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Species requirements: This section provides a summary of our existing knowledge concerning birds, plants, mammals and invertebrates associated with the Broads fens. This information forms a basis for the fen management strategy.

- Vegetation resource
- Mammals
- Birds
- Invertebrates

Summary of special features for each valley: This section mainly identifies the botanical features within each valley. The distribution of birds, mammals and invertebrates is either variable or unknown, and so has been covered only in a general sense in the section on species requirements. However, where there is obvious bird interest concentrated within particular valleys, this has been identified. The botanical section provides a summary analysis of the fen vegetation resource survey and considers the relative importance of fen vegetation in a local and national context. A summary of the chemical variables of the soils for each valley has also been included.

- Ant valley
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Management methods - These have been outlined to present the value of each of the available methods historically and in the present context concerning the future management of the fens. Within the appendix are tables which identify the advantages and disadvantages of each method in more detail.

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Mowing
Burning
Scrub clearance
Water level control
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APPENDICES

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- 2 Analysis of fen vegetation resource survey and suggested management
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Purpose and Use of the Fen Management Strategy

The fen management strategy has been produced as a working document for fen habitat within the Broads. It follows on from the UK Biodiversity Action Plan which sets out national objectives and targets for habitats and species, and the Broads Natural Area Profile, which provides a long term view for the region as a whole.

Whilst accepting the various designations which apply to the fens, the main aim of the strategy has been to consider the fens in totality and to restore them to a favourable nature conservation state. The ideas developed within the fen management strategy and the outcome of discussions with landowners will provide the basis for site management statements currently being produced by English Nature.

The strategy is a ten year document, with a suggested five year review. A costed five year management plan is to follow this document by the end of the current financial year (1996/7), and it is envisaged that most of the strategy will be implemented within the next five years. This timescale is also in line with the next review of the Broads ESA Scheme which is of particular importance pending the imminent introduction of a new fen tier into the existing scheme.

FEN MANAGEMENT STRATEGY

Summary

The Broadland fens have developed through centuries of being harvested for a variety of useful products and they are of recognised international importance for nature conservation. However, over the past half-century their nature conservation value has been declining as a result of neglect. In spite of considerable efforts in recent years by conservation organisations to reverse this trend, they are continuing to deteriorate.

Large scale sustainable solutions to restore and maintain the fens to a favourable conservation state are needed urgently, along with a co-ordinated approach amongst the numerous owners and land managers in order to optimise the use of resources. The Fen Management Strategy provides a mechanism to trigger this change of approach.

Introduction

During Roman Britain, a large part of the Broads was an estuary with widespread saltmarsh vegetation and brackish reedbeds. Fen vegetation was probably limited to the margins of the upper valleys. A change to more freshwater conditions occurred as tidal penetration up the valleys progressively decreased between the 4th and 10th centuries. At this time, the estuary reduced in size and additional layers of deep peat were formed in the waterlogged conditions along the length of the valleys. Large quantities of peat were extracted for fuel between the

eleventh and thirteenth centuries, and during this period most of the present day Broads were created.

Although river embankment probably occurred between 1400 and 1600, most of the fens may have been too wet to exploit and so remained as reedswamp until the 18th century (Wells, 1988). However, from the mid 1800's until the First World War the fens were maintained through large scale exploitation for products such as peat turves, reed, sedge, marsh hay and litter for bedding. After the war, due to changing social and economic circumstances, the majority of rural industries based around fen harvest had declined or ceased.

Currently there are 5000 hectares of semi-natural wetland habitat remaining in the Broads although a recent vegetation survey established that less than 2000 hectares remains as open fen. Fens are minerotrophic peatlands, which means that they are irrigated both by precipitation and groundwater. (Wheeler & Shaw, 1995). Two types of fen can broadly be distinguished: rich fen, which is fed by mineral-enriched calcareous waters (pH of 5 or more), and poor fen, irrigated by acid water is derived from base-poor rock (pH of 5 or less). Land which is hydrologically isolated from riverine influences, for instance by embankment and artificial drainage, may be turned into grazing marsh or arable land. Drained areas may have peat or alluvial clay soils.

