MONITORING VEGETATION AFTER A REDUCTION IN DEER BROWSING AT LONG POINT, LAKE ERIE: 2002

by
Michael S.W. Bradstreet and Jane M. Bowles

Bird Studies Canada
P.O. Box 160
Port Rowan, Ontario, N0E 1M0

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ABSTRACT

This report summarizes the important changes found in shrub stem number, ground layer species cover and vegetation profiles in 15 breeding bird census plots (BBC) at Long Point, Lake Erie from 1991 to 2002. It represents the 12th year of a long-term study to monitor the effects of reduced browsing by White-tailed Deer.

The number of stems of tree and shrub species has generally increased in the years since deer were removed, but in 2002 a reduction in shrub stem numbers from the previous year was observed that may have been due to drought conditions. The disturbed open BBC plot (BGGR) experienced the greatest loss of shrub stems.

Tree seedling numbers have shown an overall increase, but the number of seedlings fluctuates from year to year.

The total amount of ground cover vegetation increased in plots of the late successional stage between 1992 and 2001, but in 2002 there was an overall drop in vegetation cover. Vegetation cover in early successional plots has fluctuated with water levels, but has not shown an overall increase. These plots also lost vegetation cover in 2002. The composition of the ground layer vegetation on Long Point has changed since the study began. The relative amount of graminoids has dropped, while the proportional cover of trees and shrubs has increased.

Vegetation profiles in early successional plots showed little change from previous years except for a small increase in strata below 1 m. In middle and late successional plots there has been an increase in vegetation cover in the lower strata. More shrubs and trees and fewer graminoid species were recorded. Late successional plots also showed an increase in strata above 2 m.

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INTRODUCTION

During the fall and winter of 1989-1990 and 1990-1991, the Canadian Wildlife Service organized the removal of nearly 500 White-tailed Deer from Long Point, Lake Erie, Ontario. In the fall of 1994, an additional 42 deer were removed. In 1991, a long-term monitoring study was established by Bird Studies Canada (formerly Long Point Bird Observatory) to document vegetation and breeding bird communities in the period following the removal of deer. Methodology was established in 1991. Bradstreet et al. (1991) reported results from the first year of effort and results from subsequent years have been reported in Bradstreet and Bowles (1992; 1994; 1995; 1996; 1997, 1998, 1999, 2000 and 2001). This report summarizes the major findings from the twelfth year of monitoring in 2002.

METHODS

One hundred and fifty permanent vegetation quadrats, ten in each of fifteen breeding bird census (BBC) plots, have been monitored annually since 1991 and were revisited during late June and July 2002. Some of the quadrats had to be moved slightly in 1992 and the results reported here represent the changes between 1992 and 2002 for the new plot positions. Details of the methods used to establish the plots were reported in Bradstreet and Bowles (1992). Sampling protocol and monitoring methods are given in Bradstreet *et al.* (1991).

The BBC plots can be grouped into three successional classes: early, middle and late, based on age of dune, position on Long Point, and vegetation characteristics. One plot is classed as disturbed because the tree cover was removed by fire and has never regenerated.

Field Methods:

In 2002, as in previous years, shrub stems in four height classes were counted in ten permanent 10 x 1 m quadrats in each of the 15 BBC plots. Stem counts were made for all shrub and tree species occurring in the 10 x 1 m quadrats. Height classes were recorded as 0-0.5 m, >0.5-1 m, >1-2 m and >2-5 m. All individual shrub stems emerging from the ground were counted. In the case of Common Juniper (*Juniperus communis*) and Eastern Red Cedar (*J. virginiana*) growing in loose sand this count was difficult because of the partial burial by sand of some branches.

Vegetation cover was estimated in ten 1 x 1 m quadrats nested within the shrub quadrats. Cover-abundance estimates were made for all species occurring in the 1 x 1 m quadrats. A 5-point Braun-Blanquet scale (see Mueller-Dumbois and Ellenberg, 1974) was used to estimate cover in each quadrat. Cover values for quadrats in each BBC plot were converted to percentage midpoints and then averaged over the plot. Ground cover estimates for non-living material (litter, sand, water, wood, etc.) were also made. In 1991, 1992 and 1994 to 2002 plots were sampled in late June and early to mid July, but in 1993, sampling was done in mid June.

In 2002, as in 1992 and 1997, ocular readings were made to assess vegetation cover in each of five strata. The presence or absence of living vegetation in each stratum on a vertical profile was recorded. Strata were <0.5m, 0.5-1

m, >1-2 m, >2-5 m and >5 m. Five rods, each 1 m long with joints at one end were stacked to establish point profiles. The presence of vegetation was recorded if living plant material touched a line running up the front of the rod. Hits above 5 m were recorded by siting through a periscope attached at eye level to one of the rods. Vegetation hits in each profile were classified into physiognomic classes: graminoid, forb, fern, shrub and tree. Where two or more types of plants were present in one stratum, the lowest hit in each stratum was used to record the physiognomic class. Starting at 20 permanent stakes in each BBC plot, 10 profiles were measured in a line at 2 m intervals, for a total of 200 profiles per BBC plot. The starting stakes and direction of travel were established in 1991 and retained for the 2002 survey.

