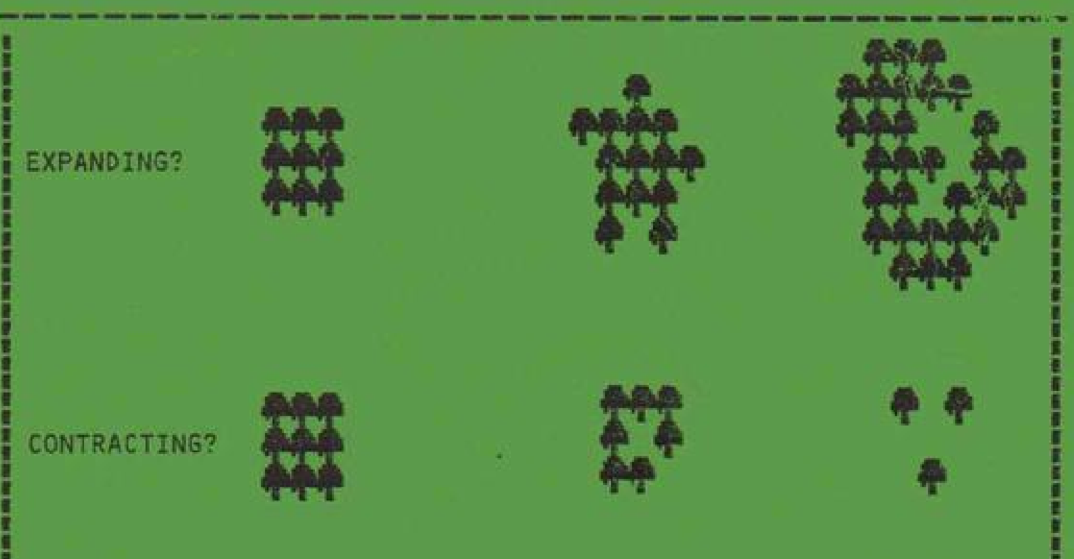
THE STATE OF HIGHLAND BIRCHWOODS

THE REPORT OF THE SWT 1984 SURVEY OF BIRCHWOODS IN HIGHLAND REGION

James Fenton



SCOTTISH WILDLIFE TRUST

Scottish Ecological Consultants

THIS SURVEY CARRIED OUT AND REPORT PREPARED

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THE SWT 1984 HIGHLAND BIRCHWOOD SURVEY

THE REPORT OF A SURVEY OF 41 RANDOMLY SELECTED BIRCHWOODS FROM 21 KILOMETRE SQUARES THROUGHOUT HIGHLAND REGION

"just a run of the mill collection of birch woods - nothing particularly special although each wood special in its own unique way"

CONTENTS

MAIN CONCLUSIONS RELEVANT TO CONSERVATION MANAGEMENT

The 1984 survey was a preliminary one; it is to be used as a basis for further research by the Scottish Wildlife Trust. The following conclusions should, at this stage, be treated as only valid for unenclosed birch woods within Highland Region (but excluding Speyside).

Regeneration

* The mean max diameter was 34 cm in the north of the region and 48 cm in the south; a wood will not be mature, therefore, until some trees have reached this size and no concern about lack of regeneration need be expressed until then
  (Page 9)

* There were always enough seedlings present for natural regeneration (if any pressures preventing regeneration are removed) (p. 13)

* Regeneration was commonest in the long heather at the edges of woods; it was never observed in closed canopy and rarely in the grassy swards characteristic of these woods (p. 13)

* There appeared to be a positive correlation between regeneration and the presence of Calluna (p. 13)

* Regeneration tended to occur in discrete even-aged blocks (p. 13)

* A large healthy wood may not have a closed canopy throughout - bracken and grassy clearings may be a natural feature (p. 7)

* It is possible that sheep grazing does not prevent regeneration, only deer grazing - this needs further study (p. 19)

* Regeneration was observed in every kilometre square visited and in all but 3 woods (p. 13)

Expanding, constant & contracting woods

* Most woods had a permanent core area where regeneration is and has always taken place; this area can be small, big enough for only 2 or 3 mature trees, and acts as a permanent seed source (p. 14)

* A reasonable hypothesis is that woods expand out from the core area when conditions are favourable and retreat back when unfavourable (p. 21)

* There were 3 categories of birchwood: Burnside/cliff woods, Hillside woods and woods of Enclosed pasture (p. 9)

* Burnside/cliff woods tend to be constant in size and hillside woods tend to fluctuate (p. 19)

* 46% of the woods are currently expanding in size, 10% contracting and 44% constant in size (p. 14)

* 38% of the kilometre squares had a birch wood cover expanding in area, 19% contracting and 43% constant (p. 14)

* Most of the current expansion appeared to be due to reduced burning (p. 19)

* Although over a long period the average size of a wood may be constant it is possible that at a given time the wood may be expanding or contracting, i.e. fluctuation about a mean (Page 20)

* As woods tend to regenerate at the edges it is a reasonable hypothesis that over long periods they move around (p. 20)

* The area of the wood, therefore, should not be defined as the current area of trees but the whole area over which the wood has or will move (p. 20, see also front cover)

* Fencing to help regeneration may be more effective if the unwooded edge of the wood is also included (p. 20)

Woodland Flora & Conservation Value

* About 70% of the km squares had woods containing what was defined as a woodland flora, and so will probably have been continuously wooded; of these 24% had a rich flora and so will almost certainly have been continuously wooded (p. 22) [author note 2015: questionable conclusions!]

* The 30% of km squares that contained woods with no or a limited woodland flora may represent secondary wood (i.e. at one time the site was unwooded) or woods too small to contain many species (p. 22)

* Woods of less than 1 hectare generally had a poorer flora than the larger woods (p. 22)

* As more than half the woods contain a woodland flora these woods are therefore a valuable habitat in a mainly species-poor landscape

Conclusions

* The birchwoods studied appeared on the whole to be in a not too unhealthy state, although there is no doubt that some woods are contracting - retreating back to their core areas; there should be concern, though, that:

  - from a random sample of 21 km squares 20% were found to have a contracting birchwood cover

  - birchwoods only covered on average 7% of the km squares visited (page 7) and their % cover of the whole region will be much lower (only wooded squares were visited), i.e. the resource is at a very low level

  - some birchwoods are being affected by new forestry plantations - no account of this has been taken in this survey

INTRODUCTION

BACKGROUND

Recently, because of competing land-use problems, there has been an increased interest in the Highland landscape. Birchwoods are a significant part of this landscape but in the past they tend to have been taken for granted and so have been relatively little studied.

In 1984 therefore the Scottish Wildlife Trust (SWT) decided to set up a project studying Highland birchwoods with the overall aim of aiding conservation management of these woods.

At the start of the project there was discussion with people working for organisations which had previously carried out woodland surveys, as well as a brief review of the literature (see Appendices 2&3); this was to find but the current state of knowledge. From this it was determined that the main gaps in the knowledge of birchwoods, and therefore the main topics to study, centred around the following questions:

a. their status: what is their origin? are they secondary woods (a biotic climax) or have they always been present on a given site (climatic climax)?
b. their dynamics: when and where do they regenerate? is regeneration cyclical?
c. their wildlife value: are they valuable reservoirs of wildlife?

SELECTION OF SITES

In the summer of 1984 Highland Regional Council (HRC) carried out a survey of the woodlands of Highland Region, with advice from the Institute of Terrestrial Ecology (ITE). ITE have devised a system of land classification involving 32 land classes. HRC have classified all of Highland Region using this system, although have modified it slightly by subdividing some of the land classes. For a description of the ITE system see Bunce et al (1981) and Bunce & Last (1981).

Highland Regional Council for their woodland survey selected a random sample of one kilometre squares (from all the land classes) containing woodland, from which they could then generalise about the state of woodlands throughout the whole region. SWT joined in with this survey for three reasons:

1) Highland Regional Council had set up a random sampling system which SWT could also use, so facilitating the setting up of a survey. In addition a <u>random</u> survey technique has the advantage of eliminating subjective bias, i.e. it eliminates the possibility that preconceived notions might influence one's choice of site.
2) By visiting the same sites as Highland Regional Council there could then be a two-way exchange of data between the Council and SWT.
3) Links between the Council and SWT might be beneficial to both sides.

METHODS

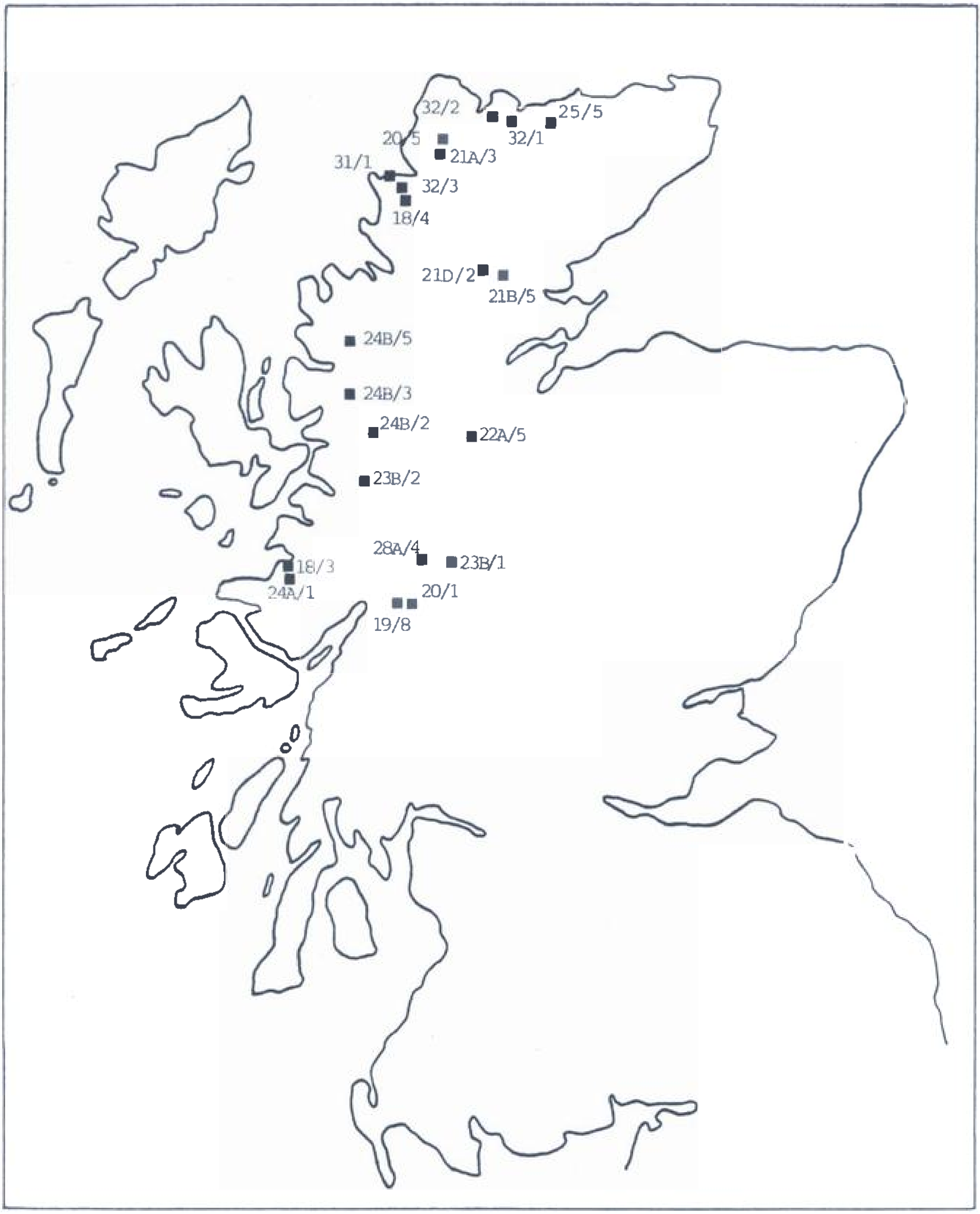
During the survey about 35 kilometre squares were visited which were known to contain birch but of these only 21 contained what could be defined as 'unenclosed birch woods', for it was decided to limit the survey to unfenced woods*. These 21 squares represented a wide range of ITE land classes over the full length of Highland Region (Map 1) although none of the islands were visited and by chance no unenclosed birch woods occurred in the kilometre squares surveyed in the Speyside area.

