ASSESSMENT OF MIGRATORY BIRD DAMAGE TO BLUEBERRY CROPS IN NEW BRUNSWICK DURING 1973

by
Gary P. A. Moran
December 17, 1973

150.44
CWS-AR
Moran
1973
DATA FILE

150.4
Mora
1973

ASSESSMENT OF MIGRATORY BIRD DAMAGE TO BLUEBERRY CROPS IN NEW BRUNSWICK DURING 1973

A Report to the
Canadian Wildlife Service
Contract Number WE73-74-20

by

Gary P. A. Moran
Wildlife Biologist
December 17, 1973

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

The author should like to take this opportunity to express his appreciation to those blueberry growers whose fields were utilized during the summer. Without the growers' complete co-operation, this work would not have been possible.

INTRODUCTION

The report, on bird damage to blueberry crops in New Brunswick, (Moran, 1972), indicated that birds were responsible for some degree of damage to the blueberry crops in New Brunswick during 1972. However, an accurate assessment of the total amount of damage, by birds to the blueberry industry, was not possible. A summation of the returns from the blueberry/bird damage questionnaire suggested that bird damage was extensive, approximately 200,000 dollars for the 1972 crop year.

Regardless of the time of origin, or the causal factors, of the present blueberry crop depredation problem in southern New Brunswick, it is essential to determine if the economic losses suffered by the blueberry farmer warrant further expenditure of federal government agencies' research funds.

This report summarizes the research on bird damage to blueberry crops in New Brunswick during 1973. The research was financed by Canadian Wildlife Service, Department of the Environment, contract number WE 73-74-20, dated 30 March 1973.

OBJECTIVES and PROCEDURES

The first objective of this study was to determine the blueberry crop losses sustained, as a result of robin feeding activities, in relation to geographic location of blueberry fields and crop ripening phenology.

During April twelve blueberry fields were selected for study. Eleven of the selected fields were in New Brunswick (Figure 1) and represented fields in five major blueberry growing areas of southern New Brunswick. One field, a control, was selected in Cumberland County, Nova Scotia (Figure 1). Map references, grid references and the field owner's name, for each study field, are given at Table I.

After discussion with the field owners, their permission was received to utilize the selected fields for the purposes of this study.

Eighteen exclosures, each measuring 150 centimeters long by 30 centimeters wide by 30 centimeters high, were erected in each study field. The exclosures were constructed with four corner posts and enclosed by 2.54 centimeters (one inch) mesh net poultry wire. Two control areas, each measuring 150 centimeters long by 30 centimeters wide were associated with each exclosure. Two control areas were chosen so that a more accurate estimate of the yield would be obtained in case the exclosure had any effect on bird behaviour. The control areas were established 30 and 120 centimeters away from but on the same blueberry clone as the exclosure (Figure 2). The same clone was utilized for the exclosure and the associated control plots to eliminate any variability of fruit yield between the exclosure and controls which could have been due to variability of yield between clones (Moran, 1972).

Each field was divided into three sections, an edge, a mid and

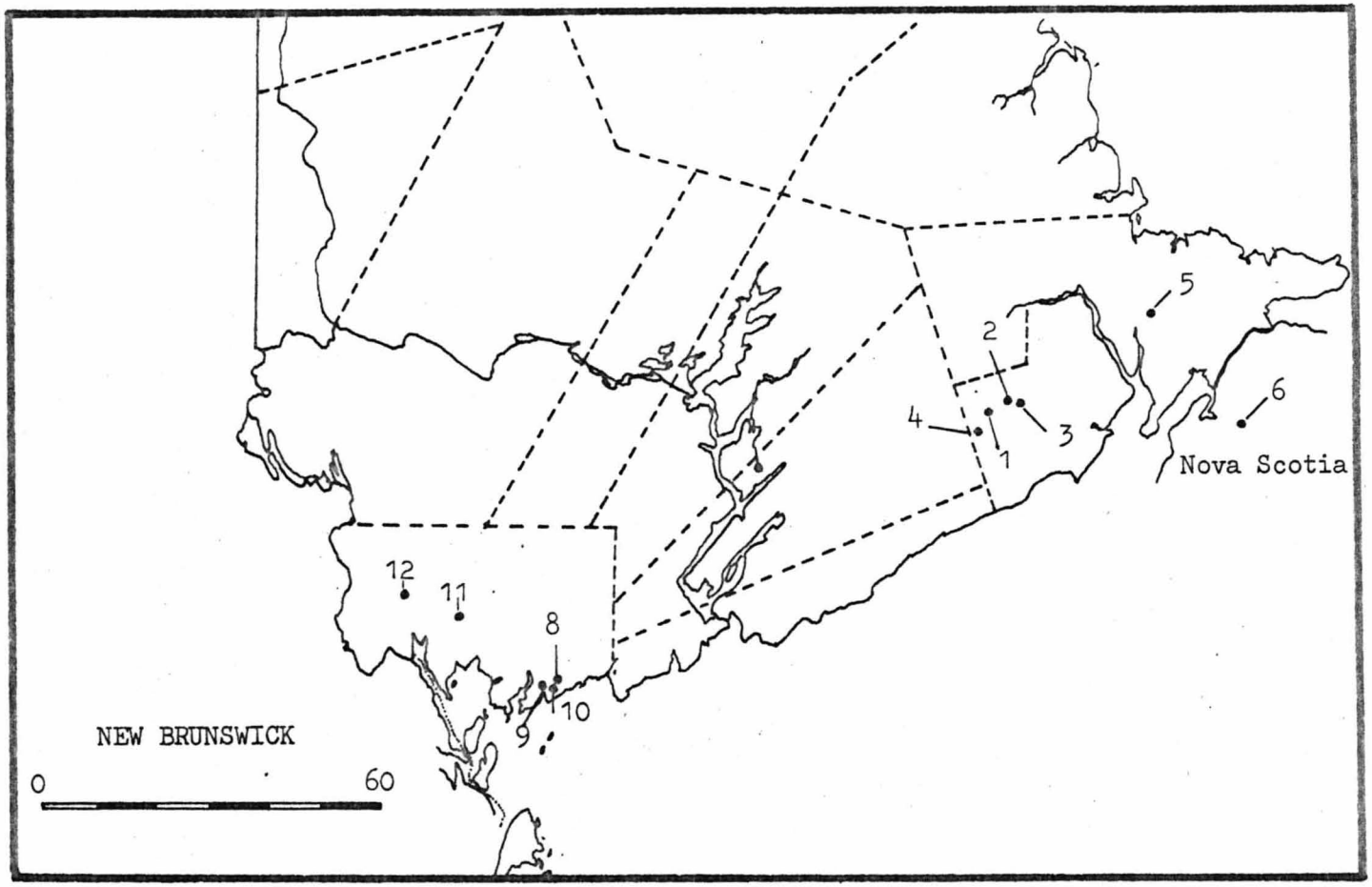

Figure 1. Map of southern New Brunswick and the western portion of Nova Scotia (bordering on New Brunswick) with the approximate locations of the selected blueberry fields indicated. 1. Elgin; 2. Mapleton; 3. Gowland Mountain; 4. Goshen; 5. Memramcook East; 6. Fenwick (Nova Scotia); 7. West Scotch Settlement; 8. Pennfield Station; 9. Pennfield Ridge-McDowell; 10. Pennfield Ridge-McKay; 11. Elmsville; 12. Central Tower Hill.

Table I. Universal transverse mercator grid references for the blueberry fields utilized for study during 1973.

Field Number	Name	Map Reference Number	Edition	Series	Grid Reference	Field Owner
1	Elgin	21 H	3 MCE	A501	LF3673	Raymond Steeves
2	Mapleton	21 H	3 MCE	A501	LF4178	Raymond Steeves
3	Gowland Mountain	21 H	3 MCE	A501	LF4277	Bridges Brothers Ltd.
4	Goshen	21 H	3 MCE	A501	LF3370	Bridges Brothers Ltd.
5	Memramcook East	21 I	2 ASE	A501	LF8399	Leonard Dupuis
6	Fenwick (Nova Scotia)	21 H	3 MCE	A501	MF0768	Roy Hoeg
7	West Scotch Settlement	21 H	3 MCE	A501	KF7565	Bridges Brothers Ltd.
8	Pennfield Station	21 G	2 ASE	A501	FA8401	Martin McDowell
9	Pennfield Ridge, McDowell	21 G	2 ASE	A501	FV8097	Martin McDowell
10	Pennfield Ridge, McKay	21 G	2 ASE	A501	FV8298	Gordon McKay
11	Elmsville	21 G	2 ASE	A501	FA5617	Ward McCann
12	Central Tower Hill	21 G	2 ASE	A501	FA4020	Gordon McKay

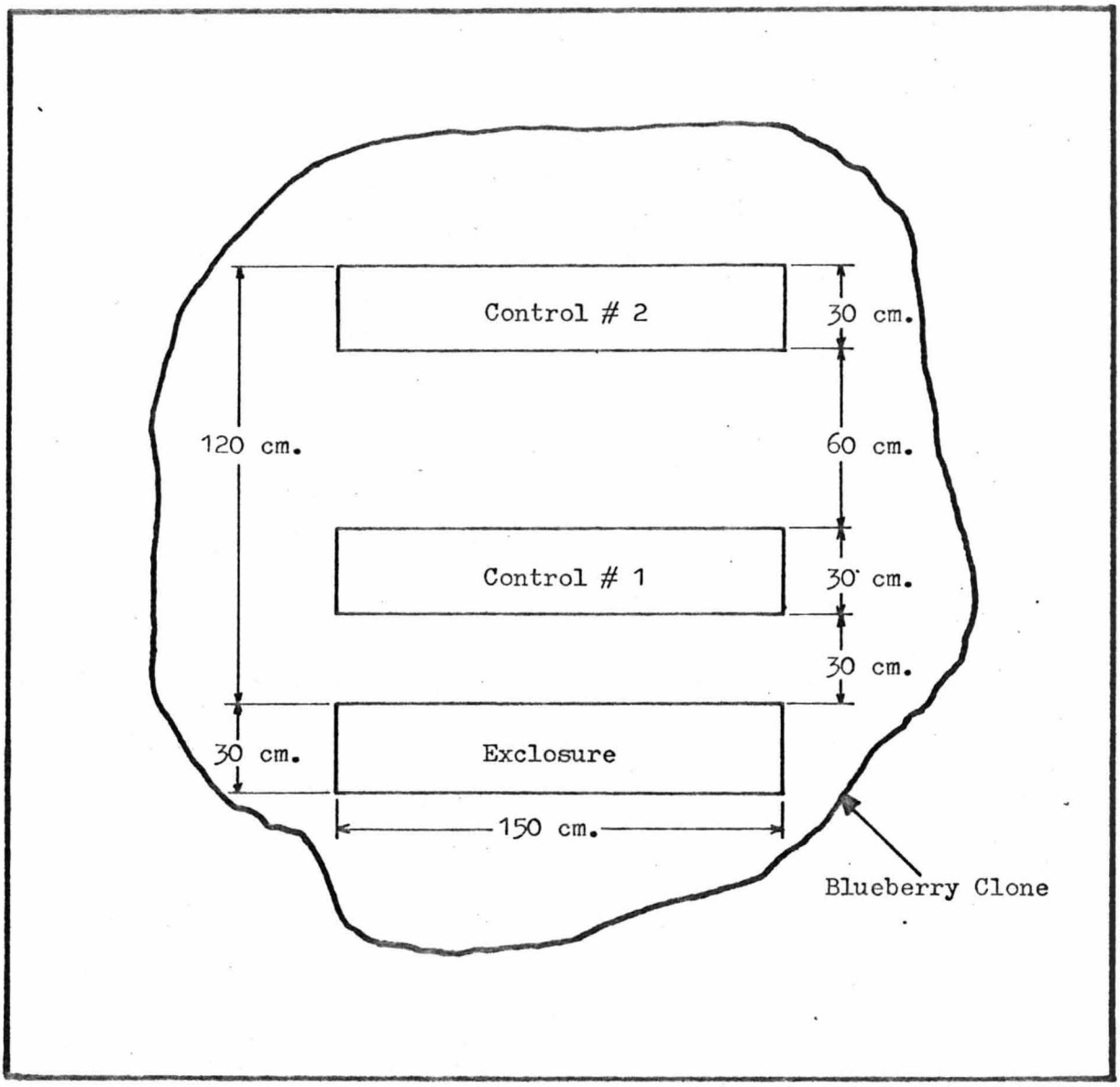

Figure 2. Blueberry clone showing the relative positions of the exclosure and control areas 1 and 2.

a centre section (Figure 3). This was done to increase the accuracy of the damage estimate because it was known that damage was greater close to the field edge (Moran, 1972). Six sample plots, each having one exclosure and two control areas, were distributed throughout each section. Clones were randomly selected, however, they were required to have minimum diameter of 240 centimeters and a uniform bush cover.

Sample plots were set up in May so that clone identification was aided by blossom colour.

Throughout the growing and harvest season, several visits were made to each of the study fields to determine what species were involved in damage to the field.

Harvest of the sample plots was done concurrently with the field owner's harvest. The weight, to the nearest tenth of a gram, was recorded for the blueberries harvested from each exclosure and control plot. The harvest was done with a blueberry harvest rake, 30 centimeters wide, similar to the rakes used by the blueberry pickers.

The crop losses sustained by each field were calculated as follows:

1. The arithmetic mean of the exclosure plot yields for each section was calculated. The standard deviation, $s = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n - 1}}$, where s = standard deviation, Σ = sum of, x = exclosure plot yield, $\bar{x}$ = mean of exclosure plot yields and n = number of exclosures; and, the confidence interval, $\bar{x} - t_{\alpha/2}\frac{s}{n} < u < \bar{x} + t_{\alpha/2}\frac{s}{n}$, where $t_{\alpha/2} = t_{.1}$ per table Freund, 1967, and u is the mean of the population; were also calculated.

2. The arithmetic mean of the control plot yields for each section was calculated. The standard deviation and confidence interval, $t_{.1}$, were also calculated.

3. The possible or before damage yield, (from the exclosures) and

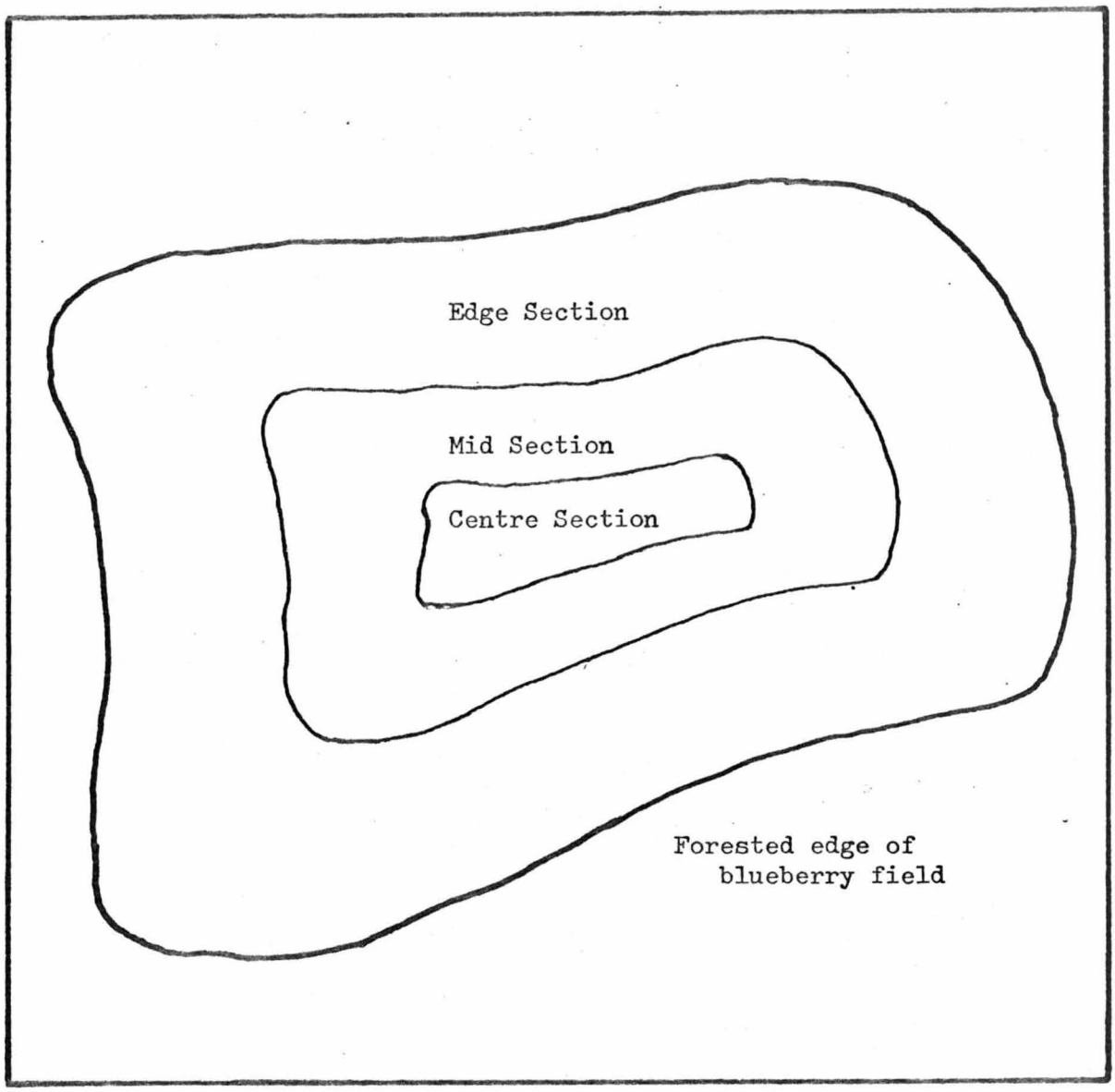

Figure 3. Diagram of a blueberry field showing the field divided into the three sections, edge, mid and centre.

the actual or after damage yield (from the control areas) was calculated for each section by multiplying the mean in each case, by the percent cover, by the area of the section in hectares, and, by the number of 150 by 30 centimeter (4500 square centimeters) areas in one hectare.

With the exclosure and control areas situated on clones no provision was made for those areas of the field which did not produce blueberries. Therefore the yield of each section had to be modified by multiplying the mean yield from each sample by the actual amount of area in the section which was capable of producing crop. The most efficient indicator of this parameter was the percent cover. The percent cover was estimated by using a one meter by one meter quadrate and a percent cover curve. Quadrate samples were taken randomly throughout the field and the percent cover in each quadrate determined visually. The mean percent cover was determined for the ith plot by averaging all the individual percent covers from each plot up to and including the ith plot. This ith mean (vertical axis) was plotted against the ith sample (horizontal axis), the resulting curve was the percent cover curve. Such a curve was obtained because, as the number of sample plots was increased, it included at first a considerable diversity of percent cover, then later as the curve declined to a point of diminishing returns there was little to be gained by increasing the number of sample plots.

The area of each section was determined by the use of a Kent Number 40120 polar compensating planimeter and aerial photographs.

4. The total possible yield for each field was calculated by summing the possible yields of each section.

5. The total actual yield for each field was calculated by summing the actual yields of each section.

6. The total loss of each field was the difference between the

total possible yield of the field and the total actual yield of the field.

7. The percent loss from each field was calculated by dividing the total loss by the total possible yield.

8. The grower's economic loss was calculated by multiplying the total yield lost (pounds) by the average farm price per pound of blueberries.

9. The possible and actual yield in grams per hectares and pounds per acre were calculated.

10. The grower's actual yield at the time of harvest has also been included for comparative purposes.

The second objective was the determination of whether crop damage was caused by robins of local or non-local populations, and an assessment of nesting and feeding attractiveness to robins of habitat surrounding selected blueberry fields.

Two methods were utilized to determine the population composition of robins causing damage to the selected blueberry fields. The first was to wing-tag mature and immature robins using the method described by Hester, 1963. The second was a banding campaign. Robins were banded in, adjacent to, and away from blueberry fields. In order to assess the movement of the banded birds it had been planned to use the band returns from the robins shot during the protection permit holders' shooting campaign.

The second portion of the second objective was an assessment of nesting and feeding attractiveness to robins of habitat surrounding selected blueberry fields. A habitat survey was undertaken for each of the twelve fields utilized during the study and on two occasions a song bird census was done. Continuous observations were also made of

one particular field to assess the feeding attractiveness.

The third and final objective was to assess the relative effectiveness of killing offending robins and alternate control measures. This objective was significantly altered due to the policy set by the Minister of the Environment that no authorized killing of robins would be permitted to protect blueberry crops in New Brunswick during 1973. Due to the shortage of funds provided for the contractor, control devices with which to undertake specific effectiveness test were not available. Control devices which were owned, located and used by the blueberry growers were subjectively evaluated. Evaluations of the growers' control devices were made by observation and by flush count.

CROP DAMAGE ESTIMATES

Yield data and harvest date for each sample plot of study fields one through twelve are given at Tables II to XIII respectively.

Field two, Mapleton, was severely damaged by a hail storm on June 23, 1973. The sample plots were re-established in order to estimate the before and after bird damage yield subsequent to the hail damage. The sample plot relocation was necessary because the crop inside the exclosure plot was partially protected from hail damage.

The percent blueberry bush cover data for each study field is included at Tables XIV to XXVI. These data are also represented graphically on Figures 4 through 16. Field twelve, Central Tower Hill, was in fact two separate fields and percent blueberry bush cover was estimated separately for each field. The data for the centre section, one field, are at Table XXV and are represented graphically on Figure 15. The data for the edge and mid sections, the other field, are at Table XXVI and are represented graphically on Figure 16.

Analyses of the sample plot data for fields one through twelve are included at Tables XXVII to XXXVIII respectively. The economic loss was calculated from an average farm price of $0.28 per pound (Pers. Comm. Ted Pratt).

Due to the minimal yield of field two, Mapleton, the exclosure plot yields were combined and therefore no standard deviation or confidence interval was calculated. Most of the crop was destroyed by the hail storm and birds consumed the remaining crop as it became ripe and thus no blueberries were obtained from the control areas.

It will be noted that the control area yield is greater than

Table II. Yield Data. Field 1. Elgin. All data shown in grams. Field harvested August 19, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	296.4	4.1	5.5
	2.	100.4	12.6	11.4
	3.	202.3	4.8	5.1
	4.	671.5	296.1	240.9
	5.	356.3	128.4	116.2
	6.	207.4	0.0	0.0
Mid	1.	315.2	58.8	47.7
	2.	284.5	*	*
	3.	459.7	227.7	308.1
	4.	110.3	72.2	71.0
	5.	400.4	265.5	217.2
	6.	178.1	*	*
Centre	1.	304.8	187.1	174.6
	2.	207.6	28.8	23.6
	3.	99.7	21.5	25.9
	4.	442.8	246.7	219.4
	5.	288.9	211.1	186.5
	6.	441.8	385.6	467.8

* - Controls harvested by pickers prior to author's arrival.

