		6		14		21		14		50									
EXOTIC SPECIES																																
Achillea millefolium																																
Anthoxanthum odoratum			2	30	5	36					10	36											3	24								
Leucanthemum vulgare																			2	24												
Cirsium vulgare + C. arvense	25	48									6	48							3	12												
Dactylis glomerata																																
Erechtites minima	25	36	20	26	25	48	15	40	60	36	20	48	25	40	40	36	50	40	30	42	25	60	50	54								
Festuca arundinacea			20	24									3	24																		
Holcus lanatus	75	48	85	48	85	42	90	40	70	40	70	40	75	40	10	30	50	48			50	42	40	36								
Hypochaeris radicata																																
Rubus discolor (himalaya)					15	42			2	24					1	60																
Rumex acetosella							6	18			3	12					5	12			10	12										
Stachys rigida					1	12	2	12																								
Cerastium glomeratum																																
Subtotal - exotic cover	125		127		131		107		138		108		106		51		115		33		85		93									
Total sum cover(%)	130		153		156		128		143		127		118		59		129		54		99		143									
Wtd mean height vegetation(")		44		35		37		35		36		34		36		33		38		35		39		38		43		30		34		12

	0	0	0	0	0	0			0	0
	5	0	3	0	1	0			12	0
	0	11	0	0	0	0			1	33
	2	22	5	33	1	17			0	17
	0	0	0	0	0	0			0	0
	32	100	28	100	37	100			31	100
	1	0	3	0	1	0			0	0
	58	94	79	100	39	83			57	100
	1	11	0	0	0	0			2	33
	1	22	3	50	0	17			0	0
	1	22	1	17	3	50			0	0
	0	17	1	33	0	0			1	17
	0	0	0	0	0	0			0	0
	103		122		81				103	
	121		140		100				121	
	33	(HT)	37		36				26	

FRE = % frequency within group specified

APPENDIX A3. VEGETATION AND WESTERN LILY SURVIVAL AND GROWTH IN 48 SEED PLOTS PLANTED FALL 1993 (EXPERIMENTAL HABITAT MANIPULATION STUDY); SAMPLED 10/24-26/93.

COASTAL PRAIRIE PLOTS

TREATMENT	MOW			CATTLE GRAZE									BURN			CONTROL						AVERAGE COVER% FREQUENCY							
																PLOTS						OVERALL		MOW		GRAZE		BURN	
Transect designation	150			180			220			250			290			320			120			350			AC**	FR**	AC	FR	AC	FR	AC	FR
X Coordinate	150	150	150	180	180	180	220	220	220	250	250	250	280	280	280	320	320	320	120	120	120	350	350	350								
Y coordinate	80	100	120	80	100	120	80	100	120	80	100	120	80	100	120	75	90	105	60	80	100	80	50	80								
BULB PLT'D (NW#4)***		~6			~9					~8	~9			~12					~12													
GENERAL																																
Canopy cover (hemispheric)	10	15	25	10	15	20	15	20	30	15	40	65	15	30	40	15	30	50	10	15	20	20	30	25	27		16		31		30	
Spruce cover	0	0	0	0	0	0	0	0	0	0	10	98	0	0	80	0	0	50	0	0	0	0	0	0	13		0		13		22	
Total ground cover	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		100		100		100	
NATIVE SPECIES (%/fr)	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht								
Baccharis pilularis							5 42																									
Calamagrostis nutkaensis		20 42	5 48			10 54			35 54	2 36																						
Carex obnupta	75 36	10 36	15 36	30 42	60 42	25 36	75 42	25 36	25 36	40 30	40 60	60 48	15 66	50 42	30 36	35 54	20 54	25 42	25 54	5 48	25 54	55 54	55 36		0 4		0 0		1 17		0 0	
Corylus cornuta													10 30	5 24		2 30	25 42	5 42	20 48	5 42	20 42	25 36	5 36	10 24	17 67		6 50		6 33		29 100	
Gaultheria shallon		10 18											15 36			30 30	5 42		10 48						28 96		36 100		44 100		8 83	
Heracleum lanatum																									3 17		0 0		0 0		0 0	
Iris douglasiana	25 30		10 30	20 36	10 24	15 24																			0 4		2 17		0 0		0 0	
Maianthemum dilatatum								1 24				10 18	5 18			4 24	5 24	15 30	35 36	5 72					0 4		0 0		0 0		1 17	
Polystichum munitum		25 36										20 8		1 12	2 12	3 8		5 8		25 42	10 36	10 24	10 30	30 24	10 71		13 83		2 33		5 67	
Pteridium aquilinum	15 36	10 30	10 36								15 36			15 48		25 36	40 42	40 42							1 21		0 0		3 17		2 67	
Rosa nutkana					5 35	10 36	25 42	20 42	30 36	5 42	2 24	8 30	2 16	5 30		10 36	5 36		20 42	25 48	5 42	15 36	5 36		7 25		4 17		3 17		20 67	
Rubus parviflorus														1 24			1 42								10 83		8 83		15 100		4 67	
Rubus spectabilis				30 72			8 24			40 42	25 42		5 42				15 42						5 30		0 8		0 0		0 0		0 33	
Rubus ursinus	25 18	75 36	90 36	80 12	50 36	90 42	60 36	80 30	80 30	50 36	40 36		40 30	25 36	6 12	15 24	55 42	45 42	75 46	75 42	90 48	60 30	55 36	75 30	4 25		0 0		12 50		3 33	
Solidago spathulata									1 30				3 24			1 24	2 24								1 4		5 17		0 0		0 0	
Spiraea douglasii																									56 96		68 100		52 83		31 100	
Stachys rigida																									0 17		0 0		0 0		17 1	
Subtotal - native cover	140	150	130	160	125	150	173	160	139	140	122	98	95	102	37	126	174	135	190	140	150	165	135	130	1 4		0 0		0 0		0 0	
EXOTIC SPECIES																									1 17		0 0		1 17		0 33	
Achillea millefolium	10 3				1 30	2 30																			136		143		139		112	
Aster chilensis													5 30	5 24	4 18		1 30					2 30									152	
Cirsium vulgare + C. arvense			10 48							2 42			3 30							10 54		2 30	2 24		1 33		2 50		0 0		3 67	
Holcus lanatus	20 30	2 24	5 24	5 30	5 24	10 24						1 24					1 12					2 30			1 25		0 0		0 17		17 17	
Subtotal - exotic cover	30	2	5	5	6	12	0	0	5	0	5	0	30 38	10 36	4 22	10 30	10 24	10 24	2 24	2 24	2 24	10 30	10 30	10 24	1 13		2 17		0 17		1 17	
Total sum cover(%)	170	152	135	165	131	162	173	160	144	140	127	98	130	147	111	136	185	145	192	142	152	177	145	140	11 83		8 100		2 33		28 100	
Wtd mean height vegetation(")	30	35	39	32	37	39	38	38	32	37	44	36	37	38	30	36	41	36	46	48	47	39	35	27	12		10		2		31	
																									148		153		140		142	
																									37 (HT)		35		38		37	

SPRUCE FOREST PLOTS

TREATMENT	MOW			CATTLE GRAZE									BURN			CONTROL													
																PLOTS													
Transect designation	150			180			220			250			290			320			180	180	200	340	340	360					
X Coordinate	150	150	150	180	180	180	220	220	220	250	250	250	290	290	290	320	320	320	310	320	310	310	320	300					
Y coordinate	220	240	260	220	240	270	220	240	260	220	240	260	210	240	260	220	240	260	310	320	310	310	320	300					
GENERAL																													
Canopy cover (hemispheric)	65	80	60	80	60	60	80	80	68	90	90	58	75	80	60	65	95	80	60	75	75	85	90	80	82		64		87		78	
Spruce cover	90	0	0			98	70	95	85	99	0	99	99	70	90	5	25	98	80	50	60	90	95	95	65		47		75		65	
Total ground cover	50	80	90	90	85	15	8	25	6	50	2	2	90	90	75	100	70	85	5	20	30	60	40	85	47		68		15		85	
NATIVE SPECIES (%/fr)	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht	cov ht								
Baccharis pilularis	1 6			2 12																												
Calamagrostis nutkaensis		6 12	2 6										5 24			6 24	3 12							0 8		1 33		0 0		0 0	
Carex obnupta		4 12	2 6	35 30		1 4				85 48			10 30												1 21		2 33		0 0		2 50	
Festuca subulifiora					15 24																				6 31		7 75		14 33		2 17	
Juncus bufonius		20 8																		3 24	3 24				1 13		3 17		0 0		0 0	
Lonicera involucrata																									1 4		3 17		0 0		0 0	
Maianthemum dilatatum																																
Polystichum munitum			3 6	1 5			1 3	4 8	4 4				10 12				1 6															
Pteridium aquilinum				3 12									25 24					15 18					2 4		0 13		0 0		0 0		2 50	
Ribes sanguineum	1 4		10 4	3 4	1 4								20 10				10 36								2 33		1 33		2 50		7 33	
Rubus spectabilis														2 2	2 2				1 2		1 3	1 3	1 3	1 4	1 13		1 17		0 0		5 33	
Rubus ursinus	2 2	3 4	10 6	1 4	2 6	1 3	1 2	3 16	1 3																1 50		3 67		0 0		1 50	
Salix spp.			1 3	1 3		1 2							5 12			1 4	1 4	1 12				1 4	2 12	1 6	1 67		3 100		1 50		1 67	
Sambucus racemosa	1 4		10 4	5 4	3 4	1 2	2 6	1 8	2 4	50 8	1 2	2 3	5 8	40 8	15 8				1 4	1 3	1 4	1 8	2 6	5 12	0 13		1 59		0 0		0 0	
Subtotal - native cover	5	35	38	51	21	4	4	7	7	135	1	2	60	42	16	6	15	17	1	5	6	1	7	6	6 63		3 83		10 100		10 50	
EXOTIC SPECIES																									21		26		26		30	
Achillea millefolium		1 3																													4	
Anthoxanthum odoratum																5 12																
Leucanthemum vulgare	1 4		3 4	10 12																					0 8		0 17		0 0		1 17	
Cirsium vulgare + C. arvense	3 30	3 36	10 5	15 12	15 6	3 8	2 3							3 3									1 4									
Dactylis glomerata																1 6	1 4			3 4		2 6		1 2	1 21		2 50		0 0		1 17	
Erechtites minima	20 48	5 36	25 24	5 30	30 36	1 8					1 4		3 8	4 8											2 50		8 100		0 17		0 33	
Festuca arundinacea													5 12	25 48	20 42			5 42	3 12	15 30	2 12	3 24	1 42	8 24	0 8		0 0		0 0		1 33	
Holcus lanatus	30 30	50 30	25 30	30 24	30 12	1 16	1 3	10 18			1 6			2 8	1 3	1. 6			1 3	1 3	2 3				7 71		14 100		0 17		8 67	
Hypochaeris radicata		2 3				3 3					1 4	1 4	60 24	40 30	55 18	100 24	65 24	75 24	5 8	3 18	5 12	60 12	35 12	70 24	31 88		24 100		2 50		65 100	
Rubus discolor (himalaya)				2 3				1 60											1 3	1 3	2 3			2 12	1 46		1 33		0 33		1 50	
Rumex acetosella																									0 8		0 17		0 17		0 0	
Stachys rigida																									0 8		0 17		0 8		0 0	
Cerastium glomeratum																									0 4		0 0		0 0		0 0	
Subtotal - exotic cover	54	59	65	62	75	6	3	11	0	0	0	0	68	74	77	107	69	80	9	37	19	65	38	86	1 8		0 0		0 0		0 0	
Total sum cover(%)	59	84	103	113	96	12	7	18	7	135	1	2	146	118	93	113	81	97	10	42	24	65	45	86	44		54		2		79	
Wtd mean height vegetation(")	33	22	16	21	20	5.3	3.7	19	3.9	33	2	3	20	24	21	23	24	24	8.3	15	8.3	12	11	23	65		80		28		108	
																									17 (HT)		20		11		23	

"AC = average cover; %FRE = % frequency within group specified.