Many of the 21 km squares visited contained more than one birch wood [see Appendix 1] so many of the results are given both on a km squares basis (21) and a woods basis (41 woods in all). Within the squares there were woods of varying sizes but in this survey clumps of only a few trees were defined as woods and given the same weighting as large woods. Where a wood overlapped into a neighboring km square only the part of the wood falling within the randomly selected square was included in the survey.

It was quickly realised that because there was very little time available for the survey it would be best to study a large number of woods to get the general picture than a few woods in detail. The following were measured at each wood:-

1. whether <u>Betula pubescens</u> or <u>pendula</u>
2. state of the canopy
3. girth of the largest tree
4. presence of seedlings
5. where regeneration occurred
6. whether the wood were expanding, constant or contracting in size
7. extent of grazing and burning
8. other tree species and woodland flora

* this being an easily identifiable category



MAP 1. Distribution and land class of kilometre squares included in the survey.

RESULTS

DESCRIPTION OF SITES

Nearly all the woods were Betula pubescens (Map 2) although there was doubt in two cases. All the woods contained rowan and in five woods oak occurred as an occasional tree; hazel was only found in three km squares (4 woods) and all these kilometre squares also contained oak.

The canopy cover varies considerably and few woods had a continuous closed canopy; some woods had what appeared to be permanent clearings of bracken. See Appendix 1 for a wood by wood breakdown of the extent of canopy cover.

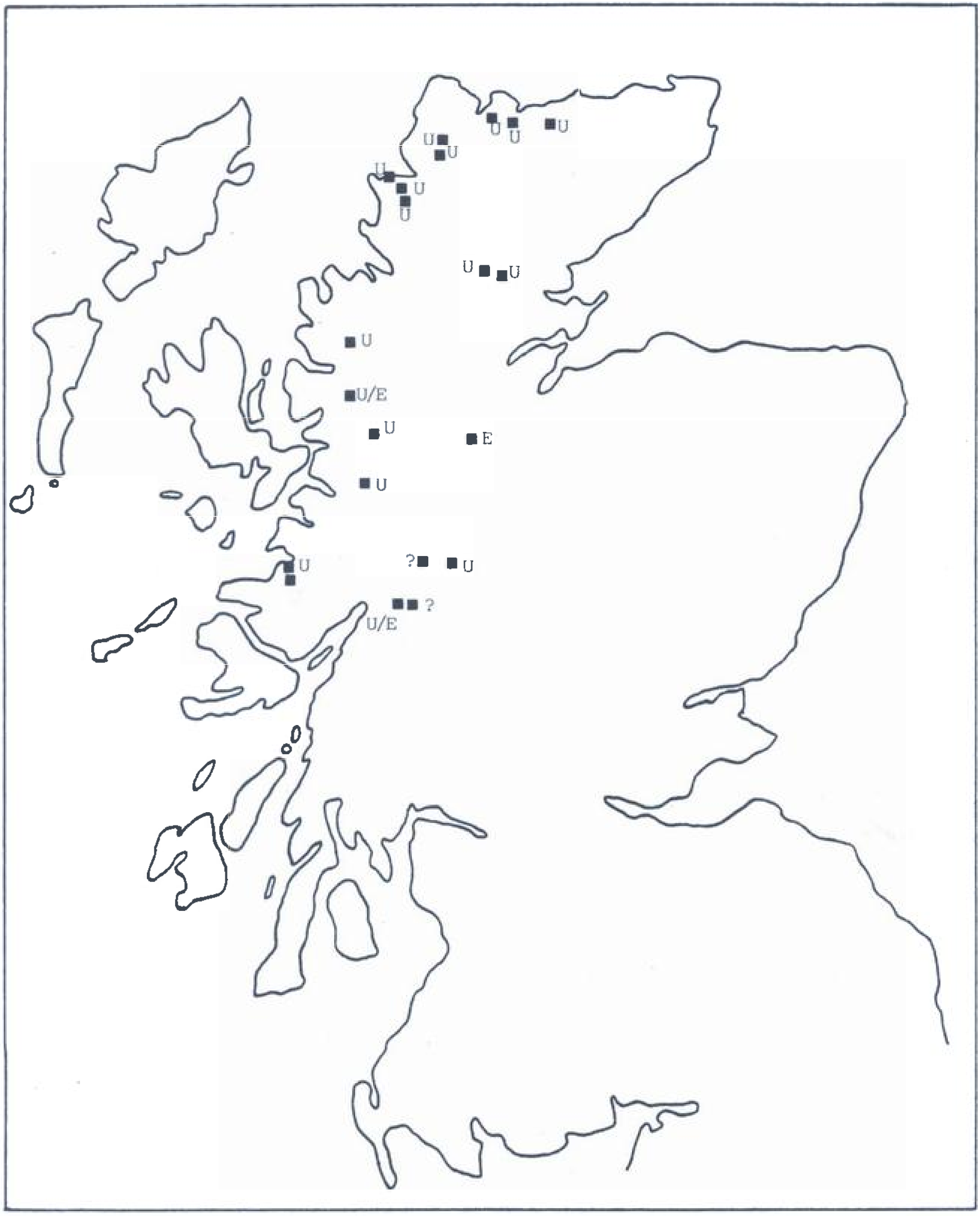
Most of the woods were small (less than 5 hectares, Table 5) with only three greater than 10 ha. Only a small proportion of most squares was covered by birchwood, most being mainly moorland although six had significant forestry plantation. On average 7% of the km squares visited were covered with birch wood (the area of small woods has possibly been over-estimated).

The woods visited could be classified into various types (Table 3).

- woods on gently sloping hillside with few crags or boulders
- woods on more steeply sloping often craggy hillside
- woods beside burns and rivers including gorges
- woods beside lochs
- woods of enclosed pasture

In practice the distinction between these categories is often not clear cut, for example: a common type of wood is one on a steep bank near but not immediately adjacent to a burn (often a former burn bank); should this be classified as a hillside or a burnside wood? A similar problem occurs when trying to classify a wood on the hillside above a steep gorge. Again the category lochside woods presents difficulties for the presence of a loch may be irrelevant to the origin and current survival of the wood; on the other hand in some cases woods are only surviving because regeneration is possible right at the water's edge.

Woods of enclosed pastures would generally fall outside the scope of this survey. However where the enclosure is very large woods within the enclosure would be expected to be similar to un-enclosed woods; one such wood has been included in this survey.



MAP 2. Distribution of Betula species; U=B.pubescens, E=B.pendula; U/E= difficult to determine, probably both species.

Although the above provides a useful working classification it has its drawbacks and so a more simple classification was devised with three broader categories:

- Hillside woods [H]
- Burnside and cliff woods (BC]
- Enclosed pasture woods [P]

Woods previously classified as lochside woods were reclassified as either BC woods when trees were at the water's edge or H woods when spreading up the hillside. Again, some of the burnside woods may have trees on steep banks a short distance away from the burn – these still classified as burnwoods (BC).

Although the majority of the woods are of the BC type these woods tend to be small and only comprise 18% of the area (Table 4).

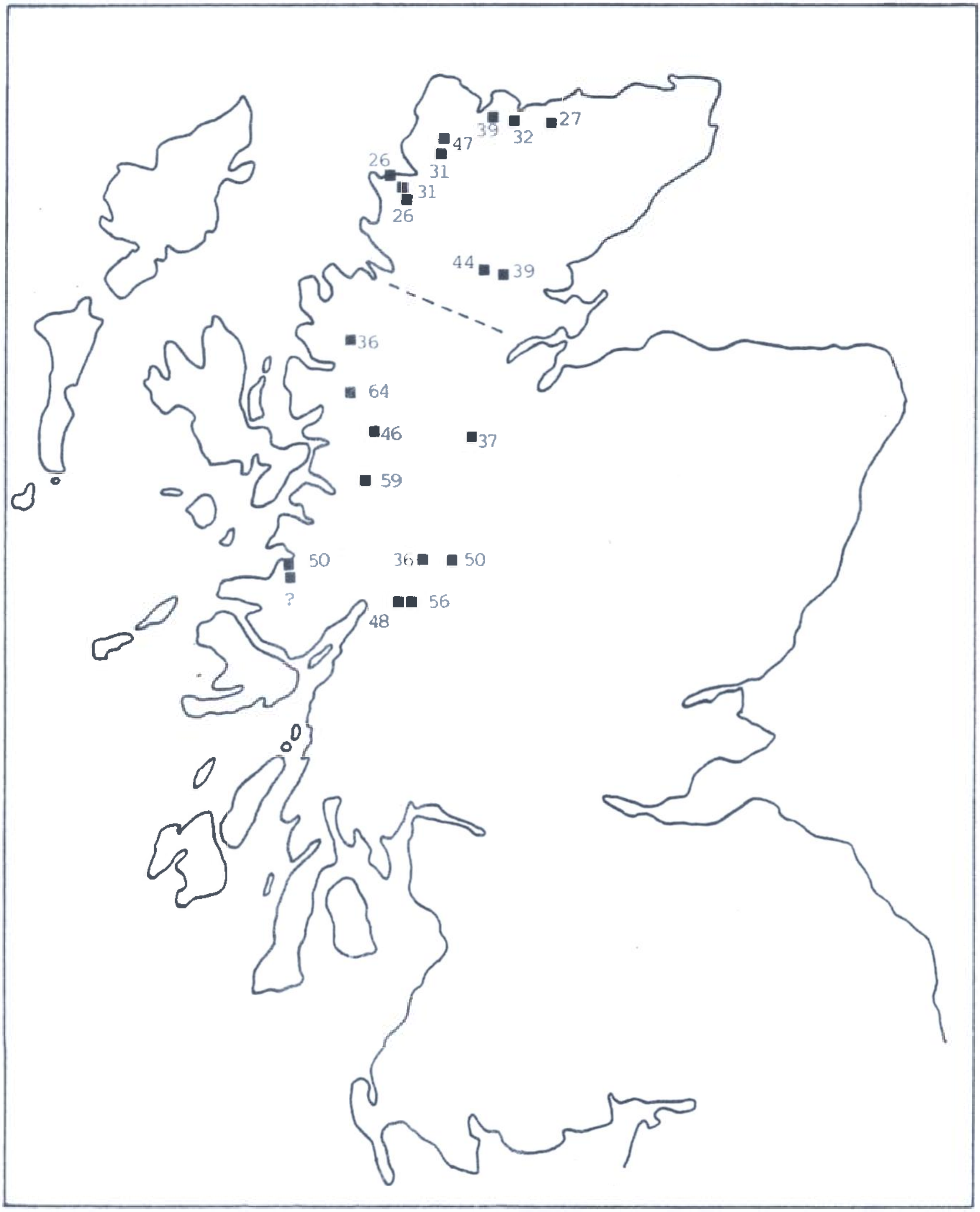
The diameter at breast height (DBH, 1.3m) was measured of the largest tree in each wood; the larger woods were not searched exhaustively for the biggest trees so the following figures should only be taken as guides. The maximum DBH observed of a birch trees was 64 cm (Table 1). Figs 1&2 illustrate how there is a falloff in max DBH after a diameter of 40 cm has been reached. This suggests that on average birch trees would be expected to die off after a girth of 40 cm has been reached. However further analysis of the figures shows that there is a difference on a north/south basis in Highland Region (Map 3). The mean max DBH for trees in the north of the region is 34 cm and in the south 48 cm.

