7.4 The character of long-term ecological research (LTER)

Much of the research for which minimum intervention reserves are suitable is long-term. Many natural processes take decades or centuries, eg, soil maturation, the full growth cycle of trees that live 500 years or so, intervals between disturbances. Monitoring is an open-ended exercise. Short-term research is not precluded, save for the restrictions on impact on the wood itself. But short-term research is generally carried out in a context of long-term change: one should interpret results against the long-term background. The implications are that research on minimum intervention reserves is subject to the peculiarities of long term ecological research, ie (i) the human aspects, (ii) unsustainable hypotheses, (iii) unpredictable subject matter (Strayer *et al* 1986).

The passive, observational character of long term ecological research means that one does not always know what one will be studying. Thus, at Lady Park Wood the originators would not have known that the effects of drought on beech, or of Dutch elm disease would be studied. Long term ecological research extending over decades inevitably takes the form of open-ended observation followed by interpretation, in contrast to most (ie short-term) research, which should take the form of hypothesis, test, analysis and conclusion (Taylor 1989).

7.5 Observing minimum intervention woods and reserves: the basic minimum record

Given the importance of science in minimum intervention woodland reserves, there is a case for ensuring that each reserve is in fact used for scientific research. This goal, however, is as difficult to achieve now as it was when National Nature Reserves were originally established in the 1950s and 1960s primarily with research and demonstration in mind. Resources will not only remain generally limiting, but few mechanisms are available to direct researchers to reserves (and might well be undesirable if they were available).

Perhaps the best provision in these circumstances is for a basic minimum record to be made of key features. The aim would be a quantitative record of (i) the state of the wood, (ii) how it is changing, and (iii) the factors that appear to be driving change. This would itself be of scientific interest, but it would also provide background information that would enable short-term studies and one-off observations to be assessed. In the interests of economy, the record would be simple and repeated only at intervals of several years.

The components of a basic record remain a matter for debate, but the following seem necessary:

a. vegetation recording in permanent plots. The composition and structure of the stand is fundamental to interpreting change in any wood. Permanent plots enable the demography of individual tree species, and the fate of individual trees to be assessed. They are also helpful in demonstrating change to a general audience;

b. photographic record, including fixed points. These are cheap to record, and the record they make is not 'edited' or biased by codes and current interests, though the information is rarely quantitative;

c. event record, ie a record of natural and man-made happenings that leave a mark on the reserve, made as soon as possible after the event. These are necessary for interpreting states and changes observed later;

d. species lists at a whole-reserve scale for as many groups as possible.

8. International comparisons

The UK is a late-comer to minimum intervention woodland reserves. Although Britain has had protected woodlands for at least 120 years, few British woods have been explicitly reserved as minimum intervention reserves, and no special designations exists even now which are equivalent to the strict forest reserves of many other European countries, or the Research Natural Areas of the USA.

This section summarises the progress made in other countries.

8.1 Strict forest reserves in Europe

The most recent summary of the number and extent of strict forest reserves in Europe was given by Parviainen *et al* (1999) as a product of the COST Action E4, Forest Reserves Research Network. The information was evidently supplied by contributors from each country and presented both as individual country accounts and as Table 8.1 (p.31) in a general compilation. Strict forest reserves (SFR) were defined as forests left free for development without human influence.

Unfortunately, the figures have some internal inconsistencies. Where necessary, I have corrected the figure in Table 8.1 by using the figure in the national account. Numerous gaps in the estimate of natural and semi-natural forest area have been filled by my estimates. The curious coincidence in the identical number and area of reserves in Italy and Portugal suggests that a mistake has been made, but neither national account allows this to be checked. Furthermore, exercises of this kind depend a good deal on interpretation of terms. In this instance, the Greek interpretation of 'strict forest reserve' appears to have been particularly optimistic.

Area

Table 8.1 demonstrates that all countries have strict forest reserves. The actual number and area depends on the size and total forest area of each country. The proportion of all land, all forest or all natural+semi-natural woodland in strict forest reserves varies substantially, but there is very little pattern. In general, strict forest reserves comprise less than 2% of the area of natural and semi-natural woodland, but the proportion is larger in (i) Sweden and Finland, where vast boreal reserves have been designated, (ii) Czech Republic, where the substantial reserves have been accentuated by an over-strict interpretation of the concept of 'semi-natural woodland', (ii) Ireland and Netherlands, which have limited resources of semi-natural woodland, and (iv) Denmark, where the definition of semi-natural was strict, but the programme of strict forest reserves designation is well advanced.