***Note: 100 seed planted southeast quarter all plots.

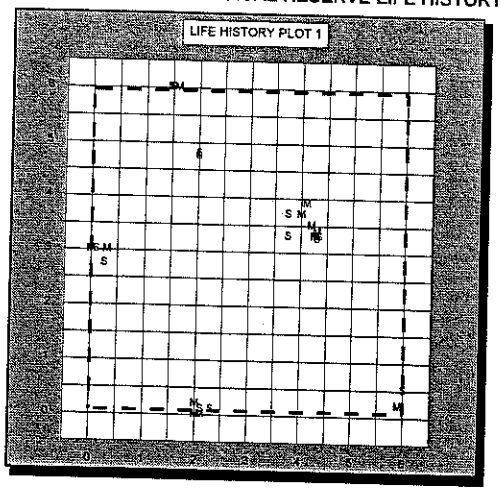
WESTERN LILY VEGETATION STRATEGY

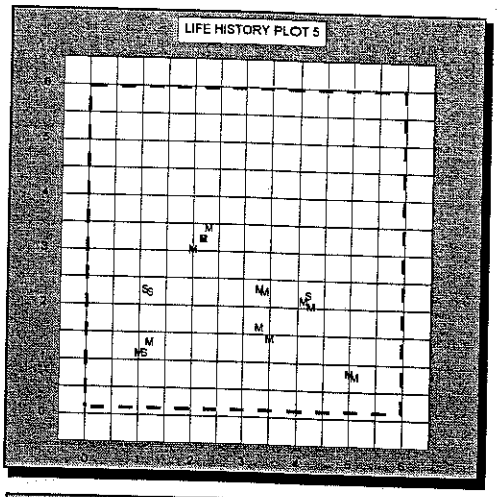
1999 STATUS REPORT

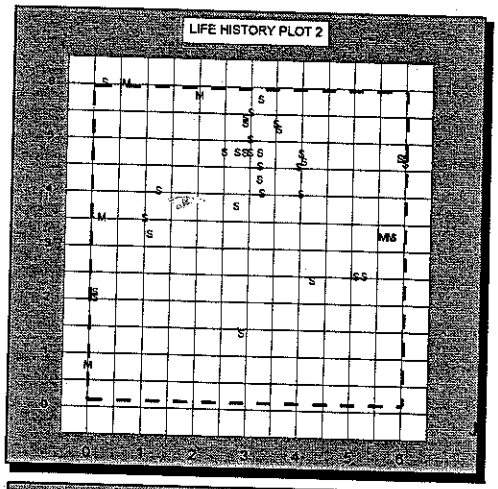
APPENDIX B

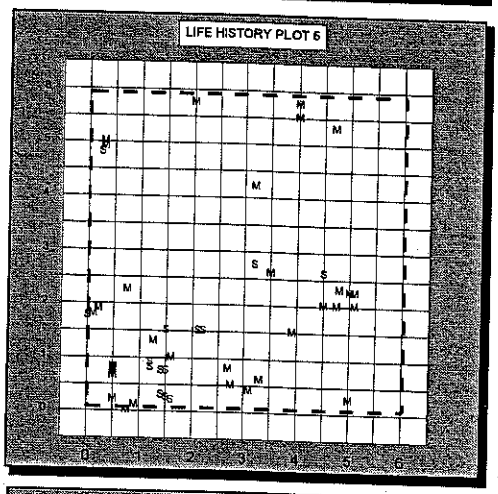
1999 MAPS OF WESTERN LILY 27 LIFE HISTORY PLOTS, TBER

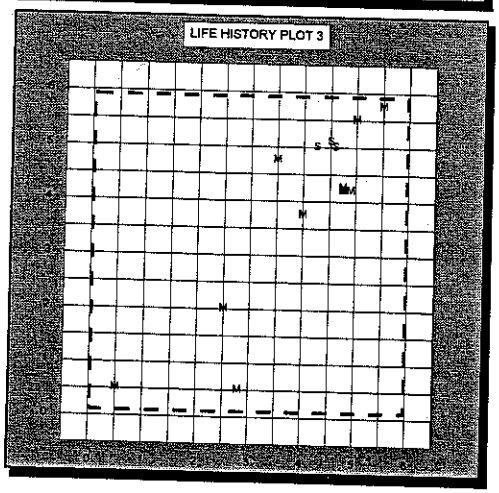
APPENDIX B
TABLE BLUFF ECOLOGICAL RESERVE LIFE HISTORY PLOTS 1999

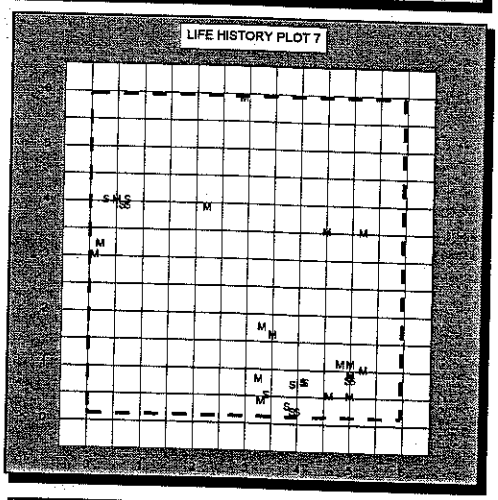


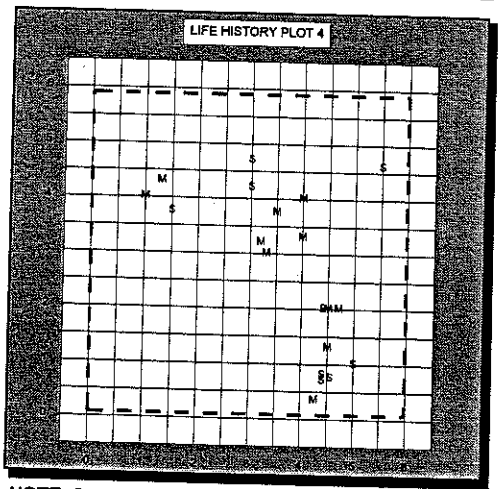


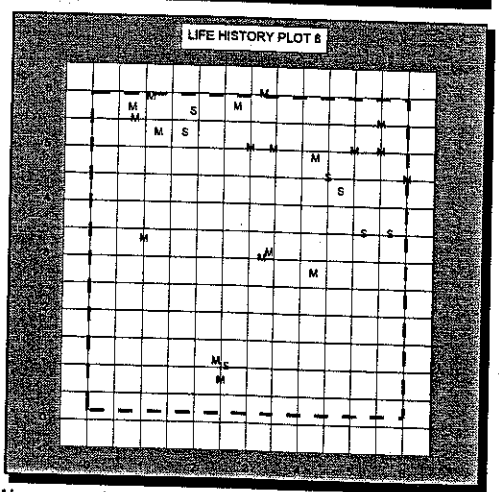






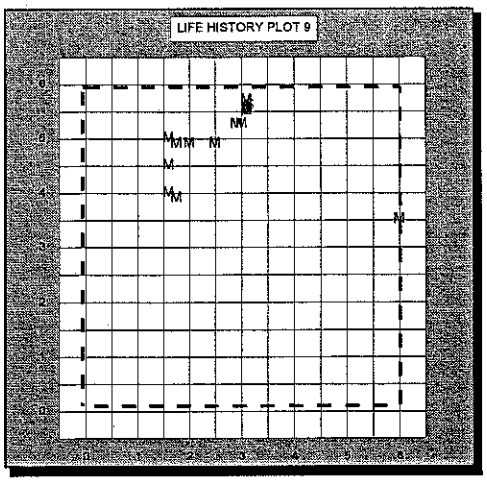


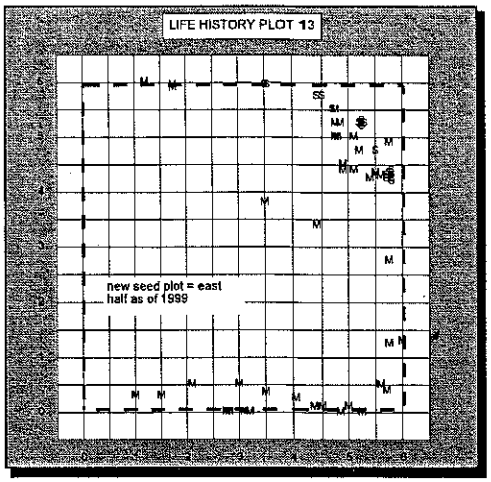


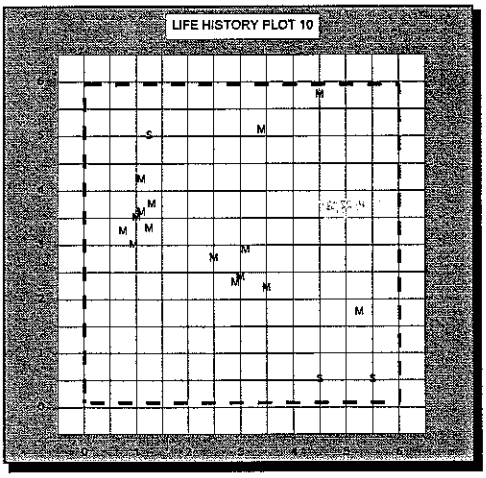


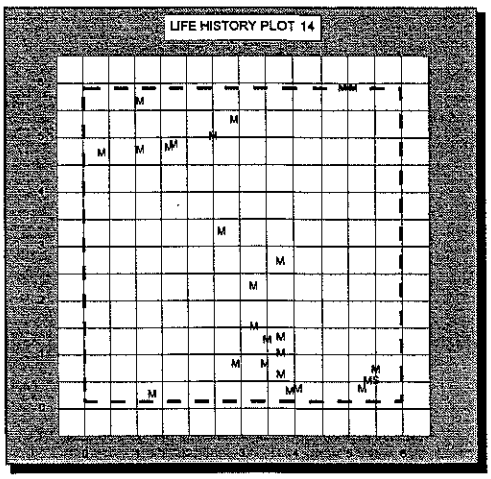
NOTE: S=seedling; M=mature; plots all oriented east, origin = NW corner; unless noted, seedling plots = the entire 6'x6' plot.

