

REVIEW OF MANAGEMENT POLICY FOR THE MALHAM TARN ESTATE

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INTRODUCTION

THE Malham Tarn Estate is a Site of Special Scientific Interest and in 1947 it was leased by the National Trust to what is now the Field Studies Council. Although not large, the central reserve, with its tarn and associated wetlands, has a diversity of habitats unparalleled in Britain for land higher than 300 m.

The setting of the Tarn in superb glaciated limestone scenery has a wide range of soils and so a great variety of plants and vegetation types. The mixed woodlands, mainly planted in the nineteenth century, further enrich the flora, and so add greatly to the range of animal habitats. The ornithologist can expect to record 100 species on the Estate in any one year. This wealth of species, unexpected in an upland area, is also found in other groups of animals. Situated where it is, the Estate contains a mixture of "northern" and "southern" as well as "lowland" and "upland" species.

The scientific interest of the reserve is heightened by the continually growing, published documentation, which embraces many disciplines. Indeed the Estate is one of the best documented areas of comparable size in Britain (or elsewhere), largely as a consequence of the establishment of the Field Centre. Much detailed work remains to be done. The growing understanding of the scientific importance of the Estate, coupled with an ever-increasing public and student impact, underline the need for a positive and explicit conservation/management policy. After consulting many people on different aspects and after sifting through notes left by the three previous Wardens I drafted in 1972 the first review which resulted in the Field Studies Council setting up a Management Advisory Committee for the Estate, which first met on 29 March 1973. It exists to ensure that proposed actions are soundly based and are related to agreed priorities. It ensures continuity and consistency of purpose. The Warden of the Field Centre is responsible for the maintenance and improvement of the Estate in accordance with the recommendations of the Committee.

This review of the Committee's policy is a working document. Deviation from some of its recommendations is expected in the future because of new knowledge, changing pressures or new ideas. We have meanwhile agreed the following statement of aims and priorities.

Primary Land Use

To conserve and enhance the WILDLIFE and SCENERY of the Estate.

Secondary Land Use

To realize the maximum potential of the EDUCATIONAL and RESEARCH VALUES as will not prove incompatible with the primary land use.

The Estate comprises a most attractive set of working sites for the field biologist.

It can be made even more attractive by constructive conservation (see below). Such measures then themselves become useful teaching demonstrations. The constant concern is that student-impact shall not lead to degradation of plant and animal communities.

Tertiary Land Use

To allow the fullest enjoyment of as much of the inherent RECREATIONAL VALUES as can be accommodated without diminishing our higher priorities. There remains a challenging opportunity (if not an obligation) to develop further the countryside interpretation at present being inadequately performed by the Nature Trail leaflet.

No other land use is to be countenanced unless it is related to this list of priorities. Likewise adjacent land uses that might prove a threat to the Estate (e.g. pesticide or fertilizer run-off or inappropriate tree planting) should be tolerated only if the impact can be assimilated or harmonized with the priority values of the Reserve.

REVIEW OF THE ESTATE

The foundation of any management plan primarily concerned with Wildlife must be a thorough vegetational survey, such as that for the Malham Tarn area by Sinker (1960). In addition we need to consider all information that throws light on the diversity of organisms and the varied patterns and processes that combine to give us the astonishing complexity that we refer to as "the Estate".

For information on the general aspects of the Estate and its setting, see for geology and geomorphology O'Connor (1964), Clayton (1966) and Clark (1967). Manley (1957) introduces the climate. Bullock (1971) described the soils, Raistrick and Holmes (1962) the archaeology and Williams (1963) the farming patterns of the area.

Sinker's paper on the vegetation should be supplemented by Proctor (1960) on mosses and liverworth, Lund (1961) on algae and Raistrick and Gilbert (1963) for both these groups and lichens.

Holmes (1960a) and Williamson (1968) should be consulted for birds. The publication edited by Flint (1963) introduces the insects, Duffey (1963) the spiders and Cameron and Redfern (1972) the molluscs of the area. Publications dealing more specifically with parts of the Estate are cited in the relevant sections below.

This information enables us to identify those areas that need little or no management, those which require active management in order to maintain existing variety and those which are available for diversification of their vegetation and animal habitats.

The geological and hydrological aspects of the Estate do not appear to be at risk from student or recreational impact. However, it might be wise to study the hydrological systems in more detail, especially possible changes in water quality.

The need to preserve the scenery influences almost anything that might be done. Where a development is necessary we must minimize any adverse visual impact.

Education and Research needs various constructions to aid the student (e.g. board-walks, tree platforms or bird hides). There is also considerable scope for the replication of small systems (such as ponds) or for the setting up of field experiments. As a general principle, before student pressure on a site leads to degradation of wildlife, a replica of that site should be provided for student use, which is equally attrac-