Table III. Yield Data. Field 2. Mapleton. All data shown in grams. Field harvested September 5, 1973.

Area	Exclosure	Control (1)	Control (2)
Edge	1.	0.0	0.0
	2.	0.0	0.0
	3. 178.0	0.0	0.0
	4.	0.0	0.0
	5.	0.0	0.0
	6.	0.0	0.0
Mid	1.	0.0	0.0
	2.	0.0	0.0
	3. 36.7	0.0	0.0
	4.	0.0	0.0
	5.	0.0	0.0
	6.	0.0	0.0
Centre	1.	0.0	0.0
	2.	0.0	0.0
	3. 97.4	0.0	0.0
	4.	0.0	0.0
	5.	0.0	0.0
	6.	0.0	0.0

Note: Figures indicated are the total yield of the combined plots.

Table IV. Yield Data. Field 3. Gowland Mountain. All data shown in grams. Field harvested August 21, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	355.3	175.7	103.6
	2.	255.3	*	*
	3.	143.1	79.0	49.0
	4.	113.9	107.1	64.3
	5.	161.7	133.4	90.8
	6.	253.1	127.3	86.8
Mid	1.	498.1	246.8	346.4
	2.	128.8	153.1	143.2
	3.	539.4	359.0	115.3
	4.	514.4	363.2	316.8
	5.	66.8	66.1	66.5
	6.	378.3	360.0	263.8
Centre	1.	232.4	268.5	179.0
	2.	254.4	264.2	263.6
	3.	386.4	229.5	223.2
	4.	342.0	163.2	183.1
	5.	333.7	368.2	239.1
	6.	419.1	274.2	268.8

* - Controls harvested by pickers prior to author's arrival.

Table V. Yield Data. Field 4. Goshen. All data shown in grams. Field harvested August 15, 1973.

Area	Exclosure	Control (1)	Control (2)
Edge	1. 201.8	134.2	93.5
	2. 212.4	119.8	83.3
	3. 368.8	210.7	83.5
	4. 312.5	61.0	30.7
	5. 349.9	239.4	190.8
	6. 141.0	80.4	53.4
Mid	1. 256.1	209.8	164.5
	2. 201.4	194.5	119.4
	3. 318.6	242.3	291.0
	4. 149.6	78.0	120.0
	5. 94.8	64.5	63.8
	6. 152.5	148.5	100.8
Centre	1. 175.5	197.6	196.6
	2. 87.6	33.8	81.6
	3. 115.0	74.7	153.4
	4. 154.9	134.0	131.4
	5. 68.5	37.8	58.5
	6. 217.0	164.9	209.9

Table VI. Yield Data. Field 5. Memramcook East. All data shown in grams. Field harvested August 20, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	55.5	17.0	17.0
	2.	*	*	*
	3.	183.7	82.3	69.7
	4.	29.1	2.5	8.0
	5.	35.1	0.8	1.0
	6.	29.0	0.9	1.1
Mid	1.	30.2	0.8	0.2
	2.	80.1	0.5	1.6
	3.	243.0	77.2	90.8
	4.	105.1	45.7	78.2
	5.	251.1	118.2	82.5
	6.	144.9	60.1	43.3
Centre	1.	175.5	69.6	73.3
	2.	128.1	48.7	40.8
	3.	198.5	120.2	108.8
	4.	112.1	24.6	43.3
	5.	285.9	176.1	135.6
	6.	329.0	165.3	200.4

* - Exclosure and controls destroyed by raccoon.

Table VII. Yield Data. Field 6. Fenwick, N.S. All data shown in grams. Field harvested August 16, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	564.4	296.3	343.3
	2.	186.3	132.6	119.6
	3.	226.9	224.3	248.2
	4.	470.6	589.3	610.0
	5.	216.5	230.0	257.2
	6.	*	*	*
Mid	1.	203.3	244.8	251.3
	2.	416.7	395.0	346.4
	3.	250.0	312.3	278.9
	4.	188.0	218.1	302.0
	5.	285.9	316.1	343.4
	6.	233.1	260.0	310.0
Centre	1.	140.6	143.6	98.8
	2.	189.0	**	**
	3.	314.2	404.3	416.8
	4.	119.4	81.3	96.2
	5.	413.8	321.3	456.9
	6.	329.4	233.0	476.4

* - Sample plot unable to be relocated.

** - Controls harvested by pickers prior to author's arrival.

Table VIII. Yield Data. Field 7. West Scotch Settlement. All data shcwn in grams. Field harvested August 23, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	170.3	112.7	152.9
	2.	*	*	*
	3.	48.4	12.5	2.9
	4.	216.5	29.3	21.8
	5.	148.1	141.2	68.4
	6.	187.0	130.9	123.4
Mid	1.	325.3	242.6	194.0
	2.	120.0	99.6	61.3
	3.	215.8	192.6	151.0
	4.	248.4	176.3	137.8
	5.	144.1	79.0	51.3
	6.	173.0	224.2	196.3
Centre	1.	67.5	114.1	102.6
	2.	74.1	77.5	43.3
	3.	224.7	108.4	106.1
	4.	164.5	77.0	67.4
	5.	188.8	138.9	164.3
	6.	77.9	61.1	97.0

* - Damaged by an insect, believed to be Altica sylvia Mall. or Chlamisus cribripennis (Leconte). Specific nomenclature from Hall et al, 1972.

Table IX. Yield Data. Field 8. Pennfield Station. All data shown in grams. Field harvested September 9, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	143.6	145.8	85.0
	2.	100.0	42.3	36.5
	3.	*	*	*
	4.	51.6	49.4	81.7
	5.	251.7	148.9	171.0
	6.	75.7	29.6	28.2
Mid	1.	90.7	30.6	18.9
	2.	169.0	239.4	140.0
	3.	184.8	165.0	173.3
	4.	266.8	191.2	125.6
	5.	112.7	50.2	91.5
	6.	165.3	251.5	134.2
Centre	1.	345.2	217.3	187.1
	2.	256.1	200.0	169.5
	3.	192.0	150.8	139.1
	4.	153.1	111.4	96.4
	5.	330.7	472.0	333.0
	6.	322.4	175.8	158.6

* - Sample plot destroyed by a black bear.

Table X. Yield Data. Field 9. Pennfield Ridge-McDowell. All data shown in grams. Field harvested August 27, 1973.

Area	Exclosure	Control (1)	Control (2)
Edge	1. 50.9	21.3	18.8
	2. 165.1	27.3	43.8
	3. 150.0	57.5	72.2
	4. 67.1	7.3	16.8
	5. 102.7	43.6	51.8
	6. 48.1	21.7	18.9
Mid	1. 91.8	76.4	84.3
	2. 135.5	57.6	132.2
	3. 144.9	76.1	88.9
	4. 127.6	66.3	51.2
	5. 92.4	67.8	73.9
	6. 63.8	38.9	51.4
Centre	1. 123.1	71.6	18.1
	2. *	*	*
	3. 62.4	17.0	45.5
	4. 50.0	34.7	28.4
	5. 16.9	18.9	7.3
	6. 18.9	12.4	23.9

* - Damaged by insect, luper worm, genus and species unknown. Personal communication George Wood, Federal Department of Agriculture.

Table XI. Yield Data. Field 10. Pennfield Ridge-McKay. All data shown in grams. Field harvested August 26, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	30.2	83.7	68.3
	2.	*	*	*
	3.	229.8	182.1	105.3
	4.	96.6	77.3	101.7
	5.	181.1	58.6	65.8
	6.	155.3	42.5	32.7
Mid	1.	326.1	**	**
	2.	49.3	**	**
	3.	12.4	22.0	31.5
	4.	67.0	95.1	76.3
	5.	118.7	51.6	86.4
	6.	255.6	197.1	155.4
Centre	1.	100.4	108.4	91.2
	2.	77.5	74.8	76.9
	3.	134.9	**	**
	4.	71.5	68.5	78.5
	5.	100.3	97.1	95.5
	6.	87.0	83.8	86.0

* - Clone infected by Red Leaf disease, Exobasidium vaccinii Wor. Specific nomenclature from Hall et al, 1972.

** - Controls harvested by pickers prior to author's arrival.

Table XII. Yield Data. Field 11. Elmsville. All data shown in grams. Field harvested August 18, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	84.3	51.5	62.4
	2.	167.8	72.5	93.2
	3.	138.9	56.9	75.9
	4.	35.2	0.0	6.8
	5.	*	*	*
	6.	18.8	10.0	15.3
Mid	1.	126.2	137.5	100.4
	2.	110.0	109.6	51.5
	3.	202.3	282.1	139.8
	4.	98.3	63.5	93.0
	5.	59.1	55.0	74.8
	6.	18.1	38.8	29.5
Centre	1.	86.3	76.3	78.9
	2.	66.3**	148.3	85.2
	3.	51.7	31.6	32.6
	4.	59.1	33.9	29.6
	5.	*	*	*
	6.	56.8	10.7	7.2

* - No berries developed.

** - Cage damaged.

Table XIII. Yield Data. Field 12. Central Tower Hill. All data shown in grams. Field harvested August 14, 1973.

Area		Exclosure	Control (1)	Control (2)
Edge	1.	59.5	24.0	51.1
	2.	90.3	25.1	21.6
	3.	52.3	46.4	27.9
	4.	79.0	31.4	45.8
	5.	127.9	112.3	64.1
	6.	84.5	76.5	90.1
Mid	1.	200.0	87.5	86.2
	2.	496.2	329.0	304.6
	3.	202.1	136.0	141.9
	4.	30.4	18.0	23.0
	5.	22.6	12.4	14.4
	6.	79.7	38.3	43.9
Centre	1.	311.3	159.4	294.4
	2.	161.0	*	*
	3.	180.5	178.8	199.4
	4.	233.8	236.3	155.0
	5.	350.0	334.1	323.1
	6.	133.8	91.1	120.3

* - Controls harvested by pickers prior to author's arrival.

Table XIV. Percent blueberry bush cover data. Field 1. Elgin. (See Figure 4)

Quadrate Number	Estimated % Cover	Mean % Cover
1	50	50.0
2	30	40.0
3	10	30.0
4	0	22.5
5	0	18.0
6	0	15.0
7	20	15.7
8	20	16.3
9	30	17.8
10	5	16.5
11	20	16.8
12	50	19.6
13	10	18.8
14	80	23.2
15	20	23.0
16	50	24.7
17	50	26.2
18	20	25.8
19	30	26.1
20	50	27.3
21	30	27.4
22	20	27.0
23	10	26.3
24	5	25.4
25	20	25.2
26	10	24.6
27	30	24.8
28	40	25.4
29	10	24.8
30	20	24.7
31	30	24.8
32	40	25.3

Table XV. Percent blueberry bush cover data, Field 2. Mapleton. (See Figure 5)

Quadrate Number	Estimated % Cover	Mean % Cover
1	10	10.0
2	20	15.0
3	5	11.7
4	0	8.8
5	60	19.0
6	60	26.0
7	0	22.0
8	50	25.6
9	10	24.0
10	30	24.5
11	20	25.0
12	0	23.0
13	30	23.5
14	30	24.0
15	40	25.0
16	40	26.0
17	0	24.4
18	60	26.4
19	10	25.5
20	10	24.8
21	40	25.5
22	10	24.8
23	10	24.1
24	40	24.8
25	10	24.2
26	30	24.4
27	10	24.0
28	40	24.5
29	10	24.0
30	30	24.2
31	20	24.0
32	40	24.4

Table XVI. Percent blueberry bush cover data. Field 3. Gowland Mountain. (See Figure 6)

Quadrate Number	Estimated % Cover	Mean % Cover
1	30	30.0
2	0	15.0
3	10	13.3
4	10	12.5
5	10	12.0
6	40	16.7
7	70	24.3
8	30	25.0
9	0	22.2
10	20	22.0
11	10	20.9
12	70	25.0
13	50	26.9
14	20	26.4
15	60	28.7
16	40	29.4
17	0	27.6
18	50	28.9
19	20	28.4
20	40	29.0
21	20	28.6
22	40	29.1
23	50	30.0
24	30	30.0
25	40	30.4
26	20	30.0
27	20	29.6
28	40	30.0
29	30	30.0
30	40	30.3

Table XVII. Percent blueberry bush cover data. Field 4. Goshen. (See Figure 7)

Quadrate Number	Estimated % Cover	Mean % Cover
1	30	30.0
2	40	35.0
3	50	40.0
4	30	37.5
5	40	38.0
6	30	36.7
7	30	35.7
8	40	36.3
9	50	37.8
10	30	37.0
11	10	34.5
12	50	35.8
13	40	36.2
14	20	35.0
15	5	33.0
16	60	34.7
17	0	32.6
18	10	31.4
19	40	31.8
20	70	33.8
21	40	34.0
22	80	36.1
23	30	35.9
24	40	36.0
25	80	37.8
26	50	38.3
27	40	38.3
28	30	38.0
29	40	38.1
30	40	38.2
31	30	37.9
32	40	38.0

Table XVIII. Percent blueberry bush cover data. Field 5. Memramcook East. (See Figure 8)

Quadrate Number	Estimated % Cover	Mean % Cover
1	40	40.0
2	0	20.0
3	30	23.3
4	5	18.8
5	20	19.0
6	0	15.8
7	30	17.9
8	20	18.1
9	40	20.6
10	15	20.0
11	0	18.2
12	20	18.3
13	20	18.5
14	0	17.1
15	0	16.0
16	50	18.1
17	20	18.2
18	40	19.4
19	15	19.2
20	40	20.3
21	10	19.8
22	15	19.5
23	20	19.6
24	30	20.0
25	70	22.0
26	30	22.3
27	20	22.2
28	30	22.5
29	30	22.8
30	10	22.3
31	20	22.3
32	20	22.2

Table XIX. Percent blueberry bush cover data. Field 6. Fenwick, N.S. (See Figure 9)

Quadrate Number	Estimated % Cover	Mean % Cover
1	40	40.0
2	0	20.0
3	30	23.3
4	60	32.5
5	20	30.0
6	20	28.3
7	80	35.7
8	30	35.0
9	30	34.4
10	75	38.5
11	70	41.4
12	50	42.1
13	10	39.6
14	30	38.9
15	25	38.0
16	70	40.0
17	20	38.8
18	40	38.9
19	20	37.9
20	30	37.5
21	40	37.6
22	10	36.4
23	50	37.0
24	40	37.1
25	60	38.0
26	40	38.1
27	30	37.8
28	60	38.6
29	40	38.6
30	30	38.3
31	40	38.3
32	20	37.8

Table XX. Percent blueberry bush cover data. Field 7. West Scotch Settlement. (See Figure 10)

Quadrate Number	Estimated % Cover	Mean % Cover
1	70	70.0
2	10	40.0
3	60	46.7
4	30	42.5
5	10	36.0
6	60	40.0
7	0	34.3
8	60	37.5
9	100	44.4
10	50	45.0
11	90	49.1
12	40	48.3
13	30	46.9
14	80	49.3
15	0	46.0
16	90	48.8
17	30	47.6
18	50	47.8
19	10	45.8
20	5	43.8
21	80	45.5
22	15	44.1
23	30	43.5
24	20	42.5
25	50	42.8
26	60	43.5
27	50	43.7
28	40	43.6
29	60	44.1
30	50	44.3
31	60	44.8
32	40	44.7

Table XXI. Percent blueberry bush cover data. Field 8. Pennfield Station. (See Figure 11)

Quadrate Number	Estimated % Cover	Mean % Cover
1	70	70.0
2	30	50.0
3	80	60.0
4	60	60.0
5	30	54.0
6	50	53.3
7	40	51.4
8	40	50.0
9	25	47.2
10	90	51.5
11	0	46.8
12	30	45.4
13	50	45.8
14	80	48.2
15	40	47.7
16	90	50.3
17	70	51.5
18	20	49.7
19	5	47.4
20	70	48.5
21	60	49.0
22	75	50.2
23	60	50.7
24	80	51.9
25	80	53.0
26	50	52.9
27	60	53.1
28	60	53.4
29	50	53.3
30	45	53.0
31	70	53.5
32	50	53.4

Table XXII. Percent blueberry bush cover data. Field 9. Pennfield Ridge-McDowell. (See Figure 12)

Quadrate Number	Estimated % Cover	Mean % Cover
1	40	40.0
2	10	25.0
3	60	36.7
4	20	32.5
5	25	31.0
6	10	27.5
7	5	24.3
8	20	23.8
9	40	25.6
10	30	26.0
11	10	24.6
12	70	28.3
13	25	28.1
14	70	31.1
15	35	31.3
16	40	31.9
17	15	30.9
18	60	32.5
19	30	32.4
20	20	31.8
21	50	32.6
22	20	32.1
23	50	32.8
24	80	34.8
25	40	35.0
26	30	34.8
27	40	35.0
28	30	34.8
29	20	34.3
30	40	34.5
31	20	34.0
32	40	34.2

Table XXIII. Percent blueberry bush cover data. Field 10. Pennfield Ridge -McKay. (See Figure 13)

Quadrate Number	Estimated % Cover	Mean % Cover
1	50	50.0
2	70	60.0
3	60	60.0
4	30	52.5
5	50	52.0
6	50	51.7
7	30	48.6
8	80	52.5
9	30	50.0
10	40	49.0
11	20	46.4
12	40	45.8
13	30	44.6
14	20	42.9
15	50	43.3
16	40	43.1
17	25	42.1
18	60	43.1
19	10	41.3
20	80	43.3
21	0	41.2
22	70	42.5
23	25	41.7
24	60	42.5
25	40	42.4
26	50	42.7
27	30	42.2
28	25	41.6
29	60	42.2
30	40	42.2
31	70	43.1
32	50	43.3

Table XXIV. Percent blueberry bush cover data. Field 11. Elmsville. (See Figure 14)

Quadrate Number	Estimated % Cover	Mean % Cover
1	15	15.0
2	0	7.5
3	30	15.0
4	5	12.5
5	60	22.0
6	40	25.0
7	80	32.9
8	60	36.3
9	10	33.3
10	30	33.0
11	70	36.4
12	80	40.0
13	10	37.7
14	40	37.9
15	20	36.7
16	30	36.3
17	50	37.1
18	10	35.6
19	25	35.0
20	40	35.3
21	60	36.4
22	30	36.1
23	70	37.6
24	50	38.1
25	30	37.8
26	30	37.5
27	50	38.0
28	30	37.7
29	50	38.1
30	40	38.2
31	30	37.9
32	40	38.0

Table XXV. Percent blueberry bush cover data. Field 12. Central Tower Hill. (Centre Field) (See Figure 15)

Quadrate Number	Estimated % Cover	Mean % Cover
1	80	80.0
2	60	70.0
3	80	73.3
4	60	70.0
5	30	62.0
6	90	66.7
7	20	60.0
8	0	52.5
9	60	53.3
10	100	58.0
11	95	61.4
12	80	62.9
13	100	65.8
14	60	65.4
15	70	65.7
16	60	65.3
17	50	64.4
18	30	62.5
19	30	60.8
20	90	62.3
21	100	64.0
22	90	65.2
23	80	65.9
24	60	65.6
25	50	65.0
26	60	64.8
27	40	63.9
28	70	64.1
29	60	64.0
30	70	64.2
31	50	63.7
32	60	63.6

Table XXVI. Percent blueberry bush cover data. Field 12. Central Tower Hill. (Mid and Edge Fields) (See Figure 16)

Quadrate Number	Estimated % Cover	Mean % Cover
1	5	5.0
2	10	7.5
3	20	11.7
4	40	18.8
5	50	25.0
6	0	20.8
7	0	17.9
8	0	15.6
9	60	20.6
10	80	26.5
11	20	25.9
12	40	27.1
13	10	25.8
14	80	29.6
15	70	32.3
16	70	34.7
17	10	33.2
18	40	33.6
19	40	33.9
20	50	34.8
21	25	34.3
22	0	32.7
23	90	35.2
24	40	35.4
25	60	36.4
26	60	37.3
27	60	38.1
28	40	38.2
29	60	39.0
30	30	38.7
31	20	38.1
32	40	38.1

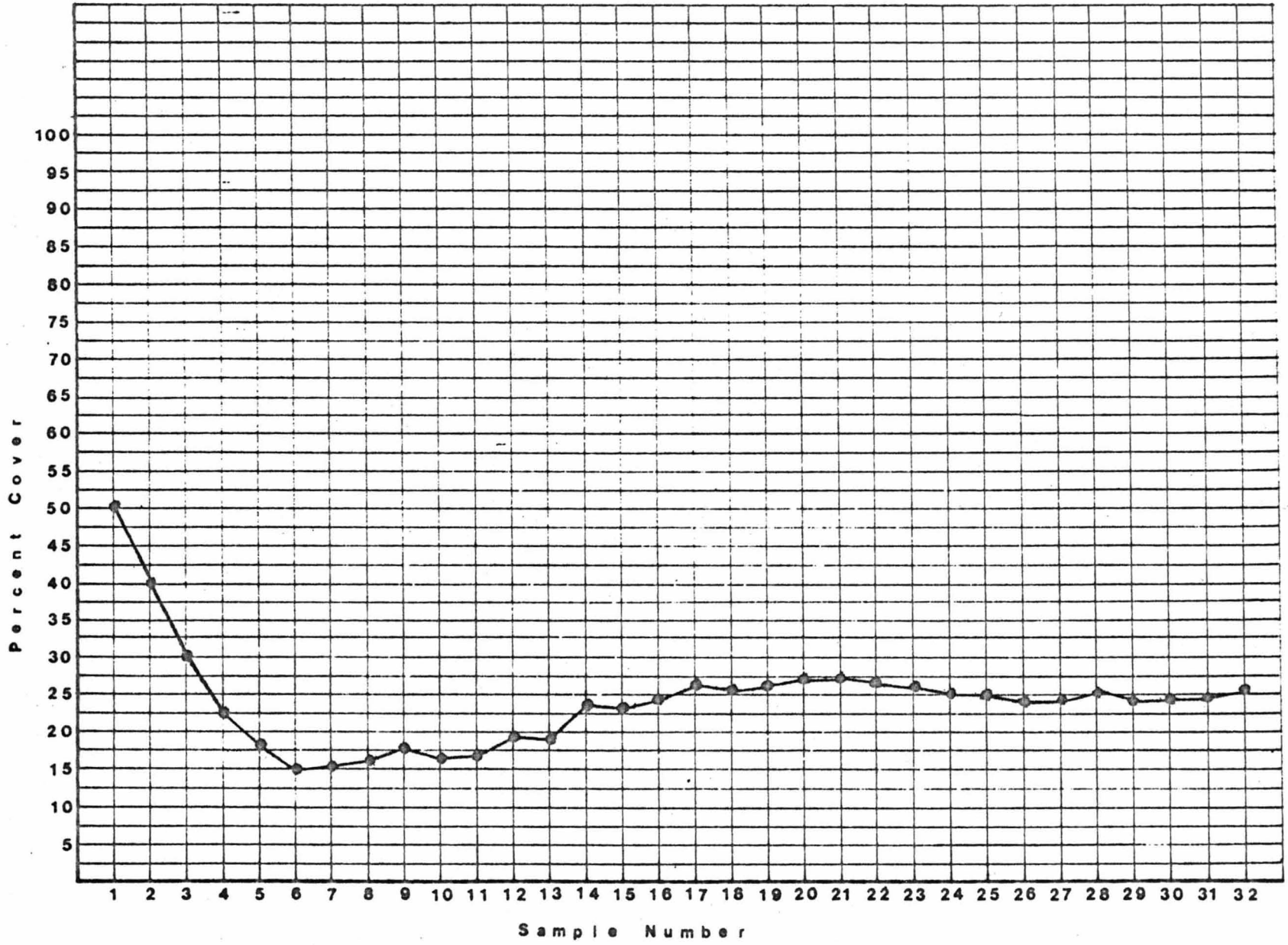

Figure 4. Field 1. Elgin. Percent blueberry bush cover represented graphically. (See Table XIV)