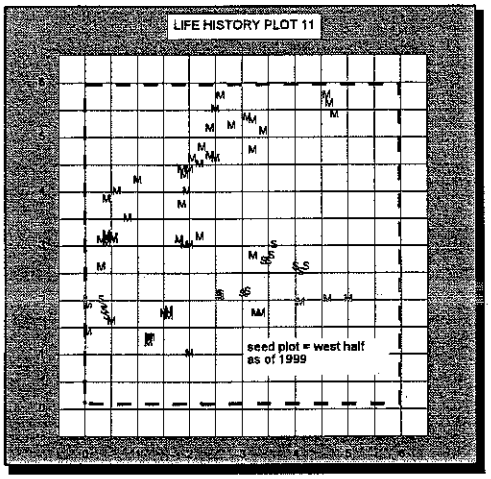
APPENDIX B (CONTINUED)
TABLE BLUFF ECOLOGICAL RESERVE LIFE HISTORY PLOTS 1999

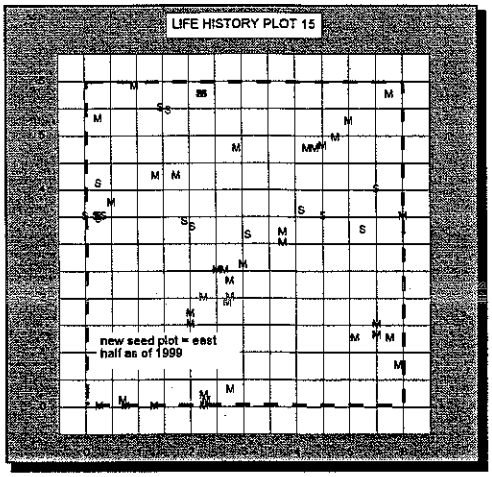


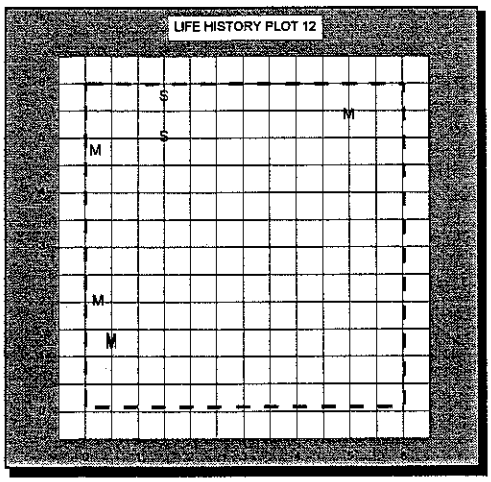


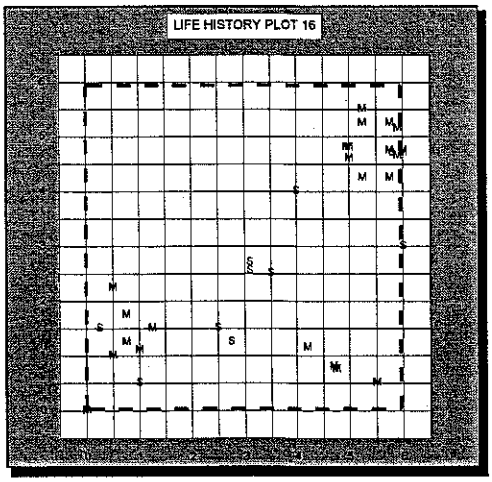






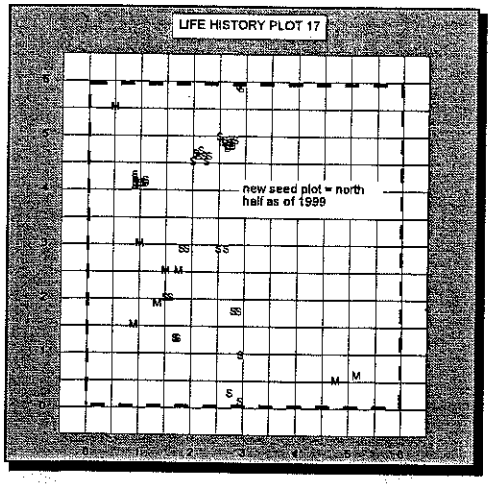


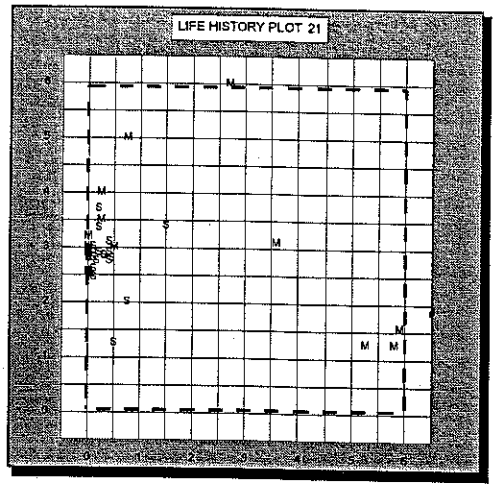


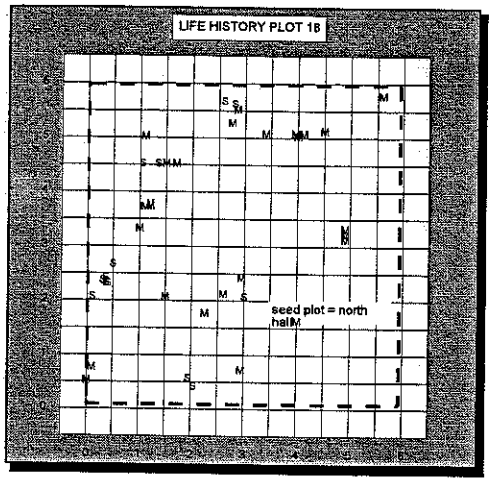


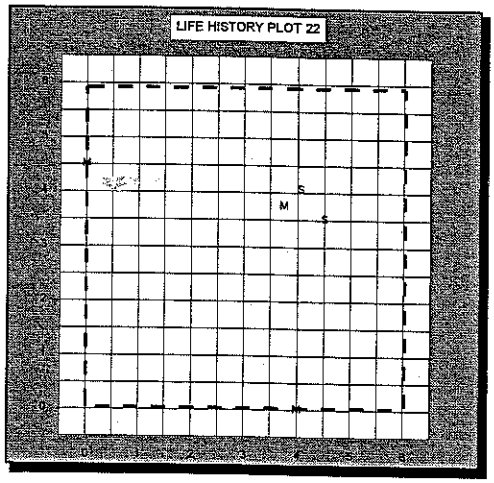
NOTE: S=seedling; M=mature; plots all oriented east, origin = NW corner; unless noted, seedling plots = the entire 6'x6' plot.

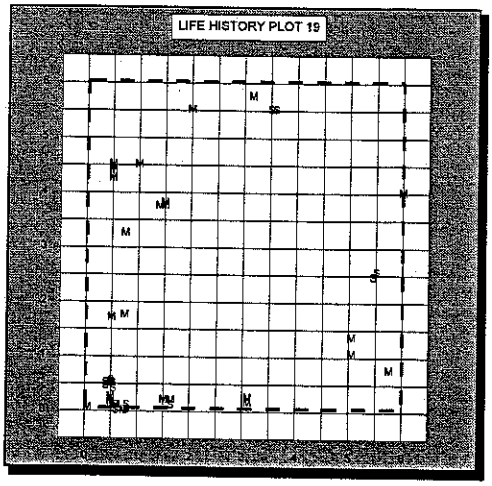
APPENDIX B (CONTINUED)
TABLE BLUFF ECOLOGICAL RESERVE LIFE HISTORY PLOTS 1999

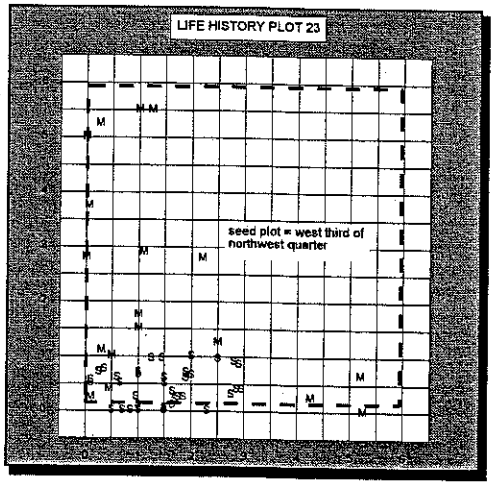


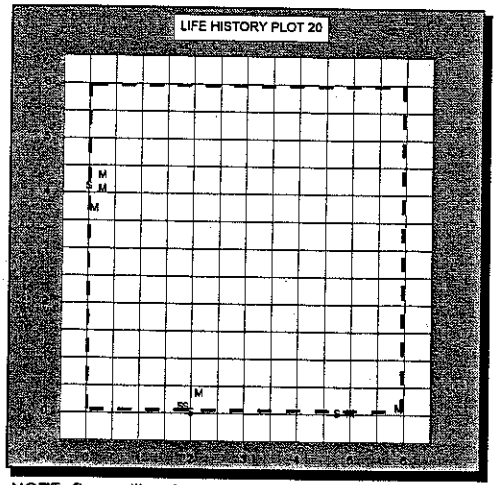


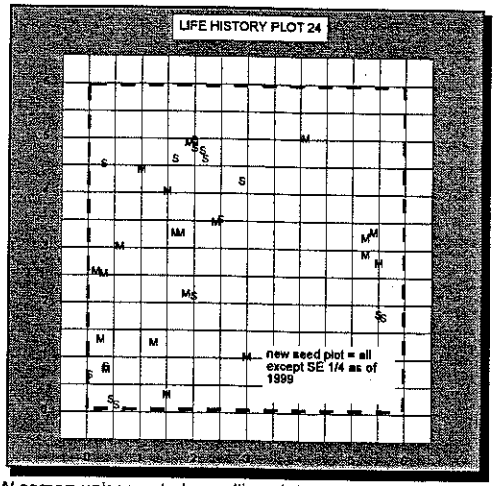






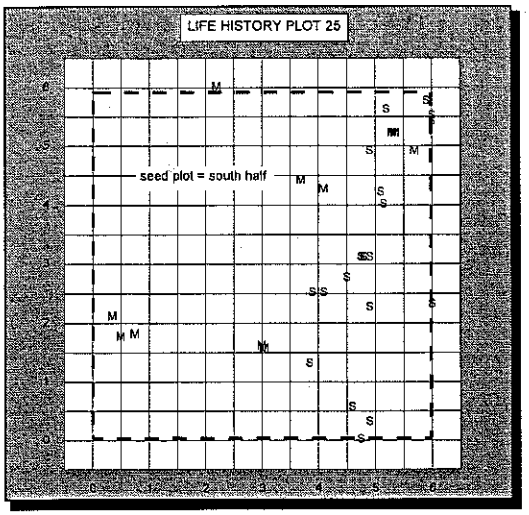


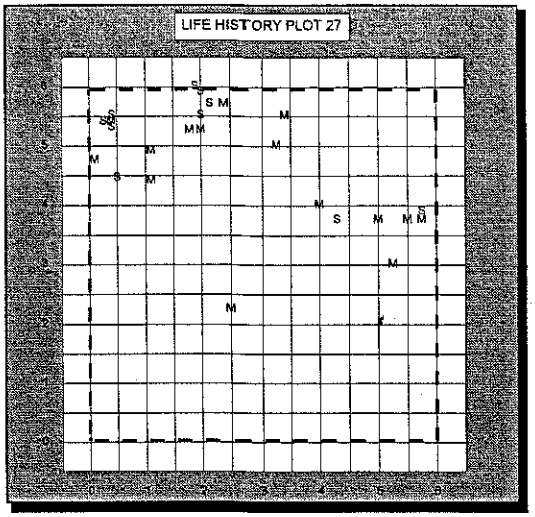


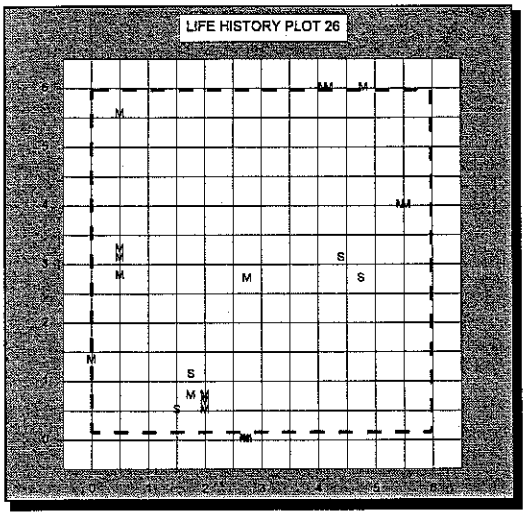


NOTE: S=seedling; M=mature; plots all oriented east, origin = NW corner; unless noted, seedling plots = the entire 6'x6' plot.

APPENDIX B (CONTINUED)
TABLE BLUFF ECOLOGICAL RESERVE LIFE HISTORY PLOTS 1999





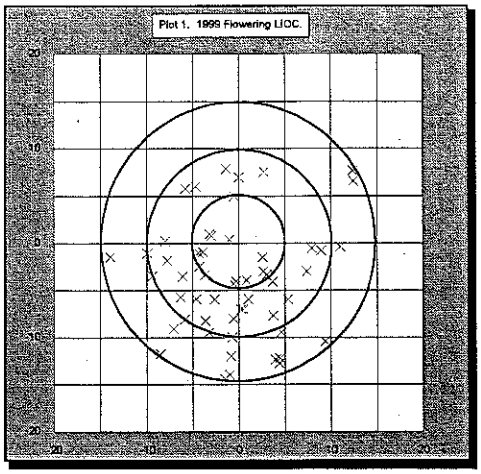


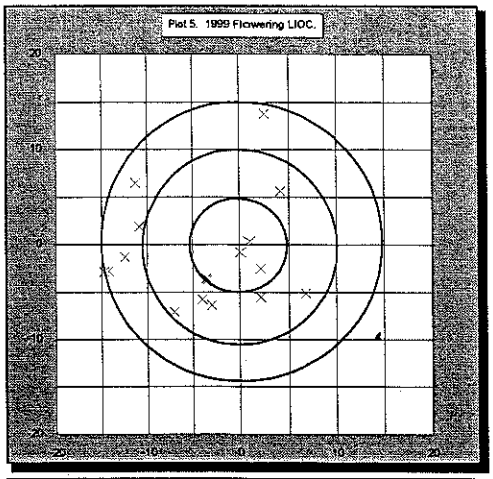
NOTE: S=seedling; M=mature; plots oriented east, origin = NW corner.
Unless indicated, seedling plots = the entire 6'x6' plot.