In a small wood the largest tree measured may still be relatively young so that the max DBH in this wood may not the maximum possible. If a whole kilometre square, though, is searched the chances that the max DBH found will be the max possible are increased. Hence Fig. 2 gives a better indication of the maximum possible DBH for an area than Fig.l. In conclusion it can be stated that trees would be expected to die off after a DBH of 35 cm in the north and 50 cm in the south has been reached.

TABLE 1. Maximum DBH of birch trees.

DBH size class (cm)	No. of sites with max DBH within these size classes	
	a. Woods	b. Km squares
0-10	1	
11-20	6	
21-30	6	2
31-40	11	8
41-50	7	6
51-60	3	3
61-70	1	1

Mean max DBH = 40 cm
Mean max for northern area (see Map 3) 34 cm
Mean max for southern area = 48 cm
DBH of largest tree= 64 cm



MAP 3. Distribution of max DBH encountered for each kilometre square; ------- seperates northern and southern area (see text).

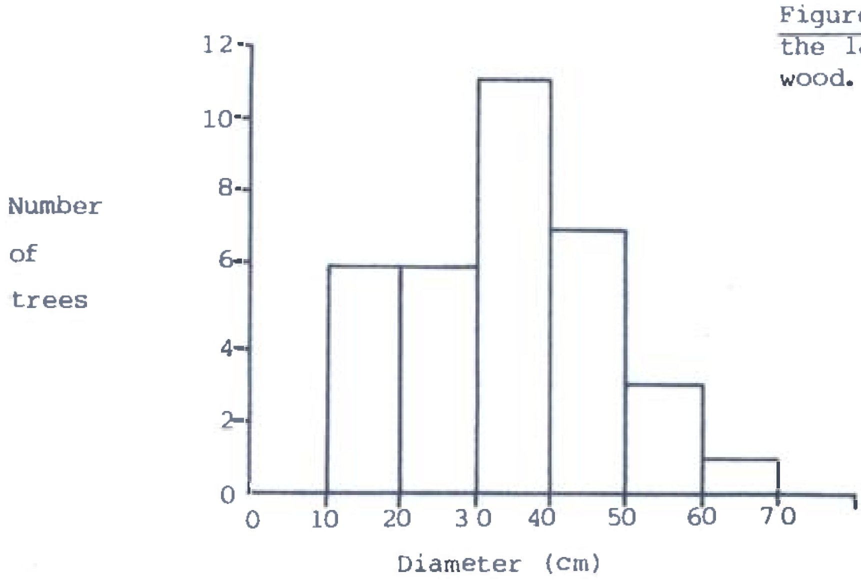


Figure 1. Range of DBHs of the largest tree in each wood.

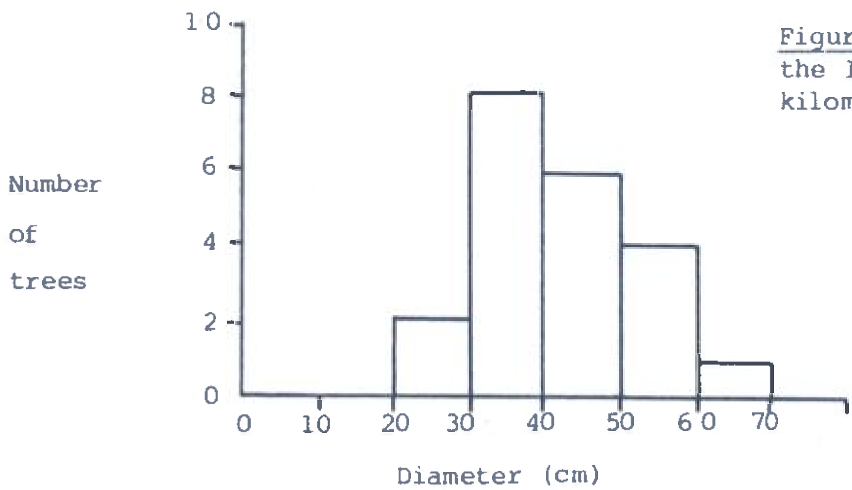


Figure 2: Range of DBHs of the largest tree in each kilometre square.

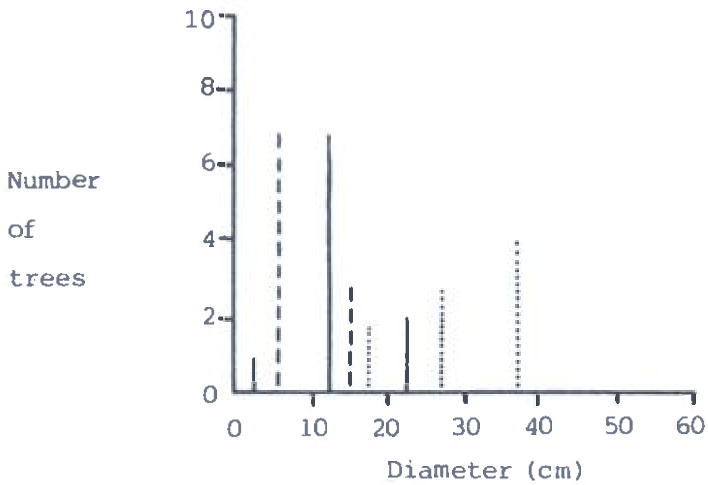


Figure 3: Range of DBHs of ten trees in each of three different parts of one wood (______, ------, ...)

REGENERATION

A major aim of the study was to determine the amount of regeneration and hence the dynamic state of the birch woods (whether the woods were expanding, contracting or constant in size).

In practice it was easy to determine if regeneration were present, regeneration here defined as the occurrence of saplings with their apices out of reach of grazing sheep or deer.

It was found that all the woods contained birch seedlings throughout, although, except perhaps in one instance they were never seen under a closed canopy (many previous authors have noted the absence of regeneration under a closed canopy). In all but three woods seedlings were abundant. It can therefore be concluded that all the woods studied had the potential for regeneration.

Regeneration, indeed, can occur very rapidly, for example one wood was expanding from six moribund trees to 6 hectares of saplings. When rapid, regeneration tends to occur throughout the wood, excepting closed canopy, and on all soil types. More normally though it is associated with long heather (Calluna) at the edge of the wood (Table 7). Indeed most regeneration appeared to be associated with Calluna and rarely occurred in the grassy swards characteristic of these woods (these swards my attract grazing animals).

Regeneration normally occurs in discrete blocks - a large number of saplings of similar age all growing in one area; it is sometimes difficult to elucidate the cause of this for a nearby apparently identical area may have no saplings. If regeneration does occur in discrete blocks, i.e. very rapidly in one area at a time, then the resulting wood would be expected to consist of blocks of even aged trees. Evidence for this is presented from one wood where 10 trees were measured in each of three areas and the range of diameters in each area plotted (Fig. 3). Although there is some overlap (trees of the same age would not necessarily be expected to have the same DBH) each area has a different mean DBH.

Regeneration was observed in all the kilometre squares studied and in all but three of the woods.

Core areas

One idea to emerge from the survey is that most of the remaining woods in the Highlands have a permanent 'core area'. This will be an area protected from grazing and burning (eg. cliff, gorge, burn- or loch-side) where it is assumed that regeneration has, and will always occur. The area may be very small, perhaps able to support only 2 or 3 mature trees, but acts as a permanent seed source.

Expanding, constant and contracting woods

Woods were classified as being expanding, contracting or constant in size. An expanding wood was defined as one which at present is increasing in area; a contracting wood was defined as one actively decreasing in area and some regeneration may or may not be present. A constant wood was defined as one which at present is neither increasing or decreasing in size and there appears enough regeneration to keep the wood at its present size (although the area of regenerating trees may be less than the area of mature trees - but see below).

Of the woods visited a similar number were staying constant in size (44%) or expanding (46%), although there is a significantly greater area of woodland that is expanding (66% as opposed to 23%). The proportion of contracting woods is similar on both a number and an area basis (10-11%). [Table 2)

If kilometre squares are considered instead of individual woods, then of the 21 squares visited 9 (43%) had a birch wood cover staying constant in area, 8 (38%) had an expanding area and 4 (l9~) had a contracting area (Table 2).

There appeared to be no correlation between size of an individual wood and whether it was contracting or expanding (Table 5) or between geographical area and whether it was contracting or expanding (Map 4). There was not enough data to correlate the regeneration status of woods with the ITE land classes (Table 6).

As mentioned above two main categories of birch wood were identified during this survey - hillside (H) and burnside/cliff (BC) woods. These categories can be considered separately (Tables 3,4 & 8). Table 8 summarises the regeneration status of each wood and also the presence or absence of the two greatest influences affecting regeneration - grazing and muirburn.

TABLE 2. Number & area of woods at present remaining constant in size, expanding or contracting.

	Number of individual woods	Number on a km square basis*	Area of woods (hectares)
Expanding	19 (46)	8 (38)	98 (66)
Constant	18 (44)	9 (43)	34 (23)
Contracting	4 (10)	4 (19)	17 (11)

*No of km squares with woodland cover constant, expanding or contracting; () = % figures

TABLE 3. Classification of woods by type.

Type	Number of individual woods	No. of km squares with woods	Area of woods (ha)	Number of woods: Expanding	Constant	Contracting
Hillside	8 (20)	7 (24)	92 (62)	3 [3]	3 [2]	2 [2]
Gentle hillside	8 (20)	5 (17)	27 (18)	6 [3]		2 [2]
Cliff	2 (5)	2 (7)	15 (10)		2 [2]	
Burnside & gorge	15 (37)	11 (41)	12 (8)	3 [3]	12 [8]	
Lochside	7 (17)	2 (7)	4 (3)	6 [1]	1 [1]	
Enclosed pasture	1 (2)	1 (3)	1 (1)	1 [1]		

() = % figures; [] = No. of km squares with woods in these categories

TABLE 4. Classification of woods by type: Summary. (excluding the pasture wood)

Type	No. of woods	Area (ha)	% of each category: Expanding	Constant	Contracting
Hillside	17 (41)	122 (81)	53 [60]	24 [22]	24 [100]
Burnside/cliff	23 (56)	27 (18)	30*[40]	70*[78]	

() = % figures; [] = % of expanding, constant or contracting woods; *3 woods here counted as one as all were next to each other round the same loch

TABLE 5. Classification of woods by area.

Area (ha)	No. woods	No. km squares*	Expanding	Constant	Contracting
<1	18	3	8	9	1
1-5	18	10	9	8	1
6-10	2	4			2
>10	3	4	2	1	

*No. of km squares with cover of birch within these size classes

TABLE 6. Classification of woods by land classes

Land class*	No. km squares	No. woods	Number of woods: Expanding	Constant	Contracting
18	2	2		2	
19	1	1	1		
20	2	5		4	1
21A	1	1		1	
21B	1	3		3	
21D	1	2	1		1
22A	1	2	2		
23B	2	5		3	2
24A	1	2		2	
24B	3	3	2	1	
25	1	2	2		
28A	1	1	1		
31	1	3	3		
32	3	9	7	2	

*ITE land classes subdivided for Highland Region

TABLE 7. Location of regeneration.

Location	Number of woods	Number of km squares
Cliffs (Cl)	7	7
Edges (in long heather) (Ed)	12	5
Burnsides and associated banks (B)	11	9
Throughout the wood (T) (except closed canopy)	12	7
None (-)	3	0

Note: it is sometimes difficult to seperate these categories, especially in small woods.

TABLE 8. Grazing, burning and regeneration.