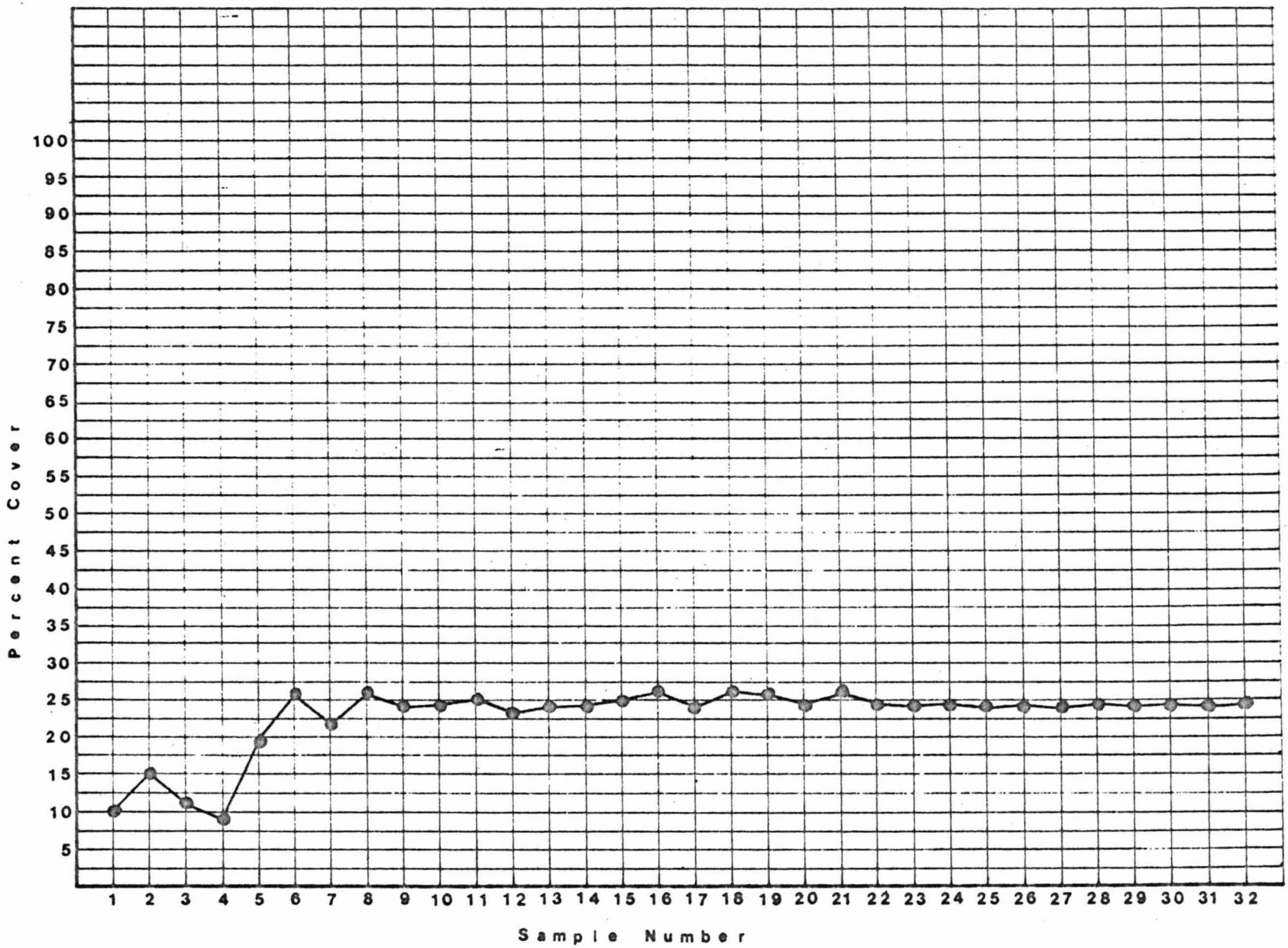

Figure 5. Field 2. Mapleton. Percent blueberry bush cover represented graphically. (see Table XV)

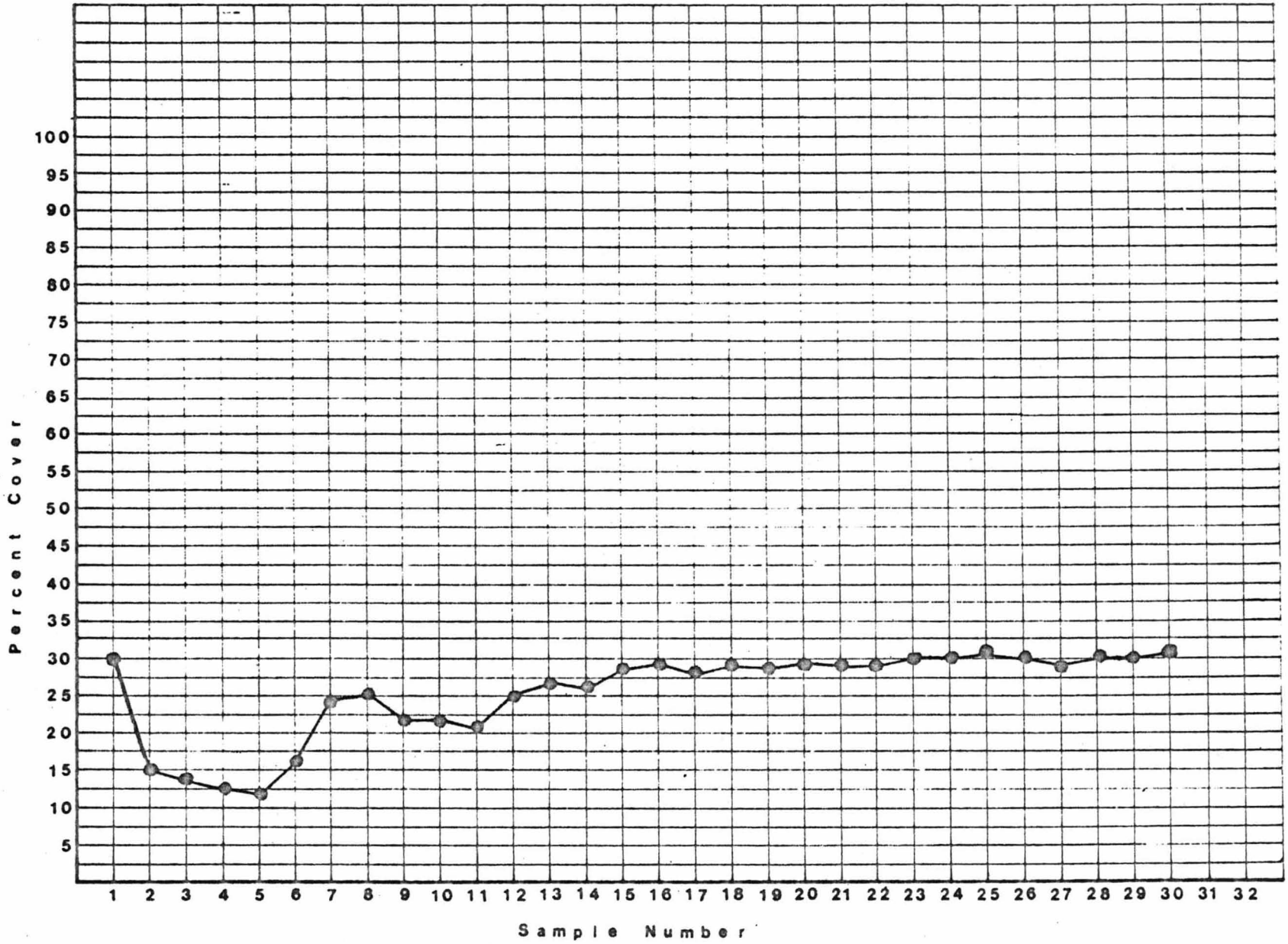

Figure 6. Field 3. Gowland Mountain. Percent blueberry bush cover represented graphically. (See Table XVI)

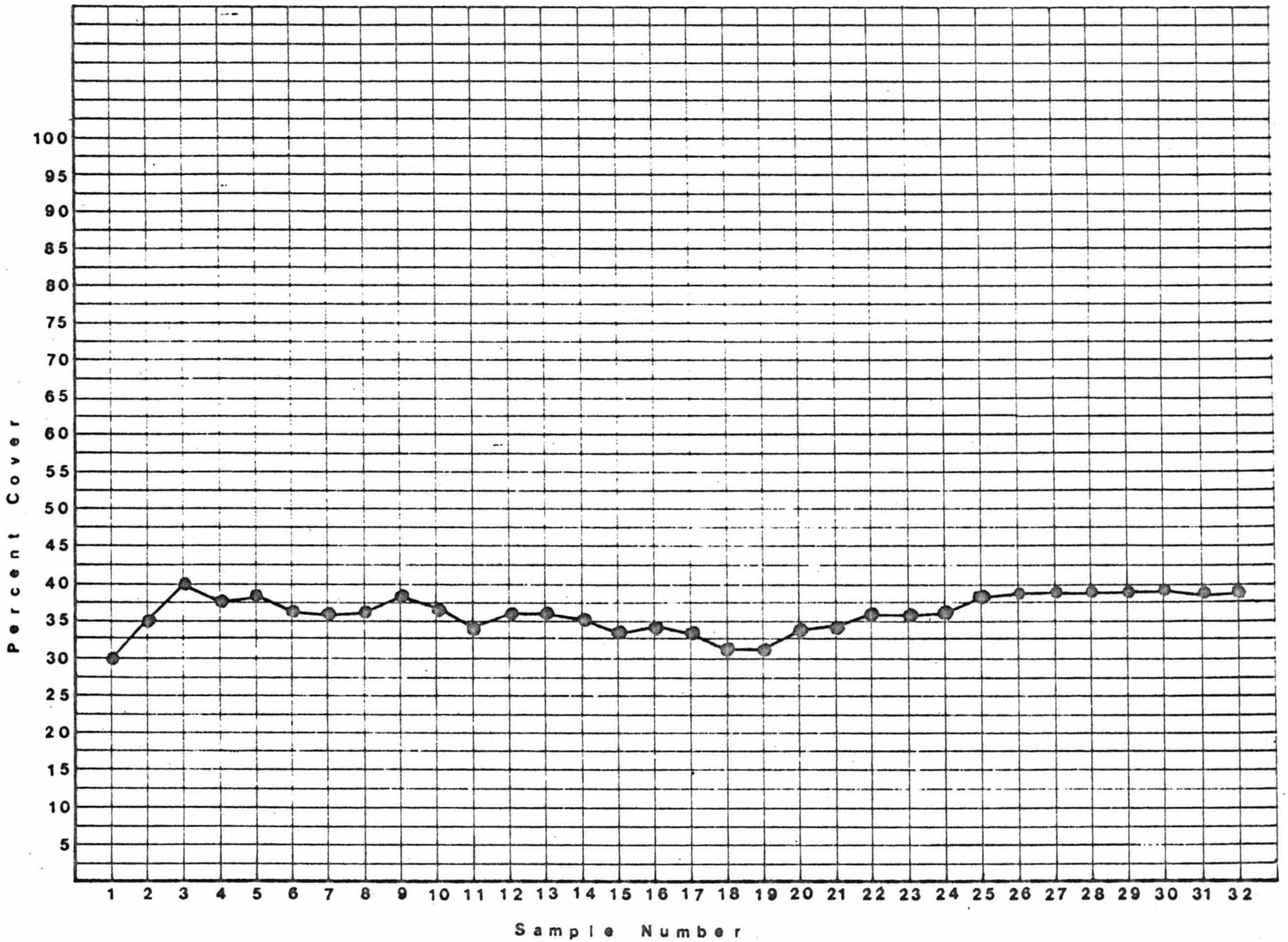

Figure 7. Field 4. Goshen. Percent blueberry bush cover represented graphically. (See Table XVII)

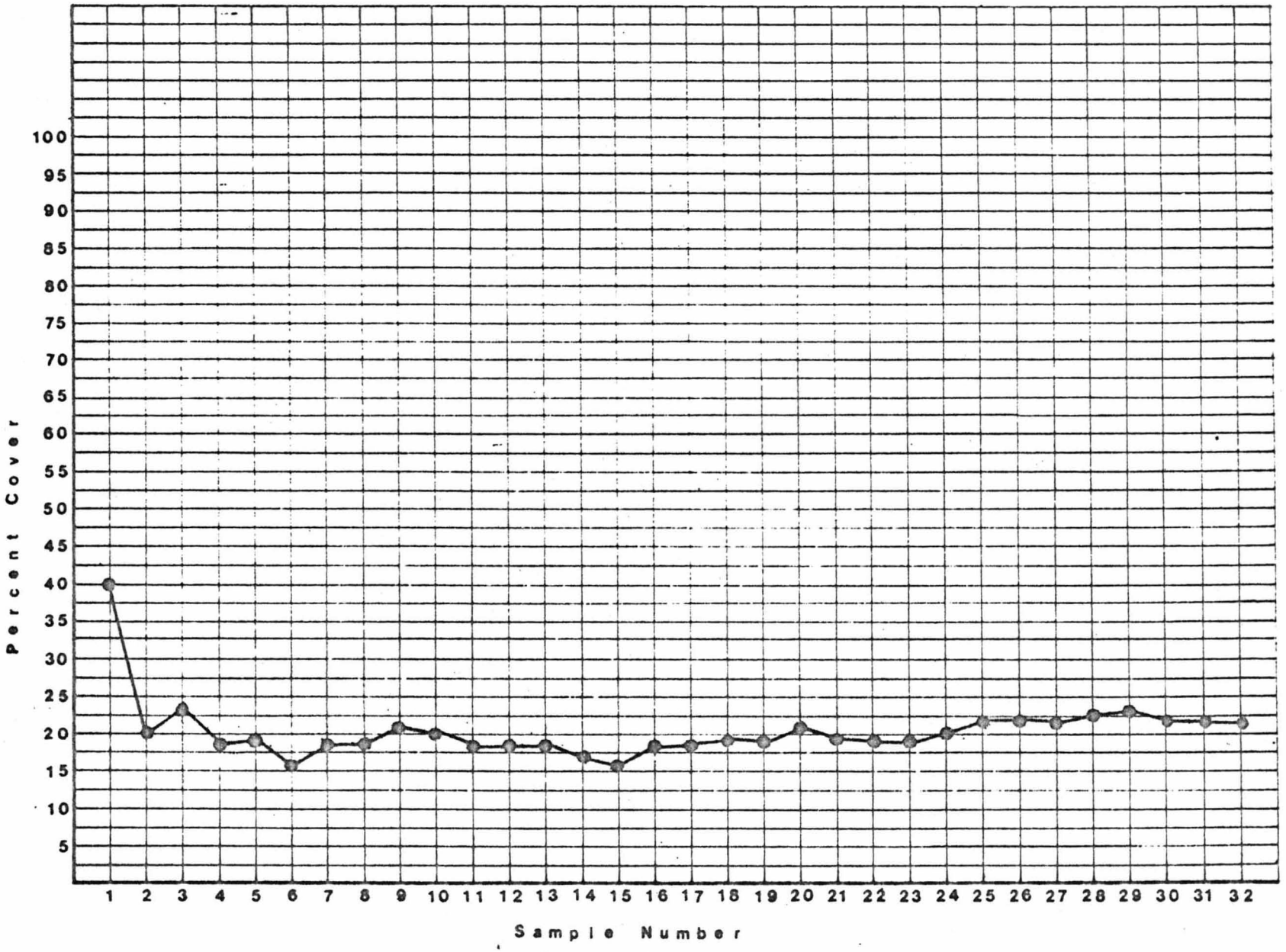

Figure 8. Field 5. Memramcook East. Percent blueberry bush cover represented graphically. (See Table XVIII)

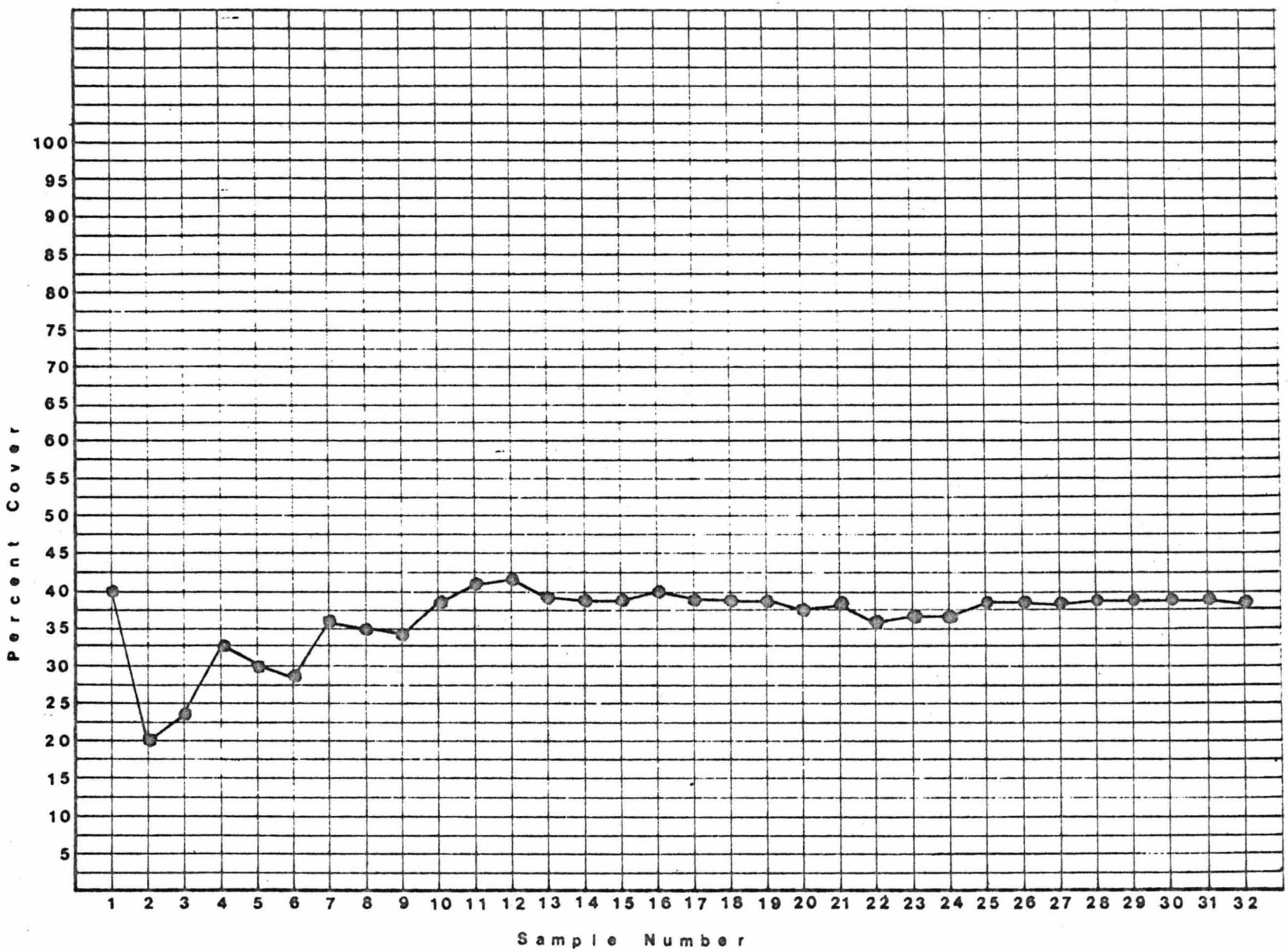

Figure 9. Field 6. Fenwick, N.S. Percent blueberry bush cover represented graphically. (See Table XIX)