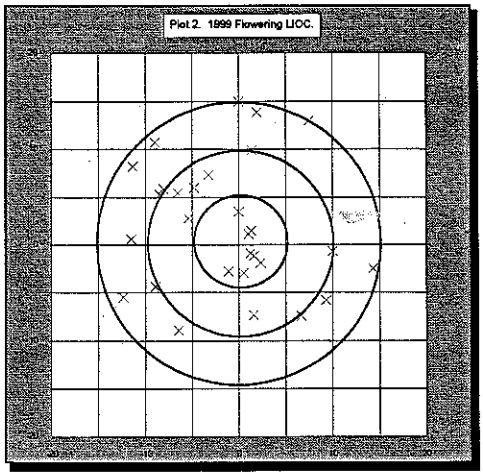
APPENDIX C

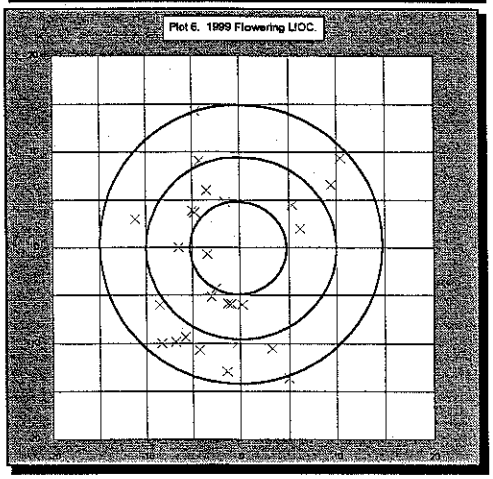
1999 MAPS OF WESTERN LILY
24 VEGETATION & LIFE HISTORY PLOTS, CCMWA

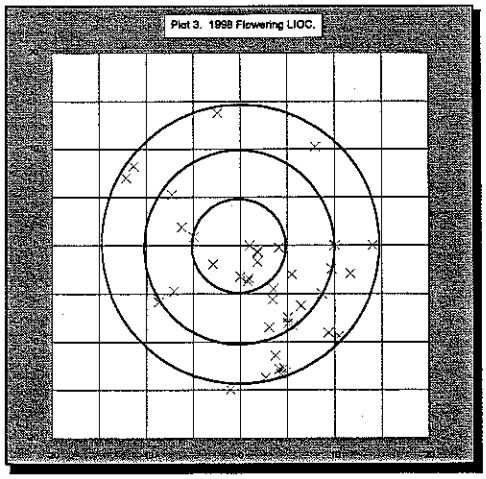
APPENDIX C1
CRESCENT CITY MARSH WILDLIFE AREA VEGETATION PLOTS 1999

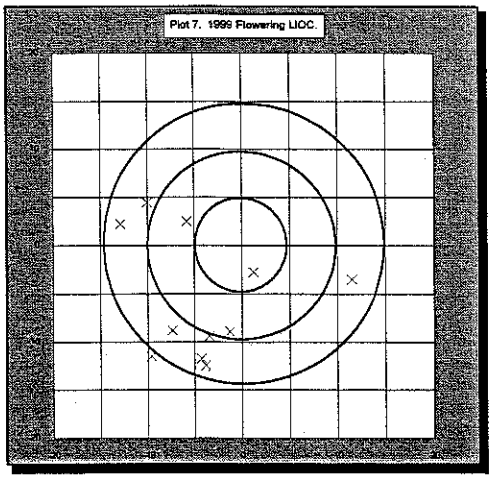


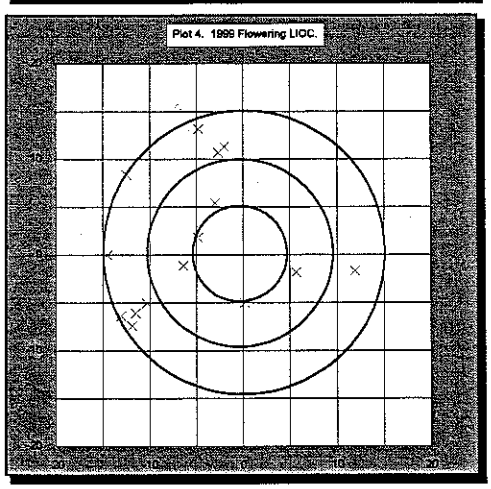


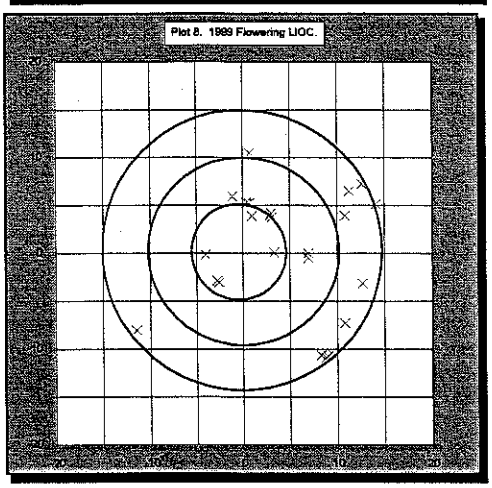






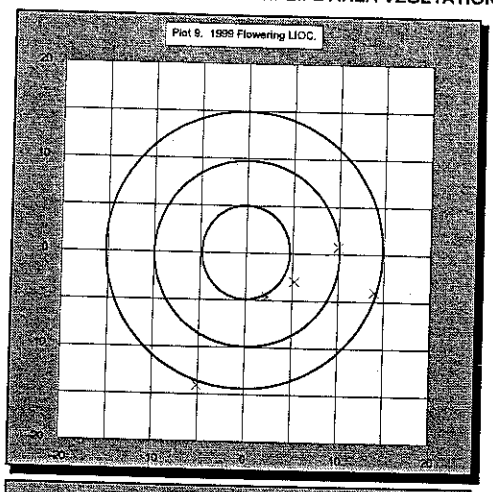


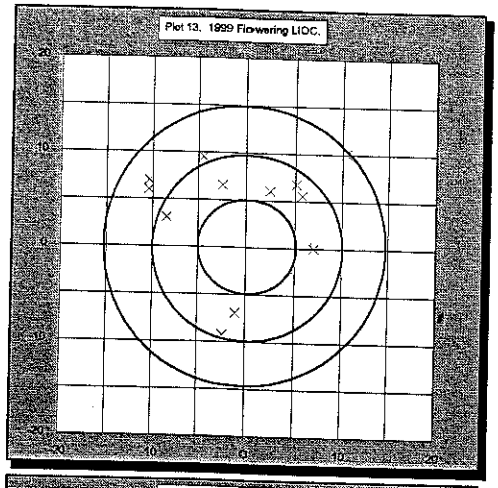


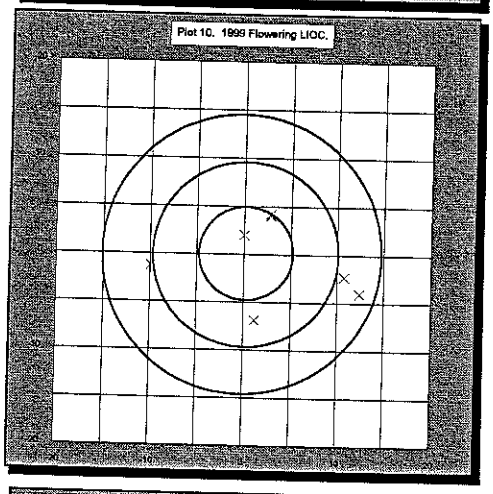


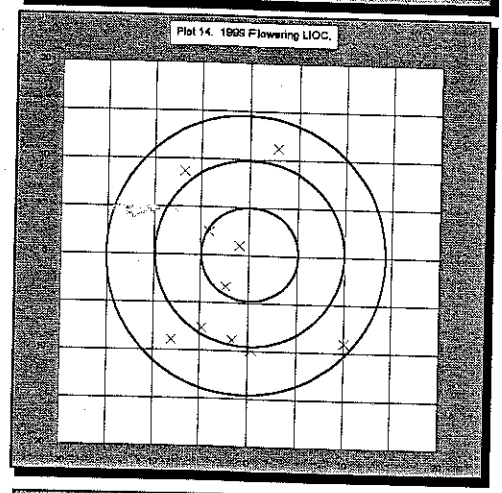
NOTE: plots all oriented north, 30' diameter.