Despite their limitations, these comparisons provide a reference point for determining what area of strict forest reserves is needed to compare with the provision in other European countries. Comparison is most appropriate with the four other countries in north-west Europe, which, like the UK, have about 10% forest cover and a low proportion of semi-natural woodland within the national forest area. For what it is worth, they average 8.7% of all semi-natural woodland assigned to strict forest reserves. Elsewhere, the proportion of natural and semi-natural stands in strict forest reserves is generally lower, but the total area of such woodland is generally much higher.

If the UK were to establish 1% of its 437000ha of semi-natural woodland as strict forest reserves, the area needed would be 4370 ha. If the proportion sought is 8.7%, the area needed would be 38,000 ha.

Size

Table 1 also gives average areas for strict forest reserves in each country. Most lie below 100ha, but larger average areas are recorded in the Boreal countries and some well-wooded states in central Europe and the Balkans. The values for Mediterranean countries are also high, but difficult to take at face value.

Averages, however, mean little: it is the range that is most interesting. Table 8.2 is a summary compiled from those national accounts that gave enough information. These illustrate the general pattern, that very large reserves have been made in remote Boreal forests, but elsewhere reserves tend to be less than 3000ha in well-wooded countries, and no more than 500ha in less well-endowed countries. Although France claims (p.105) to have minimum sizes of 50ha 'in plain regions' and 100ha in mountain regions, some of their current reserves fall below these thresholds. Generally, there is no sense of a minimum area.

8.2 North America

Numerous minimum intervention forest reserves have been established in the USA under a wide variety of designations. Forests dominate most National Parks and other wilderness areas, and numerous old-growth stands have been protected within managed landscapes. Given their size and frequency, minimum intervention reserves make a major contribution to nature conservation and recreation, but they have also been copiously used for research. Indeed, much of our understanding of the dynamics of temperate and boreal natural woodland comes from research in such reserves. Furthermore, when hitherto unlogged districts are felled, this is regarded as 'forest fragmentation', even though the forest grows again and total forest cover is maintained.

The American old-growth minimum intervention reserves provide only a limited precedent for minimum intervention reserves in Britain, since we cannot duplicate the scale, variety, history and cultural significance of pristine (to Europeans) forested wildernesses. There is, however, one designation which is worth considering, the "Research Natural Area". These are representative tracts of virgin old-growth which are protected against exploitation and excessive use for recreation, where natural processes are allowed to predominate, primarily for research and education. They have been established by several agencies to preserve natural features, provide comparisons with managed forests, and preserve rare and endangered species and gene pools. Some have in fact been used for large long-term research projects.

The objectives of these Research Natural Areas are very similar to the original objectives of British National Nature Reserves. They are also similar to the strict forest reserves established in many European countries. An equivalent designation is worth considering in Britain.