Data Analysis:

Shrub stem counts and ground cover estimates for each species were summarized over the 10 quadrats in each of the BBC plots for each year. Data were summarized in spreadsheet format. All data for 1992 to 2001 are also stored in Paradox database format.

RESULTS AND DISCUSSION

Shrub stem counts:

The total number of woody stems of all species counted in all plots for eleven years, 1992-2002, is given in Table 1. The numbers of stems counted in each height class for each species are presented in Appendix A. Values in Table 1 and Appendix A should be multiplied by a factor of 100 to represent the estimated number of stems per hectare. A legend to BBC plot codes in given in Table 2.

Overall there has been an increase in the number of shrub stems over the study period, but patterns of increase vary among the plots and the successional stages. In early successional peak numbers of shrubs were reached in 1996. Since then shrub numbers have fluctuated and in 2002 shrub stem numbers reached the lowest of any years since the study started. In the disturbed plot, Bluegrass Grassland (BGGR), there was a consistent increase from 12 stems in 1992 to over 1300 in 2001, but in 2002 the shrub stem numbers dropped dramatically. The number of shrub stems in middle successional plots increased steadily until 1996. In 1997 there was a drop in the number of shrubs, partly caused by high water levels in some of the plots. Between 1997 and 2000 the number of shrub stems increased again, but since then has been declining. Numbers of shrubs in the late successional plots have also fluctuated, but show an increasing trend followed by a sharp drop in 2002.

Table 1: Total number of shrub stems counted for each BBC plot in 1992-2001.

SUCCESSIONAL STAGE		YEAR										
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
EARLY	**DCSD**	5	14	19	16	55	66	103	98	146	190	215
	SRS1	84	278	256	785	260	38	2	214	138	38	6
	SRS2	1120	1222	1208	1674	1703	620	579	1246	1572	326	325
	IDSS	560	993	983	1386	1356	618	265	158	92	66	63
	DCJS	1397	1710	1778	1729	2372	1051	869	1183	987	594	354
	TOTAL	3166	4217	4244	5590	5746	2393	1818	2899	2935	1214	963
MIDDLE	**STDP**	358	283	421	540	588	527	614	707	900	849	752
	TMSL	757	940	1008	1008	1423	901	882	890	1091	1086	1050
	WPWC	744	693	688	697	975	1027	1097	1150	1348	902	817
	TOTAL	1859	1916	2117	2245	2986	2455	2593	2747	3339	2837	2619
LATE	**ROWB**	230	308	376	522	811	909	982	1314	1556	1596	1532
	ROWP	43	152	290	557	1204	881	696	743	891	1059	711
	ROIS	10	12	39	32	26	52	32	63	39	40	50
	RORA	359	414	538	963	1737	1655	1687	1616	1716	1570	987
	ROMS	236	348	632	648	769	467	569	973	1307	1388	1372
	ROSF	144	2086	714	593	575	831	719	704	920	1276	812
	TOTAL	1022	3320	2589	3315	5122	4795	4685	5413	6429	6929	5464
DISTURBED	**BGGR**	12	31	103	267	462	665	738	953	1239	1305	362
OVERALL TOTAL		6053	9469	9002	11284	14085	9976	9465	11536	13323	11633	9227

Increases in shrub stems in all plots during the early years of the study can probably be attributable to a reduction in deer browse, but other factors affect shrub numbers and complicate the picture. Different species in plots at various successional stages respond differently to external factors such as deer browse, changes in lake level and drought. Growth patterns and means of recruitment in different species also affect overall stem counts.

In early successional plots, Kalm=s St. John=s-wort (*Hypericum kalmianum*) (HYPKALM) is the most abundant shrub species. This shrub may be responding to changes in lake levels as well as associated increases in species such as Twig-rush (*Cladium marisicoides*) that grow in the same habitat (Bradstreet and Bowles, 2002).

Numbers of stems of other species in early successional plots have fluctuated over the study period. Table 3 shows the number of stems of all species recorded in early successional plots since the study began. Most species show a fluctuating pattern of recruitment with a small number of species “flashing” in and out over the years. This kind of pattern can be expected when species are recruiting through seedlings and survivorship is an important factor. For

example Cottonwood (*Populus deltoides*) (POPDELT) has wind blown seeds that germinate along strand lines around the edge of dune ponds. Only when conditions are right will recruitment occur. Seedling mortality is very high and most seedling do not survive past their first year. Since 1997 the lake levels, and the water levels in dune swales has been relatively low and wide strand areas has been available for Cottonwood seeds to germinate. The appearance of Cottonwood in the counts since 1997 reflects this phenomenon. Other species show similar fluctuations, with the long term establishment of only a few individuals.

Table 2: Legend to breeding bird census plot codes and successional stage.