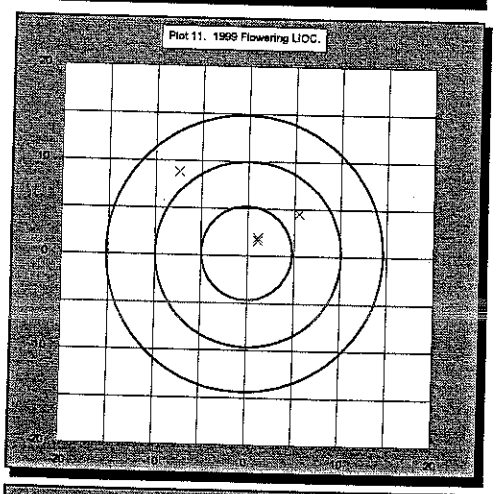
APPENDIX C1 (CONTINUED).
CRESCENT CITY MARSH WILDLIFE AREA VEGETATION PLOTS

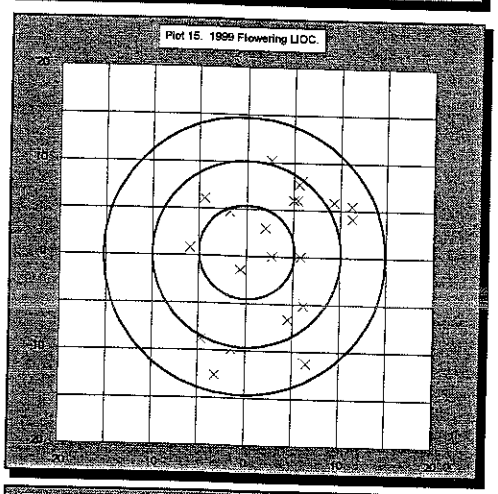


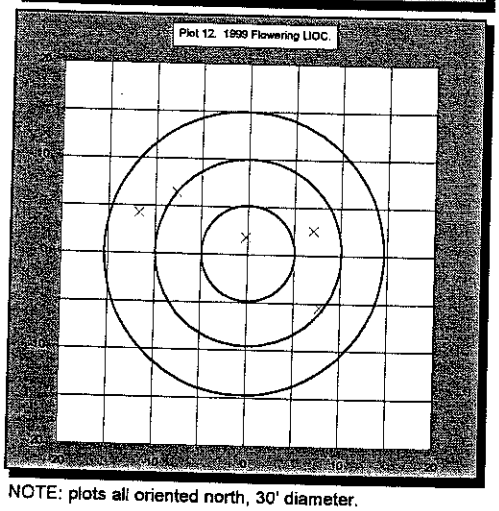


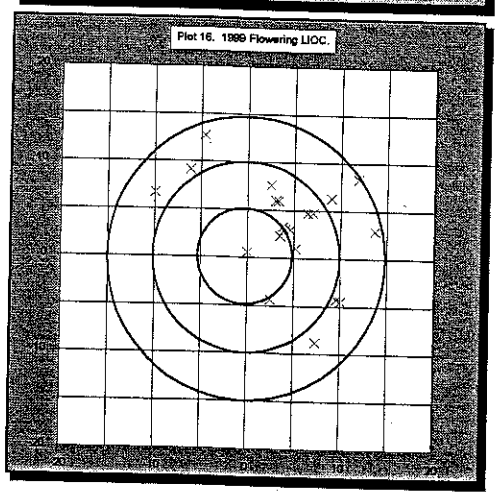






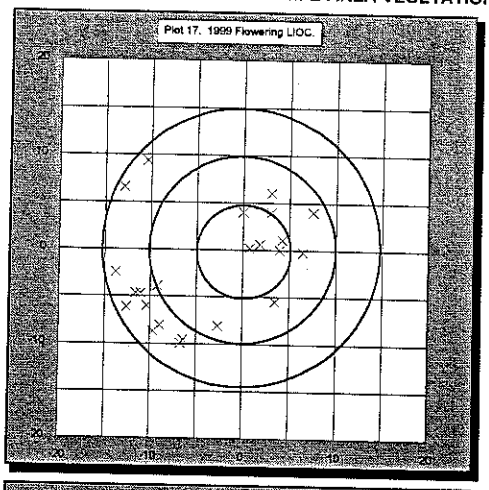


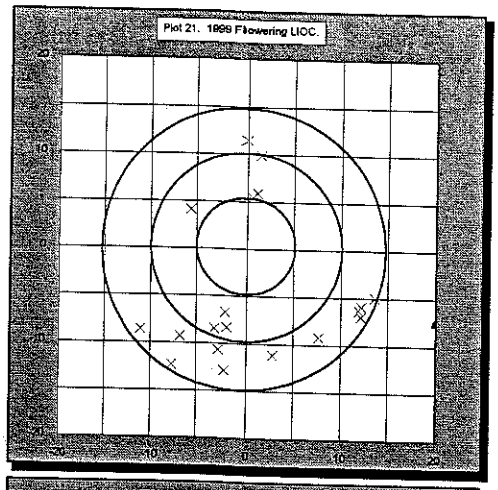


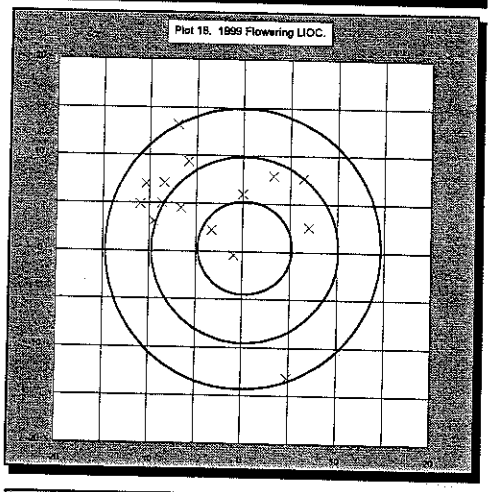


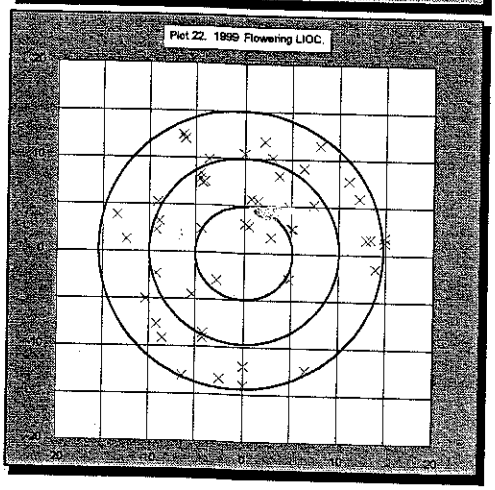
NOTE: plots all oriented north, 30' diameter.

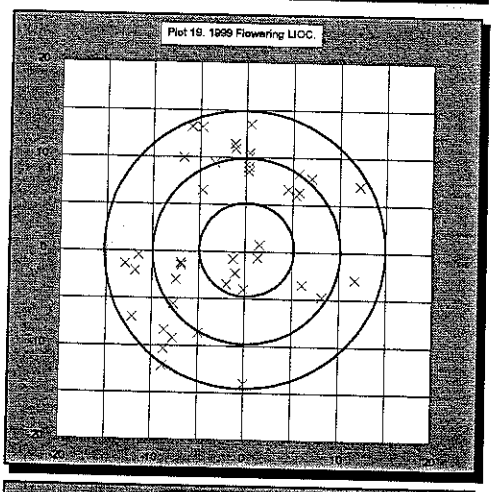
APPENDIX C1 (CONTINUED).
CRESCENT CITY MARSH WILDLIFE AREA VEGETATION PLOTS

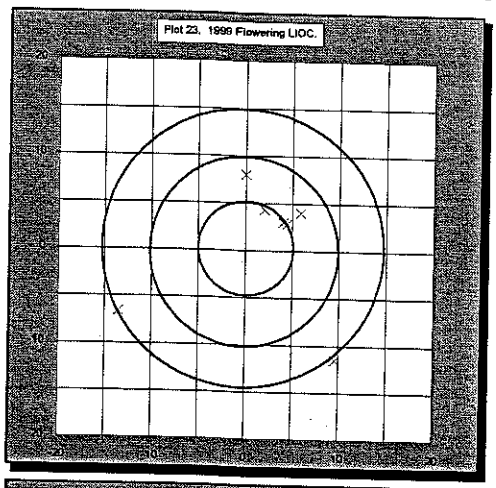


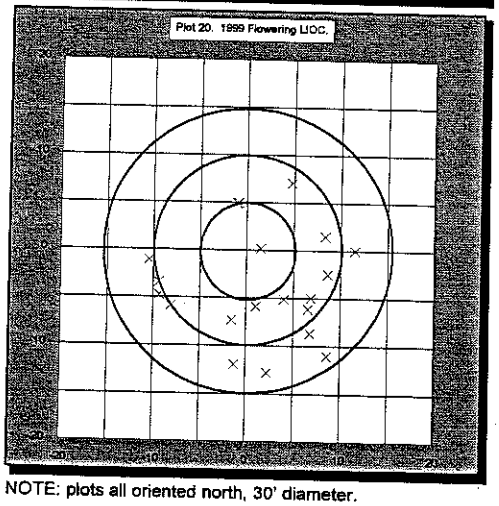


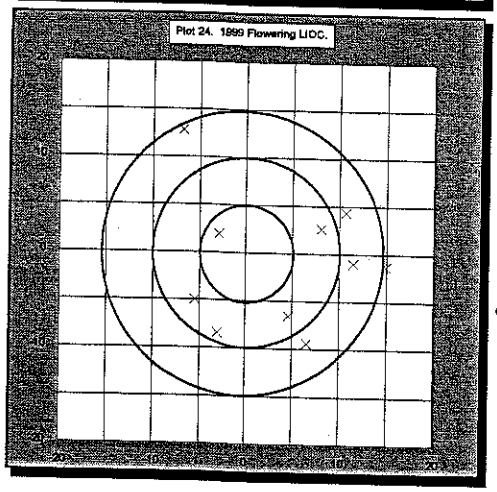






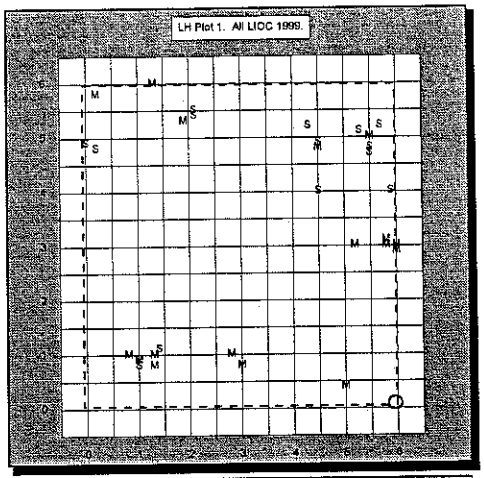


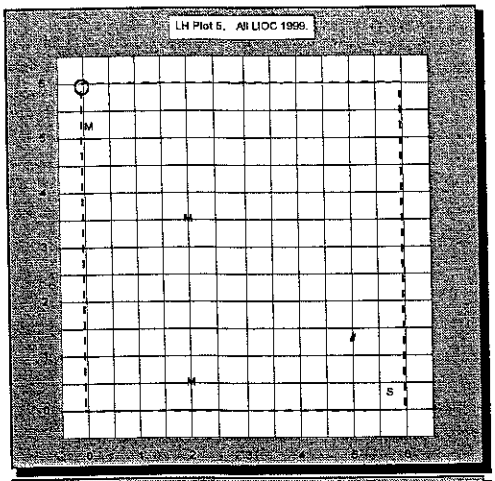


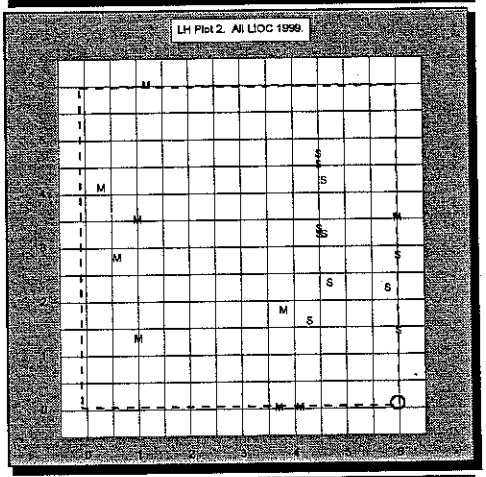


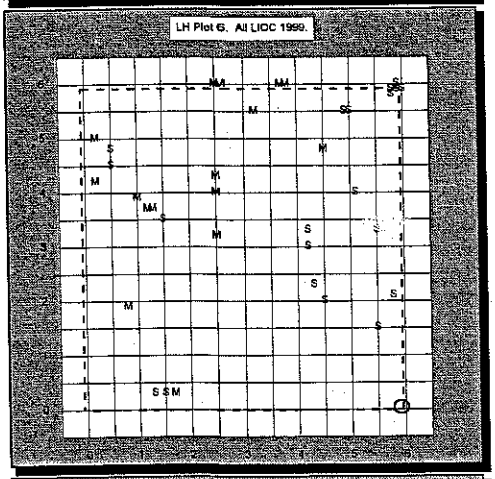
NOTE: plots all oriented north, 30' diameter.