Type	Status	C	S	D	H	Fire	Regen.
H	EE	C	?	?		(f)	T
H	EE	C	S	D	H	(f)	T
H	EEE	C	S	D	H	(f)	T
H	E		S	D		(f)	T
H	EE		S	?		(f)	T
H	E		S			nf	T
H	E		S	?		(f)	T
H	E	?	S	?		(f)	T
H	E		S	D		(f)	Ed
BC	E		S	D		(f)	Ed/B
BC	E			D		(f)	T
BC	E		S	?		(f)	T
BC	E		S	D		(f)	Ed
BC*	E		S	D		(f)	Ed
P	E	C				nf	T
H	R		S	D		f	
H	R		S	D		(f)	Cl
H	R		?	D		nf	
H	R			D		nf	Cl

Type	Status	C	S	D	Fire	Regen.
H	C		?	D	nf	Cl
H	C			D	?	Cl/Ed
H	C		S	D	(f)	Ed
H	C			D	nf	Cl
BC	C		S	D	nf	B
BC	C		S	D	nf	-*
BC	C		S	D	nf	Cl
BC	C		S	D	nf	Ed
BC	C		S	D	nf	Ed/B
BC	C		S	D	nf	Ed/B
BC	C		?	D	nf	B
BC	C		?	D	nf	Cl/B
BC	C			D	nf	B
BC	C		?	D	nf	B
BC	C		?	D	nf	B
BC	C		S	D	nf	B
BC	C		S	?	(f)	B
BC	C	?	S	?	f	B

Notes:

Type: H, BC, P: Hillside, Burnside/cliff, Pasture woods (see text)

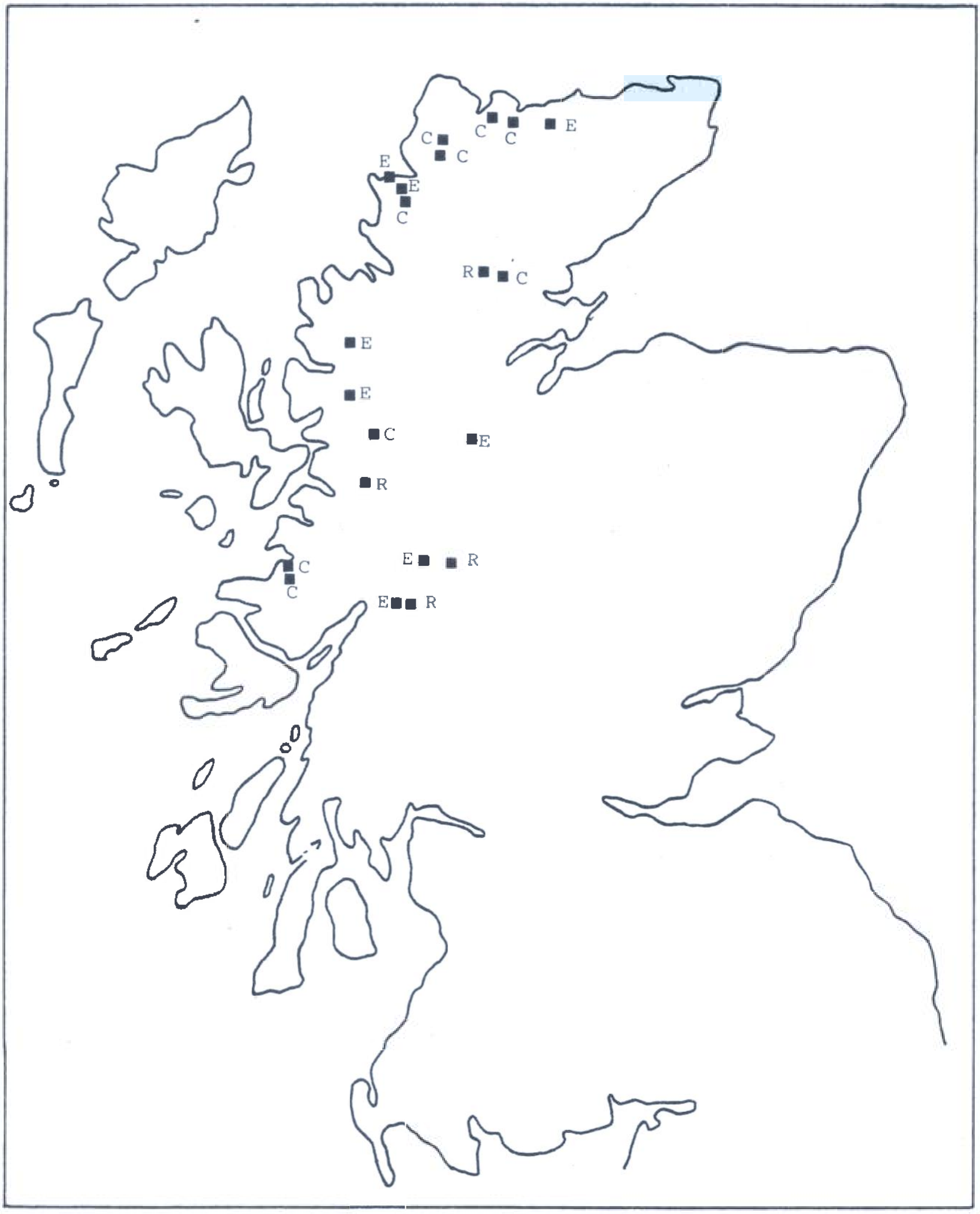
Status: E,C,R: Expanding, Constant & Contracting woods (EE,EEE=rapid expansion)

CSDH: evidence of grazing by Cattle, Sheep, Deer, Horses

Fire: (f)=evidence of fire in km square in past; f=fire in recent past actively preventing regeneration; nf=no evidences of fire

Regen.: position of regeneration, abbreviations as in Table 7.

* see note at base of Table 4.



MAP 4. Distribution of kilometre squares with cover of birch wood Expanding (E), Constant (C) and Contracting (R).

BC woods tend to be constant in area and none of this type were contracting, although a few were expanding. Obviously these woods have stabilised in core areas where they have been able to survive centuries of grazing and burning - regeneration tends to occur in protected areas.

H woods are less protected from grazing and burning and currently appear to be in a state of flux - half are expanding and the other half equally expanding or contracting (Table 8). Woods on gentle hillsides, where there are less cliffs for regeneration, tend to be in a more extreme state of flux - either expanding or contracting but none remaining constant in size (Table 3). These woods will have the least protection from grazing and burning and are obviously very sensitive to changes in these influences.

An analysis of the expanding woods shows that all but two of them *have* evidence of fire within their vicinity in the past (Table 8). This suggests that these woods are expanding due to the removal of the burning pressure rather than reduced grazing pressure. In two of the woods surveyed recent fire was actively preventing expansion and in one of these actually causing contraction as the mature trees were moribund. All this suggests that there is less muirburn nowadays (perhaps associated with increased forestry), and also that any expansion could easily be stopped by new fires.

In the two cases where a wood was expanding and there was no evidence of fire (Table 8) there was also no evidence of red deer although sheep were present; also all the woods which were staying constant in size but without evidence of fire had evidence of red deer. This suggests that it is red deer that prevents regeneration rather than sheep (most of the woods that were expanding also exhibited evidence of sheep grazing). It is possible that birch woods can regenerate with the low stocking densities of sheep found in much of the Highlands but are more susceptible to the heavy deer grazing. It must be admitted that the evidence for this is by no means conclusive and further research is needed.

At first glance the concept of expanding, contracting and constant woods appears very simple, but deeper analysis shows that the concept has to be used with caution. Consider the following facts:

1. Regeneration is commonest at the edge of woods outside the current boundary (and associated with long heather).
2. There is no regeneration under closed canopy.
3. The canopy is rarely closed throughout the wood.
4. The area of regenerating trees at a given time does not always equal the area of mature trees.
5. Regeneration tends to occur in discrete blocks, sometimes very rapidly.

The above means that a wood on average may be constant in size over a long period but at any given time may be expanding or contracting. It is not yet known how many of the woods, if any, which were observed to be expanding were doing so only as part of a temporary expansion phase in a normal regeneration cycle.

Computer modelling

The situation lends itself to computer modelling and computer simulations are being developed to model the woodland dynamics over a long period [see Appendix 4].

Simulations can test: how much regeneration is needed to sustain a wood indefinitely; how the shape and position of the wood will change in time; how the chances of a wood becoming extinct are affected by the size of the wood; the effects of different regimes of burning, grazing and soil fertility; how the presence of a permanent core area affects the survival of the wood; how the fencing off of areas affects the woodland dynamics; etc.

Some preliminary results indicate that woods without core areas move around considerably, changing shape all the time but their chance of extinction is high; that the chances of any woods surviving indefinitely without a core are low; that the area of a wood is always more than the current area of trees; that fencing the wood round the current area of trees can lead to extinction; that having the fence a long way away from the wood is no more beneficial than having it a medium distance away.

Miles (1981) has previously suggested that birch wood regeneration may be 'cyclical - birch colonising heather moorland, this moorland then becoming woodland with a grassy ground flora. When the wood becomes moribund heather re-invades. The present study supports this but adds that in this heather the wood will regenerate again as birch.

It can be postulated that in a large wood this cycle could be going on at different stages in different parts of the wood, resulting in a mosaic of open and closed canopy.

In conclusion

In conclusion it can be stated that birch woods spread out from their core area when conditions are favourable and retreat back when not. For example at Rhidorrich there is a very extensive area of birch wood without a single regenerating tree although it is adjacent to a gorge (core area) with continuous regeneration. Conditions are now unfavourable (heavy deer grazing) so the wood is at present retreating back to its core area. The contracting area is on gentle hillside and it is possible that it expanded here in the last century when there ·was more sheep farming and hence less grazing pressure from deer. Indeed this could explain the large areas of moribund birch wood on many hillsides in the Highlands - all are retreating back to their core areas. It would be interesting to test the core area hypothesis by studying a much larger sample of birchwoods.

In contrast to the contracting Rhidorrich woods, are woods such as the one observed near Kintail which is rapidly covering the whole hillside since deer have recently been excluded from this area.

Note: no account has been taken in this survey of the loss of birchwood due to forestry plantation. Although this tends to destroy the large woods it may be beneficial to the very small woods (woods on crags and burnsides which are not destroyed on planting).

CONSERVATION VALUE

The woodland flora of each wood was noted and a quick classification system devised to illustrate the species richness of the ground flora (Table 9).

Table 9 also has a list of plant species which the author bas noted as being species restricted to wooded sites (in the study area, that is) and whose presence, therefore, will suggest that the site has been continuously wooded. For reference, included also in this list are species falling into this category but not actually observed in any of the 1984 study sites. [author note 2015: observations in later years suggest that none of the species listed in Table 9 are obligate woodland species, so the conclusions here need to be treated with caution]

There was no obvious correlation of the extent of the woodland flora with the type of wood except that gentle hillside woods had a more limited flora than hillside woods. As mentioned above these are the woods most likely to have fluctuated in the past and could have Los t their wood Land flora if once unwooded or only partly wooded.

Likewise there was little correlation between the woodland flora and the dynamic state except that the woods with the richest flora tended to be constant in area (although one was expanding and one contracting).

Woods of less than 1 ha tended to have a more limited woodland flora. Many of the Burnside/cliff woods are small and fall into this category (although half of the Burnside/cliff woods have a richer flora).

72% of the km squares (59% of the woods) contained what was defined as a woodland flora or extensive woodland flora and so will probably have been continuously wooded; of these the 24% of kill squares with an extensive flora will almost certainly have been continuously wooded.

The remaining 29% of km squares with no or only a limited flora are perhaps either secondary woods or woods too small to contain many species (or woods that at one time in the past were too small). Only two woods contained no woodland flora at all, i.e. exclusively moorland species, and of these one was contracting and one expanding.

As more than half the woods contain woodland species they are therefore a valuable habitat in a species-poor landscape; the small woods may have a limited flora but between them add up a valuable reservoir of species.

TABLE 9. Extent of woodland flora.