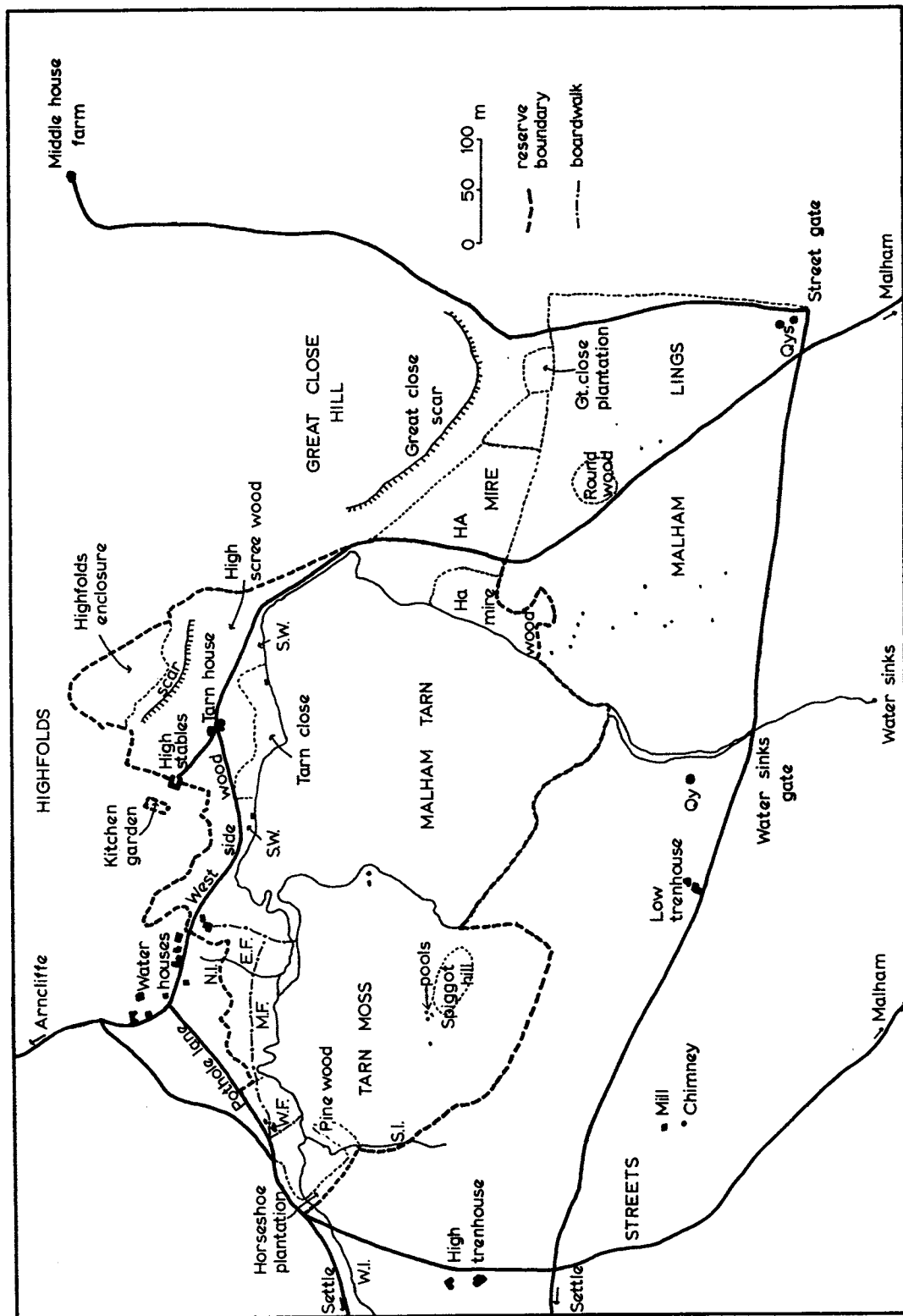


FIG. 1.

Map of the Malham Tarn Estate. SW = Shoreline Woods; W.F., M.F., and E.F. = West, Middle and East Fen; N.I. = North Inflow (or Cowbeck); S.I. and W.I. = South and West Inflow streams. Scale Line is superimposed on Great Close Mire.

tive from the student's point of view. The scope for recreation development is considerable, despite the severe constraints. We need constantly to monitor the public pressure to ensure that fragile ecosystems are not at risk. We also need to strive continually to cater better for people's needs, exploiting all opportunities that will enable us to add to their enjoyment and appreciation of the Reserve. We must never allow the actions of a few vandals make us forget that the vast majority of the visitors not only feel a sense of privilege at being allowed to walk through the Estate but are also eager to learn more about it.

THE TARN

This unique upland calcareous lake is the centre-piece of the Reserve. The invertebrate communities are not only rich and varied but include one or two rare species.

Holmes (1965) provided an admirable introduction to the Tarn. Pigott and Pigott (1959 and 1963) should be consulted for details of the post-glacial history. Holmes (1960b) deals with Brown Trout, for which the Tarn is renowned. Philipson (1968) reports on some aspects of trophic relationships and standing crop of the organisms. Calow (1973) reports on molluscan associations. There is still no complete species list or detailed understanding of the Tarn as an ecosystem or hydrological system: it is somewhat surprising still to know so little about such an unusual lake.

Policy

To conserve the fauna and flora and to facilitate their study. To allow only limited recreational development in order to minimize disturbance.

Event record

- 1962 Conservation Corps repaired spillway and south shore embankment.
- 1972 National Trust lowered level about 1 m. while spillway was repaired.
- Populations of many animals were affected (e.g. the limpets).

Management suggestions

- a. The outflow spillway needs to be maintained (this is National Trust responsibility).
- b. Facilities for the observation and sampling of the flora and fauna should be improved. A jetty into deep water is a possibility. Bird hides would be welcome.
- c. A fishery management policy is needed, based on sound ecological information and our first priority, to conserve wildlife. In the long run, this requires a detailed research programme.
- d. Some years ago it became necessary to ban shore fishing (because of unacceptable trampling on shore vegetation). It is now desirable to increase the number of boats for anglers from two to four. A sampling jetty might also be used by anglers.
- e. Swimming should continue to be restricted to the part of the Tarn between the south boundary of Ha Mire Plantation and the sluice. Sub-aqua diving is only allowed for authorized investigations.
- f. The only boating on the Tarn is that authorized by the Warden of the Field Centre.

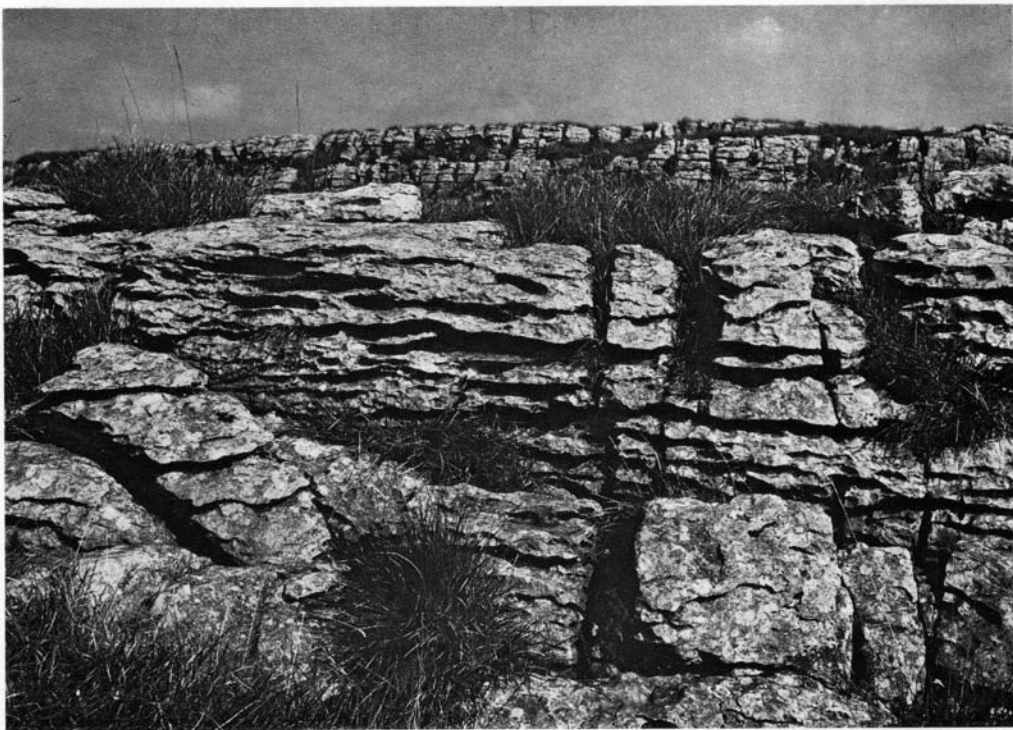


PLATE I.

Weathered limestone on Highfolds. (Photographed in 1972 by C. Crosthwaite).



PLATE II.

Above: Looking from North Shore of Tarn towards mouth of Inflow Stream.

Below: Upstream from mouth of Inflow Stream, with Horseshoe Plantation in distance. (Photographed in 1964 by Dr. M. C. F. Proctor).