Considerable areas of former fen habitat have been lost to grazing marsh or arable since the mid 1800s following improvements in drainage, although several large blocks of fen, which were only partially drained earlier this century have been allowed to revert to fen in recent decades. Examples include the Barton Fens and Reedham Marshes in the Ant valley, Hoveton Marshes in the Bure, and Strumpshaw Fen in the Yare valley. Most of these areas now support internationally important fen habitat. Other areas of peat which do not currently support fen vegetation retain the potential for restoration under appropriate hydrological and management conditions.

At present the primary reason for managing fens is nature conservation. Since the 1980's, in recognition of its importance, considerable resources have been committed by conservation organisations to preventing the loss of fen to woodland. Apart from approximately 300 hectares which are still managed commercially for reed and sedge or by grazing, 50 hectares of fen vegetation are mown non-commercially on a regular basis. These areas have been targeted as priorities for conservation. Technical difficulties, lack of sufficient resources and the absence of economic incentives have limited the scale of works undertaken elsewhere. Despite this, conservation organisations have maintained the majority of the remaining fen in an open condition by cyclical removal of trees and scrub as necessary. These areas are urgently awaiting follow-up management.

(see maps 1-6 showing current management).

(see map 7 showing scrub and woodland development in the Ant valley).

When woodland develops, many fen plants may persist in low numbers, although specialised plant, bird, mammal and invertebrate species dependent upon open fen habitat, are likely to become regionally extinct. Nationally recognised plant communities would disappear, as they are an artefact of traditional fen management practices.

A notable indicator of this trend is the bittern (*Botaurus stellaris*). With peak breeding figures this century at around 60 booming males in 1954, the bittern is now reduced to two breeding pairs in the Broads. Reasons may include a lack of management of reedbed and fen habitat, resulting in scrub encroachment and drying out, and a decline in water quality, particularly affecting prey. Conversely, populations of some invertebrates and some small mammals dependent on deep litter layers of unmanaged vegetation are thought to have increased.

Under the Ramsar Convention (1971) the majority (4646 hectares) of wetland habitat in the Broads has been recognised as being of global importance and also as a Special Protection Area (SPA) for its Internationally important bird populations. More recently, the fens have been put forward as priority sites for designation as Special Areas for Conservation (4624 hectares) for the internationally important flora and fauna (excluding birds). The UK Government has made a commitment in Europe to support positive management which achieves nature conservation objectives for these sites.

The UK Biodiversity Action Plan sets out how the government will meet its obligations following our signature of the Biodiversity Convention at Rio in Brazil. Biodiversity conservation requires a commitment to protect the whole range of variation in living organisms, and to maintain the delicate balance of species and habitats. Key species have been identified as requiring conservation measures to secure their populations into the future.

The Fen Management Strategy has resulted from a commitment by partner organisations to define and work towards a favourable nature conservation state for both habitats and species within the Broads fens. Favourable nature conservation state is a concept of ideal management, where a holistic approach is adopted to consider all the natural interests of fens and which supports biodiversity at a local, national and European level. The aim of the strategy has been to identify and describe long-term goals which work towards ideal management. This is essential in the development of suitable resources and techniques to manage the whole area in an environmentally sustainable way.

Approach to producing a Strategy

Our first step in approaching the Strategy was to provide an evaluation of the natural resource, including information on habitats, birds, invertebrates and mammals.

A botanical resource survey was carried out over a four year period as the first stage (Parmenter, 1991-1995). Vegetation communities and rare plant information were mapped, and wherever possible historical information relating to species and management was compiled. This information was analysed and a summary of the interest within each valley was produced (appendix 2). A number of chemical variables were also measured during the fen resource survey to assess their possible relationship to the vegetation types. These variables were subsequently mapped to show distribution patterns.

The fen management strategy mainly considers those areas which were included in the fen resource survey. However, the resource survey refers to some areas of grazing marsh and ronds which are outside of the scope of the strategy, and although some fen meadows have been included, there is an urgent need to survey and incorporate those that were not. (For further information on ronds see Harris, 1992).