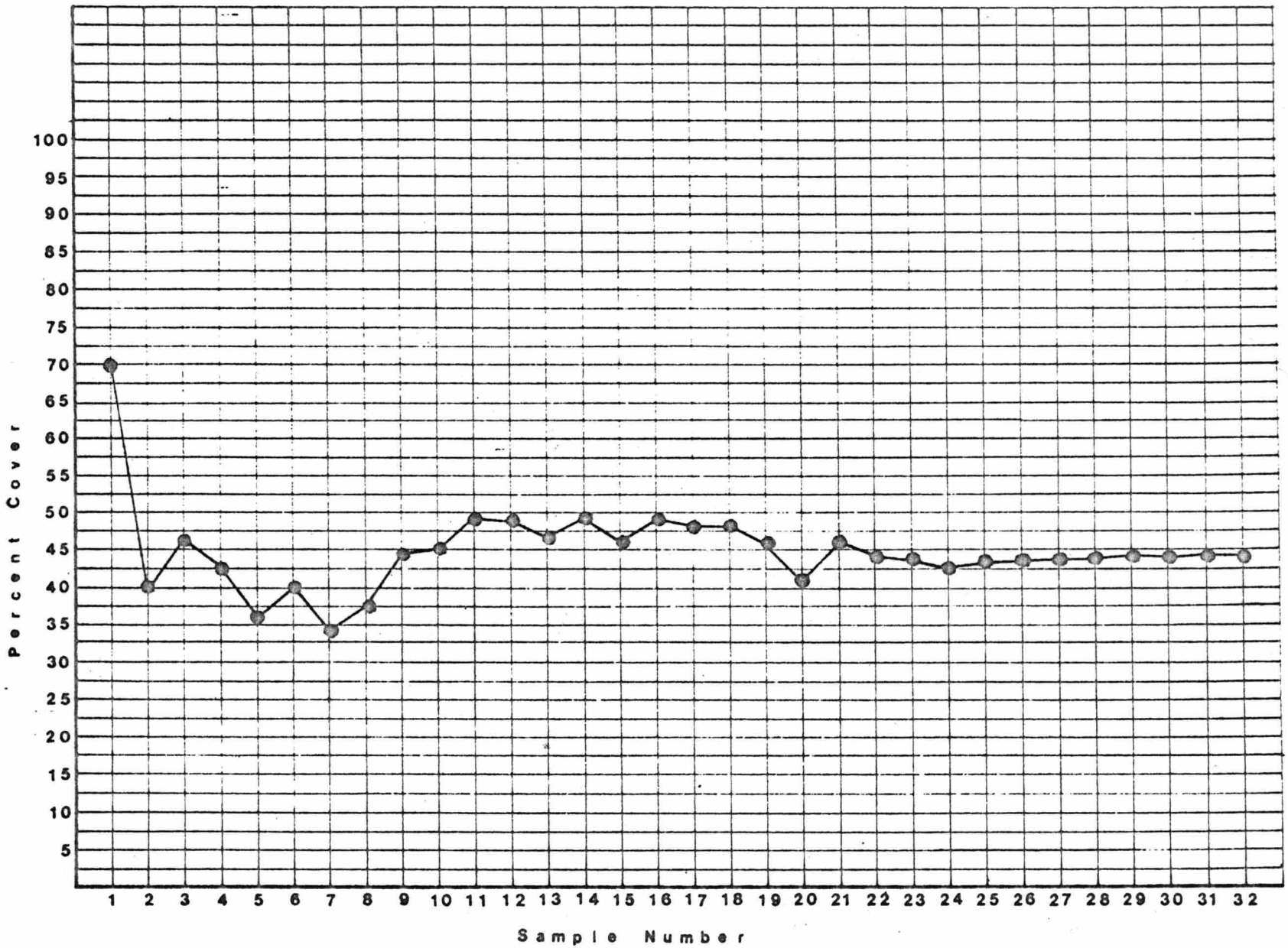

Figure 10. Field 7. West Scotch Settlement. Percent blueberry bush cover represented graphically. (See Table XX)

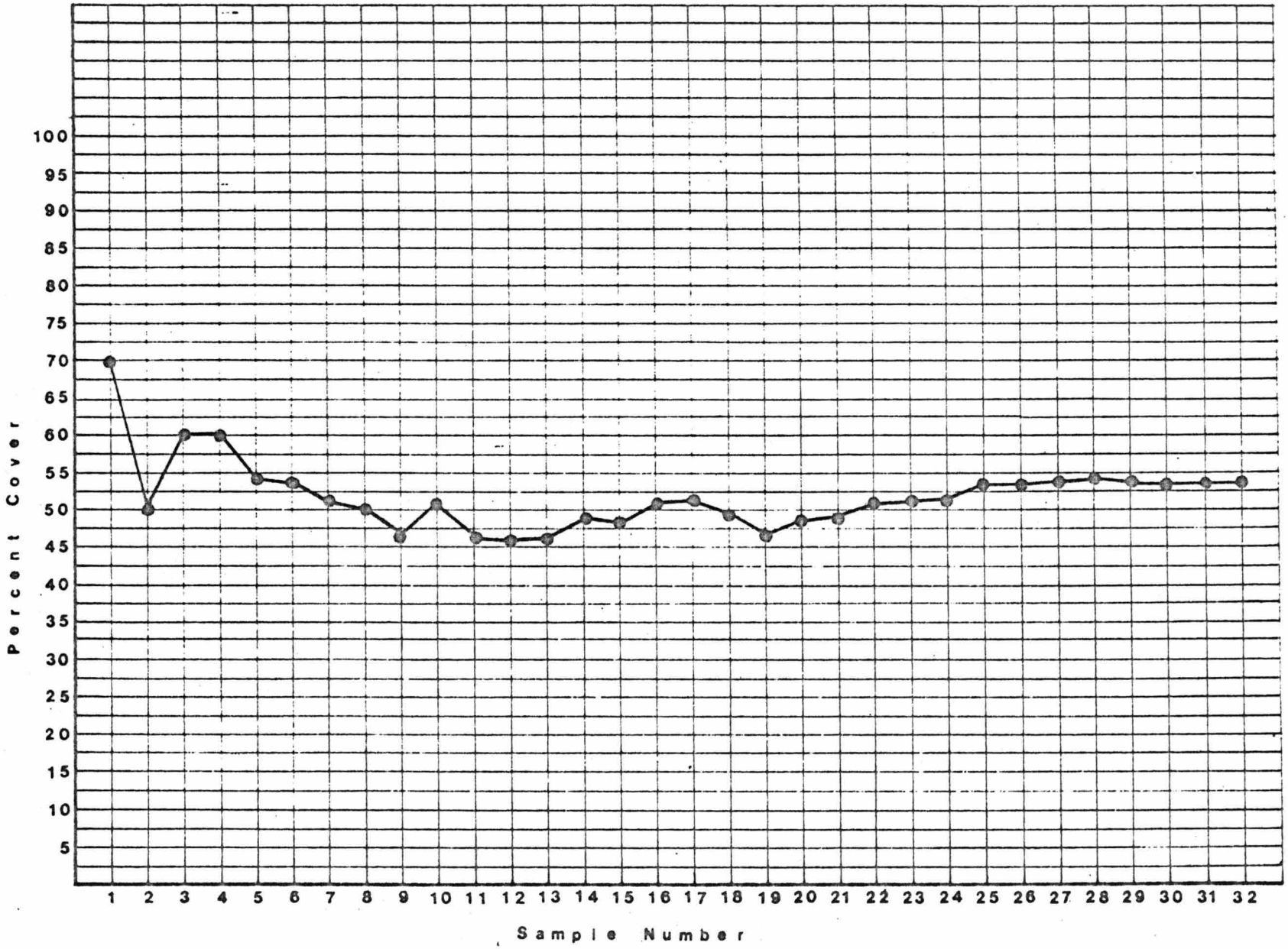

Figure 11. Field 8. Pennfield Station. Percent blueberry bush cover represented graphically. (See Table XXI)

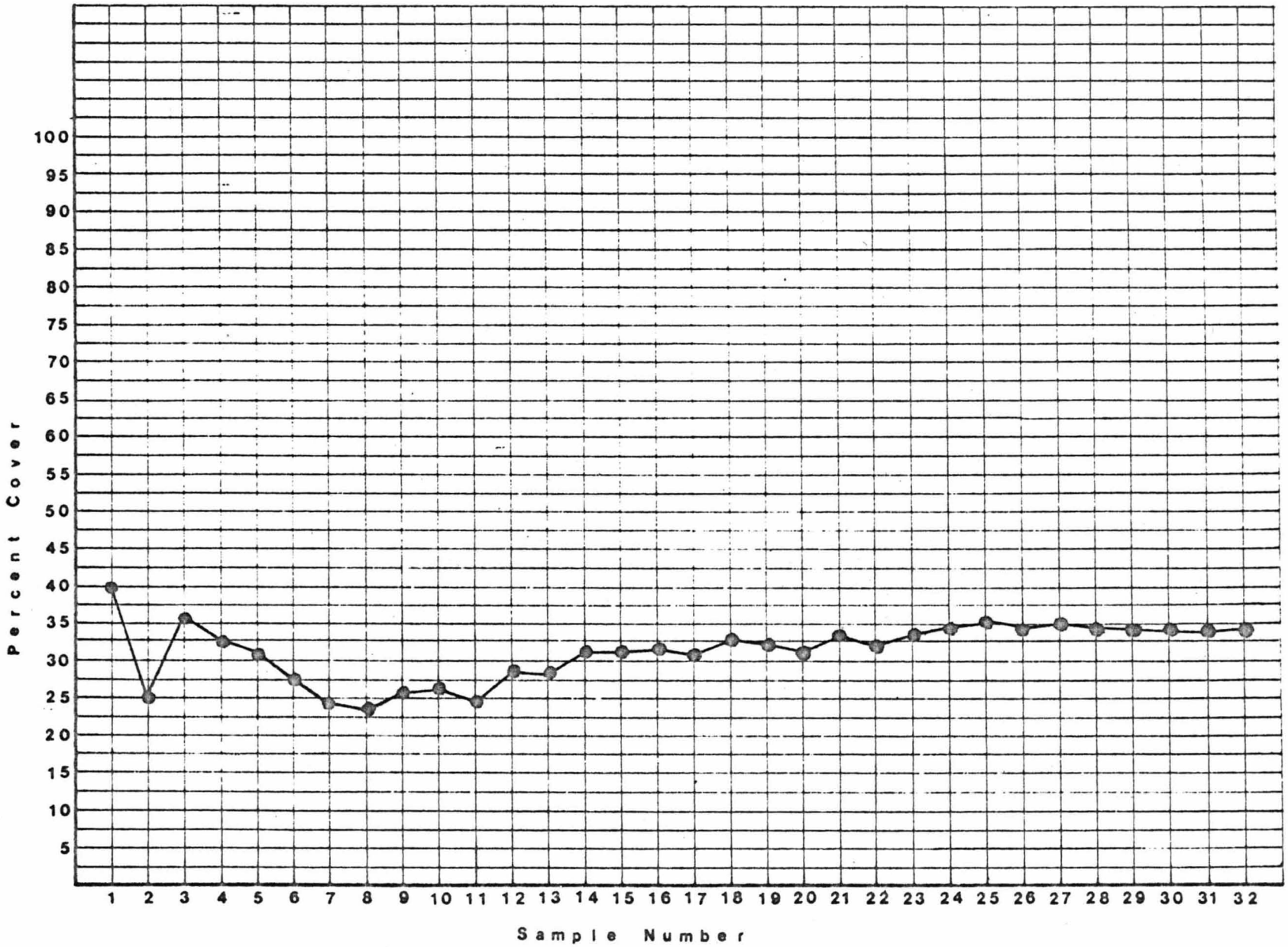

Figure 12. Field 9. Pennfield Ridge-McDowell. Percent blueberry bush cover represented graphically. (See Table XXII)

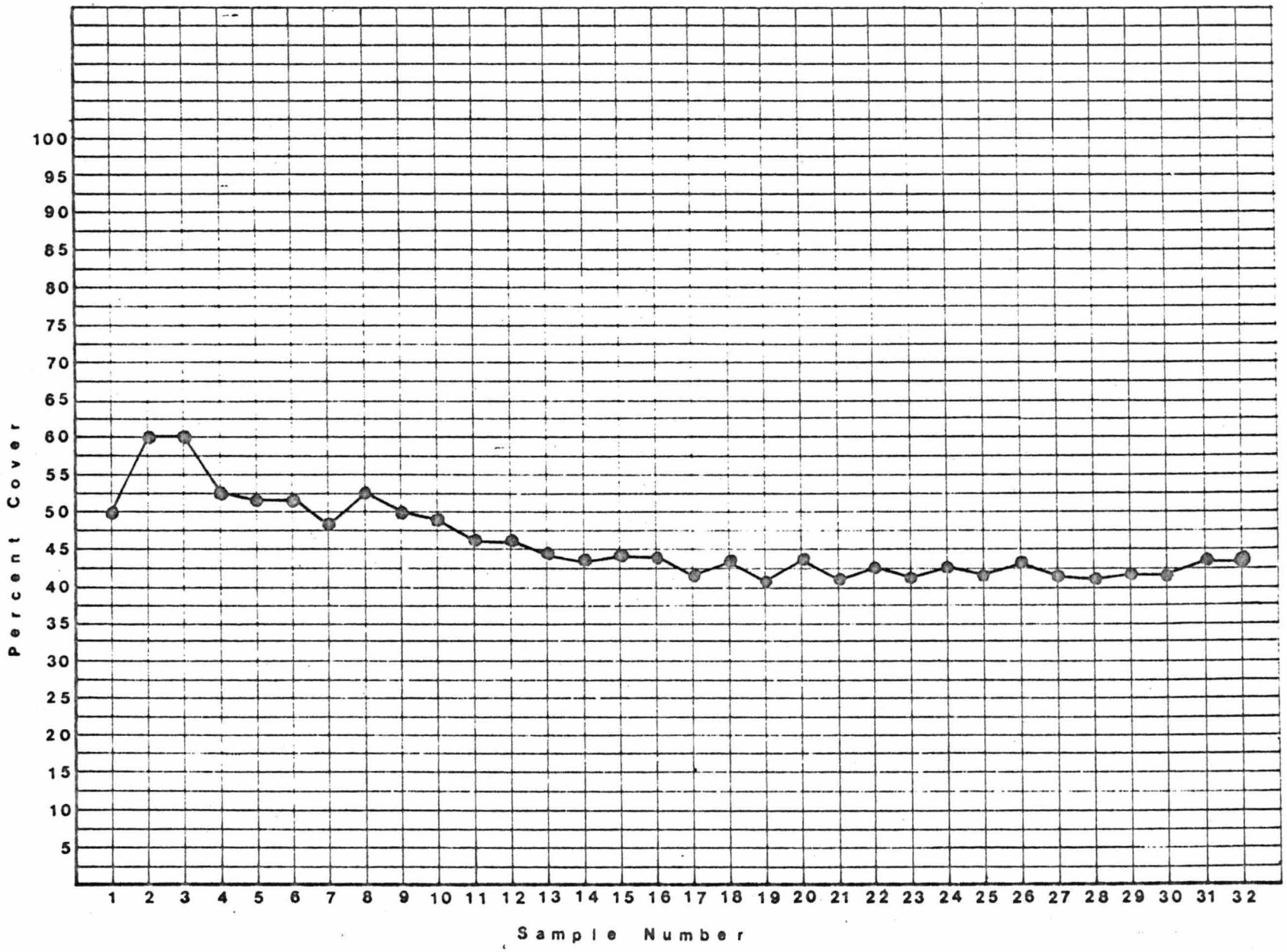

Figure 13. Field 10. Pennfield Ridge-McKay. Percent blueberry bush cover represented graphically. (See Table XXIII)

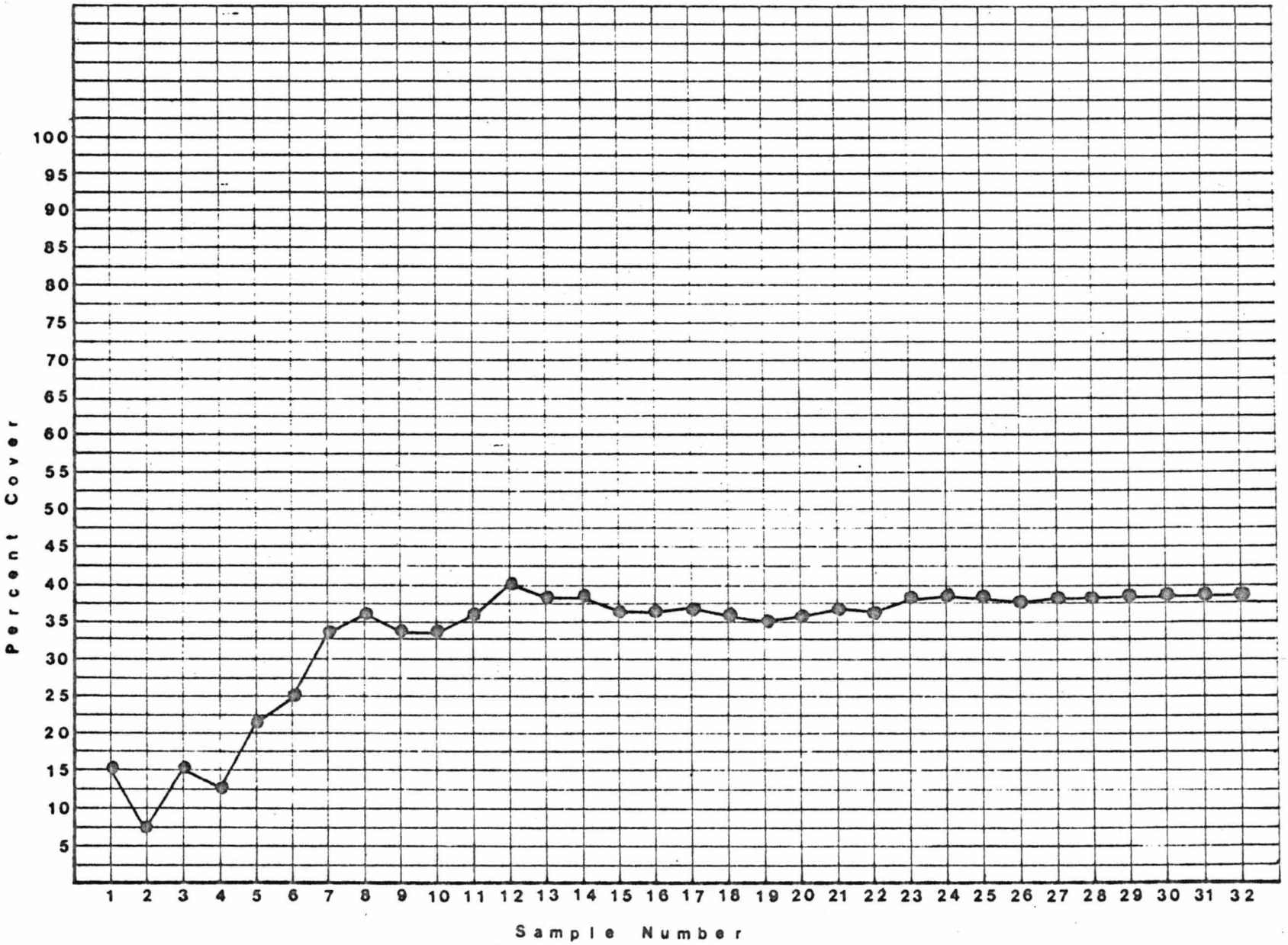

Figure 14. Field 11. Elmsville. Percent blueberry bush cover represented graphically. (See Table XXIV)

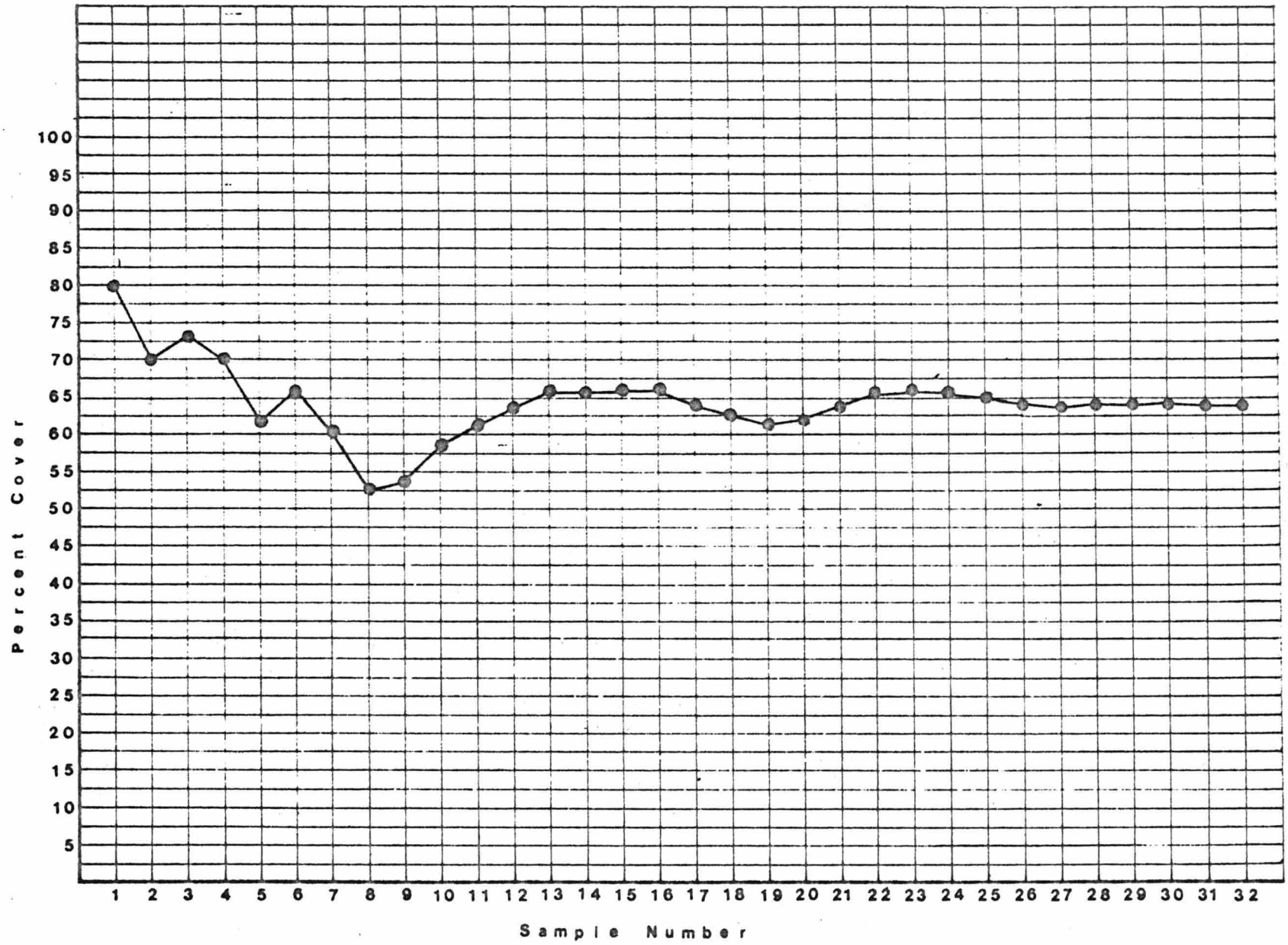

Figure 15. Field 12. Central Tower Hill. (Centre Field) Percent blueberry bush cover represented graphically. (See Table XXV)

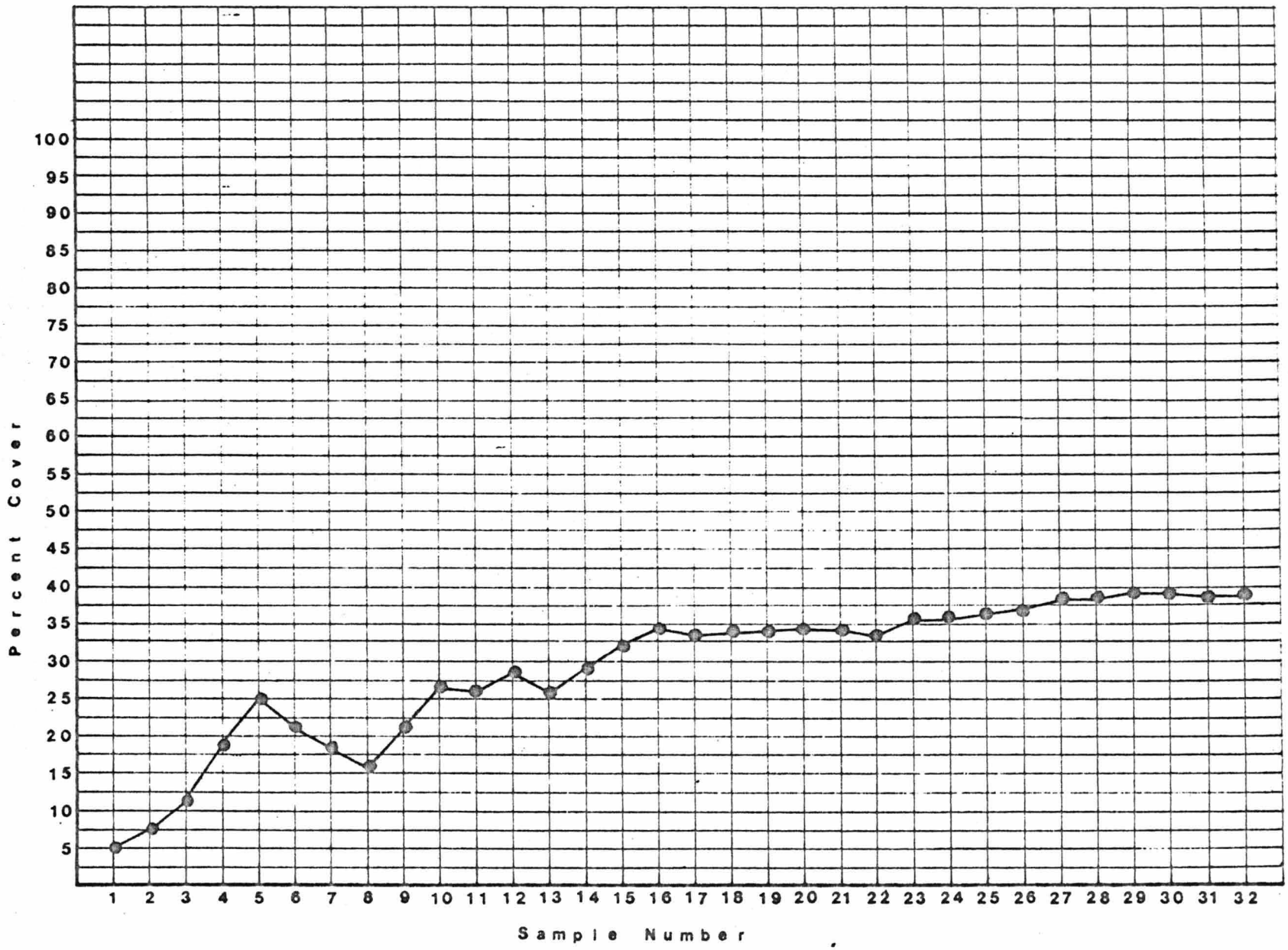

Figure 16. Field 12. Central Tower Hill. (Mid and Edge Fields) Percent blueberry bush cover represented graphically. (See Table XXVI)

Table XXVII. Analysis of yield data. Field 1. Elgin.