WOODLAND CLASSIFICATION		No woodland flora	Limited woodland flora	Woodland flora	Extensive woodland flora
a. By number:	Woods basis	2 (5)	15 (37)	18 (44)	6 (15)
	Km square basis		6 (29)	10 (48)	5 (24)
	()=% figures				
b. By type:	Hillside			5	3
	Gentle hillside	1	3	4	
	Cliff			1	1
	Burnside/gorge		9	5	1
	Lochside	1	2	3	1
	Pasture		1		
c. By area:	< 1	1	10	7	
	1-5	1	4	10	3
	6-10		1		1
	> 10			1	2
d. By status:	Expanding wood	1	7	10	1
	Constant		7	7	4
	Contracting	1	1	1	1
e. Summary:	Hillside woods	1	3	9	4
	Burnside/cliff woods	1	11	9	2

Definition of categories (only valid within study area):

Limited woodland flora

Species associated with woodland, but by no means exclusively so: Teucrium, Rubus, Oxalis, Lysimachia

If one or more of these species then the wood defined as having a limited woodland flora (or one woodland flora species).

Woodland flora

Species common in woodlands and mainly but not exclusively limited there: Primula, Anemone, Endymion, Lonicera

If 2 or more of these species, or one plus 2 or more of the limited woodland flora species then defined as woodland flora.

Extensive woodland flora

Species restricted to woodland (those in brackets were not found in any of the study sites)

Carex pallescens (C. laevigata) (Circaea)
Hymenophyllum (Sanicula) (Ptilium)
Brachypodium sylvaticum (Poa trivialis)
Viburnum opulus (Ulmus)(Prunus avium)
Gymnocarpium dryopteris (Galium odoratum)
Trientalis (only on west coast) Allium

If one or more of these species then defined as extensive woodland flora (in all sites where one of these present then woodland flora species also present)

ACKNOWLEDGEMENTS

I thank Bob Cameron and Chris Claridge of Highland Regional Council and Bob Bunce at the Institute of Terrestrial Ecology (Merlewood Research Station) for help in the setting up of the project and Alastair Somerville of SWT for sponsoring the project.

APPENDIX 1. 1984 Birchwoods Survey: DATABASE.

LANDCLASS & WOOD	TREE	MAX GIRTH	AREA BIRCH	TYPE	S'L-INGS	CANOPY	ECR	GRAZ-ING	FIRE	REGENERATION Cl	E	B	T	N	FLORA
18/3	pub	158	3	H	T	oc(cc)	C	D S?	nf	+					wf
18/4	pub	161	3	L(H)	T	cc	C	D	(f)	+	+				vwf
19/8	pub/ pend +OH	151	50	H	T	oc/cc	a.E b.EE	C	a.(f) b.nf				h		wf
20/1B	pub	123	½	H	T	voc	R	D S	f	+					wf
C	pub +OHA	177	3½	H	VO	cc(oc)	C	D S	(f)		+				vwf
20/5A	pub	115	0·1	B	T	cl	(C)	D S	nf		+				lwf
B	pub	147	0·2	B	O	cl	(C)	D S	nf					+	lwf
C	pub	56	1½	C	T	st	C	D S	nf	+					wf
21A/3	pub	97	2	H(C)	VO	cc/oc	C	D	nf	+					wf
21B/5A	pub	79	⅓	B	T	cls	(C)	D S	nf		?				lwf
B	pub	58	⅓	B	T	cl	C	D S	nf		+	+			lwf
C	pub	123	⅓	B	T	cl	C	D S	nf	+	+				lwf
21D/2A	pub	138	8	GH	T	oc(cc)	R	D S	(f)					+	lwf
B	pub	104	1	B	T	l(oc)	E	D S	(f)			+			lwf
22A/5A	pend	116	3	GH	T	voc	EE	DSHC	(f)				h		lwf
B	pend		3	GH	T	vvoc	EEE	DSHC	(f)				h		lwf
23B/1A	pub	141	1	B	T	l	C	D S?	nf			+			wf
Ai	pub		2	GH	T	st	R	D S?	nf					+	nwf
B	pub	157	13	C(Go)	T	cc/oc	C	D S?	nf	+		+			vwf
23B/2A	pub	186	6	H	T	oc/cc	R	D	nf	+					vwf
B	pub +O		3	Go	T	oc/cc	C	D	nf			+			vwf
24A/1A	pub		¼	B	T	st	C	D S?	nf			+			wf
B	pub		¼	B	T	st	C	D S?	nf			+			lwf
24B/2A	pub	144	⅓	B	T	cc(oc)	C	D S	nf			+			wf
24B/3	pend/ pub? +OH	200	27	H	T	cc(oc)	E	D S	(f)				h+		vwf
24B/5	pub˙ +O	113	½	B	T	cl	E	D	(f)				h		lwf
25/5A	pub	84	3	GH	T	cc	EE	?D S	(f)				h+		wf
B	pub	69	1	B	T	cc	E	?D S	(f)				h+		wf
28A/4	?	112	1	P	T	cl+st	E	?D C	nf				+		lwf
31/1A	pub+H	33	1½	GH	T	cc	E	S	nf				+		wf
B	pub+H		1	GH	T	cc	E	S	nf				+		wf
C	pub +OHAs	81	5	GH	T	cc/oc	E	S	(f)				+		wf
32/1	pub	102	0·2	B	T	cl	C	?D S	(f)			+			lwf
32/2	pub+As	124	2	B	T	cc/oc	C	?D S	f			+			wf
32/3A	pub+As	57	0·1	L	T	cc	E	D S	(f)		+				nwf
B	pub	58	0·2	H	T	cc	E	D S	(f)		+				wf
C	pub	25	0.1	L	T	cl	E	D S	(f)		+				lwf
D	pub	47	0·2	L	T	cl	E	D S	(f)		+				lwf
E	pub	81	0·2	L	T	oc/cc	E	D S	(f)		+				wf
F	pub	93	0·2	L	T	oc/cc	E	D S	(f)		+				wf
G	pub	96	0·1	L	T	cc	E	D S	(f)		+				wf

Notes to Appendix 1:

LANDCLASS & WOOD: Numbers before '/' are the land class; after the '/' are the wood reference number

TREE: pub, pend = **B.** pubescens, pendula; O=oak, H=hazel, A=ash, As=aspen; all woods contain rowan; trees other than birch are only occasional

MAX GIRTH: circumference in cm at 1.3m (or as near as possible) of largest tree

AREA BIRCH: area of woods studied in hectares; also = % km square covered

TYPE: H=hillside wood, GH=gentle hillside, L=lochside, C=cliff, B=burnside, burnbank, Go=gorge

S'LINGS: = presence of seedlings; T=throughout, (V) 0 = (very) occasional

CANOPY: cc=closed canopy, oc=open, l=linear, cl=clump, st=scattered trees, v=very

ECR: state of wood; E=expanding in area (EE, EEE = very fast rates), C=constant, R=contracting; (C)=uncertainty of regen. but wood probably constant

GRAZING: D=deer, S=sheep, C=cattle, H=horses

FIRE: nf=no evidence of fire in the area now or in the past, f=recent fire to the edge of wood actively preventing regeneration or expansion, (f)= evidence of fire *in* the km square in the past

REGENERATION: where regeneration is occurring; Cl=cliffS, E=edges in long heather, B=burnsides, burnbanks, T=throughout (except closed canopy), h=mainly associated with heather (Calluna), N=none

FLORA: wf=woodland flora; l,v,n = limited, very limited, none

APPENDIX 2: PREVIOUS WOODLAND SURVEYS

The 1984 survey began with an attempt to ascertain the current state of knowledge of birchwoods. It was quickly realised that various woodland surveys had been carried out by various organisations for different reasons but no attempt has been made to extract all the information specific to birchwoods. The following is the list of surveys done which the author came across during the setting up of the survey. It is probably not complete.

TANSLEY	in 'Vegetation of the British Isles'
MCVEAN & RATCLIFFE	in 'Plant Communities of the Scottish Highlands'
ITE	- species composition and area of all deciduous woodlands in Scotland – classification of woods (indicator species analysis) - research on woodland dynamics; land use surveys
NCC	- species lists and habitat surveys of all native woods (not completed and cover varies from region to region) - in 'Nature Conservation Review' (1978)
FC	1982 woodland census and previous years
HRC	Amenity woodland census (1984) of Highland Region

<u>APPENDIX 3</u>: BIBLIOGRAPHY

Below is a list of references that the author came across during the survey. It is by no means exhaustive for there was not time to do a complete literature search or definitive review on birch woods. See also Appendix 2 for a list of organisations who have carried surveys of native woodlands in Scotland.

BUNCE, R.G.H. (1982). A field key for classifying British woodland vegetation. ITE publication.

BUNCE, R.G.H, BARR, C.J. & WHITTAKER, H.A. (1981). Land classes in Great Britain: preliminary descriptions for users of the Merlewood method of land classification. Merlewood Research and Development Paper No. 86.

BUNCE, R.G.H. & LAST, F.T. (1981). How to characterize the habitats of Scotland. In 1981 Annual Report of the Edinburgh Centre of Rural Economy.

BROWN, I.R. (1983?). Management of birch woodland in Scotland. Countryside Commission for Scotland publication. [a Review Document and useful reference source]

EMBERLIN, J.C. & BAILLIE, I.C. (1980) Aspects of birch regeneration in two woods at Inverpolly National Nature Reserve, Wester Ross, Scottish Forestry, 34, 13-34.

FORESTRY COMMISSION (1984). Report on the 1982 Woodland Census.

KINNAIRD, J.W. (1974). Effect of site conditions on the regeneration of birch. Journal of Ecology, 62, 367-472.

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PARR, T.W. (1981). Scottish Deciduous Woodlands: a cause for concern? In Forest and Woodland Ecology. ITE publication.

PHILIP, M.S. (1978). Birch: a report of the silvicultural group [Aberdeen University] 1976-77. Scottish Forestry, 32, 26-36.

RATCLIFFE, D.A. (1978). A nature conservation review. NCC.

McVEAN, D.N. & RATCLIFFE, D.A. (1962). Plant communities of the Scottish Highlands. Monographs of the Nature Conservancy, No.1.

TANSLEY, A.G. (1947). The British Isles and their vegetation. CUP.

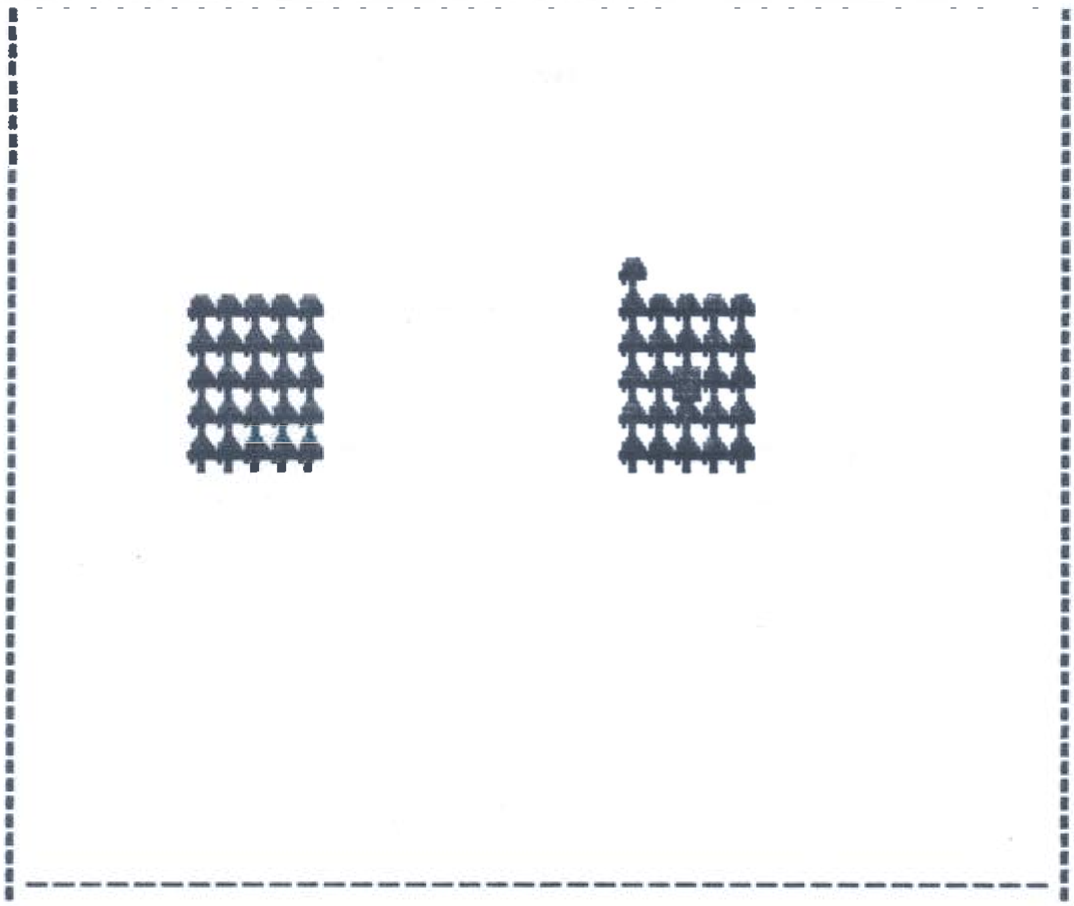
APPENDIX 4: COMPUTER SIMULATIONS

Computer simulations are being developed by the author to model woodland dynamics over long periods. The simulations are still in an early stage of development and the print-outs that follow are only included to indicate what the models are capable of. It is hoped to publish comprehensive results in the future.