TARN MOSS

The Tarn Moss is a raised peat bog of considerable interest and of great educational value. It is not suitable for recreation because too many people would undoubtedly degrade the wildlife: also parts are dangerous for the inexperienced. The flora has been somewhat impoverished by past management, particularly by grouse-moor management practices. During the quarter century of management by the Field Studies Council the flora seems to have shown signs of "recovery". For example it is observed that Marsh Andromeda (*Andromeda polifolia*) and Cloudberry (*Rubus chamaemorus*) are now more abundant and *Sphagnum* cover has gradually increased.

For more detailed information on Tarn Moss the papers by Pigott and Pigott (1959 and 1963) should be consulted. A concise introduction is given in Proctor (1960). Corbet's paper (1973), on the testate Rhizopods (the "shelled amoebae"), provides an excellent introduction to the micro-organisms of the special habitat of a *Sphagnum* hummock.

Activities that may have contributed to the impoverishment of the flora, and presumably the fauna also, include the following: heather burning; increasing rate of run-off by grip drains (designed to encourage heather); alterations to hydrology, by the raising of the Tarn level in 1791, leading to extensive erosion of the East Dome; peat extraction; grazing by sheep and cattle and finally the continuing atmospheric pollution (see Proctor, 1960 and Raistrick and Gilbert, 1963, for data). Probably the most harmful of these has been the cyclical burning of the heather in the interests of the grouse. The extinction of *Sphagnum imbricatum* could be primarily due to it. The present dominance of Cotton Grass (*Eriophorum vaginatum*) and Wavy Hairgrass (*Deschampsia flexuosa*) is likewise related to the heather burning and other practices. More recently trampling by students along more-or-less defined pathways has led to local changes.

Policy

To conserve the areas of more varied vegetation. To attempt, in some areas, to re-create a more varied vegetation, similar to that which prevailed in the past. To replicate a number of acid peat pools and swampy ponds for student use. To take advantage of the size of the bog by using parts of it for field experimental plots and ponds.

Event Record

- 1955 Sheep-proof fencing completed.
- 1959 Prolonged drought.
- 1961 First line of Board-walk to Tarn Moss completed.
- 1963 An area to the south of Spiggot Hill denied to students by protective fencing. Conservation Corps cleared birch saplings.
- 1966 Conservation Corps created the two pools on the east edge of the East Dome.
- 1969 Birch saplings cleared by Conservation Corps.
- 1970 *Carex flava* patch wired-off to exclude students.
- 1972 Dr. D. A. Goode set up two small plots on the East Dome to find out the effects on *Sphagnum* cover of a local lowering (by about 15 cm) of the vegetated surface into the water table.

- 1973 Lancaster University Conservation Corps dammed three main drains on the East Dome.
- 1974 Damming of old grip drains continued by Lancaster University C.C. Conservation Corps rebuilt bridge to Tarn Moss from East Fen.

Management Suggestions

- a. The damming of the old grip drains should be continued to impede the drainage and, in the process, make ponds for student use. In particular the system running westwards from Spiggot Hill could produce a series of large pools by this means.
- b. To the south of the Pine Wood against the western boundary lie old peat cuttings which could be used for a series of swampy ponds, some of which would receive a little calcium-enriched seepage. Such ponds would attract both wildlife and students.
- c. Some of the old peat cuttings towards the western boundary could be "treated" with replicates of Dr. Goode's experimental plots. Such plots must be properly documented.
- d. *Sphagnum imbricatum* should be re-introduced, probably best on the protected area south of Spiggot Hill.
- e. Self-sown trees appearing on the East Dome should be eliminated, apart from Scots Pines on the east point area. On the South and West Domes the situation needs to be kept under observation and selective elimination of saplings carried out when necessary.

THE FEN COMPLEX

The Tarn Fen complex embraces an astonishingly rich variety of vegetation types within a relatively small area. Because of this, it is a major attraction for students. We are very anxious that they may degrade the very riches they seek to interpret. This immensely complex mosaic of intergrading vegetation types and animal habitats results from zonations in relation to acid-alkali gradients, more or less stabilized hydroseres and disturbances of these delicately balanced processes and systems by human interference. The disentanglement of successional processes from cyclical processes is one of the more fascinating challenges confronting the investigator. Despite our incomplete understanding it is clear that man's interference has been an important contributor to the present diversity. Some of the existing variety would undoubtedly be lost if man does not continue planned interferences. For example, the maintenance of areas of open water in the ancient fishponds in the West Fen is essential for the conservation of the *Potamogeton natans* L. community, that includes the much-modified larva of the rare Chironomid midge *Cricotopus brevipalpis* Kieffer amongst the leaf-mining fauna (Disney, 1975).

The essential introduction to the Tarn Fen complex is the paper by Proctor (1974).

Policy

To ensure the continuing survival of the rich variety that exists. Particular care must be taken to conserve rare, or locally rare, plants and animals as well as good examples of each successional stage from open water to fen carr on the one hand and peat bog on the other. This will entail deliberate halting of successional processes or rejuvenation in order to regain earlier stages. The impact of students must be minimized while the educational potential is simultaneously enhanced for the

benefit of students. The construction of the board-walk and the excavation of ponds (for students) in the Middle Fen are attempts to deal with these conflicting claims.

Event Record

- 1959 Prolonged drought. Board-walk started at east end.
- 1961 First line of board-walk, across to Tarn Moss, completed.
- 1962 Conservation Corps cleared some willow.
- 1963 Conservation Corps cleared sapling willows from East Fen.
- 1964 Small (northern) fishpond in West Fen cleared of invading vegetation by Conservation Corps.
- 1965 Conservation Corps cleared some scrub.
- 1966 Conservation Corps added to Board-walk.
- 1968 Conservation Corps extended Board-walk westwards. Fence along north side renewed.
- 1969 Conservation Corps extended Board-walk.
- 1970 Conservation Corps extended Board-walk.
- 1971 Conservation Corps linked up the various sections of Board-walk, thus completing it in the East and Middle Fen. They excavated eleven small ponds in the acid peat dome of the Middle Fen.
- 1972 Conservation Corps laid the foundations of the Board-walk in the West Fen. They excavated six small ponds along the southern margin of the Middle Fen acid peat dome.
- 1973 Conservation Corps completed West Fen Board-walk (to Pot Hole Lane gate and the west end of Tarn Moss). They excavated seven small ponds along the northern margin of the Middle Fen acid peat dome. They started the clearance of *Rhododendron* and American Dogwood.
Lancaster University C.C. excavated one small pond in Middle Fen acid peat dome.
- 1974 Conservation Corps excavated three small ponds in acid peat dome of Middle Fen. They continued clearance of *Rhododendron* and American Dogwood.