Field Area

Edge	5.8 hectares	14.4 acres
Mid	5.2 hectares	12.8 acres
Centre	5.2 hectares	12.8 acres
Total	16.2 hectares	40.0 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	From	$t_{.1}$ To
Edge	Exclosure	305.7	199.48	185.6	425.8
	Control	68.8	104.16	27.8	109.8
Mid	Exclosure	291.4	131.49	212.2	370.6
	Control	158.5	106.49	105.2	211.8
Centre	Exclosure	297.6	133.62	217.1	378.1
	Control	181.6	144.08	124.9	238.3

Section Yield

Edge	Possible	9,850,332.4	grams
	Actual	2,216,888.7	grams
Mid	Possible	8,418,221.4	grams
	Actual	4,578,888.4	grams
Centre	Possible	8,597,332.5	grams
	Actual	5,246,221.7	grams

Total Field Yield

Possible	26,865,886.3	grams
Actual	12,041,998.8	grams

Table XXVII. Analysis of yield data. Field 1. Elgin. (Continued)

Total Field Loss

14,823,887.5	grams	32,651.7 pounds

Percent Loss

55.2%

Economic Loss (at farm price 28¢ per pound)

9,142.48 dollars

Yield Per Hectare

Possible	1,658,388.0	grams per hectare
Actual	743,333.3	grams per hectare

Yield Per Acre

Possible	1,479.4	pounds per acre
Actual	663.1	pounds per acre

Grower's Actual Yield at Harvest

13,620,000.0 grams

Table XXVIII. Analysis of yield data. Field 2. Mapleton.

Field Area

Edge	3.9	hectares	9.6	acres
Mid	3.0	hectares	7.3	acres
Centre	1.5	hectares	3.8	acres
Total	8.4	hectares	20.7	acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	From	$t_{.1}$	To
Edge	Exclosure	29.7				
	Control	0.0				
Mid	Exclosure	6.2				
	Control	0.0				
Centre	Exclosure	16.2				
	Control	0.0				

Section Yield

Edge	Possible	613,008.9	grams
	Actual	0.0	grams
Mid	Possible	96,526.7	grams
	Actual	0.0	grams
Centre	Possible	133,746.7	grams
	Actual	0.0	grams

Total Field Yield

Possible	843,282.3	grams
Actual	0.0	grams

Table XXVIII. Analysis of yield data. Field 2. Mapleton. (Continued)

Total Field Loss

	843,282.3	grams	1,857.5 pounds

Percent Loss

100%

Economic Loss

520.09 dollars

Yield Per Hectare

Possible	100,570.0	grams per hectare
Actual	0.0	grams per hectare

Yield Per Acre

Possible	89.6	pounds per acre
Actual	0.0	pounds per acre

Grower's Actual Yield at Harvest

0.0 grams

Table XXIX. Analysis of yield data. Field 3. Gowland Mountain.

Field Area

Edge	7.1 hectares	17.5 acres
Mid	5.2 hectares	12.8 acres
Centre	3.9 hectares	9.6 acres
Total	16.2 hectares	39.9 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	From	$t_{.1}$ To
Edge	Exclosure	213.7	90.53	153.9	273.5
	Control	101.7	36.82	96.6	128.6
Mid	Exclosure	354.3	207.20	229.4	479.2
	Control	233.4	118.26	186.9	279.9
Centre	Exclosure	328.0	72.77	284.2	371.8
	Control	243.7	55.17	222.0	265.4

Section Yield

Edge	Possible	10,113,332.3	grams
	Actual	4,813,332.9	grams
Mid	Possible	12,282,398.8	grams
	Actual	8,088,888.1	grams
Centre	Possible	8,527,999.1	grams
	Actual	6,335,554.9	grams

Total Field Yield

Possible	30,923,730.2	grams
Actual	19,237,775.9	grams

Table XXIX. Analysis of yield data. Field 3. Gowland Mountain. (Continued)

Total Field Loss

11,685,954.3 grams 25,740.0 pounds

Percent Loss

36.14%

Economic Loss

7,207.20 dollars

Yield Per Hectare

Possible	1,908,872.2	grams per hectare
Actual	1,187,517.0	grams per hectare

Yield Per Acre

Possible	1,707.1	pounds per acre
Actual	1,062.0	pounds per acre

Grower's Actual Yield at Harvest

14,883,936.0 grams

Table XXX. Analysis of yield data. Field 4. Goshen.

Field Area

Edge	1.8	hectares	4.4 acres
Mid	0.8	hectares	2.0 acres
Centre	0.5	hectares	1.2 acres
Total	3.1	hectares	7.6 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	$t_{.1}$ From	To
Edge	Exclosure	264.4	92.06	208.9	319.9
	Control	115.1	66.23	89.1	141.0
Mid	Exclosure	195.5	81.19	146.6	244.4
	Control	149.8	72.83	121.2	178.4
Centre	Exclosure	136.4	56.25	102.5	170.3
	Control	122.9	63.84	97.8	148.0

Section Yield

Edge	Possible	4,031,110.7	grams
	Actual	1,753,333.2	grams
Mid	Possible	1,279,999.9	grams
	Actual	979,999.9	grams
Centre	Possible	593,333.3	grams
	Actual	533,333.3	grams

Total Field Yield

Possible	5,904,443.9	grams
Actual	3,266,666.4	grams

Table XXX. Analysis of yield data. Field 4, Goshen. (Continued)

Total Field Loss

2,637,777.5	grams	5,810.1 pounds

Percent Loss

44.7%

Economic Loss

1,626.82 dollars

Yield Per Hectare

Possible	1,904,659.3	grams per hectare
Actual	1,053,763.4	grams per hectare

Yield Per Acre

Possible	1,711.2	pounds per acre
Actual	946.8	pounds per acre

Grower's Actual Yield at Harvest

3,217,044.0 grams

Table XXXI. Analysis of yield data. Field 5. Memramcook East.

Field Area

Edge	1.8 hectares	4.4 acres
Mid	1.4 hectares	3.5 acres
Centre	0.6 hectares	1.5 acres
Total	3.8 hectares	9.4 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	t ±1 From	To
Edge	Exclosure	66.5	66.42	21.0	112.0
	Control	20.0	30.32	6.7	33.3
Mid	Exclosure	142.4	89.22	88.7	196.1
	Control	49.9	41.30	33.7	66.1
Centre	Exclosure	204.9	86.46	152.8	257.0
	Control	100.6	59.21	77.3	123.9

Section Yield

Edge	Possible	590,519.9 grams
	Actual	177,600.0 grams
Mid	Possible	983,509.2 grams
	Actual	344,642.6 grams
Centre	Possible	606,503.9 grams
	Actual	297,776.0 grams

Total Field Yield

Possible	2,180,533.0 grams
Actual	820,018.6 grams

Table XXXI. Analysis of yield data. Field 5. Memramcook East. (Continued)

Total Field Loss

1,360,514.4	grams	2,996.7	pounds

Percent Loss

62.4%

Economic Loss

839.08 dollars

Yield Per Hectare

Possible	573,824.5	grams per hectare
Actual	215,794.4	grams per hectare

Yield Per Acre

Possible	510.9	pounds per acre
Actual	192.1	pounds per acre

Grower's Actual Yield at Harvest

668,288.0 grams

Table XXXII. Analysis of yield data. Field 6. Fenwick, N.S.

Field Area

Edge	5.1 hectares	12.6 acres
Mid	4.4 hectares	10.9 acres
Centre	2.4 hectares	5.9 acres
Total	11.9 hectares	29.4 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	$t_{.1}$ From	To
Edge	Exclosure	332.9	172.36	214.7	451.1
	Control	305.1	169.03	231.1	379.1
Mid	Exclosure	262.8	82.95	212.8	312.8
	Control	298.2	50.12	278.4	318.0
Centre	Exclosure	251.1	118.32	179.8	322.4
	Control	242.9	163.68	171.3	314.5

Section Yield

Edge	Possible	14,336,891.9	grams
	Actual	13,139,638.7	grams
Mid	Possible	9,764,479.0	grams
	Actual	11,079,785.6	grams
Centre	Possible	5,088,959.5	grams
	Actual	4,922,772.8	grams

Total Field Yield

Possible	29,190,330.4	grams
Actual	29,142,197.1	grams

Table XXXII. Analysis of yield data. Field 6. Fenwick, N.S. (Continued)

Total Field Loss

48,133.8 grams 106.0 pounds

Percent Loss

0.002%

Economic Loss

29.68 dollars

Yield Per Hectare

Possible	1,417,006.3	grams per hectare
Actual	1,414,669.8	grams per hectare

Yield Per Acre

Possible	1,258.2	pounds per acre
Actual	1,256.2	pounds per acre

Grower's Actual Yield at Harvest

27,787,524.0 grams

Table XXXIII. Analysis of yield data. Field 7. West Scotch Settlement.

Field Area

Edge	10.3	hectares	25.5 acres
Mid	7.2	hectares	17.9 acres
Centre	3.1	hectares	7.7 acres
Total	20.6	hectares	51.1 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	From	$t_{.1}$ To
Edge	Exclosure	154.1	64.12	110.1	198.1
	Control	79.6	57.83	54.3	104.9
Mid	Exclosure	204.4	75.40	158.9	249.9
	Control	150.5	64.67	125.0	176.0
Centre	Exclosure	132.9	68.28	91.7	174.1
	Control	96.5	33.91	83.1	109.9

Section Yield

Edge	Possible	15,695,939.5	grams
	Actual	8,107,701.4	grams
Mid	Possible	14,553,278.5	grams
	Actual	10,715,598.9	grams
Centre	Possible	4,074,122.9	grams
	Actual	2,958,260.8	grams

Total Field Yield

Possible	34,323,340.9	grams
Actual	21,781,561.1	grams

Table XXXIII. Analysis of yield data. Field 7. West Scotch Settlement. (Continued)

Total Field Loss

12,541,779.8 grams 27,625.1 pounds

Percent Loss

36.5%

Economic Loss

7,735.03 dollars

Yield Per Hectare

Possible	1,666,181.6	grams per hectare
Actual	1,057,357.3	grams per hectare

Yield Per Acre

Possible	1,479.5	pounds per acre
Actual	938.9	pounds per acre

Grower's Actual Yield at Harvest

Not Available

Table XXXIV. Analysis of yield data. Field 8. Pennfield Station.

Field Area

Edge	1.8 hectares	4.3 acres
Mid	1.1 hectares	2.8 acres
Centre	0.7 hectares	1.8 acres
Total	2.6 hectares	8.9 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	$t_{.1}$ From	To
Edge	Exclosure	103.8	86.90	51.4	156.2
	Control	68.2	58.77	45.0	91.4
Mid	Exclosure	164.9	61.69	127.7	202.1
	Control	134.3	76.02	104.5	164.1
Centre	Exclosure	266.6	79.95	218.5	314.7
	Control	200.9	104.48	159.7	242.1

Section Yield

Edge	Possible	2,200,559.8 grams
	Actual	1,445,839.9 grams
Mid	Possible	2,136,370.9 grams
	Actual	1,739,930.9 grams
Centre	Possible	2,197,968.7 grams
	Actual	1,656,308.7 grams

Total Field Yield

Possible	6,534,899.4 grams
Actual	4,842,079.5 grams

Table XXXIV. Analysis of yield data. Field 8. Pennfield Station. (Continued)

Total Field Loss

1,692,819.9	grams	3,728.7 pounds

Percent Loss

25.9%

Economic Loss

1,044.04 dollars

Yield Per Hectare

Possible	2,513,422.9	grams per hectare
Actual	1,862,338.3	grams per hectare

Yield Per Acre

Possible	1,617.3	pounds per acre
Actual	1,198.4	pounds per acre

Grower's Actual Yield at Harvest

4,739,760.0 grams

Table XXXV. Analysis of yield data. Field 9. Pennfield Ridge-McDowell.

Field Area

Edge	12.4	hectares	30.6 acres
Mid	7.2	hectares	17.9 acres
Centre	5.2	hectares	12.8 acres
Total	24.8	hectares	61.3 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	t ± 1 From	To
Edge	Exclosure	97.3	50.77	66.7	127.9
	Control	33.4	19.85	25.6	41.2
Mid	Exclosure	109.3	31.47	90.4	128.2
	Control	64.7	25.16	54.8	74.6
Centre	Exclosure	45.2	44.55	18.3	72.1
	Control	23.2	20.28	15.2	31.2

Section Yield

Edge	Possible	9,115,928.0	grams
	Actual	3,129,208.6	grams
Mid	Possible	5,945,919.4	grams
	Actual	3,519,679.6	grams
Centre	Possible	1,775,857.6	grams
	Actual	911,502.1	grams

Total Field Yield

Possible	16,837,705.0	grams
Actual	7,560,390.3	grams

Table XXXV. Analysis of yield data. Field 9. Pennfield Ridge-McDowell. (Continued)

Total Field Loss

9,277,314.7 grams 20,434.6 pounds

Percent Loss

55.1%

Economic Loss

5,721.69 dollars

Yield Per Hectare

Possible	678,939.7	grams per hectare
Actual	304,854.4	grams per hectare

Yield Per Acre

Possible	605.2	pounds per acre
Actual	271.7	pounds per acre

Grower's Actual Yield at Harvest

7,456,950.0 grams

Table XXXVI. Analysis of yield data. Field 10. Pennfield Ridge-McKay.

Field Area

Edge	7.1	hectares	17.6 acres
Mid	4.4	hectares	11.0 acres
Centre	2.9	hectares	7.1 acres
Total	14.4	hectares	35.7 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	t ±1 From	To
Edge	Exclosure	115.5	89.36	61.6	169.4
	Control	68.2	49.65	48.7	87.7
Mid	Exclosure	138.2	125.11	62.8	213.6
	Control	89.4	60.35	50.3	110.5
Centre	Exclosure	95.3	22.68	81.6	109.0
	Control	86.1	12.10	80.8	91.4

Section Yield

Edge	Possible	7,744,915.9	grams
	Actual	4,573,188.4	grams
Mid	Possible	5,742,977.2	grams
	Actual	3,715,066.3	grams
Centre	Possible	2,610,160.9	grams
	Actual	2,358,183.1	grams

Total Field Yield

Possible	16,098,054.0	grams
Actual	10,646,437.8	grams

Table XXXVI. Analysis of yield data. Field 10. Pennfield Ridge-McKay. (Continued)

Total Field Loss

5,451,616.2	grams	12,008.0 pounds

Percent Loss

33.9%

Economic Loss

3,362.20 dollars

Yield Per Hectare

Possible	1,117,920.4	grams per hectare
Actual	739,336.0	grams per hectare

Yield Per Acre

Possible	993.2	pounds per acre
Actual	656.9	pounds per acre

Grower's Actual Yield at Harvest

10,028,406.0 grams

Table XXXVII. Analysis of yield data. Field 11. Elmsville.

Field Area

Edge	3.7 hectares	9.2 acres
Mid	2.3 hectares	5.7 acres
Centre	1.2 hectares	2.9 acres
Total	7.2 hectares	17.8 acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	$t_{.1}$ From	To
Edge	Exclosure	74.2	68.04	33.2	115.2
	Control	37.0	34.91	23.2	50.8
Mid	Exclosure	102.3	62.61	64.5	140.1
	Control	98.0	68.29	71.1	124.9
Centre	Exclosure	53.4	29.80	36.0	70.8
	Control	44.5	46.06	26.4	62.6

Section Yield

Edge	Possible	2,318,337.5	grams
	Actual	1,156,044.3	grams
Mid	Possible	1,986,893.1	grams
	Actual	1,903,377.6	grams
Centre	Possible	541,119.9	grams
	Actual	450,933.3	grams

Total Field Yield

Possible	4,846,350.5	grams
Actual	3,510,355.2	grams

Table XXXVII. Analysis of yield data. Field 11. Elmsville. (Continued)

Total Field Loss

1,335,995.3 grams 2,942.7 pounds

Percent Loss

27.6%

Economic Loss

823.96 dollars

Yield Per Hectare

Possible	673,104.2	grams per hectare
Actual	487,549.3	grams per hectare

Yield Per Acre

Possible	599.7	pounds per acre
Actual	434.4	pounds per acre

Grower's Actual Yield at Harvest

3,427,700.0 grams

Table XXXVIII. Analysis of yield data. Field 12. Central Tower Hill.

Field Area

Edge	2.1	hectares	5.1	acres
Mid	1.0	hectares	2.6	acres
Centre	1.0	hectares	2.6	acres
Total	4.1	hectares	10.3	acres

Sample Plot Yield (grams)

		Mean	Standard Deviation	From $t_{\pm 1}$	To
Edge	Exclosure	82.3	26.78	66.2	98.4
	Control	51.4	29.13	40.0	62.8
Mid	Exclosure	171.8	177.59	64.8	278.8
	Control	102.9	109.63	59.8	146.0
Centre	Exclosure	228.4	86.57	176.3	280.5
	Control	209.2	84.89	172.1	246.3

Section Yield

Edge	Possible	1,459,453.2	grams
	Actual	911,493.2	grams
Mid	Possible	1,450,755.4	grams
	Actual	868,933.2	grams
Centre	Possible	3,222,977.5	grams
	Actual	2,952,044.1	grams

Total Field Yield

Possible	6,133,186.1	grams
Actual	4,732,470.5	grams

Table XXXVIII. Analysis of yield data. Field 12. Central Tower Hill. (Continued)

Total Field Loss

1,400,715.6 grams 3,085.3 pounds

Percent Loss

22.8%

Economic Loss

863.88 dollars

Yield Per Hectare

Possible	1,495,899.0	grams per hectare
Actual	1,154,261.1	grams per hectare

Yield Per Acre

Possible	1,311.6	pounds per acre
Actual	1,012.0	pounds per acre

Grower's Actual Yield at Harvest

6,469,046.0 grams

the exclosure area yield for the mid section of field six, Fenwick. There is no explanation for this occurance.

The weight of blueberries obtained by the owner during the harvest of field 7, West Scotch Settlement, is unknown.

The author can offer no explanation as to why the estimated actual yield of field 12, Central Tower Hill, is less than that which the grower says he obtained.

The estimated actual yields for fields 3, 4, 5, 6, 8, 9, 10, and 11 are greater than the yields obtained by the owners. This difference in actual yield is most probably due to the fact that the author's harvest of the sample plots was done more carefully than the overall harvest done by the pickers hired by the field owners. The difference between the estimated actual yield and the yield obtained by the owner can therefore be attributed to losses incurred due to harvest techniques. This seems to be a reasonable explanation due to the number of fields that this difference has occurred in.

POPULATION RESPONSIBLE FOR DAMAGE

During late May and early June, six adult and twelve juvenile robins were wing-tagged. The robins were captured in the vicinity of field 8, Pennfield Station. None of the marked birds were observed during the crop ripening period (1 August to harvest completion). It is possible that some or all of the marked robins fell prey to sharp-shinned hawks. During June, two adult sharp-shinned hawks were observed in the vicinity of field 8. The adult hawks remained in the area and in mid-August were observed hunting in field 8 with two juvenile sharp-shinned hawks.

The policy set by the Minister of the Environment that no protection permits would be issued during 1973 nullified any results which might

have been obtained through band returns from the banding campaign.

The habitat surrounding each of the twelve selected blueberry fields has been shown in the form of diagrams (Figures 17 to 28).

Census data and observations of each field were as follows:

Field 1. Elgin. First song census, 31 May - four robins. Second song census, 8 June - six robins.