CODE	BBC PLOT NAME	SUCCESSIONAL STAGE
DCSD	Dry Cottonwood Sand Dune	EARLY
SRS1	Sedge - Rush Swale #1	EARLY
SRS2	Sedge - Rush Swale #2	EARLY
IDSS	Intergrading Dune Swale Savannah	EARLY
DCJS	Dry Cottonwood - Juniper Savannah	EARLY
TMSL	Tamarack Slough	MIDDLE
WPWC	White Pine - White Cedar Savannah	MIDDLE
STDP	Sedge Tamarack Dune Pond	MIDDLE
ROWB	Red Oak - White Birch Savannah	LATE
ROWP	Red Oak - White Pine Savannah	LATE
ROIS	Red Oak - Ironwood Savannah	LATE
RARO	Red Ash - Red Oak Savannah	LATE
ROMS	Red Oak - Sugar Maple Savannah	LATE
ROSF	Red Oak - Sugar Maple Forest	LATE
BGGR	Blue Grass Grassland	DISTURBED

Wild Red Raspberry (RUBIDEA), once it is established, spreads by underground rhizomes. This species has become established in early successional plots since 1998. In 2002 there were fewer Wild Red Raspberry stems than in 2001, a trend reflected throughout all successonal stages, and discussed below.

Table 3: Number of stems of all shrub species recorded from early successional plots from 1992 to 2002. See Appendix 1 for legend to species codes.

SPECIES CODE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
ACERUBR										1	
HYPKALM	3131	4040	4142	5461	5629	2301	1630	2741	2499	932	666
JUNCOMM	2	1	1	8		3	4	7	11	7	3
JUNVIRG	11	16	12	12	13	12	15	13	22	19	23
LARLARI										1	
PINSTRO					1						
POPDELT							51	10	215	28	6
PRUNUS.		1									
PRUSERO				2	2						
PRUVIRG	1	2	4	2	11	6	4	4	3	4	3
RHURADI		1		1			1	3	3	2	2
ROSPALU								3	24		7
ROSRUBI	5	10	7	10	5	5	7	6	3	6	4
RUBIDAE	2						2	8	37	48	31
SALEXIG									4	11	11
THUOCCI	1	1		1	1	1	1	1	1	1	2
VITRIPA	13	145	78	93	84	65	103	103	113	154	205

Riverbank Grape (*Vitis riparia*) (VITRIPA) is a vine. Once established it spreads very rapidly by growth of stems. This species has shown an enormous response to a reduction in browsing pressure on early successional dunes throughout Long Point. Grapevines cover many areas that were previously open and have established themselves on many trees and shrubs on the younger dunes. The number of grape stems rooted in a quadrat may not be a particularly good indicator of the actual amount of biomass of the species. Grape stems are also difficult to count because of the form of the plant. There was a peak in the number of individuals in 1993, because a large number of seedlings germinated in one plot, and subsequent self-thinning. Since then, there has been an overall increase in the number of grape stems. Figure 1 shows the increase in the amount of grape in early successional plots measured by number of stems, the number of quadrats where it occurred and the total percent cover in plots from 1992 to 2002. Although there have been fluctuations in all three values, overall an increase in the amount of Riverbank Grape is clearly demonstrated. This increase is probably a direct result of a reduction in deer browse.

Wild Red Raspberry is the commonest shrub species in middle and late successional plots and also in the disturbed plot BGGR. The amount of Wild Red Raspberry has increased on Long Point over the study period, but once a patch is established the number of stems may actually decrease as the individual ramets get larger (Bradstreet and Bowles, 2002). The number of Wild Red Rasberry stems has also been affected by environmental factors such as flooding in some quadrats. In 2002 the number of stems of Wild Red Raspberry was somewhat less than in the previous year in middle and late successional plots, but there was a dramatic decline in numbers in BGGR (Figure

2). In middle and late successional plots the decline was of the same order of magnitude as in other years, for example in 1997, the high water year. Both middle and late successional plots show similar patterns in Wild Red Raspberry stem numbers over the study period. In contrast in BGGR there was an overall increase in all years until 2001. The most likely explanation for the sudden reduction of the number of shrub stems in BGGR is drought. 2002 was the fourth year running with lower-than-normal rainfall during the summer. The BGGR plot comprises mostly open dunes. Water stress is likely to be higher than in plots with substantial tree cover. The stems of Wild Red Raspberry in BGGR are short (<0.5 m) and widely spaced in contrast to those in the middle and late successional plots that form dense thickets over 1 m tall.