Table 1. Strict forest reserves in European countries

Country	Area of forests (1000ha)	Forests as proportion of total land area	Natural and semi-natural forests as proportion of forest area	Area of strict forest reserves (ha)	Number of strict forest reserves	Average size of strict forest reserves (ha)	Reserves as a proportion of forest area (%)	Reserves as a proportion of natural (+s/n) forest area (%)
UK	2300	0.10	0.19		81			
Belgium	623	0.11	*0.15*	1734	46	39	0.27%	(1.86)
Denmark	445	0.11	0.05	5086	292	17	1.14%	22.86
Ireland	570	0.08	0.18	5736	33	174	1.01%	5.59
Netherlands	334	0.10	*0.15*	2198	48	46	0.66%	(4.39)
Finland	23000	0.76	0.77	1300000	311	4180	5.65%	7.34
Norway	11950	0.37	*0.75*	148000	160	925	1.24%	(1.65)
Russia (Europ.)	132341	0.39	*0.75*	2763		76750	<0.01%	(<0.01)
Sweden	24400	0.59	0.73	*589110*			2.41%	(4.09)
France	15156	0.28	0.20	14000	30	467	0.09%	0.46
Germany	10700	0.30	0.22	24218	659	37	0.23%	1.02
Switzerland	1186	0.29	0.21	1018	39	30	0.09%	0.41
Austria	3924	0.47	0.25	6072	159	38	0.15%	0.62
Bosnia-Herzeg.	2589	0.51	0.85	3125	27	116	0.12%	0.14
Bulgaria	3357	0.30	0.13					
Croatia	2485	0.44	*0.80*	2856	32	89	0.11%	0.14
Czech Republic	2637	0.33	0.16	25000	103	243	0.95%	5.93
Hungary	1738	0.18	*0.70*	4000	69	58	0.23%	(0.33)
Poland	8726	0.28	0.70	3687	106	44	0.04%	0.06
Romania	6370	0.27	0.70		55			
Slovakia	1920	0.42	*0.70*	15428	76	203	0.80%	(1.15)
Slovenia	1050	0.52	*0.80*	10420	186	56	0.99%	(1.24)
Greece	6513	0.49	0.97	142000	39	3641	2.18%	4.45
Italy	8675	0.29	*0.50*	1841	4	460	0.02%	0.07
Portugal	3306	0.37	0.10	1841	4	460	0.06%	0.15
Spain	11792	0.23	0.13	32644	87	375	0.26%	1.04

Source: Parviainen et al (1999), table 1, from information supplied by individual countries.
Figures are taken directly from the published table, supplemented for Sweden by the aggregate of forests in National Parks and Nature Reserves given in the national article. For the many countries that gave no indication of the proportion of all forests that were natural or semi-natural, I have added an estimate based on personal impressions and nearby countries. All added figures are shown in italics.

Table 2. Size range of forest reserves in some European countries

Country	Category	Minimum (ha)	Maximum (ha)
Czech Republic		2	2500
Finland (p.86)	Strict nature reserve	63	71171
	National Park	421	285484
	Wilderness Areas	15268	293643
	Herb rich forest reserves	0.4	151
	Old-growth forest reserves	3	480
France (p.106)		6	210
Hungary (p.138)	Core areas	3	300
	Core + buffer zone	9	504
Netherlands (p.184)		4	700
Slovakia (p.216)		4	1800
Russia (p.260)		100	721322

9. Review of benefits and drawbacks

This section will assess the advantages and disadvantages of minimum intervention reserves. The former have been covered by the discussion of the purposes of minimum intervention reserves at the outset (section 1.3), and the scientific applications have been explored in detail (section 7), but summary points are included here for completeness.

9.1 Benefits

9.1.1 Science

A wealth of papers and books has been written about natural and near-natural forests, or have been based on research within them (Chapter 7). Despite this, there is still a persistent feeling that minimum intervention reserves are not strictly necessary for research. So, how do they fit into wider spectrum?

First, it is useful to say that several approaches are available to those who wish to understand long-term forest dynamics:

- Chronosequence. Comparisons are made between stands that supposedly differ only in age.
- Interpretation of stand characteristics, such as age-class distribution, size distribution.
- Palynology. Pollen and other sub-fossil remains yield a stratification that can be interpreted as a sequence of vegetation changes. When pollen is examined in deposits in small hollows within ancient woods, the changes revealed will be local.
- Historical records, including maps, documents, old photographs.

- Modelling. Forest processes can be represented by equations which enable current conditions and trends to be projected forward on the basis of several scenarios.

- Permanent plots. Repeated observation maintained until change can be detected and measured.

Each of these approaches has strengths and drawbacks. Historical records are rarely available. Chronosequence and modelling approaches are based on assumptions that may or may not be justified. Both pollen profiles and stand characteristics observed on a single occasion require interpretation, which may be debatable. Permanent plot studies suffer from the need for patience, and can only apply over periods of decades, but they do observe real change in real places. Each approach contributes to the spectrum. Permanent plot studies act as ground- and time-truthing for the hypotheses generated by other approaches.

Natural forests are obviously needed for the study of natural forest states and processes, which are long-term. Minimum intervention reserves are the obvious place for permanent plot studies as counterparts of other approaches. If permanent plots are initiated in woods that are not minimum intervention reserves, there is the obvious danger that the wood will be managed or destroyed.