The number of birds utilizing this field as a food resource began to increase during the last week of July. The number of birds steadily increased until the harvest was completed 20 August 1973. The field was harvested about ten days earlier than the normal harvest date due to excellent small fruit-growing weather during the summer. As many as 1000 robins and 600 starlings were observed feeding in this field prior to and during the harvest. Although robins and starlings were the most obvious depredators many other species were observed in the field in sufficient numbers to be a pest species. These include: cedar waxwing, rose-breasted grosbeak, evening grosbeak, swainson's thrush, purple finch, white-throated sparrow, house sparrow, and scarlet tanager.

Field 2. Mapleton. First song census, 31 May - five robins. Second song census, 8 June - four robins.

The breeding population of robins around this field was probably larger than was indicated by the song census. During early June, 23 robins were observed in the field. The robins observed appeared to be foraging for invertebrate food.

About 35 robins were observed in this field during the harvest. Other birds observed during the harvest included: yellow-shafted flicker, swainson's thrush, and white-throated sparrow.

Field 3. Gowland Mountain. First song census, 31 May - 11 robins. Second song census, 8 June - eight robins.

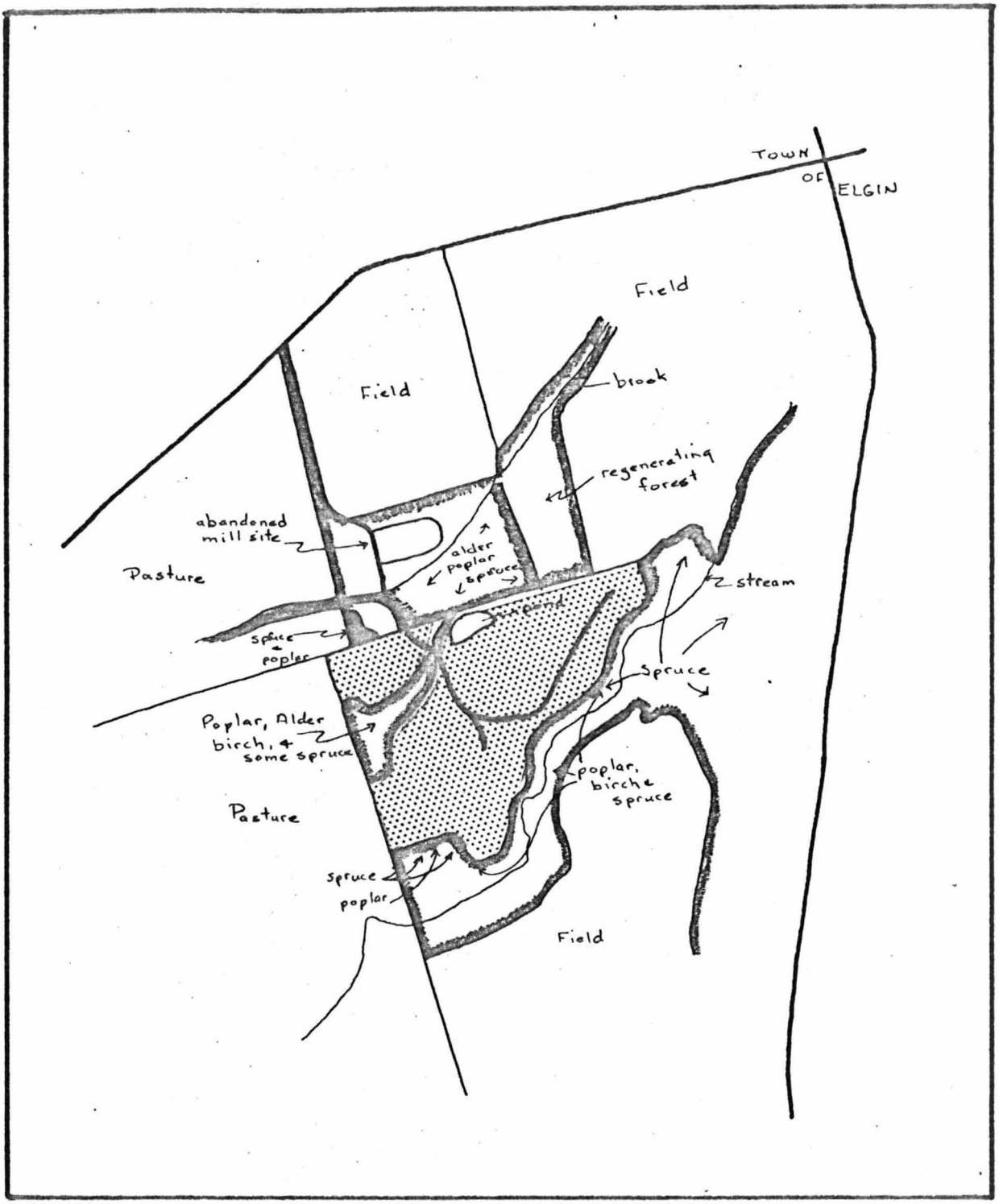

Figure 17. Schematic diagram of Field 1, Elgin, showing surrounding habitat.

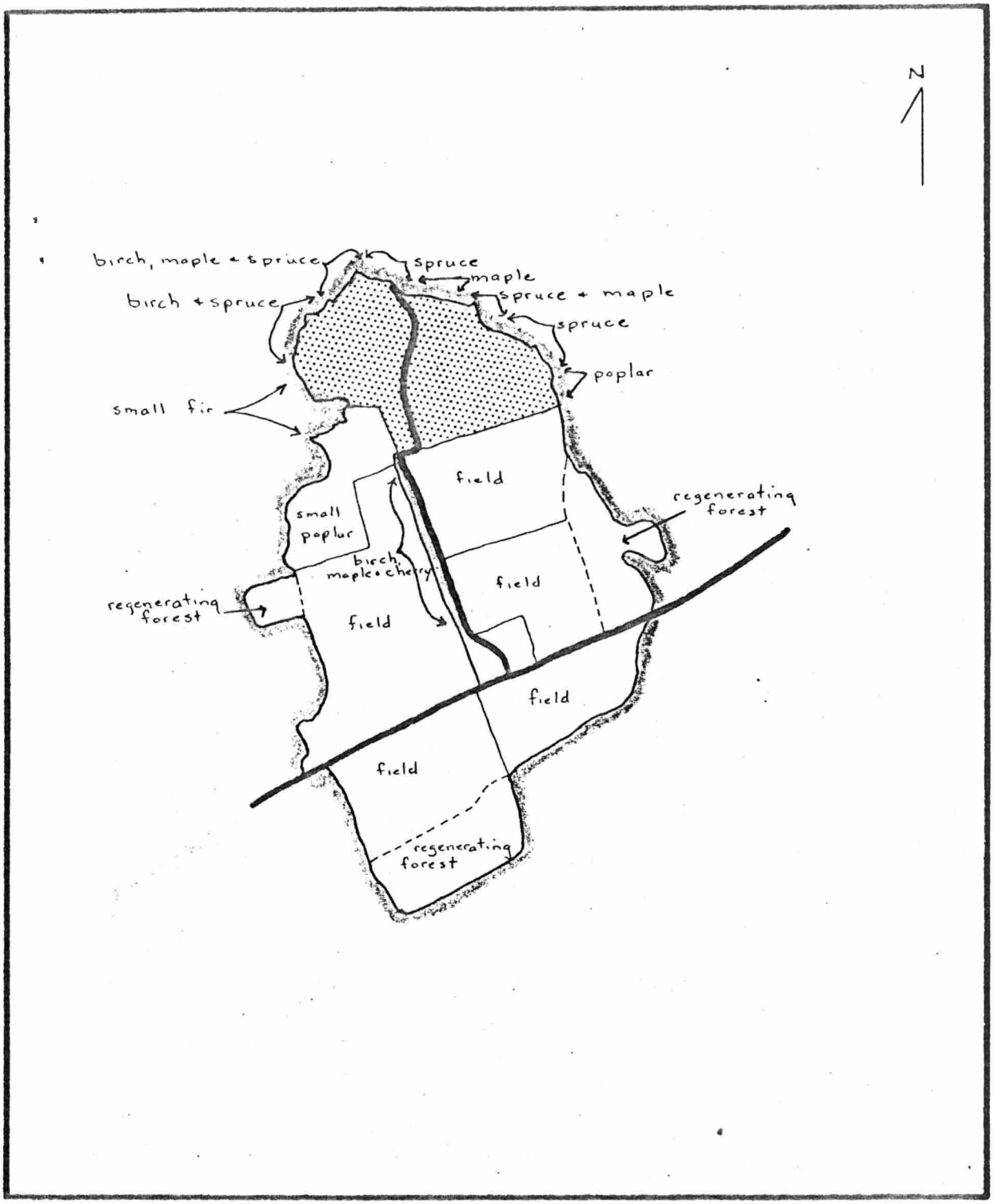

Figure 18. Schematic diagram of Field 2, Mapleton, showing surrounding habitat.

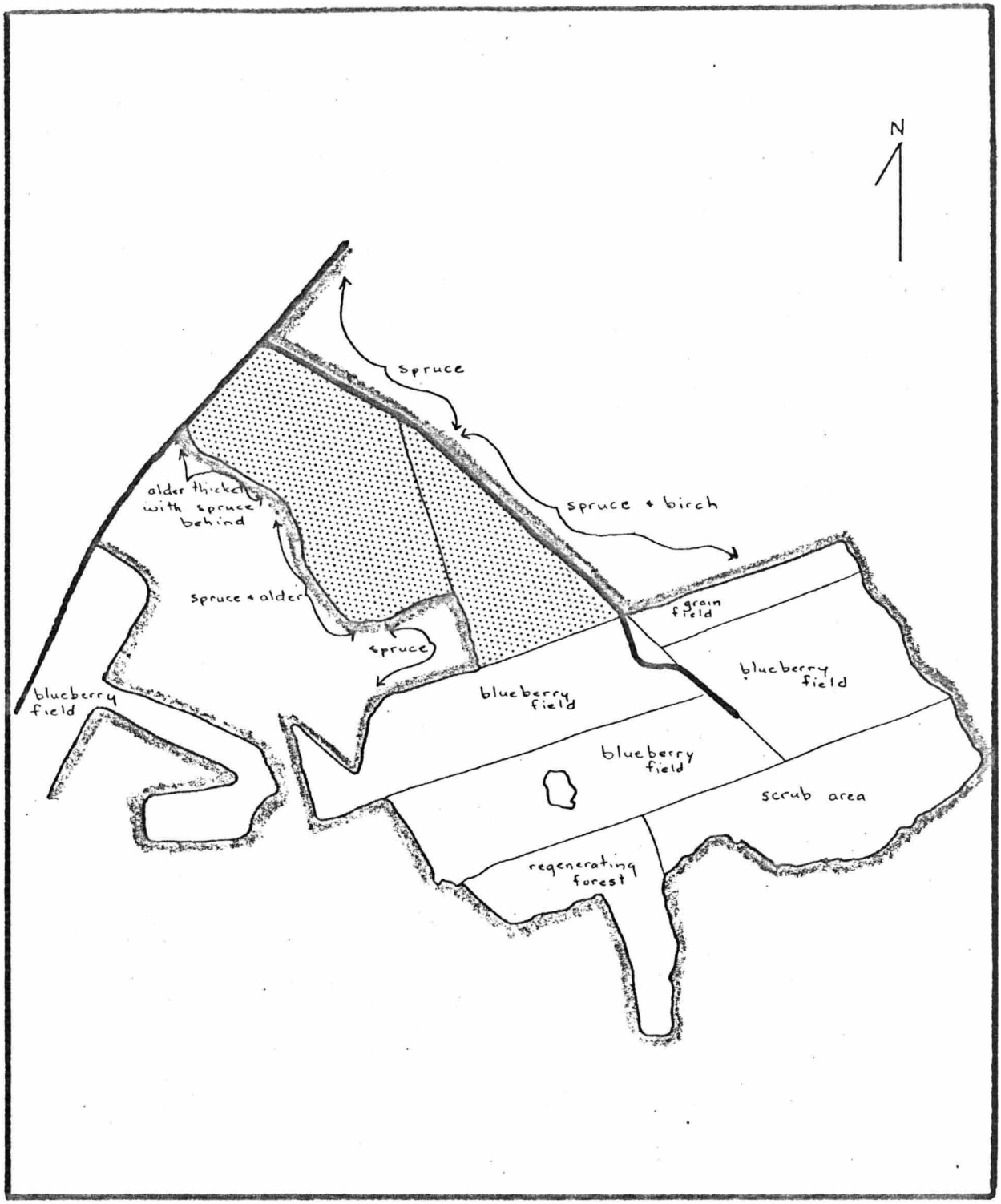

Figure 19. Schematic diagram of Field 3, Gowland Mountain, showing surrounding habitat.

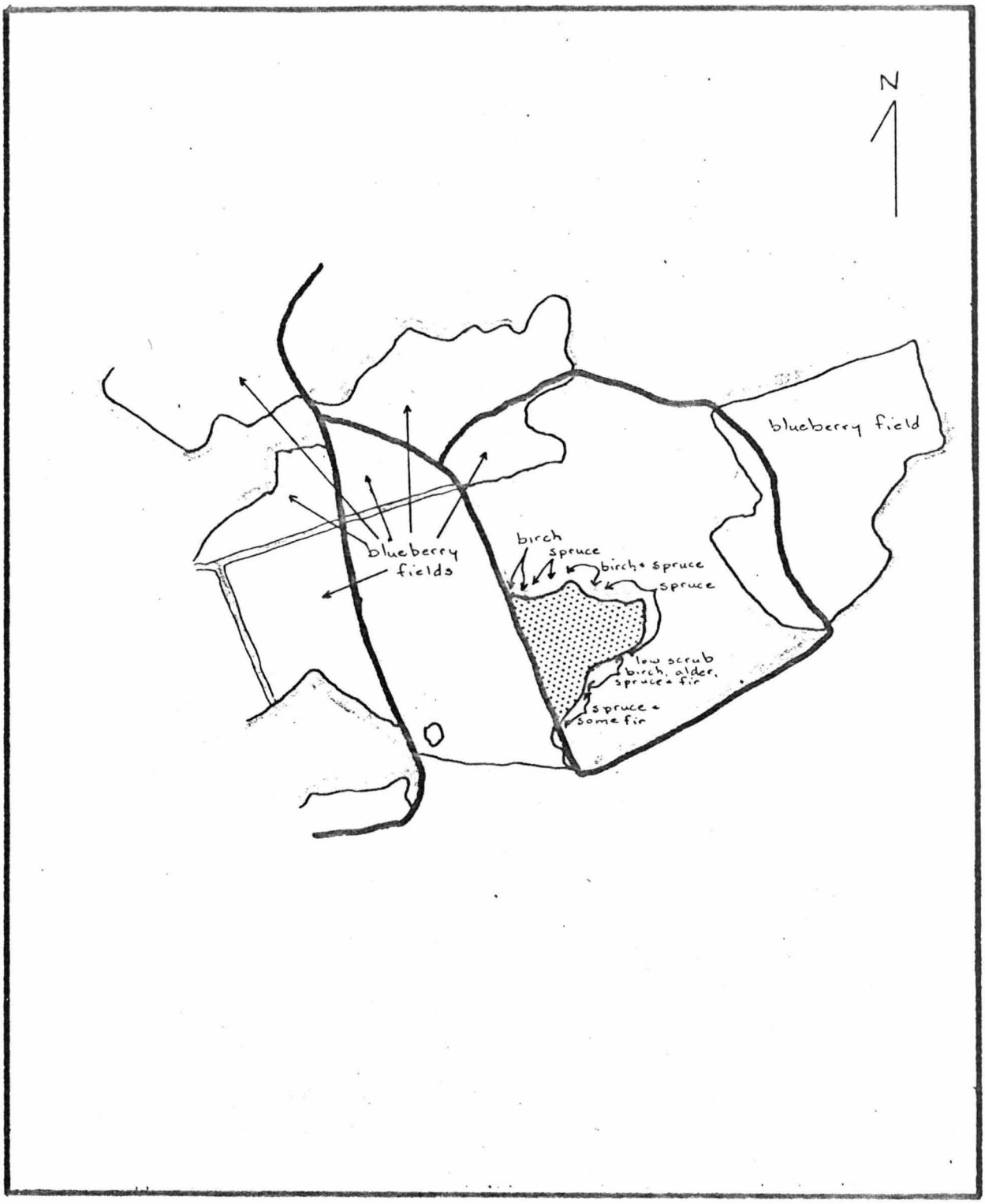

Figure 20. Schematic diagram of Field 4, Goshen, showing surrounding habitat.

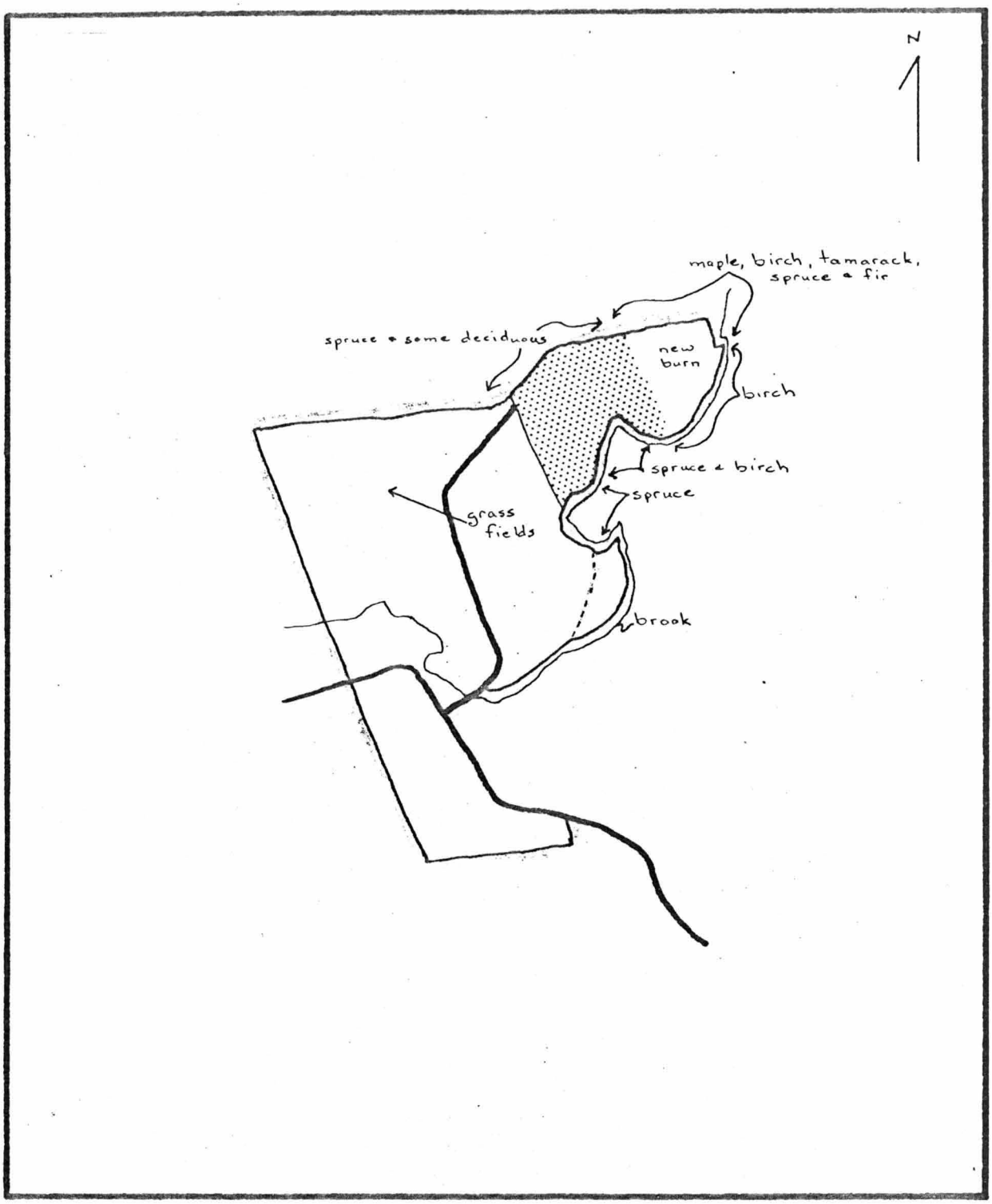

Figure 21. Schematic diagram of Field 5, Memramcook East, showing surrounding habitat.

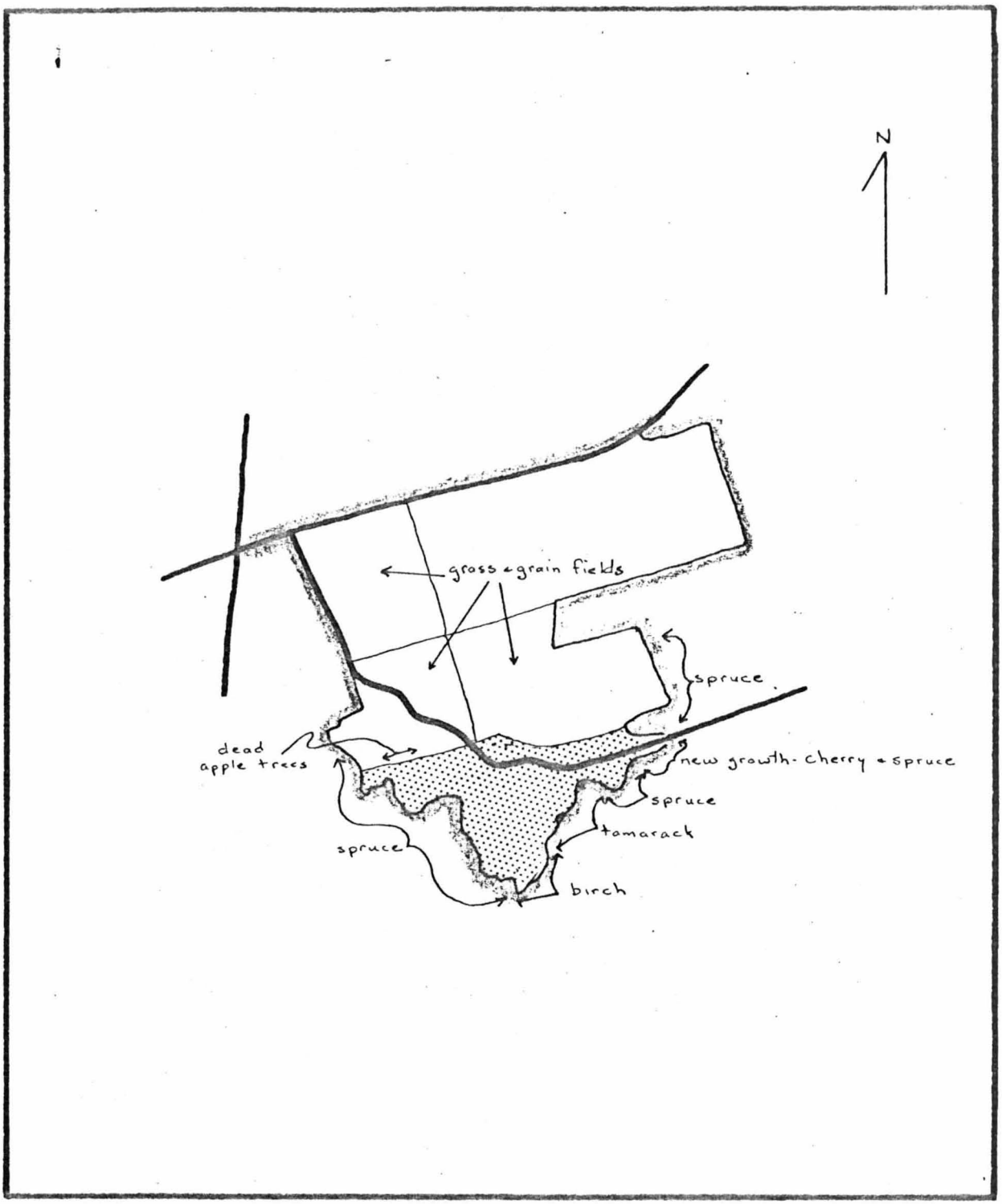

Figure 22. Schematic diagram of Field 6, Fenwick, showing surrounding habitat.