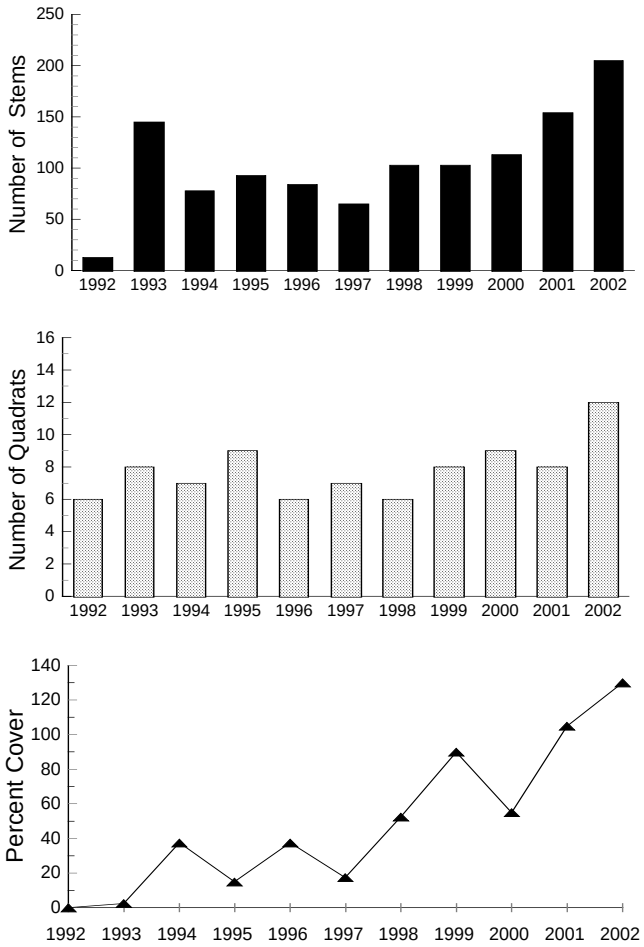

Figure 1: Number of Riverbank Grape stems, number of quadrats where the species was recorded and total estimated percent cover in early successional BBC plots at Long Point, Ontario from 1992 to 2002.

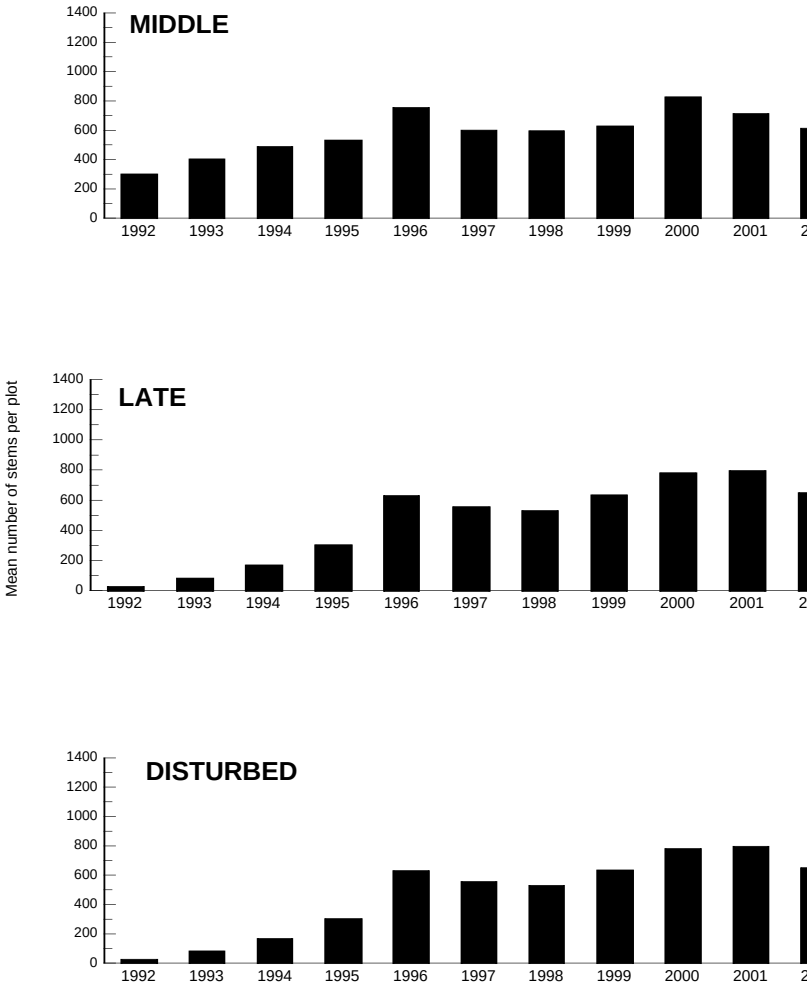

Figure 2: Mean number of Wild Red Raspberry stems counted in middle and late successional plots and the disturbed plot from 1992 to 2002.

The number of tree seedlings in late successional plots also showed a substantial decline in 2002 compared with 2001 (Figure 3). Tree seedling recruitment has fluctuated over the study period. The peaks are associated with mast years for species such as Sugar Maple (*Acer saccharum*) and oaks. Since 2001 was a peak year, it is difficult to determine whether the observed decline in the number of tree seedlings is due to natural attrition or whether it was accelerated by drought conditions.

The number of small tree recruits in late successional plots surviving to enter the larger size classes appears to be

leveling off (Figure 4). The number of recruits has fluctuated, but not changed significantly since 1997, when a large increase was observed. Since then there has been movement of trees into the>1 m and >2 m classes, but the total number of trees has not really changed. In 2002 there appeared to be a small decline, but whether this is real, or just