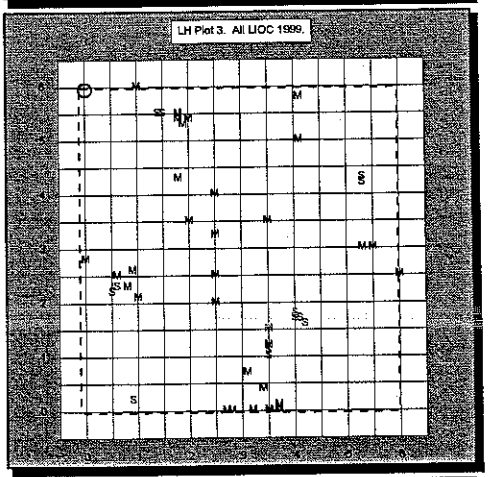
APPENDIX C2
CRESCENT CITY MARSH WILDLIFE AREA LIFE HISTORY PLOTS 1999

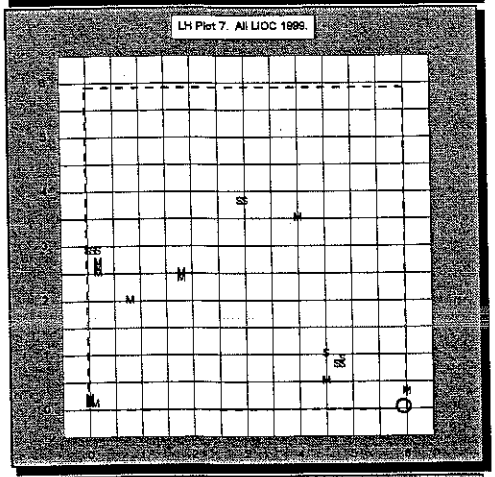


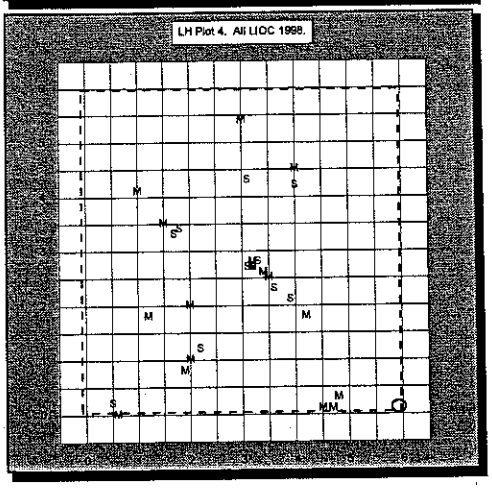


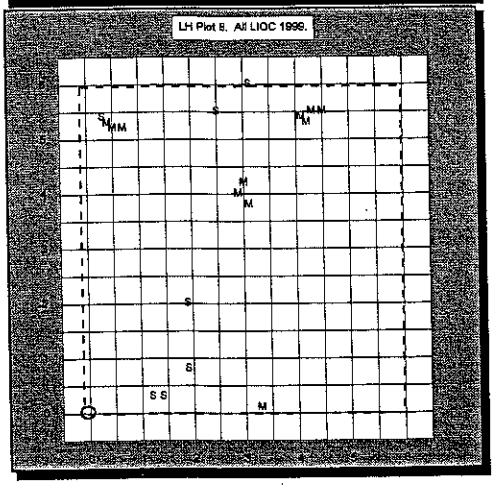






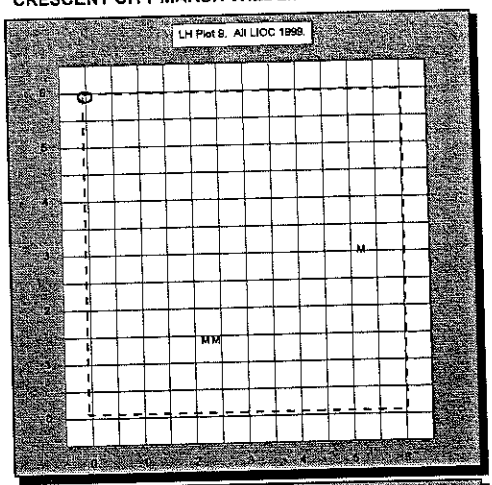


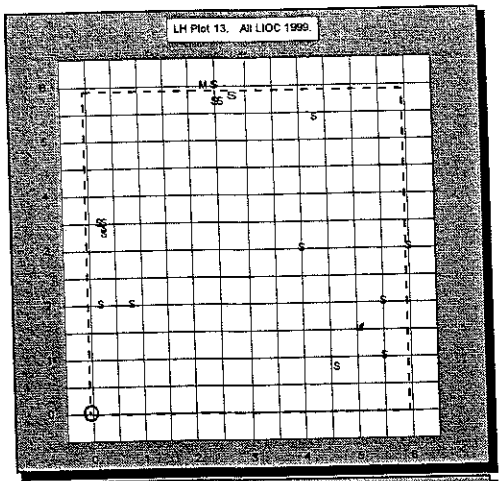


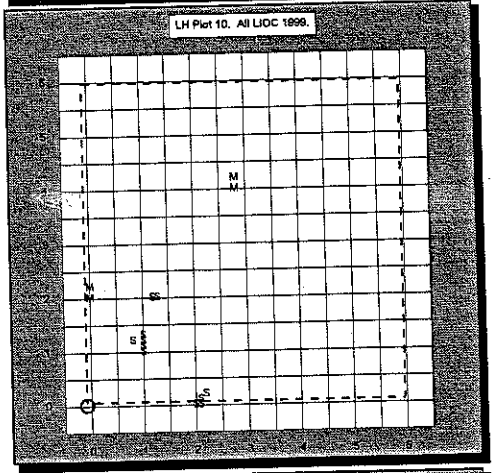


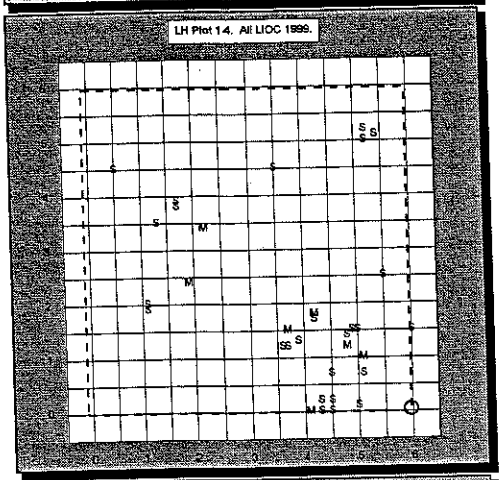
NOTE: s=seedling; m=mature; plots all oriented north; unless noted, seedling plot = entire 6x6' plot; vegetation plot center indicated.

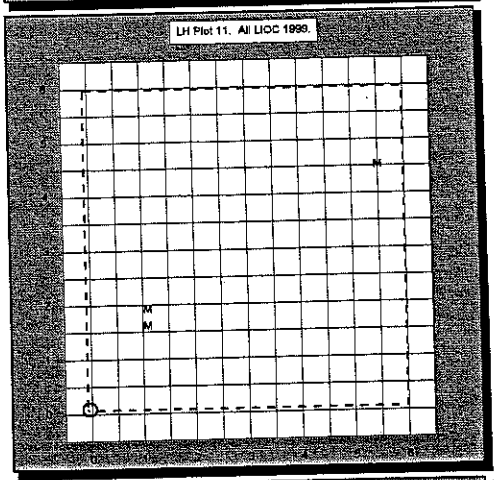
APPENDIX C2 (CONTINUED).
CRESCENT CITY MARSH WILDLIFE AREA LIFE HISTORY PLOTS

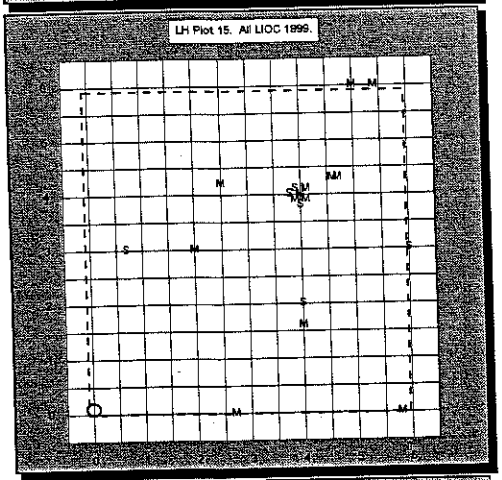


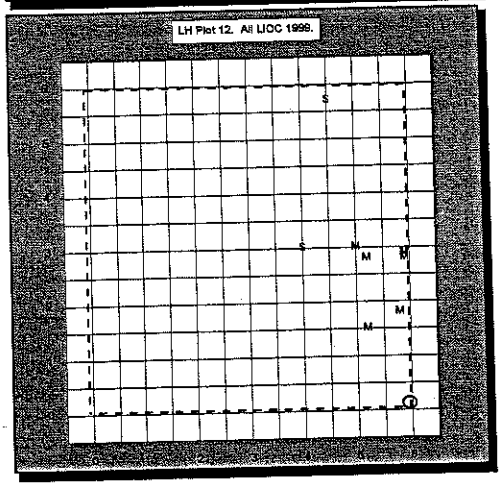


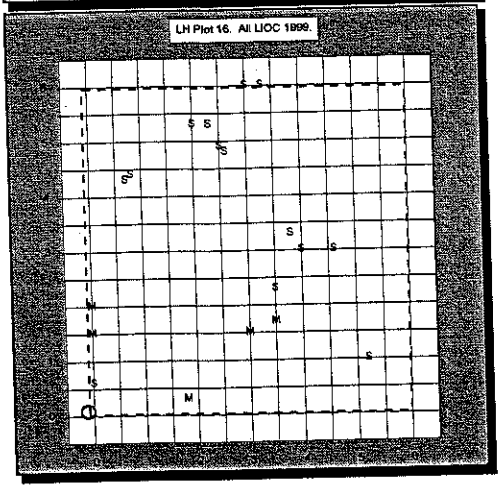






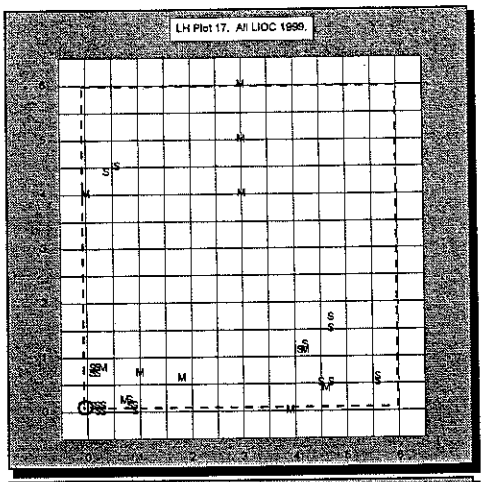


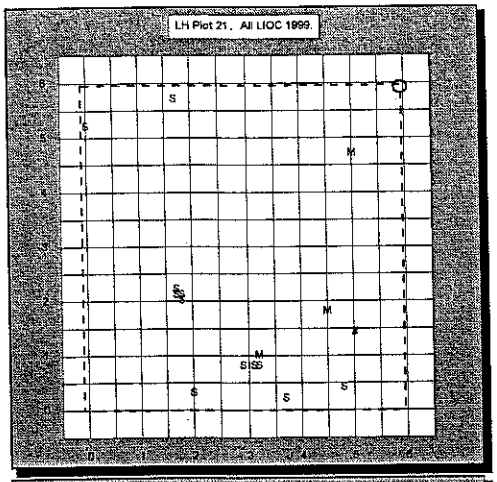


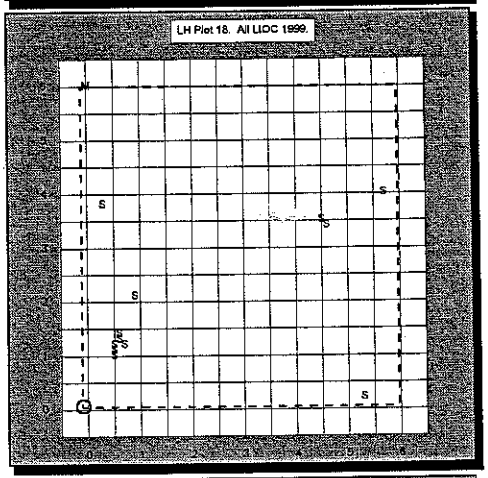


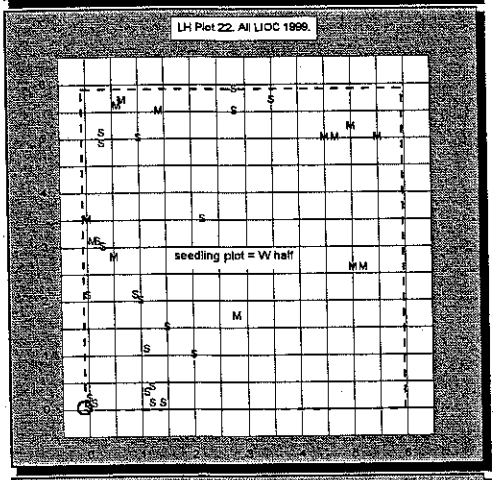
NOTE: s=seedling; m=mature; plots all oriented north; unless noted, seedling plot = entire 6x6' plot; vegetation plot center indicated.