In the print-outs a heavily shaded square represents a core area - i.e. a permanently wooded area and a lightly shaded area a barrier to tree growth. The numbers 1 – 9 are preset parameters representing different grazing pressures etc. (1 = high chance of regeneration, 9 = minimal).

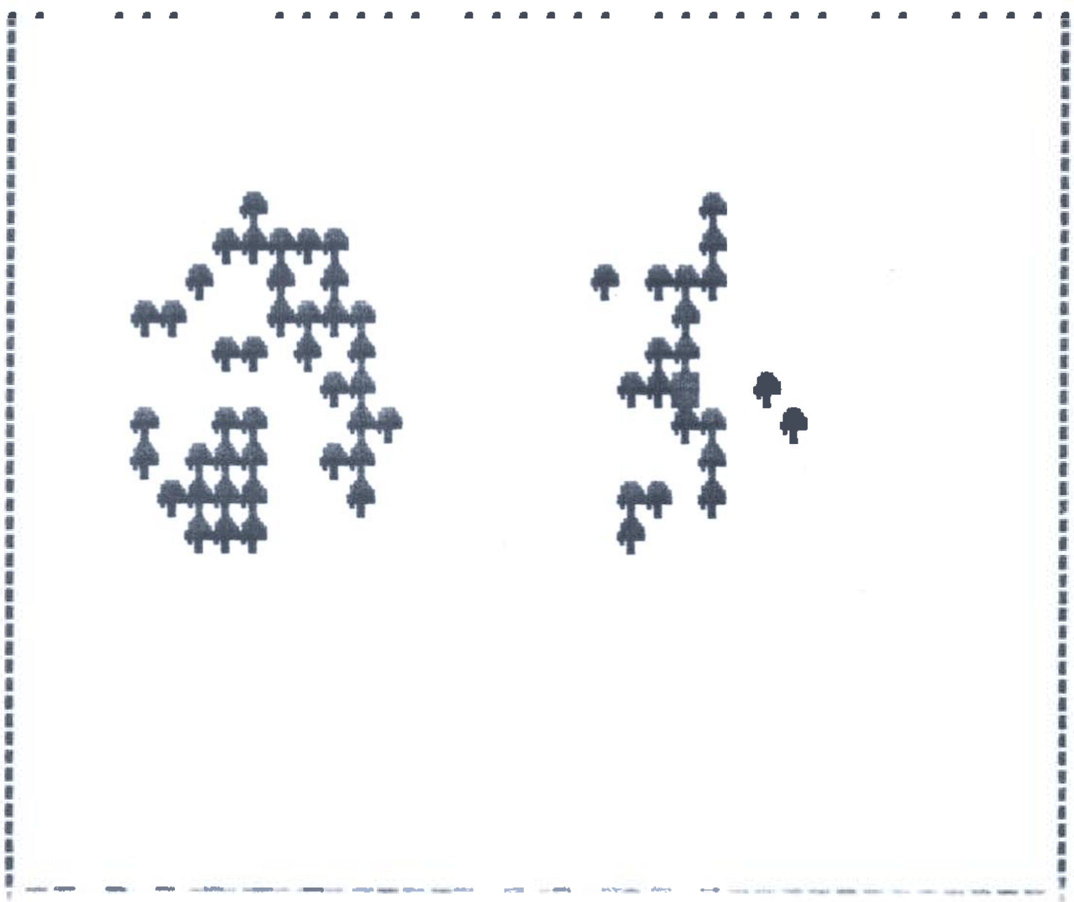
Programming by J.J.C.Fenton.

Max Age 20, Added each time 4
Extra x3 every 5 times . Infertility 2
Time: 2

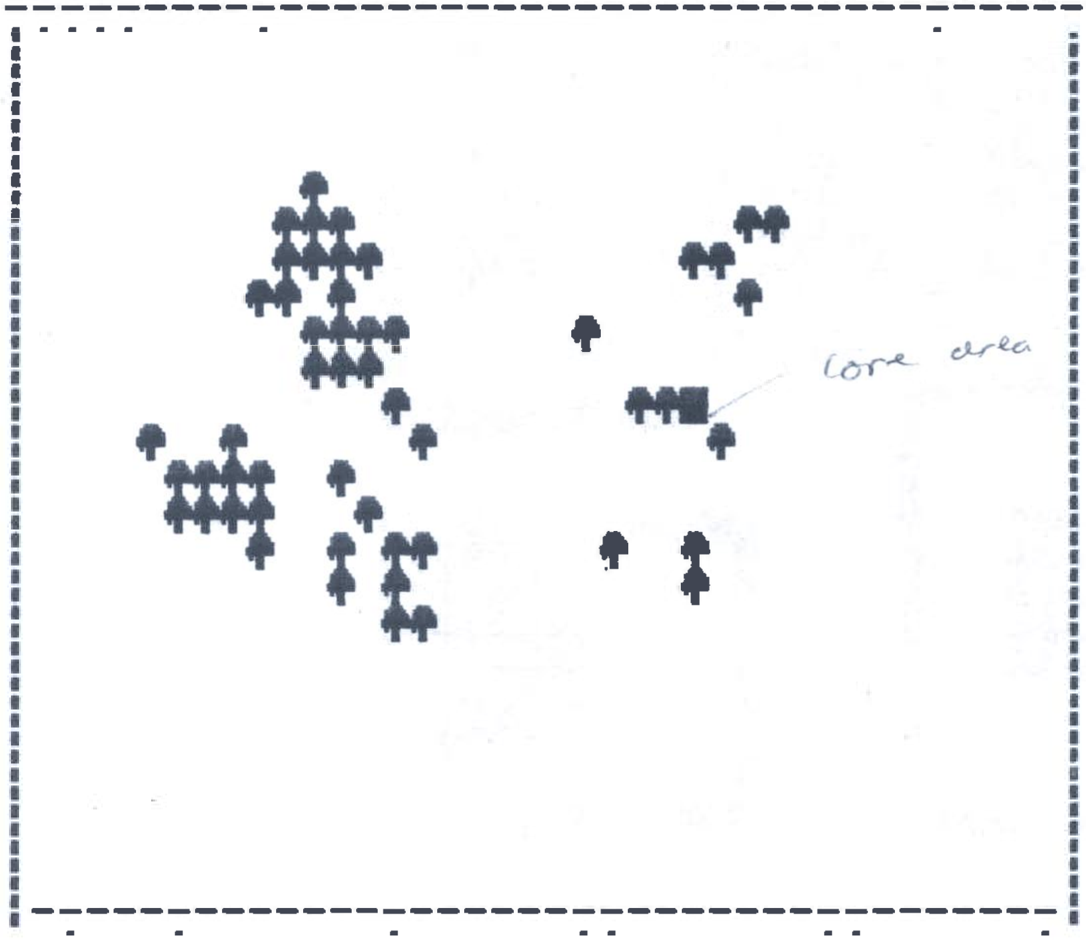


Example 1. Comparing 2 identical woods, one with a core area and one without. In this run the wood without a core area has done better. By repeating the run many times the chances of a particular outcome can be determined.