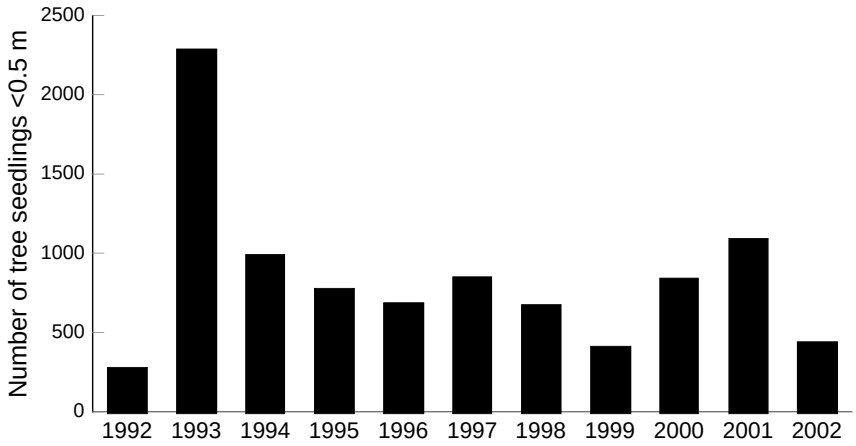

Figure 3: Number of tree seedlings <0.5 m in late successional BBC plots on Long Point, Ontario from 1992 to 2002.

part of the natural fluctuation will have to be determined in subsequent years.

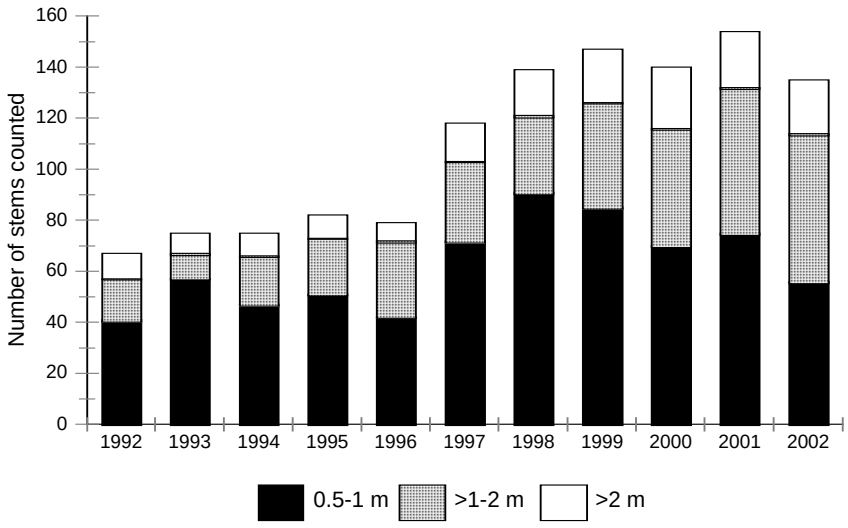

Figure 4: Number of tree recruits in three larger size classes, >0.5-1 m, >1-2 m and >2 m in late successional BBC plots on Long Point, Ontario from 1992 to 2002.

Ground layer vegetation:

Tables of ground cover estimates for species in each plot for 1992 to 2002 are presented in Appendix C. The tables show estimated ground cover for all species with a relative cover of at least 1% in at least one year, or present in at least two quadrats in the plot in at least one year. Table 3 summarizes the estimated total ground cover for all plots from 1992 to 2002 and gives the means for each successional stage. Mean values are plotted in Figure 5.

Table 3: Estimated total percent ground cover for vegetation in BBC plots at Long Point, Ontario from 1992 to 2001.

SUCCESSIONAL STAGE	PLOT	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	DCJS	33.9	49.56	59	53.55	69.2	41.73	63.44	65.61	54.1	48.33	48.84
	DCSD	36.4	49.2	61.97	68.13	53.67	51.17	69.92	88.06	76.66	84.37	73.11
EARLY	IDSS	56.3	63.58	86.36	89.99	58.21	31.93	66.7	72.65	56.66	56.58	20.17
	SRS1	32.9	8.1	12.37	30.51	13.59	1.58	12.07	12.65	28.25	61.86	43.13
	SRS2	44.3	61.7	54.14	62.63	49.81	13.15	29.1	38.26	54.12	61.55	61.55
	MEAN	40.8	46.4	54.8	61.0	48.9	27.9	48.2	55.4	54.0	62.5	49.4
	STDP	73.7	90.9	102.01	128.26	107.31	84.57	129.19	99.24	104.28	144.16	116.94
MIDDLE	TMSL	70.0	84.42	75.18	91.08	99.38	50.98	79.93	69.99	91.51	87.1	90.18
	WPWC	68.5	81.82	81.58	87.56	90.52	60.78	94.63	81.42	94.43	101.62	77.49
	MEAN	70.7	85.7	86.3	102.3	99.1	65.4	101.3	83.6	96.7	111.0	94.9
	ROWP	49.0	108.99	118.21	122.68	125.96	122.92	142.91	143.18	124.95	139.08	97.22
	ROWB	68.9	103.98	99.43	102.46	115.69	78.77	123.41	124.34	102.97	107.64	103.7
	RARO	55.5	94.96	106.97	121.66	128.95	86.72	143.41	110.17	99.15	121.35	114.47
LATE	ROIS	70.7	56.54	84.3	102.72	97.42	88.21	108.96	91.25	99.88	113.33	87.48
	ROMS	58.4	104.8	92.36	101.85	104.78	124.51	118.26	117.51	145.44	135.18	92.41
	ROSF	40.3	74.23	91.89	103.71	91.5	77.65	112.63	111.58	99.15	99.13	103.39
	MEAN	57.1	90.6	98.9	109.2	110.7	96.5	124.9	116.3	111.9	119.3	99.8
DISTURBED	BGGR	49.39	59.94	77.42	74.63	81.93	64.66	81.89	64.83	82.86	93.83	55.71