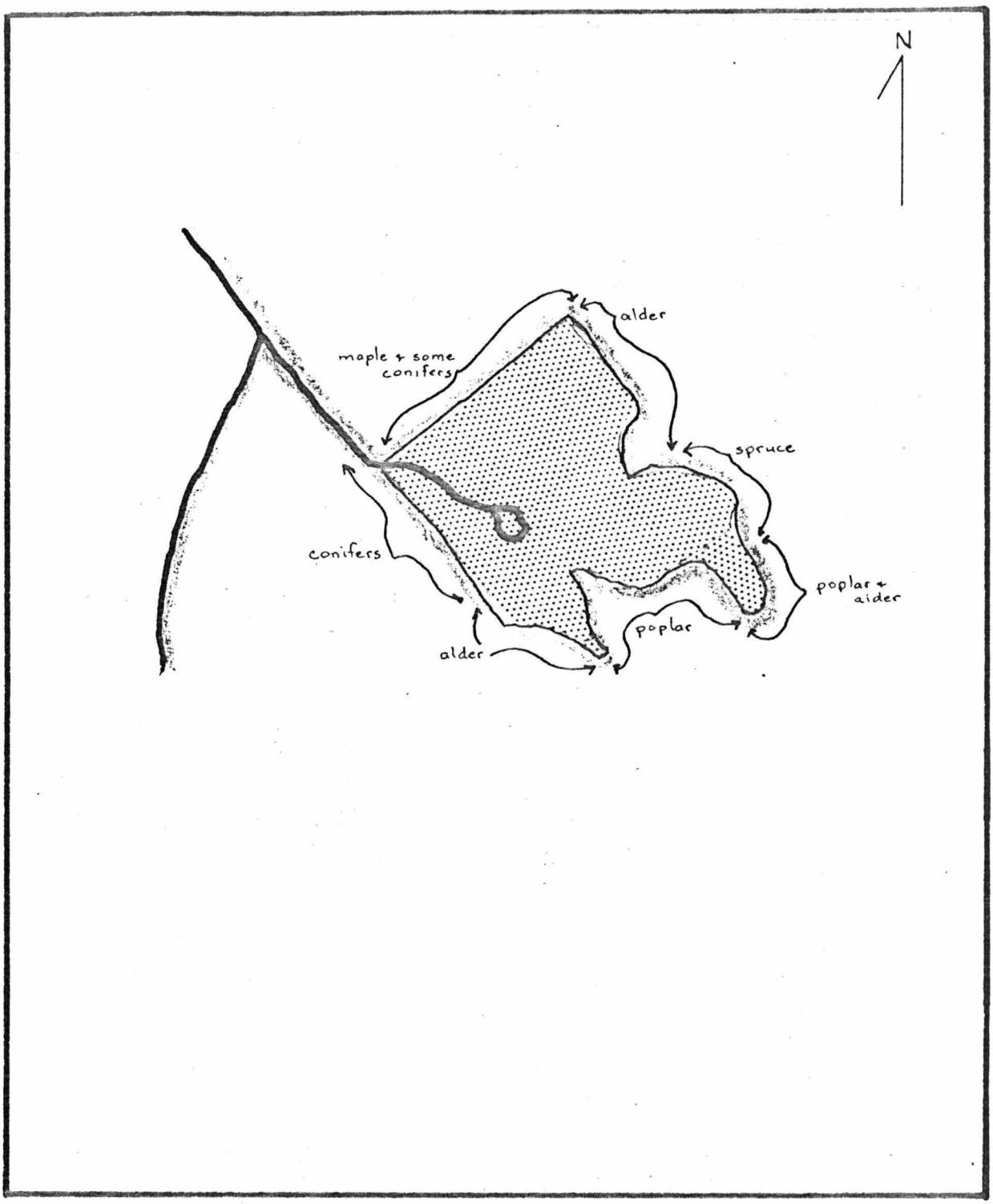

Figure 23. Schematic diagram of Field 7, West Scotch Settlement, showing surrounding habitat.

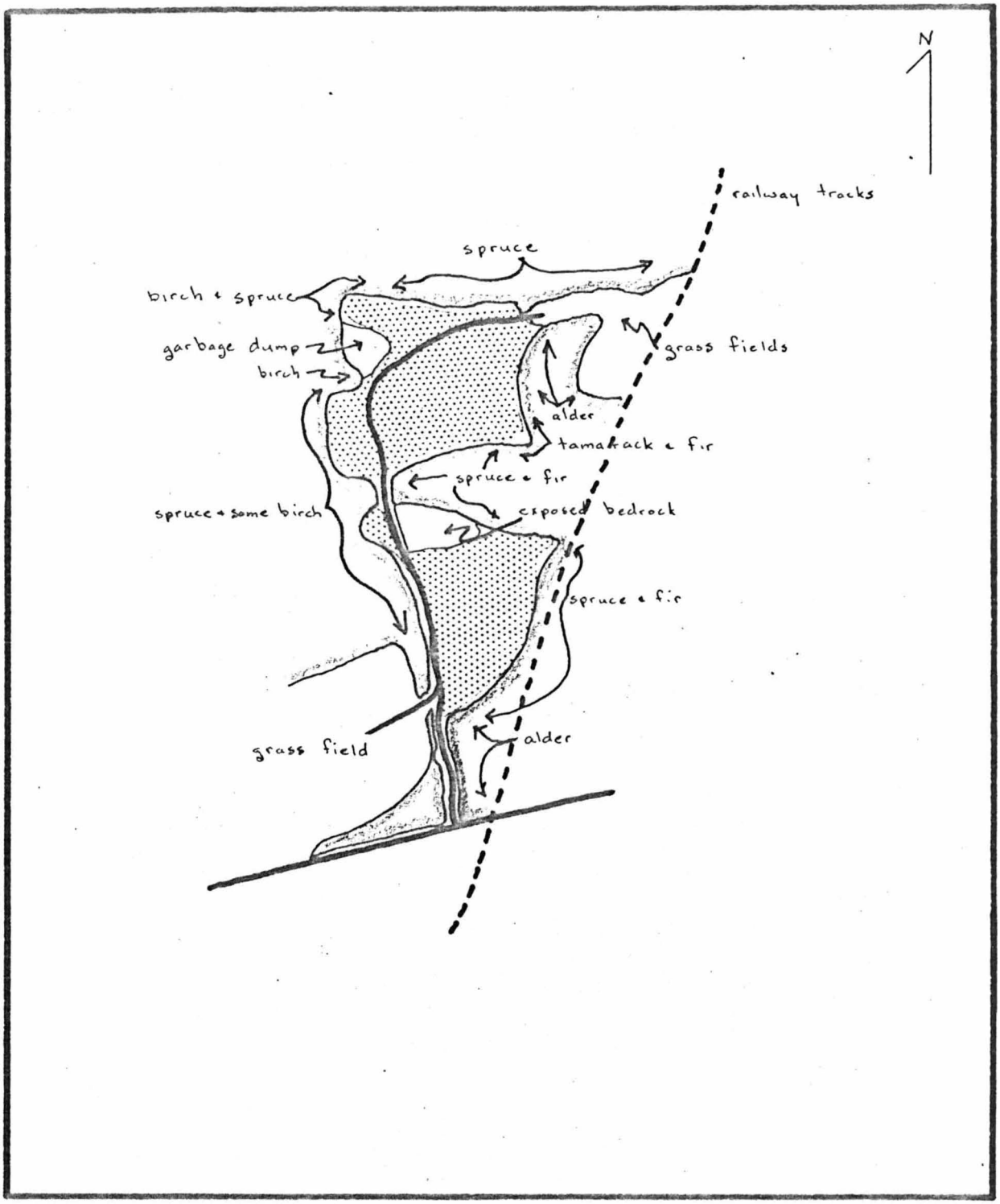

Figure 24. Schematic diagram of Field 8, Pennfield Station, showing surrounding habitat.

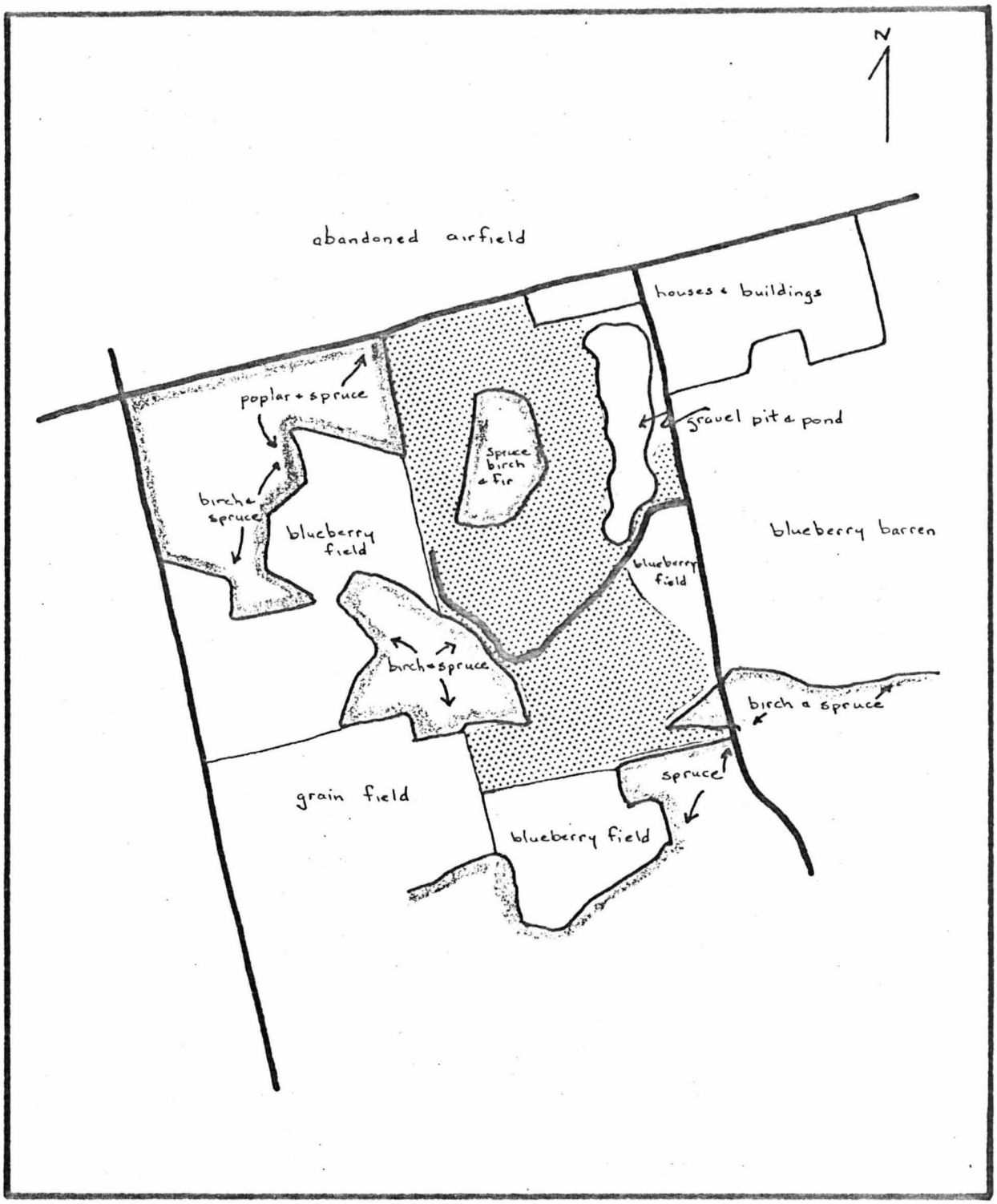

Figure 25. Schematic diagram of Field 9, Pennfield Ridge-McDowell, showing surrounding habitat.

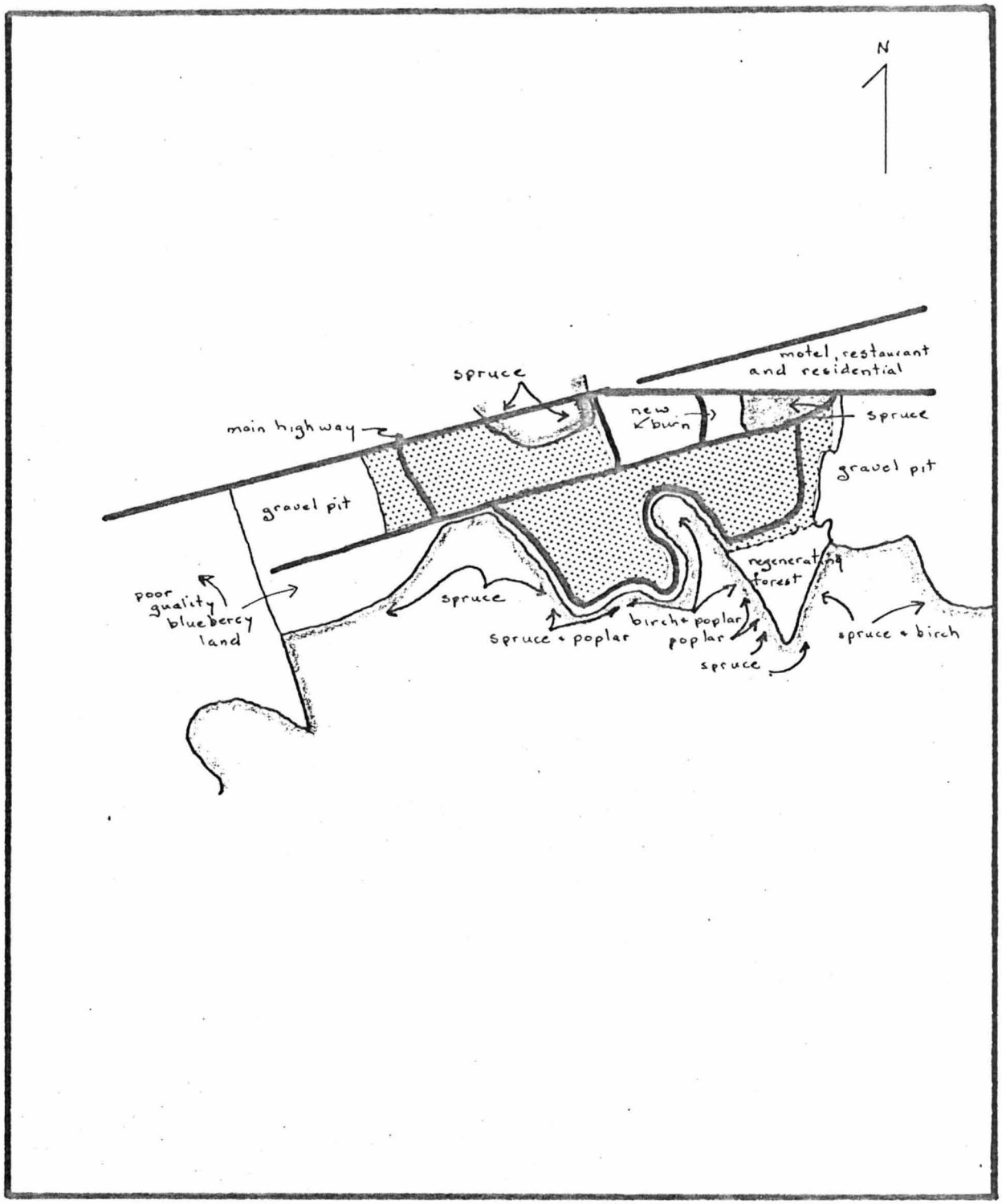

Figure 26. Schematic diagram of Field 10, Pennfield Ridge-McKay, showing surrounding habitat.

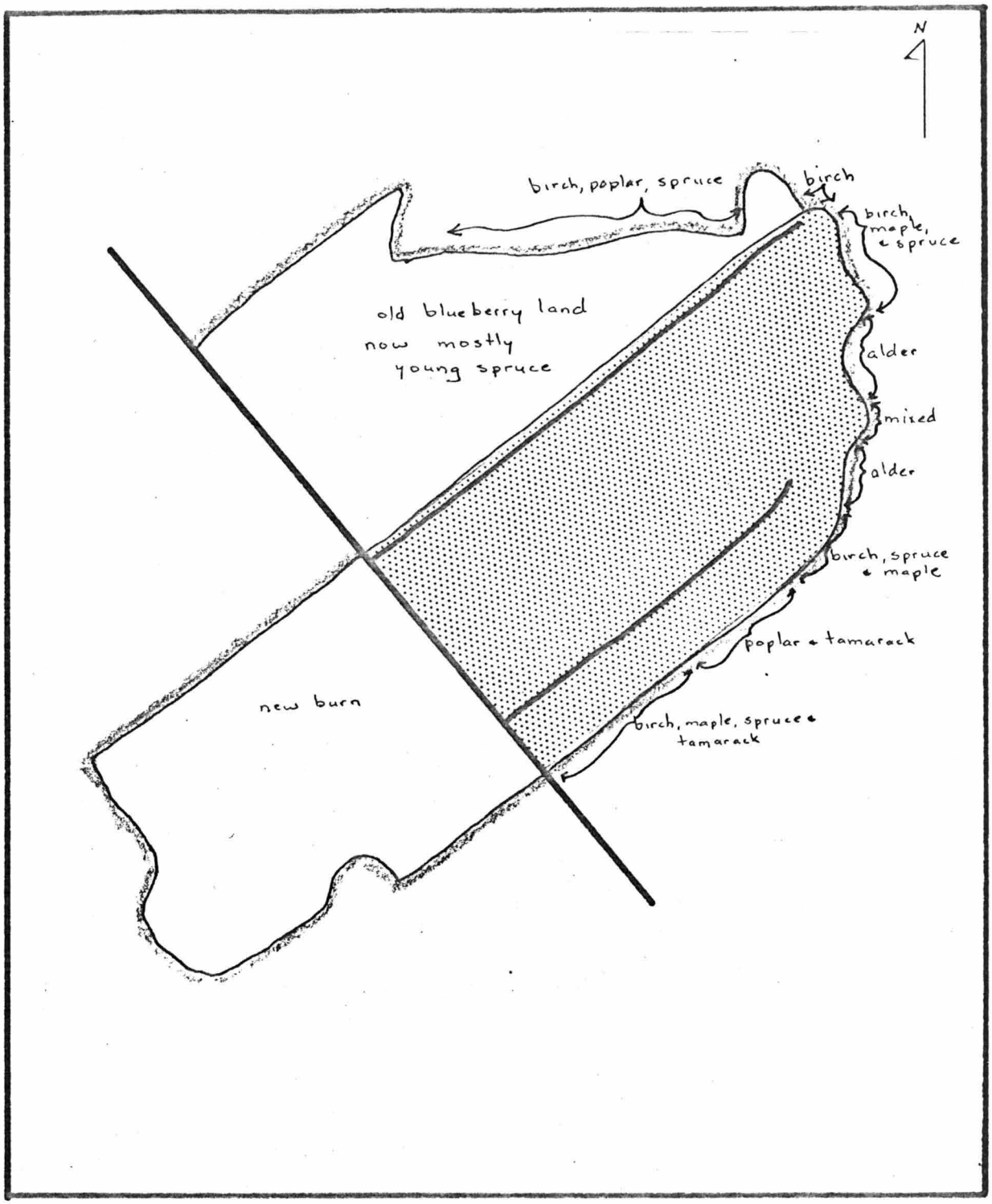

Figure 27. Schematic diagram of Field 11, Elmsville, showing surrounding habitat.

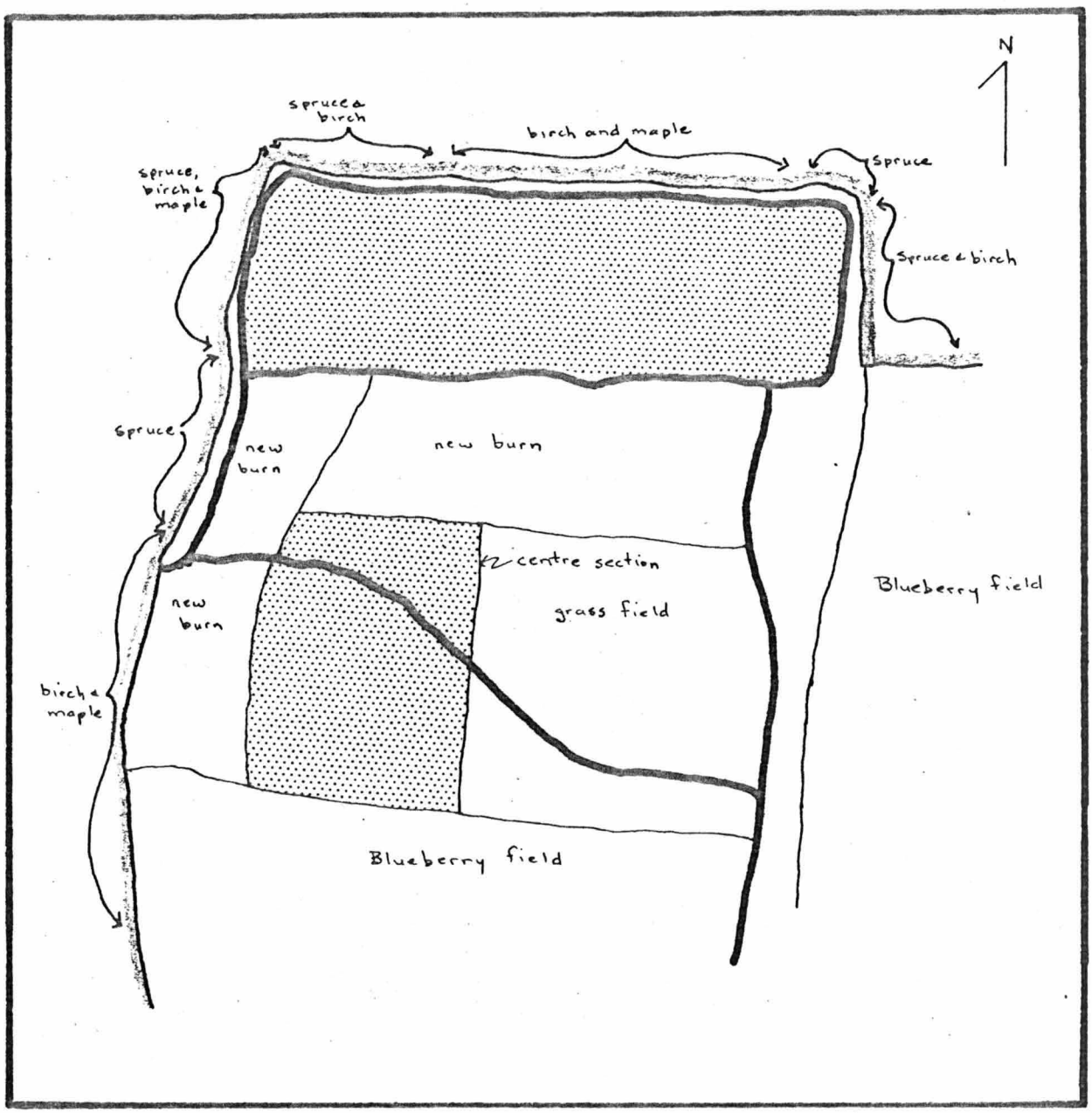

Figure 28. Schematic diagram of Field 12, Central Tower Hill, showing surrounding habitat.