Minimum intervention reserves may not be necessary for the use of natural woodland as baselines or controls. Studies of soil and hydrology might use ancient woods as controls, even though the change in dynamics from natural conditions to coppice must have altered some properties (eg, by reducing the incidence of tip-up mounds). Ancient woods have also been used as controls in studies of ground vegetation recovery in new woodland, but here, too, the ground vegetation may have been changed.

In much the same way, ancient woods have substituted for natural woodland as places to monitor widespread environmental change due to pollutants. The principal need is for woodland that receives no inputs from local sources, and that may be arranged in any woodland reserve. However, there is again a quibble: even lightly managed woods may have small local inputs from the operation of a power saw or the exhaust of the site manager's truck. And, the canopy of a managed wood may be more or less receptive to widescale pollutants than the canopy of a natural woodland.

Studies of ecosystem recovery could be accomplished mainly through chronosequence studies. In an individual study, the end-point in natural woodland has to be observed only once. However, if such studies are to be possible in the future, the natural end-point has to be available in the future.

Concluding, natural woodland has a role to play in ecological research, though approximations to it can be used in its absence. Reserves containing natural woodland are necessary for permanent plot studies and to ensure the availability of examples of natural woodland for comparisons with managed environments.

9.1.2 Nature conservation

Although some *de facto* minimum intervention woodland reserves have been established in Britain, they make no special contribution to the conservation of species because they are treated by minimum intervention. Many do harbour rare and otherwise significant species, and they certainly contribute to the conservation of these species, but the species rarely if ever depend on minimum intervention. Rather, they depend on continuity of native woodland, or some particular component, usually large trees or dead wood. Indeed, in some minimum intervention reserves, components of biodiversity have declined as open spaces have become shaded and young-growth habitats have grown old.

The issue is whether minimum intervention reserves will in future make a special contribution when they have had time to assume the characteristics of near-natural woodland. We know that continuity of dead wood is associated with high saproxylic diversity, but many saproxylic species possess only limited powers of colonisation of newly suitable woodland. The likelihood of saproxylic diversity recovering to supposed original-natural levels in isolated minimum intervention reserves must be limited, but the prospects for population expansion into minimum intervention reserves close to relict populations are good. Likewise, the possibility that young-growth associates will recover once a minimum intervention reserve has grown through its inherited even-agedness must also be good (and better in the event of prior stand diversification, section 5.1).

The conservation of species is not the primary aim of minimum intervention reserves, but such reserves may make a special contribution to maintaining wildlife if they are located close to relict populations of slow-colonising saproxylic species.

9.1.3 Culture

Some of the earliest minimum intervention reserves were established at Fontainbleau as Reserves Artistiques for the Barbizon school of painters. Jonathan Spencer tells me that old oak stands in the same forest are now regularly visited by people with mental disorders and stress-related conditions as a form of therapy. In Britain, I have several times heard people express a sense of release in mature native woodland, a need that the Woodland Trust is satisfying by promoting public access in mature, lightly-managed woods. The ancient deer-park at Staverton has not only been used as a facsimile of the original landscape from which the cultural landscape of Suffolk evolved, but it has also provided the backdrop for a concert set in supposed wild territory.

It may seem somewhat tenuous to claim cultural benefits of this kind for minimum intervention reserves, but such benefits are notoriously difficult to identify, express, and analyse. There is also a reluctance to recognise the concept of wilderness in Britain, or to accept it as beneficial when it is recognised. Nevertheless, there is a movement towards recognising the value of wild-ness, or relative wilderness, and minimum intervention reserves have a contribution to make, especially if they are large and located close to other kinds of wild countryside.

9.2 Costs and limitations

Inevitably, establishing woodlands as minimum intervention reserves incurs losses. This section details those that have arisen in Britain and gives a response.

9.2.1 Losses of opportunity

i. Timber harvesting

If a woodland is treated as an minimum intervention reserve, it clearly cannot be a source of timber. A minimum intervention reserve should be an indefinite commitment, so, even if valuable timber develops it cannot be felled and extracted without negating the purposes of the reserve. Likewise, if trees are killed, the timber should not be salvaged, for this, too, would interfere with natural processes and modify natural states. In most sites, this has not become an issue, but in Lady Park Wood after the 1976 drought had killed many canopy beech trees, there was pressure to allow these to be salvaged as timber, and the minimum intervention status of the reserve was only upheld after support had been given in the field by the Forestry Commission's Regional Advisory Committee.