The ground cover in all plots increased over the first few years of the study. This was probably a direct response to release from deer browsing. In 1997 there was a drop in vegetation cover in all successonal stages. This was mainly a result of flooding in some portions of the plots. After 1997 the ground cover in all plots increased again, but since then has fluctuated, with a smaller peak in 2001. All plots have more ground layer vegetation than they did at the beginning of the study. Except in 1992 late successional plots have had more ground layer vegetation than middle successional plots, that have had more vegetation than early successional plots. The disturbed plot falls between

early and middle successional plots. In 2002 the ground cover dropped in all plots, but the drop was most marked in BGGR. This is also the plot that had a major reduction in shrub stem numbers in 2002, and the decline is most likely a result of drought.

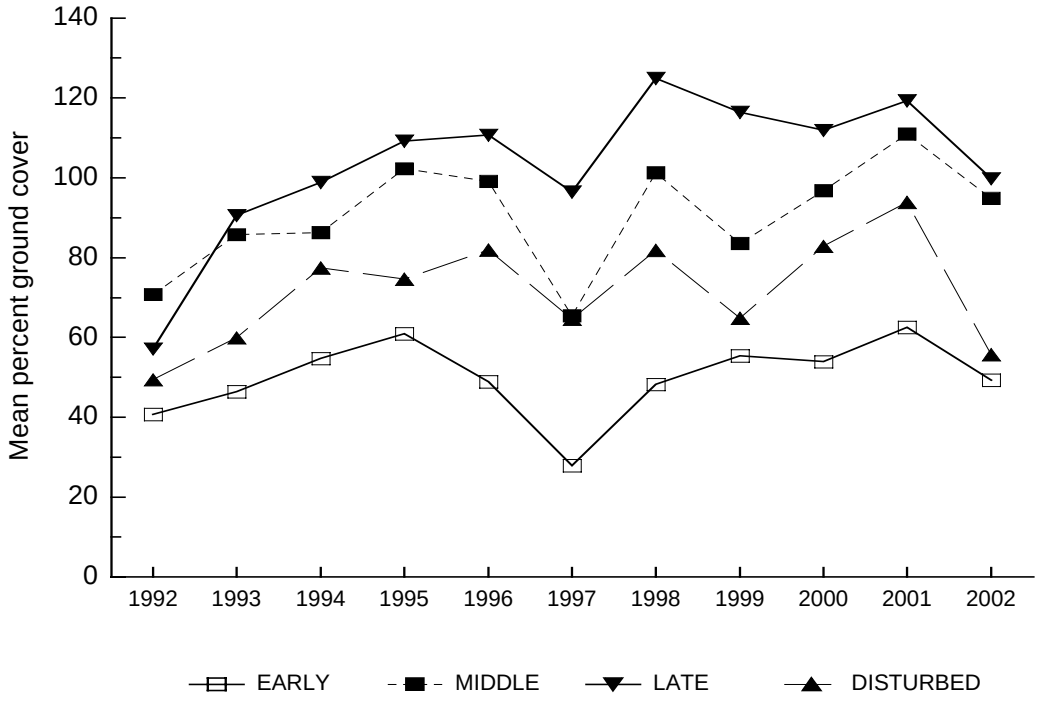

Figure 5: Plot of total ground cover estimates for early, middle and late successional and disturbed BBC plots at Long Point, Ontario from 1992 to 2002.

Figure 6 shows the relative number of different plant forms in early, middle and late successional plots in 1992 and 2002. In early successonal plots graminoids dominated in 1992 and in 2002, but in 2002 bryophytes, shrubs, ferns and forbs had all increased at the expense of graminoids. In middle successional plots the relative proportion of graminoids decreased; shrubs and some forbs have replaced them. Shrubs are now the main ground cover in middle successional plots. In late successional plots shrubs also replaced garminoids, with a small increase in forbs and ferns. Since White-tailed Deer are browsers, graminoid species are the least favoured plant type. Other plants would be expected to respond more to a decrease in browsing. It appears that the composition of the ground layer flora on Long Point has changed in response to a reduction in browsing pressure. Bradstreet and Bowles (2002) also showed that shrubs appear to have responded most consistently in the ground layer.