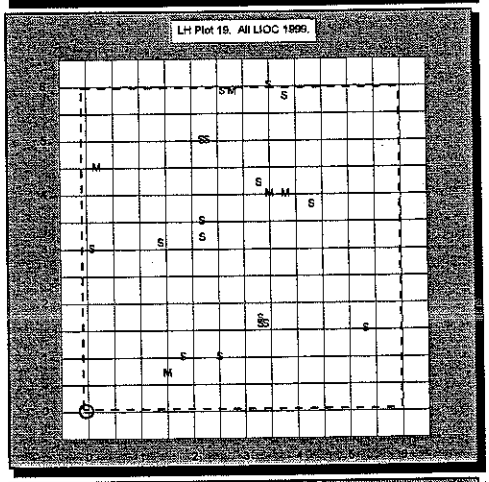
APPENDIX C2 (CONTINUED).
CRESCENT CITY MARSH WILDLIFE AREA LIFE HISTORY PLOTS

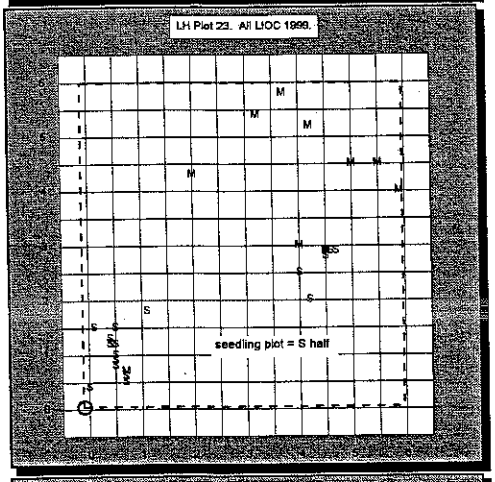


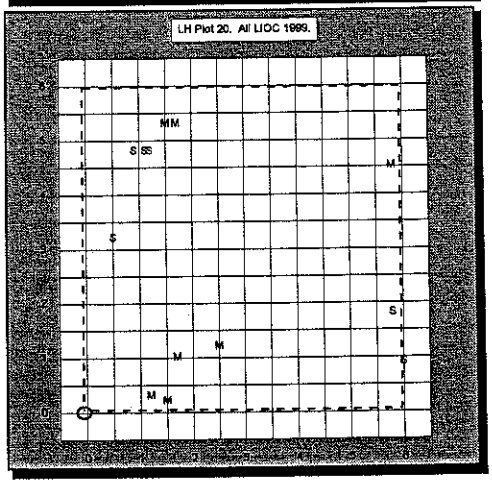


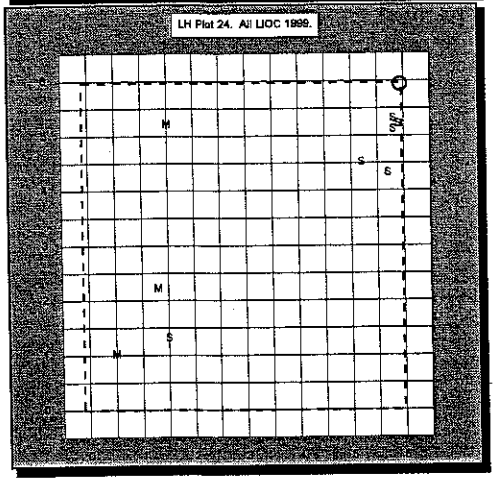












NOTE: s=seedling; m=mature; plots all oriented north; unless noted, seedling plot = entire 6x6' plot; vegetation plot center indicated. Plot 22, seedling plot = west half; Plot 23 seedling plot = south half.

APPENDIX D

SUMMARY OF SPECIES COVER AND HEIGHT 24 VEGETATION PLOTS BEFORE AND AFTER MANUAL TREATMENT, CCMWA

APPENDIX D1: VEGETATION PLOT FIELD DATA PRIOR TO MANUAL TREATMENT, CRESCENT CITY MARSH WILDLIFE AREA; SAMPLED JULY 1998..

NORTH MARSH																																		
PLOT NUMBER	1			2			3			4			5			6			7			8			9			10			11			12	
Vegetation Treated?	Y						Y												Y			Y			Y									Y	
Photopoint orientation (taken 20' from plot center)	180			90			180			360			180			90			90			180			360			360			360			360	
Vegetation type	ED			ED			ED			CM			ED			ED			CM			TLM			ED			ED			ED			ED	
SPECIES	cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht
Alnus rubra																																37	240			
Alnus viridis	2	96		15	108					15	60		15	96		37	96																			
Angelica genuflexa	2	36		2.5	60		2	24		2.5	36		15	72		2.5	72		2	36		2	60		2	36		2.5	72					2.5	72
Athyrium felix-femina													2.5	48		2.5	48					2	48		2	36					2.5	48			
Blechnum spicant													2.5	48								2	48		2	36					15	48		2	40
Calamagrostis nutkaensis	85	42		62	48		62	42		85	42		62	48		87	48		62	36		37	42		62	42		62	36		15	36		62	40
Carex obnupta	15	36		37	48		37	30		15	36		37	48		15	48		15	36		15	42		2	48		37	48		2.5	48		62	48
Carex spp.																																				
Comus sericea																																				
Deschampsia caespitosa										2.5	48																									
Epipactus gigantea																																				
Equisetum spp.																			15	24		2	24		2	36		2.5	36					2.5	36
Galium trifidum																																				
Gaultheria shallon																																				
Gentiana sceptrum	2	18					2	24		2.5	24		2.5	24		2.5	24					2	24													
Holcus lanatus																																			2	30
Hypericum formosum				2.5	24		2	18																												
Juncus leseurii																			2	24					2	48					2.5	60		2	48
Ledum glandulosum	15	48		15	48		37	30		37	48		85	48		97	36		37	36		62	36		62	36		62	48		85	48		37	30
Lonicera involucrata	15	48		15	60					15	72					2.5	48		2	36					2	48					15	84			
Lotus formosissimus																																				
Lysichiton americanum	15	30		15	48		15	24		2.5	36		15	36		15	48		15	24		15	24		15	36		2.5	24		2.5	36		2	36
Maianthemum dilatatum																																				
Malus fusca																																				
Menyanthes trifoliata	15	12		2.5	12		15	12		2.5	12		2.5	12		15	12		15	12								2.5	12						
Myrica californica										15	72					2.5	96								2	144		37	144		15	96			
Oenanthe sarmentosa																																				
Picea sitchensis										15	200					15	225											2.5	120						
Rhamnus purshiana																2.5	36																		
Potentilla palustris	37	30					37	36		37	24		15	36					37	36		37	36		15	36		15	24					15	24
Pteridium aquilinum																																				
Rhododendron occidentalis	15	60																	2	24		2.5	48		2.5	72					2.5	72		2	84
Rubus ursinus										15	24					37	48		2	36		15	24		37	36		62	36		85	48		15	30
Salix spp.													2.5	48																					
Sanguisorba officinalis	37	30		15	24		37	36		62	30		15	36		37	24		37	36		62	36		37	36		37	36		15	24		15	24
Rubus spectabilis																															2.5	72				
Aster chilensis	1	18		2.5	36		2	24		2.5	36		2.5	48																					
Spiraea douglasii	2	36		37	72		37	36		15	36					15	48								2.5	36		15	72		15	72		15	48
Veratrum californicum	2	36																																		
TOTAL COVER	260			221			285			341			274			385			243			256			249			340			312			236	

NOTES: Plots = 30 ft diameter; Treatment consisted of manual removal trees and selected shrubs (see text); Vegetation Types: ED = edge of marsh to willow scrub; CM = Calamagrostis marsh; TLM = tall ledum marsh; LLM = low ledum LLM = low ledum marsh; WS = willow scrub.

APPENDIX D1: (CONTINUED).

SOUTH MARSH																																		
PLOT NUMBER	13			14			15			16			17			18			19			20			21			22			23			24	
Vegetation treated?				Y									Y						Y						Y			Y			Y				
Photopoint orientation	180			360			360			360			45			270			90			315			45			180			45			45	
(taken 20' from plot center)																																		
Vegetation type	ED			TLM			ED			ED			LLM			ED			LLM			ED			TLM			LLM			WS			ED	
SPECIES	cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht
Alnus rubra													2	24					1	30								2	12						
Alnus viridis	15	96		2	60		2.5	60		15	72		2	24		2.5	108		2	24		37	72		2	30		2	24		15	40		62	72
Angelica genuflexa	2.5	60		15	24		15	72		2.5	60		2.5	48		15	72		2	36		15	72		2	48		2	48		2.5	36		2.5	24
Athyrium felix-femina	2.5	48		15	36		15	48					2	36					2.5	36					15	48		2.5	48					2.5	36
Blechnum spicant	15	36								2.5	36		2	36								15	36		2	42		2.5	36		2.5	24		15	48
Calamagrostis nutkaensis	85	48		62	48		62	48		85	48		37	42		85	48		62	48		62	48		15	48		62	42		15	36		15	48
Carex obnupta	37	48								15	48		15	42		15	48		2.5	36		37	48		37	36					15	36		15	48
Carex spp.																																		
Cornus sericea																																		
Deschampsia caespitosa																																		
Epipactus gigantea										2.5	12								2.5	24															
Equisetum spp.																																		
Galium trifidum																												2	24						
Gaultheria shallon																																		
Gentiana sceptrum																												2	30						
Holcus lanatus																												2	24						
Hypericum formosum										2.5	12											2.5	24												
Juncus leseurii							15	48														2.5	48											2.5	48
Ledum glandulosum	85	48		62	48		85	60		62	48		62	42		85	48		62	36		85	60		85	36		62	12		85	12		85	60
Lonicera involucrata	15	60		2	36					2.5	48		2	36		2.5	60		2.5	36		15	72		15	72								2.5	84
Lotus formosissimus																																		
Lysichiton americanum	15	48		37	36		2.5	48		15	48		15	36					15	24		15	48		15	24		15	36		15	36		15	48
Maianthemum dilatatum													2	6		15	48														2	42		15	132
Malus fusca							15	24		2.5	12		15	12		2.5	24		15	12								2.5	12						
Menyanthes trifoliata							15	108																										15	96
Myrica californica	15	96																																	
Oenanthe sarmentosa										2.5	120					2.5	84																	15	240
Picea sitchensis	2.5	36																																	
Rhamnus purshiana	2.5	24		15	30		2.5	36					37	36		15	36		37	36		2.5	24		15	36		15	30		2	24			
Potentilla palustris										2.5	36																								
Pteridium aquilinum	2.5	48					2.5	72														2.5	72		2.5	36					2.5	48			
Rhododendron occidentalis	15	36		2	36																	15	48		15	36					2	12		15	36
Rubus ursinus							37	120		15	84		2	60		37	96		2	48					15	72									
Salix spp.	15	24		37	30		15	24		2.5	24		37	36		15	36		37	36		15	36		37	36		37	36		15	36		15	36
Sanguisorba officinalis	2.5	36																																	
Rubus spectabilis				2.5	48					2.5	24					2.5	36								2.5	36		25	24						
Aster chilensis										15	48								15	36								2	30		2	48			
Spiraea douglasii				2	30																														
Veratrum californicum																																			
TOTAL COVER	327			254			284			247			235			295			260			321			275			215			176			292	

NOTES: Plots = 30 ft diameter; Treatment consisted of manual removal trees and selected shrubs (see text); Vegetation Types: ED = edge of marsh to willow scrub; CM = Calamagrostis marsh; TLM = tall ledum marsh; LLM = low ledum LLM = low ledum marsh; WS = willow scrub.

APPENDIX D2: VEGETATION PLOT FIELD DATA FOR PLOTS MANUALLY TREATED OCTOBER 98, CRESCENT CITY MARSH WILDLIFE AREA; SAMPLED JULY 1999.

NORTH MARSH																																		
PLOT NUMBER	1			2			3			4			5			6			7			8			9			10			11			12	
Vegetation Treated?	Y						Y												Y			Y			Y									Y	
Photopoint orientation	180			90			180			360			180			90			90			180			360			360			360			360	
(taken 20' from plot center)																																		
Vegetation type	ED			ED			ED			CM			ED			ED			CM			TLM			ED			ED			ED			ED	
SPECIES	cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht
Alnus rubra																																				
Alnus viridis	2	96																																		
Angelica genuflexa	2	36					2	24											2	36		2	60		2	36									2.5	72
Athyrium felix-femina																						2	48		2	36										
Blechnum spicant																						2	48		2	36									2	40
Calamagrostis nutkaensis	85	42					62	42											62	36		37	42		62	42									62	40
Carex obnupta	15	36					37	30											15	36		15	42		2	48									62	48
Carex spp.																																				
Cornus sericea																																				
Deschampsia caespitosa																																				
Epipactus gigantea																																				
Equisetum spp.																			15	24		2	24		2	36									2.5	36
Galium trifidum																																				
Gaultheria shallon																																				
Gentiana sceptrum	2	18					2	24														2	24													
Holcus lanatus																																			2	30
Hypericum formosum							2	18																												
Juncus leseuri																			2	24					2	48									2	48
Ledum glandulosum	15	48					37	30											37	36		62	36		62	36									37	30
Lonicera involucrata	15	48																	2	36					2	48										
Lotus formosissimus																																				
Lysichiton americanum	15	30					15	24											15	24		15	24		15	36									2	36
Maianthemum dilatatum																																				
Malus fusca																																				
Menyanthes trifoliata	15	12					15	12											15	12																
Myrica californica																									2	144										
Oenanthe sarmentosa																																				
Picea sitchensis																																				
Rhamnus purshiana																																				
Potentilla palustris	37	30					37	36											37	36		37	36		15	36									15	24
Pteridium aquilinum																																				
Rhododendron occidentalis	15	60																	2	24		2.5	48		2.5	72									2	84
Rubus ursinus																			2	36		15	24		37	36									15	30
Salix spp.																																				
Sanguisorba officinalis	37	30					37	36											37	36		62	36		37	36									15	24
Rubus spectabilis																																				
Aster chilensis	1	18					2	24																												
Spiraea douglasii	2	36					37	36																	2.5	36									15	48
Veratrum californicum	2	36																																		
TOTAL COVER	260			0			285			0			0			0			243			256			249			0			0			236	

NOTES: Plots = 30 ft diameter; Treatment consisted of manual removal trees and selected shrubs (see text); Vegetation Types: ED = edge of marsh to willow scrub; CM = Calamagrostis marsh; TLM = tall ledum marsh; LLM = low ledum LLM = low ledum marsh; WS = willow scrub.