The general answer must be to select sites where this cannot be an issue, or to reach a formal agreement which is incorporated in the agreed management plan. In wider terms, timber growers should recognise that the area set aside for minimum intervention reserves is a very small proportion of all woodland, and that minimum intervention reserves bring benefits elsewhere to timber growers.

ii. Conservation management

Likewise, a woodland set aside as a minimum intervention reserve cannot be managed for other conservation objectives. Neither (i) managing by traditional means, or something like it, (ii) managing for diversity, nor (iii) manipulating conditions to suit selected species or features can be allowed, for any operation would impair the natural state of the reserve. This can be a real disadvantage where, for example, open space species are important, or underwood growth threatens the diversity of ground vegetation or epiphytes.

The response lies in good site selection. If the main value of a particular wood for conservation lies in its open space habitats, young growth, historical features, or any other aspect that would be impaired by allowing a wood to run wild, then that wood should probably not be selected as an minimum intervention reserve. In practice, this is most likely to affect small- and medium-sized woods in an intensively farmed landscape, where open spaces provide refuges for species of grassland and other habitats.

9.2.2 Losses for conservation

i. Loss of diversity within reserve

Minimum intervention reserves are likely to develop into closed high forest with small gaps in the stand. Permanent open space habitats are likely to survive only around large cliffs and larger pools, mires and watercourses, ie natural permanent open spaces. Rides and other open spaces created for management will be re-occupied by trees, which will eliminate shade intolerant herbs and any fauna that depends on open spaces or edge between woodland and grassland. These changes are not absolutely guaranteed, but they are highly likely.

The greatest losses from these changes will be in the species of open space habitats. In ancient woods larger than 20ha and managed as coppice or high forest, light demanding species make up 40-60% of the total vascular flora (Peterken and Francis 1999). Most of these will be lost, and only a small proportion will survive on margins, in gaps and as dormant seed. Very approximately, a decision to assign a wood to minimum intervention could halve the plant diversity. Analogous changes in the fauna of open space are likely, but these may be offset by gains in other groups.

Two recourses are available:

- Select minimum intervention reserves as parts of larger woods. This will enable the open space species to survive outside the reserve, but within the wood. They will be close enough to recolonise the reserve if conditions again become suitable.

- Do not select as minimum intervention reserves those woods where the loss of the open space species would be significant, ie rare species and those districts where the semi-natural grassland has been completely eliminated from neighbouring farmland.

On this basis, there should be a presumption in favour of selecting minimum intervention reserves in large woods and well-wooded districts, and a presumption against isolated woods surrounded by intensive arable farmland.

ii. Attraction to deer

In several minimum intervention reserves deer have become extremely numerous. This has happened at Lady Park Wood (Monument 1997), but it seems to be a phenomenon of the whole of the North Temperate (eg, Zofin, Hearts Content). This is a landscape-scale effect, resulting from loss of natural predators, woodland clearance and management - which generates open spaces, numerous edges, prevalent young-growth and fertile feeding grounds on farmland - and public sentiment against deer control. Minimum intervention reserves may provide favoured habitats, especially if they are surrounded by dark, thicket-stage conifer plantations, and if deer control is forbidden. The consequences of excessive deer populations in minimum intervention reserves include a major transformation of and loss of diversity in ground vegetation, and prolonged failure of regeneration.

Where deer are present and the minimum intervention reserve could be more attractive than the surrounding woodland, several measures are possible, of which the first two of the following are preferable:

- Control deer in the surrounding woodland and landscape as a whole. This may require co-operative arrangements with several landowners.

- Allow deer to be shot within the reserve. This can be regarded as people substituting for the role of large carnivores.

- Fence out the deer. Fencing is expensive to install and maintain, and is rarely effective for long. Fences round the edge of woodland with large, old trees are often flattened by falling trunks and branches. Fencing could be taken back into a younger buffer zone, but that adds to the cost and the inconvenience.