Max Age 20, Added each time 4
Extra x3 every 5 times . Infertility 2
Time: 26

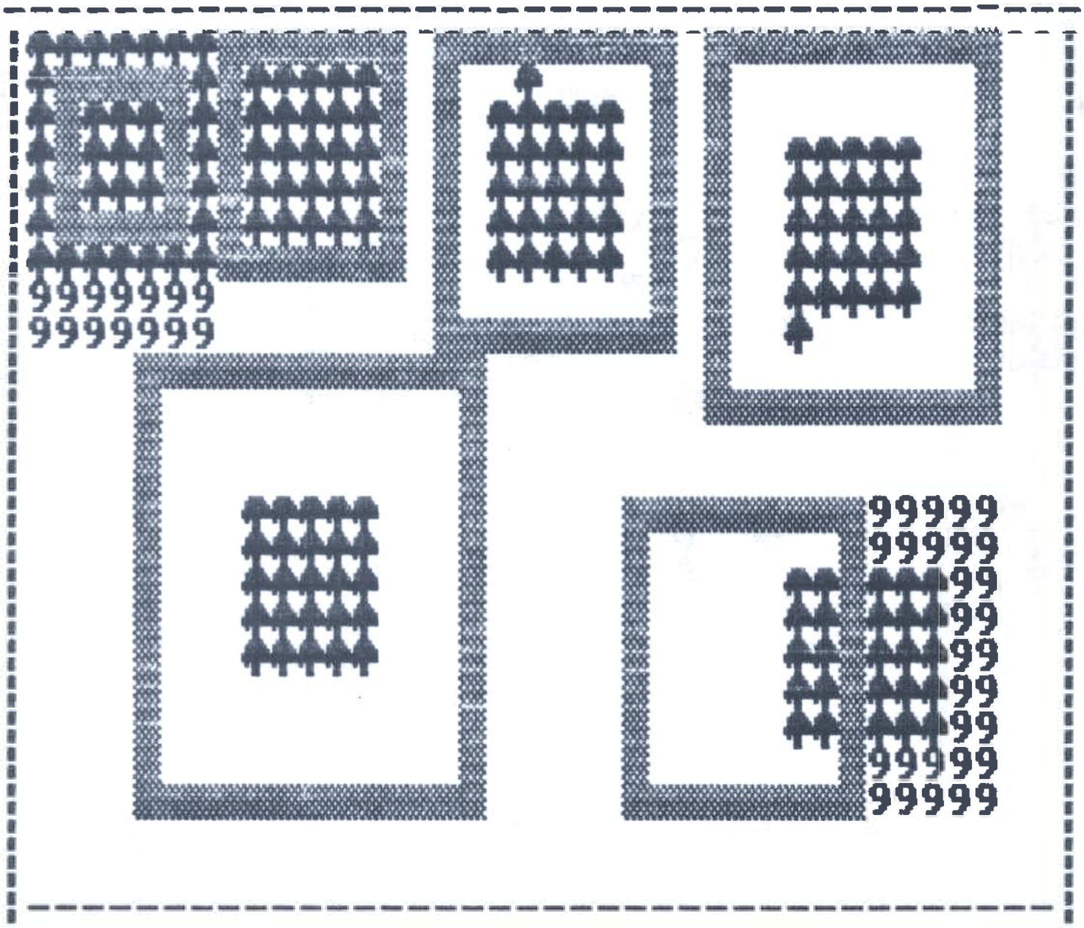


Max Age 20, Added each time 4
Extra x3 every 5 times . Infertility 2
Time: 51



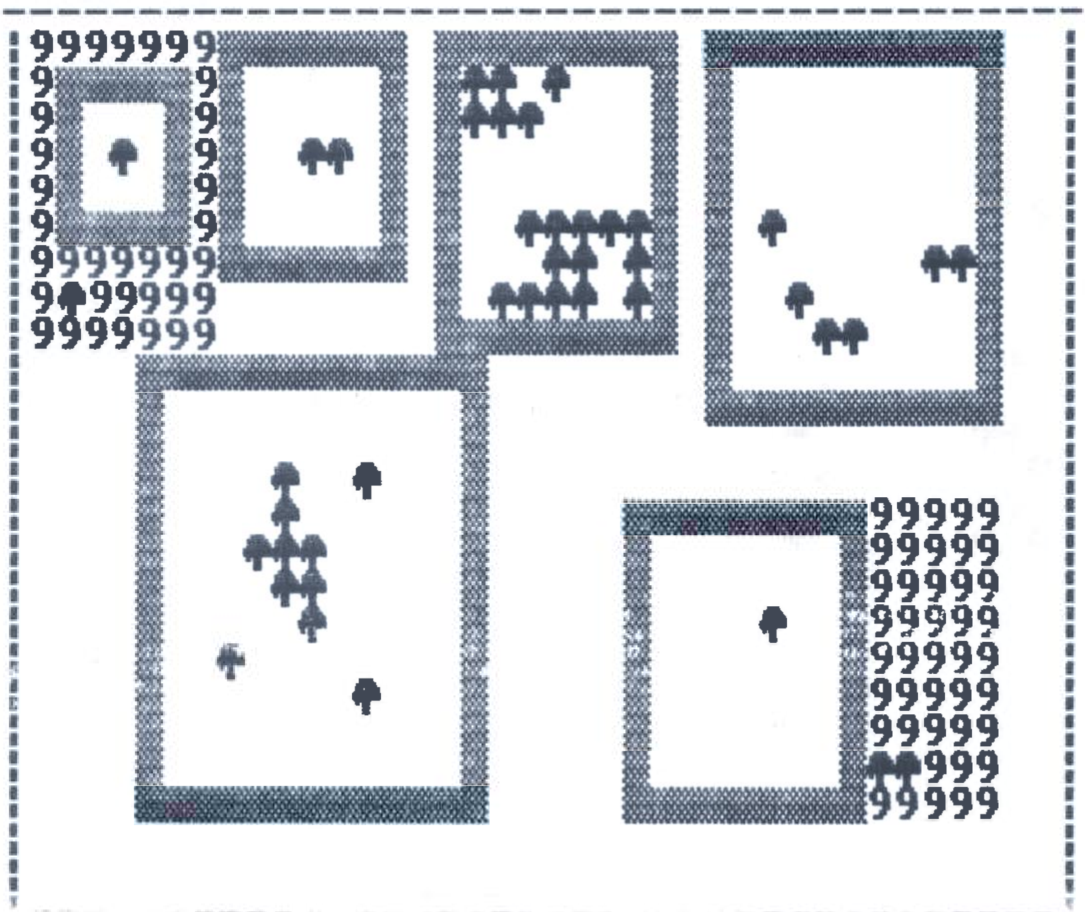
Max Age 20, Added each time 4
Extra x3 every 5 times . Infertility 2
Time: 101

Max Age 20, Added each time 5
Extra x2 every 5 times . Infertility 2
Time: 2

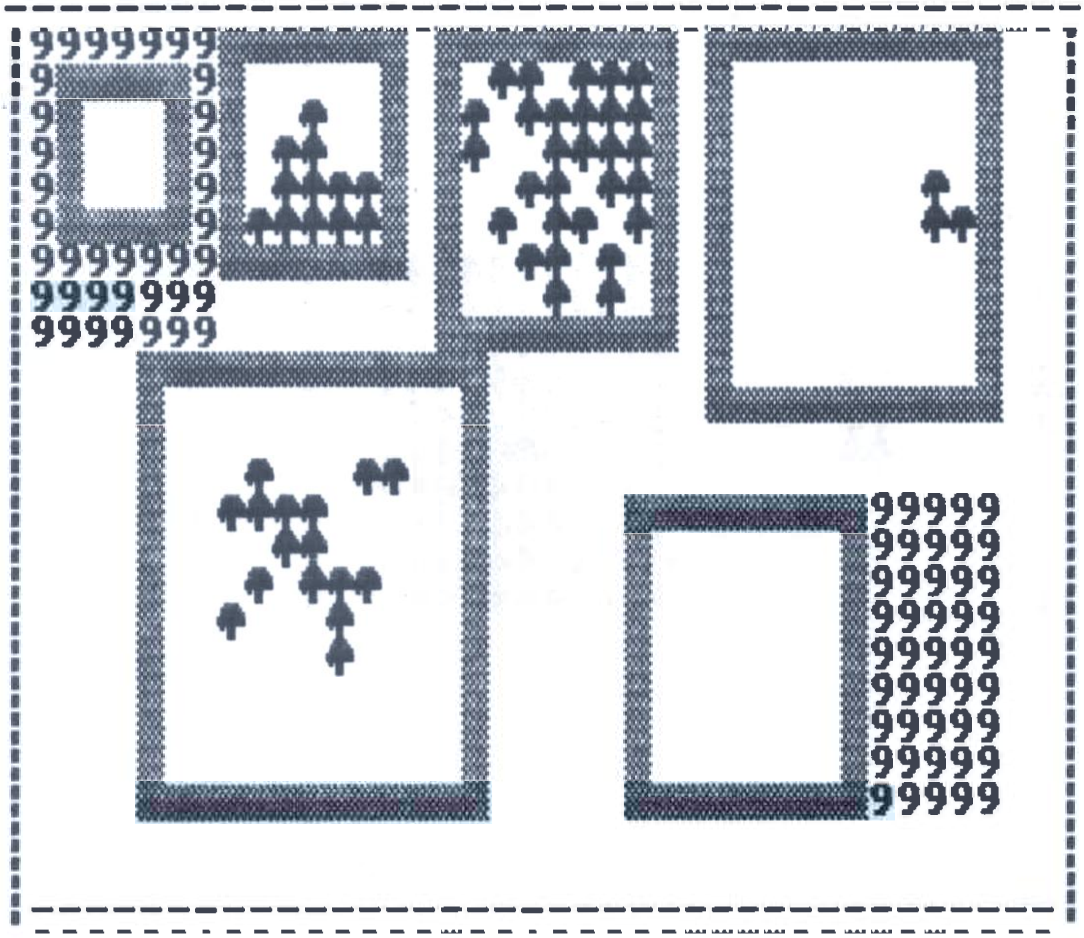


Example 2. The model can be used to test the effect of putting fences in different places round a wood.

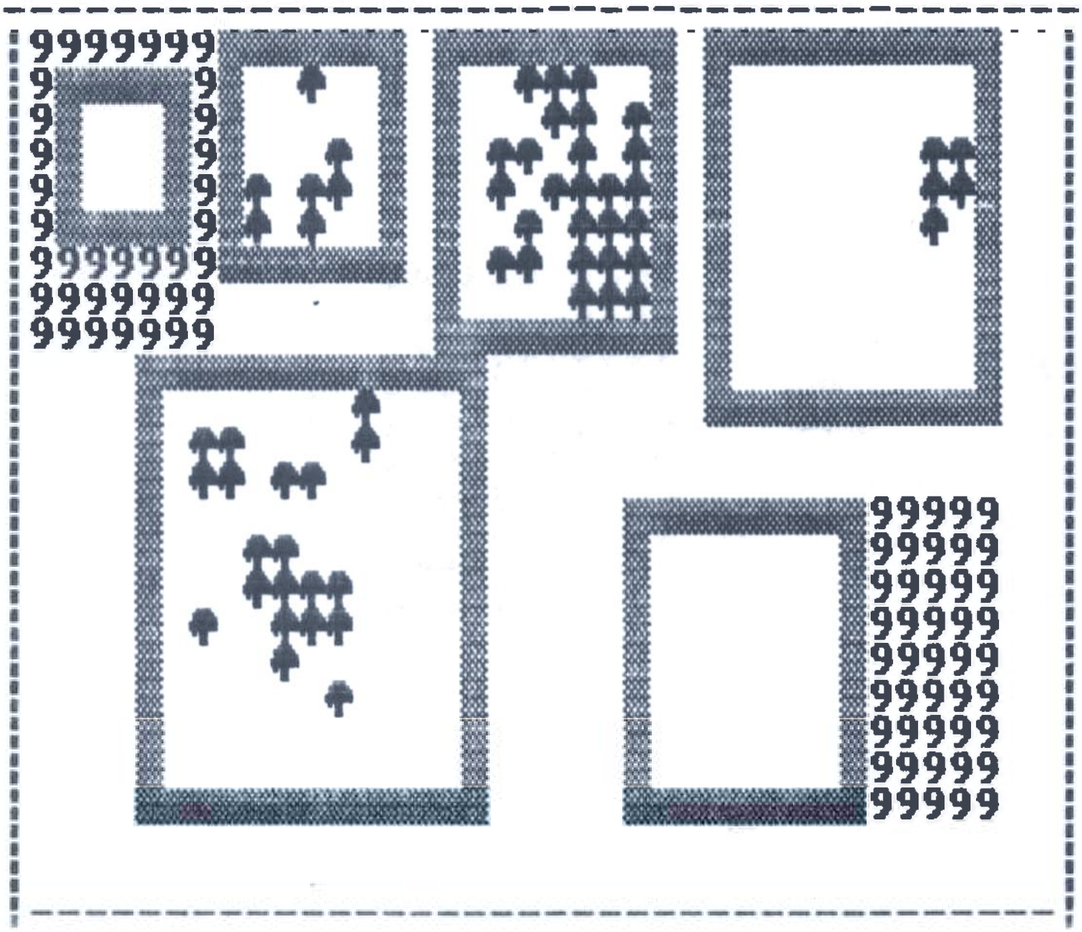
Max Age 20, Added each time 5
Extra x2 every 5 times . Infertility 2
Time: 21



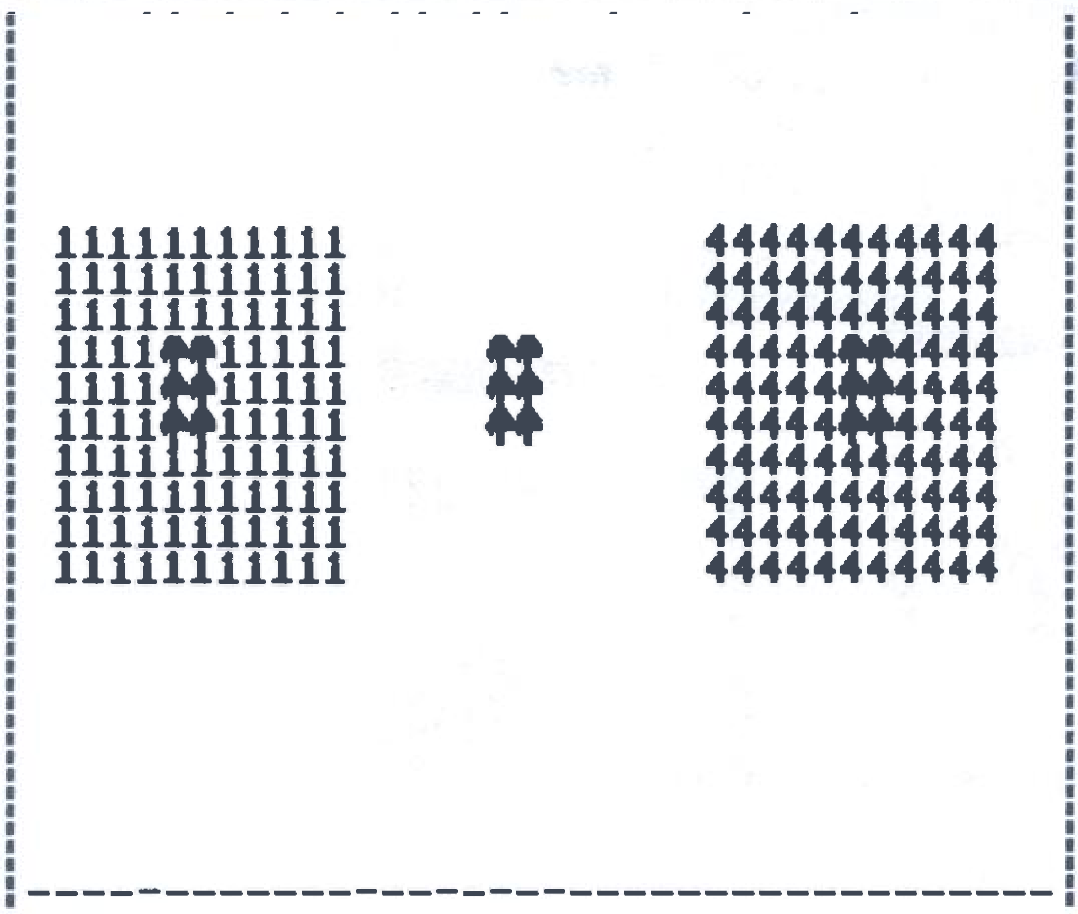
Max Age 20, Added each time 5
Extra x2 every 5 times . Infertility 2
Time: 41