Existing information on the status and habitat requirements of birds, mammals and invertebrates were collated and summarised in the form of a series of mini reports (Parmenter, 1995) and the Broads Natural Area Profile (Holve, 1996) provided a useful overview of the importance of Broadland fen habitats, including a summary of current issues and threats.

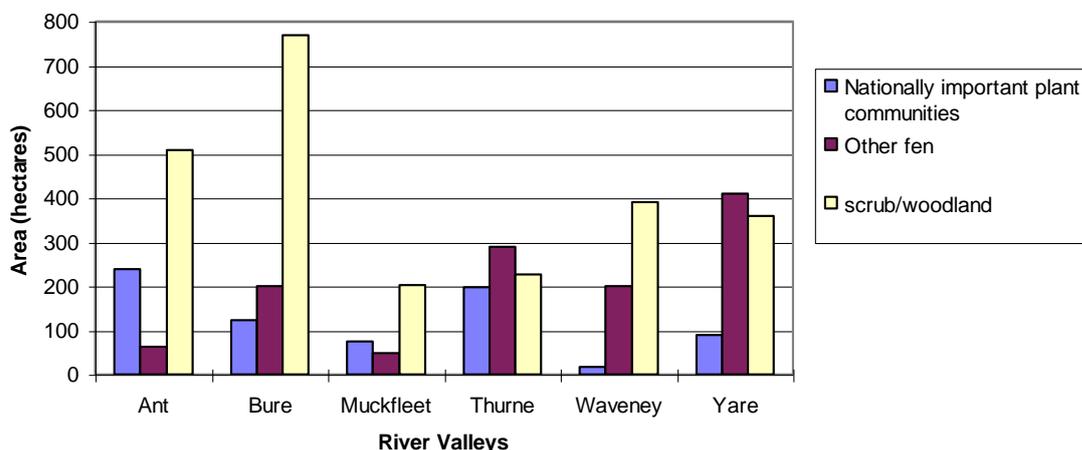
Consultation was a large part of the process, beginning with a two-day workshop attended by representatives from a wide range of organisations who have an involvement or interest in fen management (see appendix 7). The advantages and disadvantages of management techniques and the requirements of birds, mammals, invertebrates and plants were considered during the workshop. The conclusions reached within the workshop formed the foundation of the final strategy.

A variety of water management issues affecting fens were discussed by a specialised group both within the original workshop and on a separate occasion during the process of producing the strategy (appendix 3). The aim was to ascertain the level of understanding of the hydrological processes in the fens and to draw together some guidelines for management and proposals for research and monitoring.

The Importance of Broadland Fens

Vegetation resource - The herbaceous vegetation of Broadland forms the largest expanse of species rich fen in lowland Britain; it is diverse in both plant communities and species. Over one-third of the open fen area supports nationally important plant communities together with a number of nationally rare plant species.

Proportions of habitat within Broadland Valleys



Some of the plant communities are widespread in the Broads but are rare elsewhere within the UK and in the rest of Europe. Of particular note is the reed-milk parsley community (S24 *Phragmites australis-Peucedanum palustre*) which in Britain is almost entirely confined to the Broads. With all the transitions and mosaics, this community accounts for just over 20% of the open fen area.

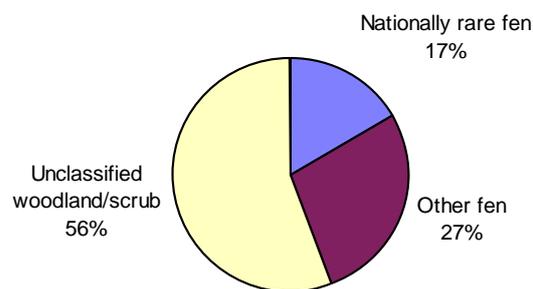
In addition to the national importance of a number of communities, eight fen and mire communities are internationally recognised in the European Habitat Directive 1994.