The majority of observations of robin activity were made in this field and in the blueberry fields adjacent to this field on Gowland Mountain. Field 3 appeared to have the largest population of breeding robins. Detailed observations indicated that as many as 20 robins had nests around field 3. There was an abundant invertebrate food supply available on the field and robins were observed flying to the field, collecting invertebrate food, and returning to nest locations in the forest edge of the field. By the end of the third week in June, many juvenile robins were observed feeding on invertebrates in this field. A flock consisting of about 60 juvenile robins was observed, in a small clearing in the forest, near the field adjacent to field 3, during the second week of July. As early as July 11 adult robins in field 3 were observed eating ripe blueberries. It is the opinion of the observer that the robin whilst foraging for invertebrate food would eat any blueberries that were ripe. By July 18 large quantities of blueberries were being consumed by some robins because purple-stained fecal deposits were noted on robin perch locations. During this week robins were observed flying to the earlier ripening blueberry clones to feed, and it appeared as though the birds were picking out the areas specifically rather than happening on them while foraging for invertebrates. During the latter part of July, robins were observed returning to the nest site to feed blueberries to the fledgling birds.

During the first week of August many of the second brood of robins had fledged and were observed feeding in the blueberry field.

Both the number of adult and immature robins feeding in field 3 and the adjacent fields began to increase during the last week of July. By the end of the first week of August about 400 robins were flushed from field 3 and the other fields in the area. By August 12, a similar flush

count was undertaken and 836 robins were observed.

The harvest date of field 3 was about two weeks earlier than the harvest date the previous year.

In early and mid July and again during early August a flush census was undertaken on a blueberry field about two miles from field 3. This field had been burned in the fall of the previous year. On all three occasions no birds were observed. After careful observation it was noted that no invertebrate food was available in this field.

Throughout the period of observation in and around field 3 many other species of bird were observed feeding on blueberries. Those birds observed in sufficient number to have contributed to the depredation of the crop were as follows: cowbird, starling, cedar waxwing, swainson's thrush, hermit thrush, evening grosbeak, rose-breasted grosbeak, white-throated sparrow, vesper sparrow, house sparrow, song sparrow, yellow-shafted flicker, slate-coloured junco, bluejay, gray jay, raven, and scarlet tanager.

Field 4. Goshen. First song census, 31 May - three robins. Second song census, 8 June - four robins.

This field was visited during the first week of August and at that time 87 robins were flushed from the field. Although no flush counts were undertaken,robins were observed in the field adjacent to field 4. During the harvest, August 15, 63 robins were flushed from this field and as before large numbers of robins were also observed in the adjacent field. The diagram (Figure 20) shows that field 4 was a small triangular field at the apex of a larger field which was owned by Donald Mann. The observations were mainly restricted to the study field although as noted above casual observation of Donald Mann's field indicated that he also had a robin problem.

Field 5. Memramcook East. First song census, 26 May - one robin. Second song census, 9 June - one robin.

About 160 robins were observed in this field August 9. The number had increased to about 190 by August 16. During the harvest of this field, August 20, about 230 robins were observed. Several other species of bird were observed in the field but only the robins were present in sufficient numbers to be classified as a pest. There was evidence to indicate that at least one raccoon had been feeding in this field.

Field 6. Fenwick. First song census, 26 May - seven robins. Second song census, 9 June - four robins.

This field was visited August 9 and very little birds activity was noted even though the blueberries on the field were well-developed. A flush count raised twelve robins, three swainson's thrushes, eight cedar waxwings, several sparrows and one yellow-shafted flicker. During the harvest, August 16, birds were occasionally observed but the number of birds observed was extremely small.

Field 7. West Scotch Settlement. No song census data is available for this field.

This was the only field which could be considered as isolated. It was surrounded on all sides by forest.

A flush count, July 23, raised 238 robins. During the harvest, August 23, 372 robins were flushed. Robins were not the only species observed feeding on the blueberries, but the numbers of other birds were fairly small. Included in the other birds observed were yellow-shafted flickers, swainson's thrushes and sparrows.

Field 8. Pennfield Station. First song census, 30 May - two robins. Second song census, 5 June - three robins.

There was not a great amount of bird activity in this field at any

time. White-throated sparrows were the most abundant birds. There were about a dozen robins and seven yellow-shafted flickers observed during the harvest. The majority of damage in this field was probably caused by one or more bears and several raccoons. One bear was observed on several occasions, but it is not known if the bear observed was the same bear each time. On one walk around the periphery of the field, 23 bear scats were noted. On several occasions raccoons were observed feeding on the blueberries in the field.

Field 9. Pennfield Ridge-McDowell. First song census, 30 May - three robins. Second song census, 5 June - four robins.

There was very little robin activity in this field until about August 24. About 2,000 robins were observed in the field just prior to the harvest. The robins observed were in a loose flock. The number of robins remained fairly constant until September 7 and from that date only about 100 were observed. Other birds observed feeding on the blueberry crop were yellow-shafted flickers, herring gulls, swainson's thrushes, white-throated sparrows, starlings, scarlet tanagers, cowbirds, rusty blackbirds and a pair of whimbrels.

The owner's harvest of this field was started August 27 and continued until September 1 at which time a large portion of the field was abandoned because of the serious loss of crop. My harvest of this field was August 27 and would therefore show less serious damage than that which actually occurred.

Field 10. Pennfield Ridge-McKay. First song census, 30 May - two robins. Second song census, 5 June - two robins.

Herring gulls were observed feeding on the blueberries about July 30. Although there was some robin activity in the field, the number of birds involved was small. During the week of August 24 about 800 robins had

moved to this field. The robin's arrival was just prior to the owner's harvest which was completed August 28. White-throated sparrows, swainson's thrushes, and yellow-shafted flickers were also observed in the field.

Field 11. Elmsville. First song census, 27 May - two robins. Second song census, 4 June - two robins.

Robin activity in this field increased from a few birds to about 80 birds during the last week of July. During the harvest, August 18, robin activity was constant, but not exceedingly heavy. A flush census was undertaken and 86 robins were observed. The robins in this field had not flocked and even during the harvest were flying in and out of the field in ones and twos. There was evidence to indicate that at least two deer had been feeding on the blueberries in this field.

Field 12. Central Tower Hill. First song census, 27 May - three robins. Second song census, 4 June - one robin.

Robins or sparrows were observed in the centre section of field 12. The edge and mid sections of field 12, which were in fact a separate field, were in poor condition. This portion had not been burned for several years and was overgrown with weeds and red leaf disease was observed. The poor condition of this section may have influenced the yield results obtained from the exclosure experiment. A flush census of the edge and mid section field was undertaken during the harvest, August 14, and 33 robins were observed. White-throated sparrows were the only other birds present in sufficient numbers to have caused any damage.

CONTROL DEVICES

Av-Alarm. "Av-Alarm is both a method and a device. Complex sounds are produced by the device and broadcast over an area from which pest birds and other animals are to be repelled or otherwise discouraged

from remaining...

It is used mostly for reducing bird depredation in crops such as grapes, berries, sweetcorn, rice, cherries, and many others...

It interferes with an animal's ability to hear the danger and social sounds upon which his security and sense of well being depend. The animal becomes psychologically stressed--nervous and uncomfortable. Some animals may not endure this attack for more than seconds; others may more gradually become worn down and depart. A sudden reaction such as fright is often evidenced. But long term effectiveness is the desired goal, and this can happen even when there is no outright fright reaction...

Sounds are specially designed to penetrate the acoustic pathways to the brain so as to activate the same set of recognition centers which the bird or other animal depends upon for maintaining security and communications with others of his species; or which must be kept clear of extraneous information so as to be able to detect potential threats. Indeed, any loud sound, if it has the proper frequency components, can jam hearing. But the Av-Alarm sound is much more efficient than simple jamming; and it also provokes nervousness and anxiety, which simpler waveforms cannot do nearly so well...

Birds and other animals are creatures of habit. Once they have established themselves in a roost or developed particular area feeding patterns, they will develop site tenacity. Attempting to repel them once a feeding or roosting habit has become established may be somewhat more difficult than when they have not developed the pattern. It is thus best to begin a control program in agriculture before the birds have been attracted to the feed in any large numbers...

There are situations where it (the Av-Alarm) must be augmented...

Some birds seem capable of ignoring it, although they often then display a heightened state of nervousness. If a bird or other animal can endure without hearing, perhaps by depending upon sight instead, then control may be difficult...

What are some typical installations like? 25 - 40 acres of blueberries, grapes, sweetcorn, etc. Rectangular. A three or four speaker Av-Alarm in the center. If there is a prevailing wind, locate the Av-Alarm somewhat upwind of the center of the field. Problem species: Robins, starlings, linnets, cedar waxwing, others." (Stewart, John L., 1973)

In field 7 the Av-Alarm was the only control device employed. Observations, to determine the effectiveness of the Av-Alarm, were made on July 23. During a one-half hour observation period 16 robin entrances and 19 robin exits were noted during the Av-Alarm 'on' time. During the same one-half hour period 49 robin entrances and 52 robin exits were noted during the Av-Alarm 'off' time. Throughout the one-half hour observation, the Av-Alarm was alternately 'on' for one minute and 'off' for three minutes. In conjunction with and about one hour later than the observations, flush counts were undertaken along

a 40 yard transect about 50 yards away from the Av-Alarm. Immediately after an 'on' period the transect was walked and 38 robins were flushed. About one-half hour later and again immediately after an 'on' time the same transect was walked and 33 robins were flushed.

The Canadian Wildlife Service set up one Av-Alarm in field 9. The date this alarm was set up is unknown. During a flush census on August 13, very little robin activity was observed until the investigator approached the area in which the alarm was operating. About 80 robins were flushed from an area of about 250 square yards. The alarm was also within that 250 square yard area and although the alarm was 'on' at the time the robins flew within a few feet of the alarm on the way to the protective cover of the forest edge.

At field 3 Av-Alarms were used in conjunction with acetylene exploders and shotgun patrols. Observations along a 100 yard woods edge on July 25 indicated that with three alarms in operation and two exploders, the number of robin entrances into the monitored area was virtually the same as it had been two days prior to the alarms and exploders being set up. The alarms and exploders were set up July 20. The before control procedures count was 1.4 entrances per minute and on July 25 the count was 1.3 entrances per minute. With a very active patrol passing by every 10 minutes, the number of entrances was reduced to .7 per minute. If the patrol passed only every half to three-quarters of an hour which was most often the case, the number of entrances was 1.1 per minute. The entrances per minute are based on one hour observation periods.

Acetylene Exploders. The only field in which an exploder was used by itself was in field 8. This exploder was set up by the Canadian Wildlife Service and the author was told that it was extremely effective

and had managed to deter the birds from feeding in this field. The author shut off the exploder with the grower's permission and without the exploder in operation there were still no bird problems. As mentioned previously a family of sharp-shinned hawks had resided in this field, and the hawks not the exploder were responsible for the lack of birds. The hawks were constantly active and did an excellent job of chasing any stray yellow-shafted flicker or robin from the open field.

Acetylene guns were also used in field one in conjunction with shotgun patrols. The exploders were non-effective against robins and had very limited success against starlings. After the first day the starling flock would flush and within five or six seconds settle to the field again.

Recorded Robin Alarm Calls. On August 5, the author and Mr. Gordon W. Boudreau observed the effectiveness of Mr. Boudreau's recorded robin alarm calls. Robins were flushed from a 4 acre field with one five second segment of the recorded alarm calls played at very low volume. The robins returned to the field within about 20 minutes but were immediately flushed again with another brief segment of the recording. At higher volume, the recording flushed robins from a 16 acre field. Unfortunately neither the recordings nor the equipment was made available to the author for further testing after its purchase from Mr. Boudreau a few days later by the Canadian Wildlife Service.

Aluminium Pie Plates. After receiving complaints of herring gull damage, the author suggested to the growers that aluminium pie plates, set up as is described by Bentley, 1964, might be successful. Unfortunately neither of the two growers to whom this suggestion was made tried this procedure.

DISCUSSION AND CONCLUSIONS

CROP DAMAGE ESTIMATE

The total provincial blueberry yield for 1973 was 4,650,000 pounds. At a farm price of 0.28 dollars per pound the value of the New Brunswick blueberry crop was 1,302,000.00 dollars. (Pers. Comm. Ted Pratt)

The total acreage that is utilized for the production of blueberries in New Brunswick is not known but is estimated to be about 12,000 acres. About one-half or 6,000 acres of this land is in production during any one year.

The arithmetic mean yield of New Brunswick blueberry land, calculated from the estimated yield per acre of fields 1, 3, 4, 5 and 7 through 12, was 737.6 pounds per acre.

The estimated total provincial blueberry yield from the author's data was 4,425,780 pounds. Although there were variations in the author's data, due to the type of growth of the crop involved in the study, the estimated total yield from the author's data represents only a 4.8 percent difference from the provincial Department of Agriculture's estimated yield.

The arithmetic mean loss of blueberries due to depredation during 1973, calculated from the estimated loss per acre of fields 1, 3, 4, 5 and 7 through 12, was 463.9 pounds per acre.

The estimated total provincial loss due to depredation was 2,783,400 pounds valued at 779,352.00 dollars.

In order to evaluate the effects of phenology and geographic field location on the amount of damage sustained by the blueberry industry, the loss per acre estimates for fields 1 through 12 have been listed in order of harvest dates, (Table XXXIX), and by geographic locations (Table XL).

Table XXXIX. Pounds per acre lost through depredation listed in order of harvest date.

Date of Harvest	Field Number	Loss in Pounds Per Acre
14 August	12	299.6
15 August	4	764.4
16 August	6	2.0
18 August	11	165.3
19 August	1	816.3
20 August	5	318.8
21 August	3	645.1
23 August	7	540.6
26 August	10	336.3
27 August	9	333.5
5 September	2	89.6*
9 September	8	418.9

* - Estimated loss not valid for comparative purposes due to hail damage which destroyed most of the crop prior to any depredation by birds.

Table XL. Pounds per acre lost through depredation listed by geographic field locations.

Area	Field Number	Loss in Pounds Per Acre
Albert County	1	816.3
	2	89.6*
	3	645.1
	4	764.4
Central Kings and Queens Counties	7	540.6
South-Eastern Charlotte County	8	418.9
	9	333.5
	10	336.3
South-Eastern Westmorland County	5	318.8
South-Western Charlotte County	11	165.3
	12	299.6
Cumberland County, N.S. (Fenwick)	6	2.0

* - Estimated loss not valid for comparative purposes due to hail damage which destroyed most of the crop prior to any depredation by birds.

From the data (Table XXXIX) it does not appear as though there is a correlation between the harvest date and the damage occurring or that less damage occurs simply due to an early harvest date. However, the author can say that the early harvest of fields 1 and 3 did save much of the crop and that if the harvest of fields 9 and 10 could have been advanced ten days very little damage would have been noted.

From the data (Table XL) a very definite correlation can be noted. Depredation of blueberry crops during 1973 was related to the geographic location of the field. The greatest losses were noted in the Albert County area.

POPULATION RESPONSIBLE FOR DAMAGE

The song census data (Table XLI) does not indicate any consistant relationship between the amount of damage and the number of breeding robins around the field. It is known from observation, however that the song census data is not accurate at least for field 2 and 3. The author's opinion is that the number of resident robins does have a direct influence on the amount of damage sustained by a field. This opinion was obtained through general observations of the selected fields.

The majority of the damage sustained by field 8 was caused by bears and raccoons. White-throated sparrows were probably responsible for most of the damage that was caused by birds.

Some of the damage to all of the other fields was caused by bears, foxes, raccoons, porcupines and deer, but the majority of the damage was due to bird depredation.

Although the robin has been singled out by most individuals as the main depredator, the author is of the opinion that the other species of birds are responsible for a much greater portion of the depredation

Table XLI. Robin song census data and damage per acre estimates of selected blueberry fields.

Number of Robins Recorded per Acre	Field Number	Loss in Pounds Per Acre
.46	4	764.4
.28	8	418.9
.24	3	645.1
.19	12	299.6
.19	6	2.0
.13	1	816.3
.11	5	318.8
.11	11	165.3
.06	9	333.5
.06	10	336.3

than has previously been realized, and in some cases birds other than the robin are responsible for most of the damage. One such case was observed by the author in Bonny River, Charlotte County. A field owned by Gordon McKay was virtually picked clean by a large concentration of starlings.

The other species which can be considered as pests are: starlings, white-throated sparrows, cedar waxwings, swainson's thrushes, herring gulls and in some cases cowbirds, evening grosbeaks and rose-breasted grosbeaks.

Robins are responsible for the majority of the damage sustained by the blueberry industry. In fields 1, 2, 3, 4, 5, 7, 11 and 12 the robin population was made up of local birds. These robins had either nested around the edge of the blueberry field or had moved to the field from the local area after fledging or completion of the nesting cycle. The blueberry fields provide excellent pre-migratory staging areas due to the availability of protein and carbohydrate food supplies.

The robin population which was responsible for the majority of damage sustained by fields 9 and 10 was not primarily of local origin. These birds had already concentrated into pre-migratory flocks before they arrived at the fields.

CONTROL PROCEDURES

Av-Alarms, acetylene exploders and shotgun patrols are not effective when used individually. The effectiveness of these devices and procedures is increased when the three methods are employed simultaneously. When all three devices or procedures are employed simultaneously, the level of effectiveness is still not satisfactory and most probably not cost effective.

Raptors, specifically sharp-shinned hawks, provided the best control of birds that the author witnessed during 1973.

In order to maintain an acceptable level of bird depredation, both auditory and visual stimuli must be employed. Along with these stimuli some form of reinforcement of the stimuli is necessary. The author is of the opinion that this could best be achieved by a mobile patrol using recorded alarm calls. The equipment, to broadcast the alarm calls, should be mounted on an all terrain vehicle, such as a tri-sport. The patrol should proceed around the periphery of the field on the all terrain vehicle and broadcast the alarm call as necessary. The auditory and visual stimuli which would be produced in this manner should be occasionally reinforced by the firing of blank rounds from a shotgun and, at times, by projecting exploding shotgun shells into flocks or groups of birds.

SUMMARY

1. The New Brunswick blueberry industry sustained substantial economic losses, estimated to be ~~$713,496.00~~ $779,352.00 due to depredation.

2. The majority of the losses are attributable to robins of both local and non-local origins, however, other species of birds and several species of mammals contribute significantly to the depredation.

3. Crop ripening phenology is an important factor dictating the degree of damage to a particular field, but, an early harvest does not preclude severe damage.

4. The geographic location of a blueberry field directly influences the severity of the loss sustained. Of the areas investigated, the greatest damage was in Albert, Kings and Queens Counties.

5. Blueberry fields represent ideal breeding and staging areas for robins as well as many other species of birds because the field edge provides protection for nesting and the field itself provides an abundant supply of both protein and carbohydrate food.

6. The control procedures and devices presently being utilized have limited success. Raptors, specifically the sharp-shinned hawk, provided the best control of birds witnessed during 1973.

RECOMMENDATIONS

1. The Provincial Department of Agriculture should employ a full-time blueberry specialist.

2. The Provincial Department of Agriculture in co-operation with the Federal Department of Agriculture should endeavour to update and upgrade agricultural practices in order to increase the yield per acre of blueberry land in the province.

3. The Provincial Department of Agriculture should promote the increase of the blueberry industry in the province.

4. The Provincial Department of Agriculture together with the Provincial Fish and Game Branch, the Federal Department of Agriculture, the Federal Canadian Wildlife Service and the blueberry industry should undertake a bird control research program. This should be a comprehensive research program and include presently utilized control methods, however, more emphasis should be placed on new procedures such as recorded alarm sounds and chemical taste repellents. This research program should be initiated immediately.

LITERATURE CITED

Bentley, Philip A. 1964. Preventing bird damage to farm crops. Nova Scotia Research Foundation. July 1964.

Freund, John E. 1967. Modern elementary statistics. Third edition. Prentice-Hall, Inc., Englewood Cliffs, N.J.

Hall, I.V., L.E. Aalders, L.P. Jackson, G.W. Wood and C.L. Lockhart. 1972. Lowbush blueberry production. Canada Department of Agriculture Publication 1477.

Hester, A.E. 1963. A plastic wing-tag for individual identification of passerine birds. Bird-Banding 34: 213-217.

Moran, Gary P.A. 1972. A study of bird damage to blueberry crops in New Brunswick during 1972. Unpublished Report to the Canadian Wildlife Service. pp. 118

Pratt, Ted. New Brunswick Department of Agriculture, Plant Industry Branch, P.O. Box 6000, Fredericton, New Brunswick. Personal Communication.

Stewart, John L. 1973. Av-Alarm Corporation, Questions & Answers. P.O. Box 2488, 2734 Industrial Parkway, Santa Maria, California. pp. 20

Wood, George. Canada Department of Agriculture, Fredericton, New Brunswick. Personal Communication.