Management Suggestions

- a. The Board-walk must be maintained (it serves to protect vegetation from trampling, to facilitate access by students and conducted parties of day visitors and to channel movement of people in the Fen).
- b. The pattern of pond and swamp in the West Fen (derived from ancient fishponds at the base of old peat-cuttings) must include open water at all times (in order to conserve the *Potamogeton* community). It is recommended that one-fifth of the sedge swamp should be cleared from the smaller fishpond in every odd-numbered year (starting in 1975).
- c. The Middle Fen acid peat dome is being developed primarily for the benefit of students, with the dual purpose of reducing student impact on other sites and of providing a highly attractive teaching area. Further replication of acid peat pools is desirable. Keeping the pools (particularly the calcareous pools) free of thick mats of floating detritus and plants will be necessary.
- d. A long term aim is the total elimination of the introduced *Rhododendron ponticum* and *Thelycrania sericea*. In the short term we should try to eradicate these two shrubs from the entire area between the original line of the Board-walk and the line from Pot Hole Lane gate to the Pine Wood.

- e. To maintain good areas of rich fen vegetation, the following parts of the Fen should be kept cleared of invading scrub:
 Either side of the Board-walk from its origin by Miss Hilary's Cottage (formerly called Sandhill Cottage) to the junction with the westward line of the Board-walk. Between the West Inflow Stream and the electricity poles to the west of the line of Board-walk that runs to the Pine Wood.
 Between the South Inflow Stream and the Pine Wood (this being one of the principal sites for *Trollius europaeus*—the Globe Flower).
- f. No trees or shrubs should be planted in the Fen.

HA MIRE (*formerly called Hall Mire*)

Only part of the Mire systems (of Ha Mire and Great Close Mire) are included in the leases to the Field Centre. Our area lies between the Estate road and the Tarn. These sites, characterized by impeded drainage and calcareous waters, support a number of rare plants and invertebrates as well as providing nesting areas for waders and ducks. An important factor helping to maintain the system is the continuing impact of livestock, whose trampling and grazing contribute to the "open" conditions interspersed through the Mire. In recent years the numbers of straying people has become too large. In particular uncontrolled dogs have been disturbing nesting birds and some ignorant or unscrupulous people have been picking or uprooting plants.

Policy

To conserve the flora and fauna.

Event Record

Steady increase in numbers of the straying public from about 1960 onwards.

Management Suggestions

- a. The public must be excluded from the Mire systems. In particular they must be discouraged from cutting across Ha Mire to the edge of the Tarn. A barrier from the north-east corner of Ha Mire Plantation to the Estate road should be considered. A ditch might serve the purpose and would not damage the scenery; it would also make an interesting habitat.
- b. In the long-term the whole of Ha Mire and Great Close Mire should be added to the central reserve, controlled by the Field Centre. The farmer should still be allowed to pasture sheep and cattle on the Mires (under some suitable arrangement between the National Trust, the farmer and the Field Studies Council).

TARN CLOSE (*formerly called Hall Close*)

The Tarn Close is an interesting example of ungrazed limestone grassland, contrasting with the extensive grazed pastures on all sides of the reserve.

A complex of Lady's Mantle, *Alchemilla* species, is of some interest. The large beds of nettles at the top are mainly due to nutrient-enrichment following problems with the old (disused since 1971) septic tank. A number of larval lepidoptera and other insects patronize these nettles.

It is interesting to record changes in the flora since 1955 (when grazing was reduced to negligible proportions). Table 1 shows plants recorded before 1956 (Sinker, 1960) and those recorded in 1974 (by Anne Burn).

Table 1. Vascular plants recorded from the Tarn Close before 1956 and in 1974. R=rare, O=occasional, F=frequent, A=abundant, D=dominant, L=local.

Species	Pre 1956	1974	
<i>Ranunculus acris</i>	F	O	Meadow Buttercup
<i>Ranunculus bulbosus</i>	F	—	Bulbous Buttercup
<i>Ranunculus repens</i>	—	O, L.F	Creeping Buttercup
<i>Ranunculus ficaria</i>	F	R	Lesser Celandine
<i>Cardamine pratensis</i>	F	O	Cuckoo Flower
<i>Viola riviniana</i>	F	O to F	Common Violet
<i>Viola lutea</i>	O	R	Mountain Pansy
<i>Hypericum perforatum</i>	—	O	Common St John's Wort
<i>Hypericum pulchrum</i>	R	R	Slender St John's Wort
<i>Helianthemum chamaecistus</i>	O	L.O	Common Rockrose
<i>Cerastium vulgatum</i>	O	—	Mouse-ear Chickweed
<i>Stellaria graminea</i>	O	R	Lesser Stitchwort
<i>Linum catharticum</i>	F	R	Purging Flax
<i>Geranium robertianum</i>	—	R	Herb Robert
<i>Geranium sanguineum</i>	F	—	Bloody Cranesbill
<i>Trifolium pratense</i>	O	O	Red Clover
<i>Trifolium repens</i>	F	R	White Clover
<i>Lotus corniculatus</i>	F	F	Birdsfoot-trefoil
<i>Filipendula ulmaria</i>	L.D	O	Meadow-sweet
<i>Rubus idaeus</i>	—	R, L.A	Raspberry
<i>Potentilla erecta</i>	—	F	Common Tormentil
<i>Potentilla sterilis</i>	L.F	R	Barren Strawberry
<i>Fragaria vesca</i>	L.F	R	Wild Strawberry
<i>Geum rivale</i>	F	A	Water Avens
<i>Alchemilla vestita</i>	F	R	Lady's Mantle
<i>Alchemilla xanthochlora</i>	O	R	
<i>Alchemilla glabra</i>	F	F	
<i>Alchemilla wickhamiae</i>	O	—	
<i>Crataegus monogyna</i>	—	R	(2 or 3 small bushes)
<i>Sanguisorba officinalis</i>	O	F	Hawthorn
<i>Poterium sanguisorba</i>	O	F	Great Burnet
<i>Saxifraga granulata</i>	R	—	Salad Burnet
<i>Saxifraga hypnoides</i>	O	—	Meadow Saxifrage
<i>Chamaenerion angustifolium</i>	—	R, L.A	Dovedale Moss
<i>Epilobium montanum</i>	—	R	Rosebay Willow-herb
<i>Conopodium majus</i>	O	R	Broad-leaved willow-herb
<i>Pimpinella saxifraga</i>	F	R	Pignut
<i>Angelica sylvestris</i>	—	R	Burnet Saxifrage
<i>Heracleum sphondylium</i>	O	F	Wild Angelica
<i>Mercurialis perennis</i>	—	F	Hogweed
<i>Rumex acetosa</i>	F	R	Dog's Mercury
<i>Rumex obtusifolius</i>	—	R	Sorrel
<i>Urtica dioica</i>	L.A	R	Broad-leaved Dock
<i>Salix</i> sp.	—	L.D	Stinging Nettle
<i>Primula veris</i>	F	R	(one small bush) Willow
<i>Gentianella campestris</i>	R	F	Cowslip
<i>Gentianella amarella</i>	O	—	Field Gentian
<i>Myosotis arvensis</i>	—	—	Felwort
<i>Veronica officinalis</i>	O	R	Common Forget-me-not
<i>Veronica chamaedrys</i>	F	—	Common Speedwell
<i>Veronica serpyllifolia</i>	O	R	Germander Speedwell
<i>Euphrasia cf. nemorosa</i>	F	—	Thyme-leaved Speedwell
<i>Thymus drucei</i>	F	R	Eyebright
			(one clump on a limestone outcrop) Thyme
<i>Prunella vulgaris</i>	O	O	Self-heal
<i>Plantago major</i>	F	R	Great Plantain
<i>Plantago media</i>	O	R	Hoary Plantain
<i>Plantago lanceolata</i>	F	F	Ribwort
<i>Campanula trachelium</i>	F	O	Harebell
<i>Galium cruciata</i>	L.F	O	Crosswort
<i>Galium verum</i>	F	F	Lady's Bedstraw
<i>Galium pumilum</i>	—	R	Slender Bedstraw
<i>Valeriana officinalis</i>	—	R	Valerian
<i>Scabiosa columbaria</i>	F	L.F	Small Scabious
<i>Succisa pratensis</i>	F	A	Devil's-bit Scabious