NVC COMMUNITIES RECOGNISED UNDER THE 1994 HABITATS DIRECTIVE	COMMUNITY DESCRIPTION	AREA WITHIN THE BROADS (hectares)
S24	Reed-milk parsley <i>Phragmites australis-Peucedanum palustre</i> community and sub-communities	550

S25*	Reed-hemp agrimony <i>Phragmites australis</i> - <i>Eupatorium cannabinum</i> community	65
S2	Saw sedge <i>Cladium mariscus</i> community and sub-community	38
S27	Bottle sedge-marsh cinquefoil <i>Carex rostrata</i> - <i>Potentilla palustris</i> community	6
M5	Bottle sedge-sphagnum moss <i>Carex rostrata</i> - <i>Sphagnum squarrosum</i> community	0.7
M13	Black bog-rush-blunt flowered rush <i>Schoenus nigricans</i> - <i>Juncus subnodulosus</i> communities	1.4
M22*	Blunt-flowered rush-marsh thistle <i>Juncus subnodulosus</i> - <i>Cirsium palustre</i> community	110
M24*	Purple moor grass-meadow thistle <i>Molinia caerulea</i> - <i>Cirsium dissectum</i> community	34
W5	Alder-greater tussock sedge <i>Alnus glutinosa</i> - <i>Carex paniculata</i> woodland	unknown
W6	Alder-nettle <i>Alnus glutinosa</i> - <i>Urtica dioica</i> woodland	unknown
W7	Alder-ash-yellow pimpernel <i>Alnus glutinosus</i> - <i>Fraxinus excelsior</i> - <i>Lysimachia nemorum</i> woodland	unknown

* Under European legislation these vegetation types qualify as internationally important, although only certain subcommunities are nationally important. See 'Criteria for the recommendation of the Broads as a possible Special Area of Conservation' in appendix 9.

Proportions of fen & woodland habitat within Broadland



Plants: The fens support two nationally rare and thirteen nationally scarce plant species. In addition, several rare and scarce species are associated with open water, such as dykes and turf ponds. Historical records show that a number of plant species have become extinct from

fens since the turn of the century and many are more restricted in their distribution than formerly.

NATIONALLY RARE (in bold) AND SCARCE FEN PLANTS	HABITAT REQUIREMENTS and DISTRIBUTION	MANAGEMENT PRESCRIPTIONS
Fen orchid <i>Liparis loeselii</i>	Stronghold within the Ant valley, where found at two sites. Also at one site in the Bure. Populations small and thought to be stable in the long term; variable in the short term.	See species action plan. Maintain appropriate summer mowing regime.
Crested buckler-fern <i>Dryopteris cristata</i>	Stable small scattered populations within birch copses throughout the broads fens. Declining nationally.	Maintain areas by appropriate mowing regime.
Marsh-mallow <i>Althea officinalis</i>	Generally grows in brackish conditions along banks of the ditches. Intolerant of grazing or cutting. Declining nationally. Stronghold in the Thurne valley.	Maintain some areas of banks free from management, or on a long rotation.
Fibrous tussock-sedge <i>Carex appropinquata</i>	Found in open fens in wet conditions. Also in fen carr, probably as a relic of more open times. Very vulnerable outside of the Broads, although it has become more vulnerable in recent years as a consequence of drought and scrub invasion. Distributed throughout the Broads, but stronghold in the Ant and Bure valleys.	Maintain areas supporting concentrations of fibrous tussock-sedge free from scrub or leave as carr. Develop mowing regimes which allow development of the tussocks; a 3/4 year rotation appears most suitable.
Cowbane <i>Cicuta virosa</i>	An aquatic species of broad and turf pond margins, mires and ditches. Also occurs in carr woodland. Its rarity may be partly due to selective elimination from some areas by man as it contains a chemical which is poisonous and often fatal to livestock. Land drainage could also be responsible. It was also selectively eaten by coypu and since their elimination may be making a comeback. Occurs in all valleys, but with its stronghold in the Ant valley.	Where concentrated populations occur, manage by mowing or very extensive grazing. Maintain shallow open water margins and swamp. Retain carr swamp which supports populations of this species.
Narrow-leaved marsh orchid <i>Dactylorhiza traunsteineri</i>	Confined to wet, base-rich habitats. Very local, but is sometimes present in large numbers. UK population presently stable in numbers but very susceptible to lowering of the water table.	Maintain good water levels. Maintain areas free from scrub invasion. Mow on an annual or biannual mowing regime.