Max Age 20, Added each time 5
Extra x2 every 5 times . Infertility 2
Time: 61



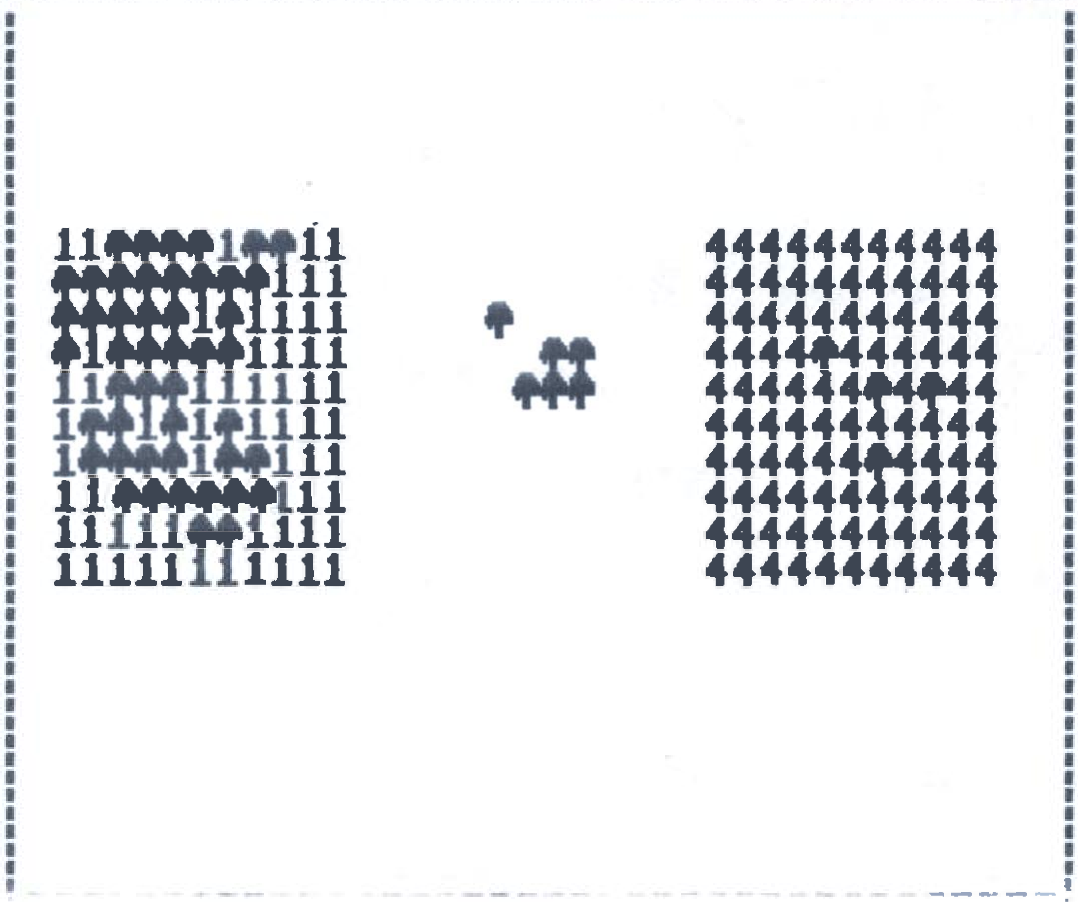
Max Age 20, Added each time 3
Extra x2 every 5 times . Infertility 2
Time: 2



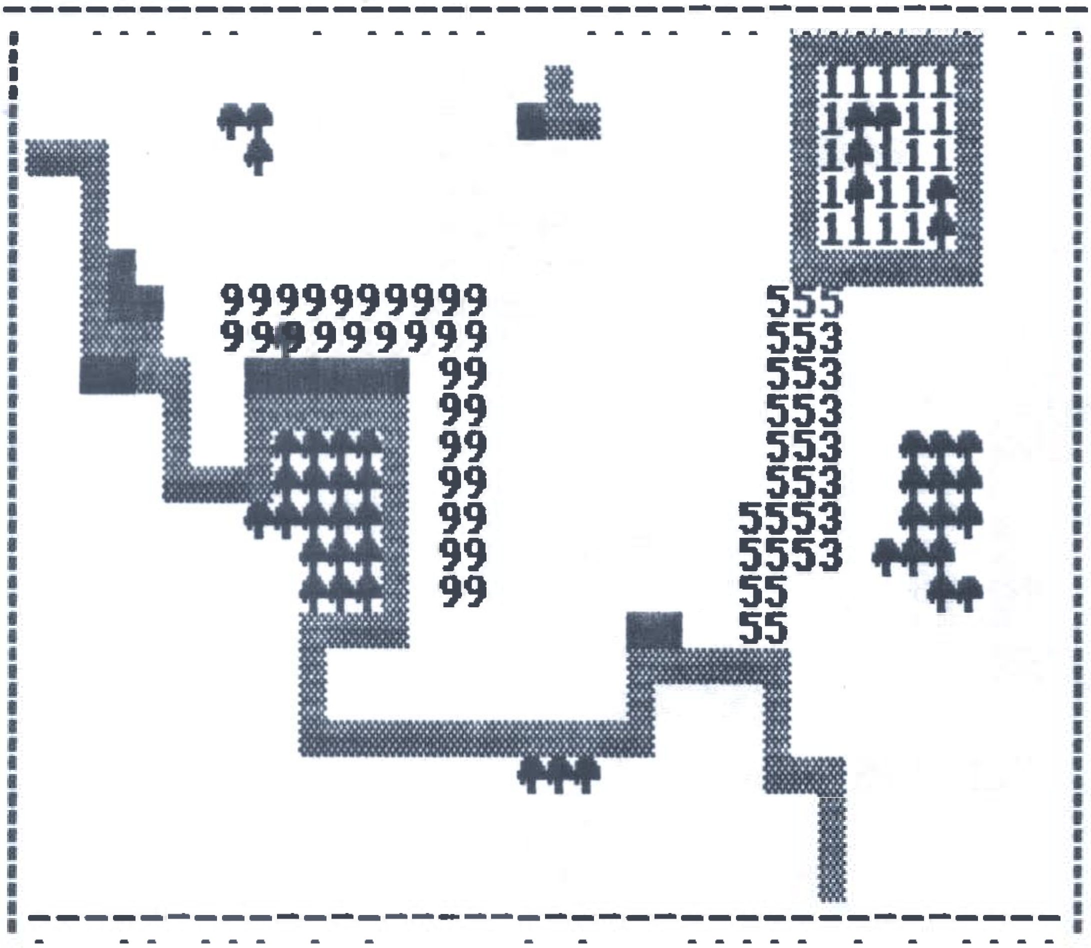
Example 3. The model can be used to test the effects of different grazing pressures.

1 = ~~High~~ low grazing
4 = High grazing

Max Age 20, Added each time 3
Extra x2 every 5 times . Infertility 2
Time: 28

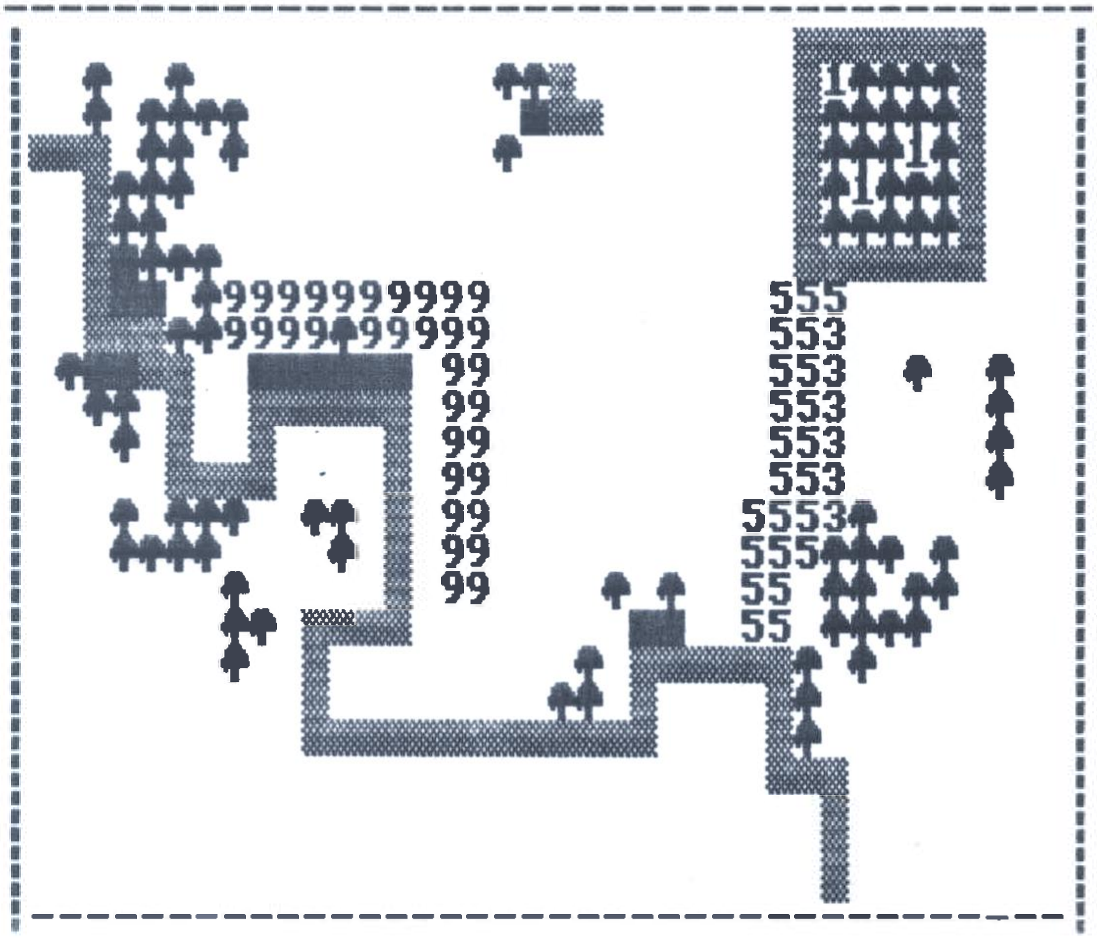


Max Age 20, Added each time 5
Extra x3 every 3 times . Infertility 2
Time: 2



Example 4. Complex landscapes can be modelled. The model on the next page had an identical starting point to the one on this but a higher grazing pressure. In both, though, the enclosed area was protected from grazing.

Max Age 20, Added each time 5
Extra x3 every 3 times . Infertility 2
Time: 80



Max Age 20, Added each time 5
Extra x3 every 3 times . Infertility 4
Time: 33