Table 1. *Continued.*

Species	Pre 1956	1974	
<i>Senecio jacobaea</i>	L.F	R	Ragwort
<i>Tussilago farfara</i>	—	R	Coltsfoot
			(mostly beside footpaths)
<i>Bellis perennis</i>	O	R	Daisy
<i>Achillea millefolium</i>	O	F	Yarrow
<i>Achillea ptarmica</i>	R	—	Sneezewort
<i>Chrysanthemum leucanthemum</i>	F	R	Moon-Daisy
<i>Cirsium vulgare</i>	F	—	Spear Thistle
<i>Cirsium palustre</i>	O	R	Marsh Thistle
<i>Cirsium arvense</i>	O	R	Creeping Thistle
<i>Centaurea nigra</i>	F	A	Lesser Knapweed
<i>Leontodon autumnalis</i>	O	—	Autumnal Hawkbit
<i>Leontodon hispidus</i>	O	O	Rough Hawkbit
<i>Hieracium pilosella</i>	F	—	Mouse-ear Hawkweed
<i>Luzula campestris</i>	F	—	Field Woodrush
<i>Juncus conglomeratus</i>	—	R	(a few clumps near Tarn)
			Rush
<i>Listera ovata</i>	R	R	Twayblade
<i>Coeloglossum viride</i>	R	—	Frog Orchid
<i>Gymnadenia conopsea</i>	R	—	Fragrant Orchid
<i>Orchis mascula</i>	O	R	Early Purple Orchis
<i>Dactylorchis purpurella</i>	O	—	Purple Orchis
<i>Carex panicea</i>	O	R	Carnation Grass
<i>Carex flacca</i>	F	F	Carnation Grass
<i>Carex caryophylla</i>	L.F	O	Spring Sedge
<i>Carex nigra</i> agg.	O	R	Common Sedge
<i>Carex pulicaris</i>	O	R	Flea-sedge
<i>Sieglingia decumbens</i>	O	R	Heath Grass
<i>Festuca pratensis</i>	R	R	Meadow Fescue
<i>Festuca rubra</i>	L.F	A	Creeping Fescue
<i>Festuca ovina</i>	F to D	F	Sheep's Fescue
<i>Lolium perenne</i>	O	R	Rye-Grass
<i>Dactylis glomerata</i>	F	A	Cock's-foot
<i>Cynosurus cristatus</i>	F	R	Crested Dog's-tail
<i>Briza media</i>	F	O	Quaking Grass
<i>Sesleria caerulea</i>	O	L.A	Blue Sesleria
<i>Koeleria cristata</i>	F	O	Crested Hair-grass
<i>Trisetum flavescens</i>	R	O	Yellow Oat
<i>Helictotrichon pratense</i>	O	O	Meadow Oat
<i>Arrhenatherum elatius</i>	O	F	Oat-grass
<i>Holcus lanatus</i>	F	A	Yorkshire Fog
<i>Deschampsia caespitosa</i>	O	A	Tufted hair-grass
<i>Agrostis tenuis</i>	A	F	Common Bent-grass
<i>Agrostis stolonifera</i>	O	O	Fiorin
<i>Phleum bertolonii</i>	R	R	Cat's tail
<i>Alopecurus pratensis</i>	R	R	Meadow Foxtail
<i>Anthoxanthum odoratum</i>	F	F	Sweet Vernal-grass
SPECIES TOTAL	92	90	
SPECIES LOST		19	
SPECIES GAINED		17	

Policy

To maintain as ungrazed grassland.

Event Record

1955 Sheep-proof fencing of Estate completed. Myxomatosis arrived.

1964–1969 Intermittent cutting of grass at west side in order to “encourage” the *Alchemilla*.

1970 Part of Nature Trail established along southern margin of Tarn Close.

1972 Nature Trail re-routed along Estate road due to unacceptable damage to young trees and vegetation in general (as well as litter and trespass into East Boathouse).

Management Suggestions

- a. It is essential to keep livestock off the Tarn Close.
- b. Any sapling trees should be eliminated, except along the Tarn edge (where a narrow belt of trees and shrubs would serve as a wind-break for the Close).
- c. Excessive spread of the nettle beds might be controlled by trampling experiments.
- d. The need, and desirability, for active conservation of the *Alchemilla* to be assessed.

WEST END OF GREAT CLOSE

This is the only area of grazed limestone grassland within the reserve boundary. There are one or two mature trees, including a beech, with many water-filled hollows at the bases of the major limbs.

Policy

To keep it as it is.

Event Record

Grazed by sheep and cattle from Middle House Farm.

Management Suggestions

- a. Leave it alone. Do not fell the trees.
- b. In the long term it would be highly desirable to add larger areas of grassland (both on limestone and drift soils) to the reserve. Such additions would extend areas with security of access for students, reduce student impact on other sites and provide space for field experiments (such as the effects of different mowing and/or grazing regimes or long term studies on terracettes).

HIGHFOLDS

The screes and scars of Highfolds are important sites for several unusual plants. The ungrazed areas of limestone pavement and grassland are also of interest. Sinker (1960) reported no bilberry (*Vaccinium myrtillus*) on Highfolds before 1956. The great reduction in grazing since then has led to this species becoming well established on top of Highfolds. Thus in 1974 Anne Burn recorded bilberry in 49 out of 1,000 random quadrats (30 cm. × 30 cm.).

The introduced *Cotoneaster microphylla* now occupies substantial areas of the scar face and has probably ousted interesting ledge species of native plants in the process.

Policy

To conserve the native flora and fauna.

Event Record

1955 Sheep-proof fencing of Estate completed. Myxomatosis arrived.

1963 The *Cotoneaster* had obviously increased since 1955, probably due to the reduction of the rabbit population.

1965 Conservation Corps initiated attack on *Cotoneaster*. There have been periodic attacks since then. Little, if anything, has been achieved by these measures, mainly due to difficulties of access but also due to a failure to kill the rootstocks.