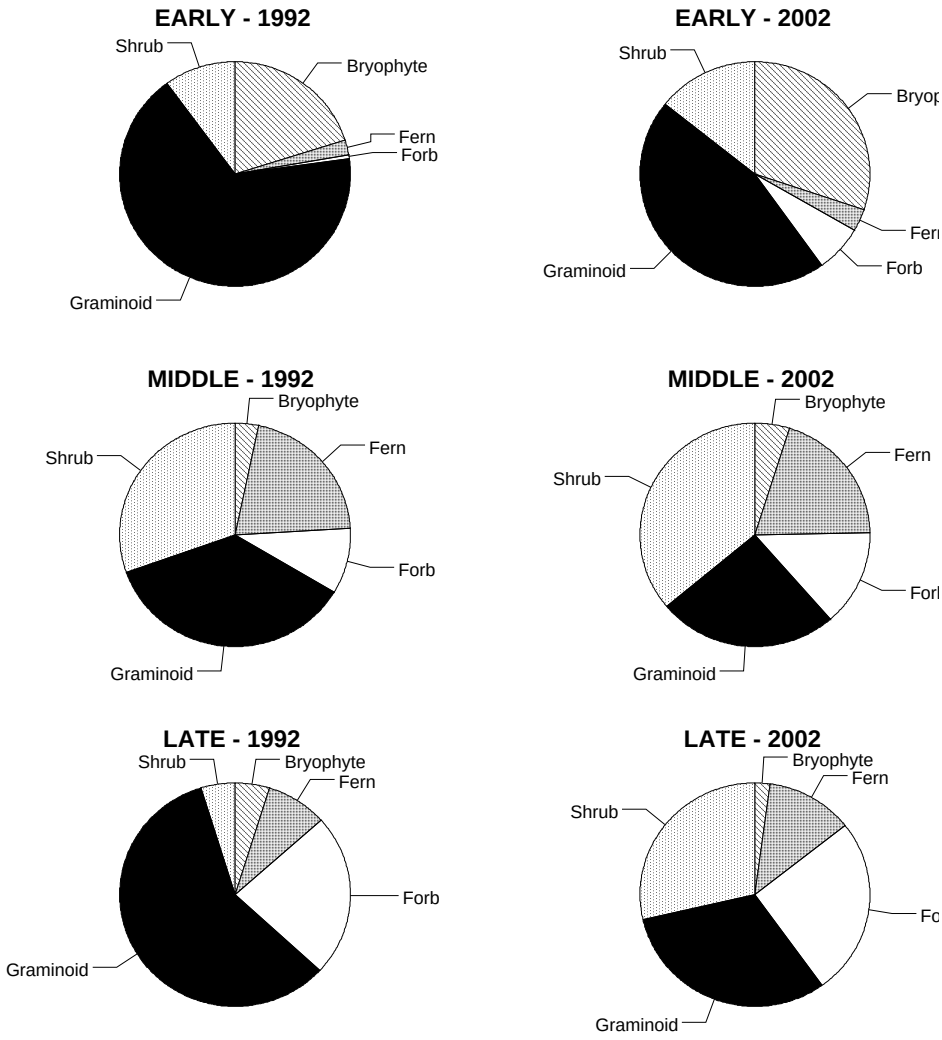

Figure 6: Pie charts showing the relative proportion of different plant forms in early, middle and late successional BBC plots on Long Point, Ontario in 1992 and 2002.

Ocular readings:

Figure 7 shows vertical profiles for each BBC plot in 1992, 1997 and 2002. Profile shapes differ significantly among the successional stages. The open early successional plots have moderate ground cover <0.5 m, low cover to 1 m and almost no vegetation above this point. The only exception is DCSD that has an open tree cover of Eastern Cottonwood. There has been little change in the vegetation profiles since 1992 except for a small increase in ground cover in most plots.