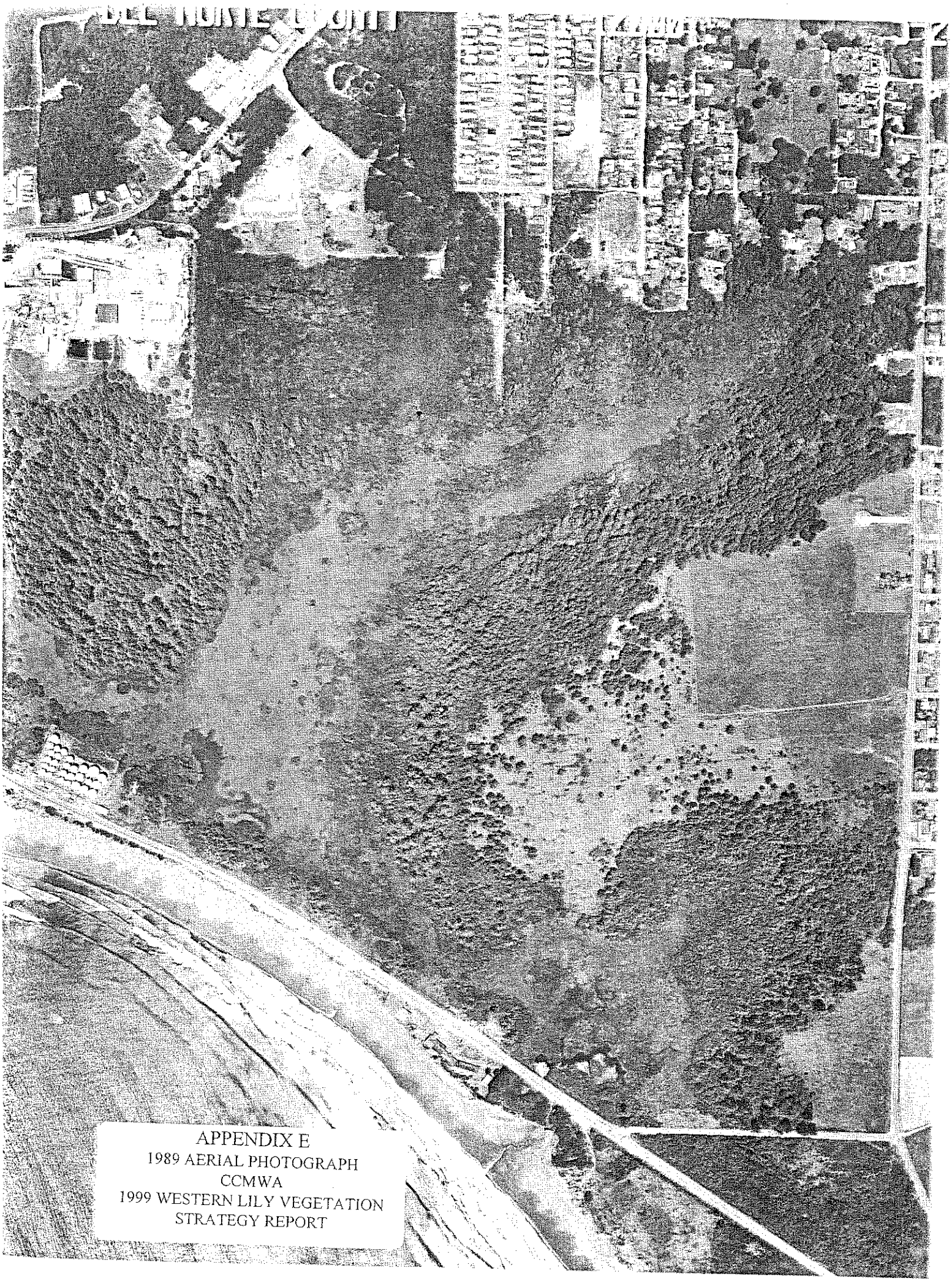
APPENDIX D2: (CONTINUED).

SOUTH MARSH																																				
PLOT NUMBER	13			14			15			16			17			18			19			20			21			22			23			24		
Vegetation treated?				Y									Y						Y						Y			Y			Y					
Photopoint orientation	180			360			360			360			45			270			90			315			45			180			45			45		
(taken 20' from plot center)																																				
Vegetation type	ED			TLM			ED			ED			LLM			ED			LLM			ED			TLM			LLM			WS			ED		
SPECIES	cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht		cov	ht	
Alnus rubra													2	24					1	30								2	12							
Alnus viridis				2	60								2	24					2	24					2	30		2	24		15	40				
Angelica genuflexa				15	24								2.5	48					2	36					2	48		2	48		2.5	36				
Athyrium felix-femina				15	36								2	36					2.5	36					15	48		2.5	48							
Blechnum spicant													2	36											2	42		2.5	36		2.5	24				
Calamagrostis nutkaensis				62	48								37	42					62	48					15	48		62	42		15	36				
Carex obnupta													15	42					2.5	36					37	36					15	36				
Carex spp.																																				
Comus sericea																																				
Deschampsia caespitosa																																				
Epipactus gigantea																			2.5	24																
Equisetum spp.																												2	24							
Galium trifidum																																				
Gaultheria shallon																																				
Gentiana sceptrum																												2	30							
Holcus lanatus																												2	24							
Hypericum formosum																																				
Juncus leseurii																																				
Ledum glandulosum				62	48								62	42					62	36					85	36		62	12		85	12				
Lonicera involucrata				2	36								2	36					2.5	36					15	72										
Lotus formosissimus																																				
Lysichiton americanum				37	36								15	36					15	24					15	24		15	36		15	36				
Maianthemum dilatatum													2	6																						
Malus fusca																															2	42				
Menyanthes trifoliata													15	12					15	12								2.5	12							
Myrica californica																																				
Oenanthe sarmentosa																																				
Picea sitchensis																																				
Rhamnus purshiana																																				
Potentilla palustris				15	30								37	36					37	36					15	36		15	30		2	24				
Pteridium aquilinum																																				
Rhododendron occidentalis																									2.5	36					2.5	48				
Rubus ursinus				2	36																				15	36					2	12				
Salix spp.													2	60					2	48					15	72										
Sanguisorba officinalis				37	30								37	36					37	36					37	36		37	36		15	36				
Rubus spectabilis																																				
Aster chilensis				2.5	48																				2.5	36		2.5	24							
Spiraea douglasii																																				
Veratrum californicum				2	30														15	36								2	30		2	48				
TOTAL COVER	0			254			0			0			235			0			260			0			275			215			176			0		

NOTES: Plots = 30 ft diameter; Treatment consisted of manual removal trees and selected shrubs (see text); Vegetation Types: ED = edge of marsh to willow scrub; CM = Calamagrostis marsh; TLM = tall ledum marsh; LLM = low ledum LLM = low ledum marsh; WS = willow scrub.

APPENDIX E

COPIES OF 1942, 1964 AND 1989 AERIAL PHOTOGRAPHS, CCMWA



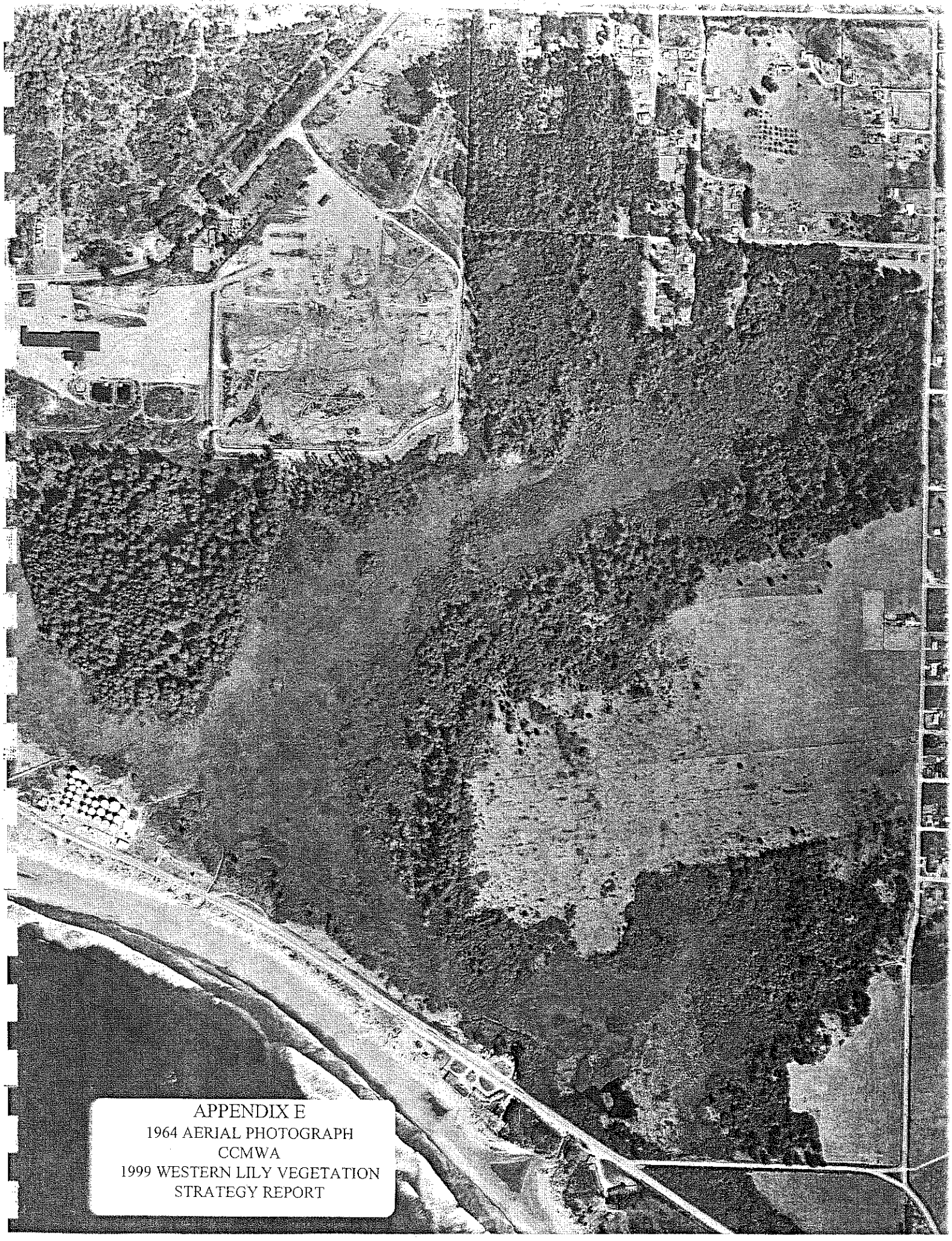
APPENDIX E

1989 AERIAL PHOTOGRAPH

CCMWA

1999 WESTERN LILY VEGETATION

STRATEGY REPORT



APPENDIX E

1964 AERIAL PHOTOGRAPH

CCMWA

1999 WESTERN LILY VEGETATION

STRATEGY REPORT

APPENDIX E

1942 AERIAL PHOTOGRAPH
CCMWA
1999 WESTERN LILY VEGETATION
STRATEGY REPORT