Management Suggestions

- a. The status of *Cotoneaster* as a weed needs objective assessment. If it is the menace it is claimed to be then effective control measures need to be found.
- b. A case could be made out for encouragement of some of the rare plants of local screes and rock ledges (e.g. *Potentilla crantzii*). Only seed from local strains should be used and anything done must be fully documented.

HIGH STABLES KITCHEN GARDEN

This old garden is available for research work. It has proved useful in studies on the performance of particular plants at this altitude.

THE WOODLANDS

With the exception of the Fen carr the woodlands on the reserve are all created by man in recent centuries. The trees around the buildings are "amenity" plantings, giving shelter and embellishing the scenery. In the nineteenth century, at least, they were also seen as commercial timber plantations as well as valuable cover for pheasants. In fact parts of the woodland were once managed primarily for pheasants (for example, the unusual stand of coppiced beech in Westside Wood). The woodlands are now rich reserves for a growing variety of plants and animals.

Policy

To retain the original shelter and scenic functions of the woodlands. To conserve and enhance the wildlife. To develop the educational potential. We explicitly reject the former commercial-timber-production function.

Event Record

- 1953 Two acres clear-felled and rest of Tarn House Plantation thinned.
- 1954 Part of cleared area replanted along with area at west end of Tarn Close.
- 1955 Sheep-proof fencing of Estate completed. Myxomatosis arrived.
- 1960 About 40 trees blown down in November gale.
- 1961 Highfolds Enclosure fenced for first time.
- 1962 About 70 trees blown down in February gales.
- 1964 About two acres replanted at east end of Tarn House Plantation.
- 1965 Area extending westwards from West Boathouse replanted.
- 1967 Felling and thinning carried out in north part of Tarn House Plantation.
Conservation Corps tidied up blown-timber in Spiggot Hill Plantation.
- 1968 Sixty nest boxes for birds installed in Tarn House Plantation.
- 1969 Conservation Corps clipped hawthorns in Pothole Lane.
Highfolds Enclosure fencing had deteriorated so that sheep were frequently getting inside.
- 1971 About two acres felled to east of Miss Hilary's Cottage (both sides of road).
Conservation Corps rewired Highfolds Enclosure.

- 1972 Area felled in previous year replanted (with larch, sweet chestnut, oak, holly, poplar and rowan).
Nature Trail re-routed along Estate road.
- 1973 Further hawthorns were planted along verges of Estate road. About 100 small junipers (from Scotland) were planted to the south-east and south-west of Tarn House. A number of trees were felled by November gales.
- 1974 Twenty holly, 20 aspen, 10 *Prunus padus* and 10 *P. avium* planted to screen the new septic tank (in east Shoreline Woods). One hundred Scots pine planted in Pine Wood (Horseshoe Plantation).

Management Principles

1. Only trees and shrubs regarded as "appropriate" should be planted in the woodlands. "Appropriate" in this context means those species which would occur in a "natural" woodland in a situation such as Malham Moor. We designate these species as "Desirable". Our second level of acceptability embraces those species which appear in the woodlands without being planted by man, but we will only deliberately plant them in a special "restricted zone" (which has been agreed will be the Shoreline Woods). These species we designate as "Acceptable". The final level of acceptability includes species only to be tolerated in the woodlands when they are planted in the "restricted zone" for some special purpose (for example, to provide the correct food plant for some insect of particular interest). These species are designated as "Special Cases".

Table 2 lists the three classes of trees and shrubs regarded as appropriate.

Table 2. *Species of tree and shrub approved, in three categories of acceptability (see text), for the Malham Tarn Estate*

DESIRABLE SPECIES	
<i>Corylus avellana</i> —Hazel	<i>Prunus spinosa</i> —Blackthorn
<i>Crataegus monogyna</i> —Hawthorn	<i>Quercus petraea</i> —Sessile oak
<i>Daphne laureola</i> —Spurge laurel	<i>Ribes alpinum</i> —Mountain currant
<i>Daphne mezereum</i> —Mezereon	<i>Ribes rubrum</i> agg.—Red currant
<i>Euonymus europaeus</i> —Spindle tree	<i>Ribes spicatum</i> —Northern currant
<i>Fagus sylvatica</i> —Beech	<i>Ribes uva-crispa</i> —Gooseberry
<i>Fraxinus excelsior</i> —Ash	<i>Rubus caesius</i> —Dewberry
<i>Hedera helix</i> —Ivy	<i>Rubus fruticosus</i> —Blackberry
<i>Ilex aquifolium</i> —Holly	<i>Rubus idaeus</i> —Raspberry
<i>Juniperus communis</i> —Juniper	<i>Rubus saxatilis</i> —Stone bramble
<i>Ligustrum vulgare</i> —Common privet	<i>Salix caprea</i> —Great willow (Goat willow)
<i>Lonicera periclymenum</i> —honeysuckle	<i>Sorbus aucuparia</i> —Rowan (Mountain ash)
<i>Malus sylvestris</i> —Crab apple	<i>Sorbus rupicola</i> —Rock white beam
<i>Pinus sylvestris</i> —Scots pine	<i>Taxus baccata</i> —Yew
<i>Populus tremula</i> —Aspen	<i>Thelycrania sanguinea</i> —Dogwood
<i>Prunus avium</i> —Gean (Wild cherry)	<i>Ulmus glabra</i> —Wych elm
<i>Prunus padus</i> —Bird cherry	<i>Viburnum opulus</i> —Guelder rose
ACCEPTABLE SPECIES	
<i>Acer pseudoplatanus</i> —Sycamore	<i>Ribes nigrum</i> —Black currant
<i>Alnus glutinosa</i> —Alder	<i>Rosa</i> spp.—Wild roses
<i>Berberis vulgaris</i> —Barberry	<i>Sambucus nigra</i> —Elder
<i>Betula pendula</i> —Silver birch	<i>Tilia cordata</i> —Small-leaved lime
<i>Betula pubescens</i> —Birch	<i>Ulex europaeus</i> —Gorse
<i>Larix decidua</i> —European larch	
SPECIAL-CASE SPECIES	
<i>Quercus robur</i> —Pedunculate oak	Others already established
<i>Rhamnus catharticus</i> —Buckthorn	(e.g. <i>Castanea sativa</i> —Sweet chestnut)

The larch is "acceptable" on two counts, despite being an "exotic". It is a useful timber tree for the Field Centre, which requires fence posts, fire logs and so on. In addition, it supports an interesting insect life, which has been studied at Malham Tarn by Dr. Broadhead and his students.