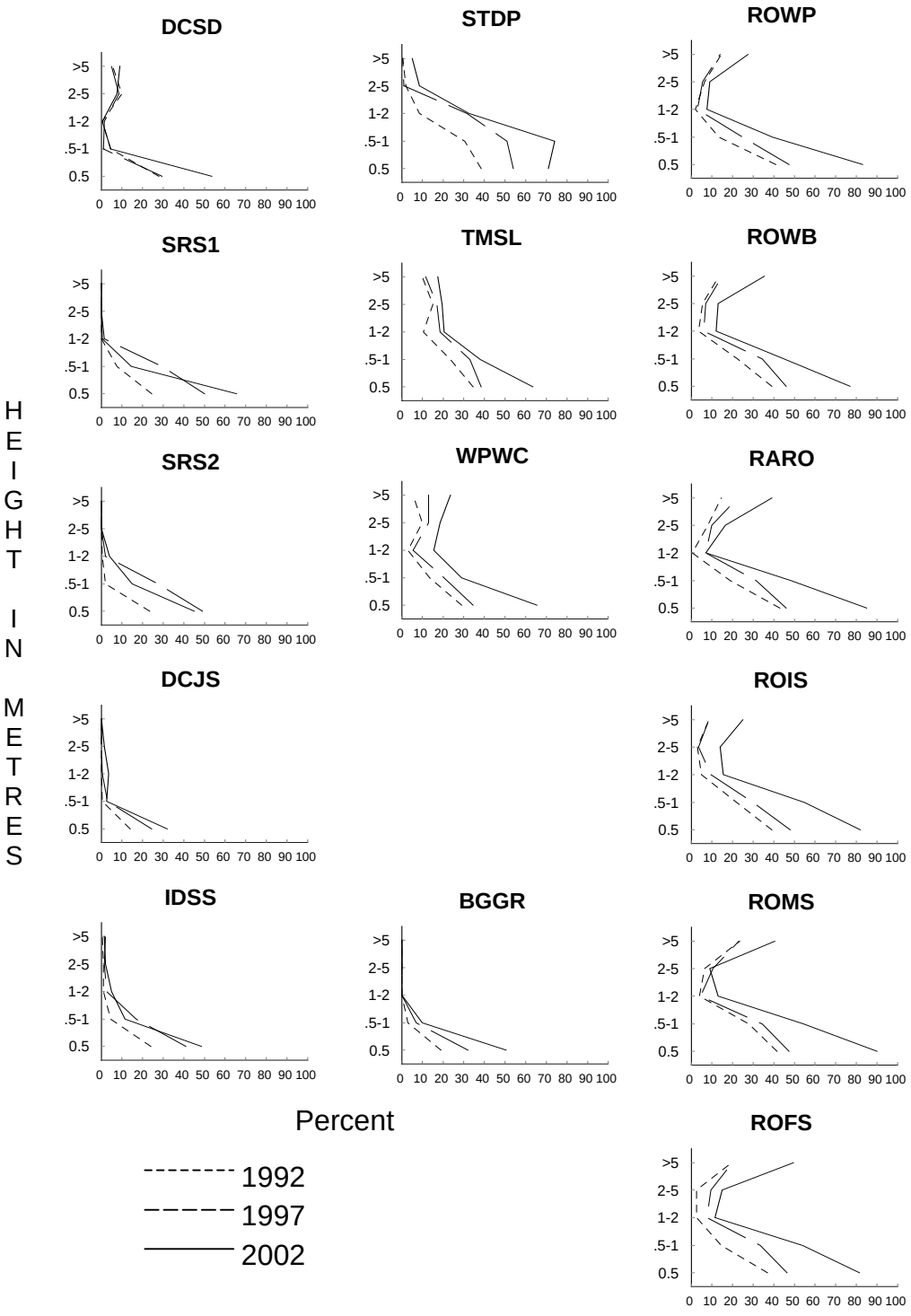

Figure 7: Vegetation profiles from 1992 to 1997 in BBC plots at Long Point, Ontario.

The disturbed plot BGGR has a similar profile to the early successional plots. The only change between 1992 and 2002 has been a consistent increase in the ground cover below 1 m. Middle successional plots show moderate ground cover, but also significant cover higher in the profile. Shrubs and trees above 1 m are apparent, and have generally increased since 1992, especially in WPWC. All three middle successional plots show a substantial increase in ground cover since 1992. Late successional plots also have a characteristic profile. Tree cover above 5 m is higher than in the early and middle successional plots. All late successional plots show an increase in tree cover since 1992. This may not be a direct response to deer browsing because the upper strata (>2 m) are well above the reach of deer. Fast growing trees of Sassafras in some late successional plots, and which are now above 5 m, may account for some of the increased cover. An increase in cover in all strata below 2 m is evident in all plots.

A breakdown of the plant form type in strata below 1 m summarized for all plots is shown in Figure 8. As with the cover data from the quadrats, these data show a gradual increase in the relative cover of shrub and tree species at the expense of graminoids. This is what is expected with recovery from heavy deer browse.

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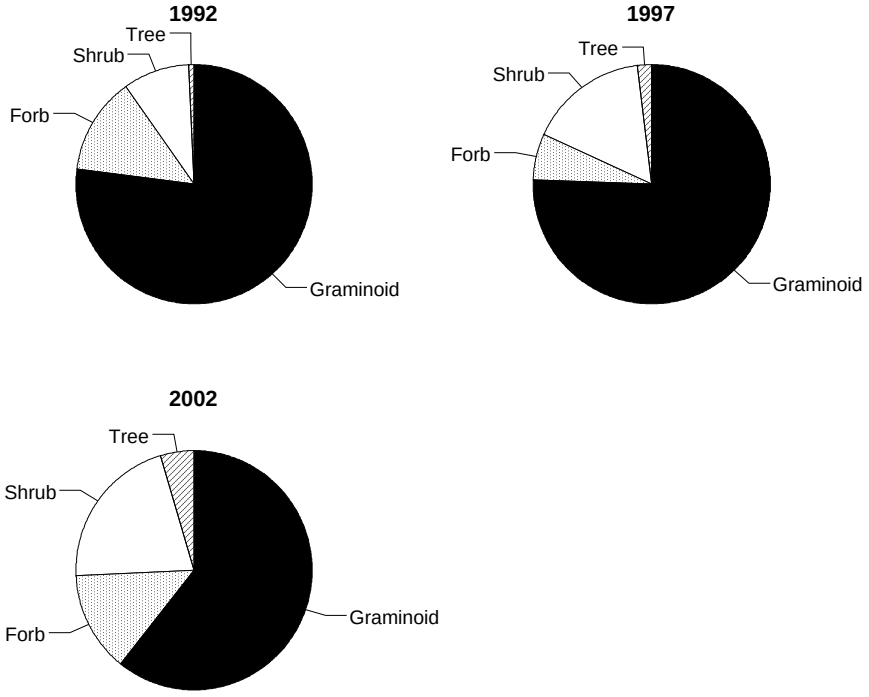

Figure 8: Pie charts showing the relative amounts of different plant forms in strata below 1 m summarized over all BBC plots at Long Point Ontario i.n 1992, 1997 and 2002.

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