The sycamore is an exotic species whose acceptability is hotly debated amongst British conservationists. On Malham Moor it regenerates and grows well, being tolerant of the cool, wet and exposed conditions. Historically it has served as a much-valued component of amenity plantings from the sixteenth century onwards and has become an accepted part of the landscape of the Craven Uplands. From an ecological point of view its foliage is exploited by rather few animal species by comparison with many native trees, notably the oak. What is often overlooked is that the leaf litter of the sycamore is far more rapidly exploited by a variety of organisms than is the case with most native trees, above all the litter of oak and beech. A more weighty objection to the sycamore comes from the claim that it will "swamp" all other species, owing to its close canopy and capacity for regeneration. That it will, in practice, "take over" woodland in this way is open to dispute, and on Malham Moor there is no hard evidence to support this claim. It undoubtedly has a high success rate in the germination of the seed but seems to experience a very high mortality in the seedling and young sapling stages. Indeed on Malham Moor most successful regeneration appears to be due to suckering from superficial roots and old stumps. Our policy for the sycamore is to plant none outside the "restricted zone" (the Shoreline Woods). There will be no attempt to eliminate mature trees from the rest of the woodland. To do so would have a disastrous effect on the present structure of the woodland. However, there will be a deliberate attempt to phase it out of the woodland, outside the Shoreline Woods, by underplanting with other species, by selective felling in places and by persistent felling of all sycamores whose trunks measure less than about 20 cm (measured about 1 m. from the ground).

2. "Proper management practices" are derived from one's policy aims. We have rejected commercial timber production and hence we need to question closely the relevance of sound forestry practice. When one's primary aim is the conservation of wildlife, a radical reversal of much traditional plantation management practice is called for. This has not always been recognized by managers of nature reserves, although recently a number of writers have drawn attention to it (e.g. Steel, 1972; Stubbs, 1972).

In a "natural" wood, all stages of the regeneration cycle of each species are represented. The spacing and dispersion patterns of the different species are regulated by natural, frequently chance, processes. Our wood will embrace thickets of saplings, tangles of vegetation and a formidable litter of falling and fallen trees. We welcome what a forester would call "weeds". To us thinning becomes an unwarranted interference rather than good housekeeping. Untidiness, in the form of dead and dying trees, becomes desirable rather than reprehensible. An uneven age structure and a chaotic mix up of species becomes an attraction rather than an uneconomic inconvenience. It follows from this appreciation that our management practices must be very different from "good forestry practice". We reject clear felling and thinning as normal practice. Weeding and selective felling will be largely confined to unwanted "exotics" and dying or dead trees whose fall might be dangerous or inconvenient. When obliged to fell trees we can cut them off so that we leave tall stumps, which will then mature into rich dead-wood habitats.

3. Left to themselves the woodlands will gradually develop a "natural" structure and the diversity of woody plant species will slowly increase. This rise in diversity, however, will take centuries rather than decades. It is desirable, therefore, to speed up this aspect of the "improvement" of the woodland by a programme of tree and shrub planting—at least for the remainder of the twentieth century.

4. Apart from the removal of hazardous trees only exotic species should be extracted from the woodlands. The one exception is that the Shoreline Woods are to be partly managed as a plantation in order to supply the Centre's limited timber needs.

Management Suggestions

The policies for the different pieces of woodland are included in the following brief reviews.

(a) HIGHFOLDS ENCLOSURE (Fig. 2).

The purpose of this experiment is to follow the establishment of woodland on limestone pavement above 450 m. under present climatic conditions. We envisage an ash dominated woodland with associated trees and shrubs from the list of Desirable Species (Table 2). The essential policy is that only SEED is to be deliberately introduced into the enclosure.

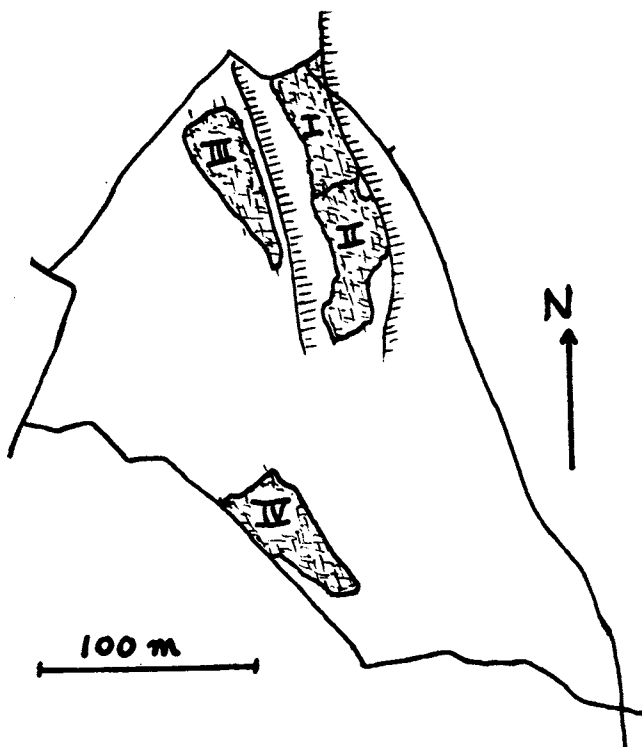


FIG. 2.

Sketch map of Highfolds Enclosure to show Pavements I-IV.

It has been decided that no seed is to be sown in the north-east corner (Pavement I). Pavement II (immediately south-east of Pavement I) and Pavement III (west of I and II) were re-sown with ash seed in December 1973. These two pavements are not to be sown again, but it is proposed to apply fertilizer to II in due course in order to assess the effects on the growth of the ash.

Pavement IV (against the south-west boundary of the Enclosure) is being repeatedly sown with ash seed in an all out attempt to get ash wood established. Elsewhere in the enclosure seeds of various appropriate trees and shrubs may be periodically scattered.

Some self-sown sycamore has appeared in the Enclosure. The policy is to leave these for the time being, in order to avoid disturbing germinating ash while attempting to uproot the sycamore. They will, however, be ring-barked before they get too large.

It is hoped that Professor Greig-Smith will be publishing information on the vegetational changes in due course.

(b) HA MIRE WOOD (*formerly called Primrose Plantation*)

This plantation on glacial drift is at present largely occupied by exotics, particularly in the southern half. It is proposed to underplant with oak, wych elm and hazel. The alder fringe on the damp west side will be maintained by planting where necessary (despite it not being a Desirable Species).

In the long term added variety could be obtained by coppicing some of the hazel. A small pond or two within this wood would be interesting.

The wet flush habitats along the Tarn edge of the wood are of considerable interest and trampling of these areas should be minimal.

(c) SPIGGOT HILL PLANTATION

This isolated plantation, perched on a drumlin, is a pleasing feature in the landscape but lacks "solidity" (especially in winter). The tree canopy should be maintained by underplanting major gaps with oak and beech. In addition there needs to be extensive underplanting with Desirable shrubs and with hazel in particular.

(d) HORSESHOE PLANTATION

This plantation is divided into two sections by the South Inflow Stream. The newer part is the Pine Wood, which lies to the east of the South Inflow Stream. The older part should be retained as somewhat open woodland merging into fen carr scrub on its inner (wetter) flanks. Underplanting in major gaps should be with ash and rowan.

The Pine Wood is largely coniferous, but most of the species are "exotics". It should be gradually underplanted with Scots pine, so that it will eventually recall the original primaeval forest. One or two tree platforms would be attractive to students. A pond beneath the pines would also be interesting.

(e) TARN HOUSE PLANTATION

The Tarn House Plantation is divided into three parts by the Estate road and the road to High Stables. The Shoreline Woods lie south of the Estate road, both to the

west and the east of the Tarn House. North of the road lies the Westside Wood to the west of the road to High Stables and to the east lies Highscree Wood, rising to the foot of Highfolds Scar.

The verges of the Estate road are best fringed with thorny shrubs and small trees (hawthorn, blackthorn, holly, etc.), which are far more effective (and less irritating) than frequent notices exhorting the public not to stray off the road.

The SHORELINE WOODS constitute the "restricted zone" referred to above. Here both Acceptable and Special-Case species may be planted. There will be a certain amount of plantation management as it is the selected site for the cultivation of larch, to meet the timber requirements of the Field Centre. Considerable disturbance by students is to be tolerated. Bird hides overlooking the Tarn would be an asset.

WESTSIDE WOOD should be gradually underplanted with Desirable Species of trees and shrubs. The following species in particular should become more and more frequent: ash, oak, wych elm, beech, yew, rowan and aspen. For educational purposes there is scope for creating small blocks (i.e. about 1,000 m²) of a single species—of ash, oak, wych elm, aspen and hazel in particular. Tree platforms would greatly add to the attraction of the wood for students.

In the long run a larger area of "natural" woodland would be desirable for student use. It may not be possible to obtain such a tract contiguous with the existing woodland, but the possibility of extending Westside Wood northwards is a most tempting prospect. In the meantime we envisage Westside Wood and the Shoreline Woods as the principal woodlands available for student use.

HIGHSCREE WOOD not only harbours some rare plants but also some interesting invertebrates associated with relatively undisturbed screes. Its wildlife values must be rated higher than the rest of Tarn House Plantation, and so it will be less disturbed by students, who are encouraged to use other woodland for anything other than special investigations. Our policy is to underplant with all the desirable species. At the same time there will be a continuing attempt to eliminate the younger specimens of the "exotic" species and to replace them with Desirable Species. We envisage the gradual development of a species-rich, jungle-like situation embracing scattered glades and patches of young trees and shrubs. By the end of the century it could be a superb example of an upland, limestone-scrub woodland (on a south facing slope) giving sanctuary to a rich fauna and interesting flora.

CONCLUSION

Table 3 summarizes the Management Suggestions. Financial (and other) constraints prevent detailed decisions about dates for completion of suggested tasks.

The richness of the Malham Tarn Estate can clearly only be maintained by a policy of active management related to clear priorities. While student damage must be minimized, we must seek to enhance the educational value wherever we can. We also need to face the challenge and opportunity posed by the growing numbers of day visitors to the Estate. The primacy of the need to conserve wildlife and scenery must shape all our policy decisions. The scientific value of the Estate is so great that we are compelled to deny students or day visitors access to some of its fragile riches. The enviable size of the Field Centre's teaching grounds, with their guaranteed long-term security of access, will be an illusion unless we can avoid degradation of the very things the students come to study and enjoy.

Table 3. *Summary of Management Suggestions for the Malham Tarn Estate*

MANAGEMENT SUGGESTION	TIMING
GENERAL	
1. Appointment of Estate warden and guide	As soon as possible
2. Provide proper car parking arrangements and toilet facilities for the public	As soon as possible
3. Encourage detailed documentation of fauna and flora by specialists	Continually
4. Encourage research on ecological and geomorphological processes	Continually
5. Encourage biological and other monitoring of pollution and other impacts on environment	Continually
6. Establish more effective sheep-proof fencing for principal boundaries	As funds allow
THE TARN	
1. Maintain outflow spillway and sluice	As required
2. Increase boats for anglers to four	When funds are available
3. Explore feasibility of deep-water jetty	When funds are available
TARN MOSS	
1. Maintain sheep-proof fencing	Continually
2. Re-introduce <i>Sphagnum imbricatum</i>	As soon as possible
3. Monitor self-sown tree saplings and remove from East Dome at least	Continually
4. Complete damming of old grip drains	As volunteer labour allows
5. Excavate swampy ponds near western boundary	As volunteer labour allows
6. Replicate Dr. Goode's experiments on West Dome	As volunteer labour allows
TARN FEN COMPLEX	
1. Maintain Board-walk	Continually
2. Prevent slippery surface on Board-walk	As soon as possible
3. Maintain sheep-proof boundary walls	Continually
4. Clear one fifth of sedge swamp from smaller fishpond in West Fen	Every odd-numbered year
5. Clear invading scrub from designated areas	Continually
6. Eliminate <i>Rhododendron</i> and <i>Thelycrania</i> from main body of Fen	As soon as possible
7. Continue programme of pond digging in Middle Fen	Over next few years
8. Monitor growth on spoil heaps from pond construction and clear birch if necessary	Continually
HA MIRE	
1. Devise means of keeping public off	As soon as possible
TARN CLOSE	
1. Keep clear of scrub and sapling trees	Continually
HIGHFOLDS	
1. Maintain sheep-proof fencing	Continually
2. Assess weed status of <i>Cotoneaster</i>	When possible
HIGHFOLDS ENCLOSURE	
1. Maintain sheep-proof fencing	Continually
2. Repeatedly sow ash seed in Pavement IV	Until ash is well established
3. Ring-bark sycamore saplings	As they appear
HA MIRE WOOD	
1. Maintain sheep-proof fencing	Continually
2. Underplant with oak, wych elm and hazel	As soon as possible
3. Maintain fringe of alders on Tarn side	As required
SPIGGOT HILL PLANTATION	
1. Underplant with hazel and other shrubs	As soon as possible
2. Maintain tree canopy by planting oak and beech in gaps	As required
HORSESHOE PLANTATION	
1. Underplant Pine Wood section with Scots pine	In all gaps that appear
2. Maintain western boundary sheep-proof fencing	Continually
3. In old section underplant with rowan and ash	As required

Table 3. *Continued.*

MANAGEMENT SUGGESTION	TIMING
WESTSIDE WOOD	
1. Underplant with Desirable species of trees and shrubs	Regularly for rest of century
2. Maintain sheep-proof fencing	Continually
3. Eliminate young exotic trees and shrubs	Continually
4. Erect tree-platforms for student use	As funds allow
HIGHSCREE WOOD	
1. Maintain sheep-proof fencing	Continually
2. Underplant with Desirable species of trees and shrubs	Regularly for rest of century
3. Eliminate young exotic trees and shrubs	Continually
SHORELINE WOODS	
1. Maintain sheep-proof fencing	Continually
2. Manage as "untidy" plantation	Continually
3. Construct bird hides which overlook Tarn	As funds allow
TARN HOUSE PLANTATION ROAD VERGES	
1. Establish and maintain thorn-barrier hedging	As soon as possible
DESIRABLE ADDITIONS TO RESERVE	
1. The rest of Ha Mire and Great Close Mire	When feasible
2. A larger area of woodland for student use	When feasible
3. An area of rough pasture embracing a variety of soils for student use and field experiments	When feasible

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