	Frequent within the Ant valley, also at several fen meadow sites within the Yare and at two sites in the Bure and Thurne valleys.	Re-excavate turf ponds.
The moss <i>Cinclidium stygium</i>	Nationally scarce. Found only in the Ant valley, mainly at two sites.	Annually mown vegetation.
The moss <i>Campylium elodes</i>	Nationally scarce. Limited distribution - found only in the Ant and Bure valleys.	Annually mown fen.
The moss <i>Drepanocladus vernicosus</i>	Nationally scarce. Found only at two fen sites within the Ant valley. Internationally rare.	Mow annually; maintain high water levels.
Marsh pea <i>Lathyrus palustris</i>	A very wide world distribution. Declining in eastern Britain, including the fens due to pasture improvements. Very sensitive to prolonged waterlogging. Prefers base-rich habitat, with tall grass, reed or scrub cover. Also found in grazing marsh at one site in the Waveney valley.	Manage by extensive grazing or on a 3/4 year mowing regime.
Milk-parsley <i>Peucedanum palustre</i>	Found most often growing on peat within tall herb fen vegetation. Declining throughout England, although frequently occurring within the Broads.	Manage using very extensive grazing regimes or on a longer mowing rotation of 4 years or more.
Round-leaved wintergreen <i>Pyrola rotundifolia</i>	Occupies diverse habitats - usually calcareous and damp. In the Broads, tends to occur on scrubby fens within former turf ponds, although it probably does not require scrub. Usually under willow, with which it may share a mycorrhizal partner. The Ant valley forms the main location for this species, which is thought to be close to extinction within the Broads, although it occurs in abundance at one site in the Bure valley. Decline may be due to less harvesting of reed and sedge and as a result of cessation of turf cutting.	Create a series of shallow turf ponds amongst young willow scrub. Maintain some areas of willow scrub in proximity to turf ponds. Encourage regular harvesting of fen vegetation on an appropriate regime.
Greater water-parsnip <i>Sium latifolium</i>	Prefers very wet, species-rich tall herb fen, often along the margins of Broads and rivers, and within old peat cuttings. Intolerant of grazing and frequent cutting. Dramatic decline over past 200 years, probably as a result of fen drainage and straightening of watercourses. Decline continuing.	Maintain areas of shallow open water. Manage by harvesting of fen vegetation on a long rotation, particularly adjacent to open water habitat. Maintain undisturbed areas where mechanical dredging

	Stronghold in the Ant valley, but found in all valleys, except the Waveney.	takes place.
Marsh sow-thistle <i>Sonchus palustris</i>	Occurs within tall herb fen, most frequently adjacent to major rivers. May be favoured by infrequent winter cutting. Does not persist in carr or scrub. Stronghold within the Thurne; found in all river valleys except the Muckfleet. Appears to be increasing generally within Broadland, mostly occurring on river dredgings.	Ensure some areas remain uncut when river banks are mown. Harvest rond vegetation on a long rotation. Maintain areas free from scrub, where there is a large population of this plant.
Marsh fern <i>Thelypteris thelypteroides</i>	Occurs within mesotrophic mires, occasionally as a dominant plant. Also colonises new peat cuttings where there is a high winter water table in neutral or slightly alkaline water conditions. Persists under shady conditions created by fen carr. Broadland population stable and quite widespread throughout all the valleys. Nationally has been in decline - mainly due to drainage of mires.	Maintain areas of shallow open water within fen system. Create a series of shallow turf ponds in waterlogged conditions.

Note: Although the botanical fen resource survey considered 4400 hectares of the total resource, some 600 hectares of additional woodland and scrub were omitted, as well as extra areas of marshland and meadow which may provide potential options for fen restoration. Some of these areas are not shown on the geographical information system.

Mammals - The fens support 8 mammal species listed under Annex IV of the European Habitats Directive; including 7 species of bat (out of a total of 12 species found in Britain) and the otter *Lutra lutra*. The otter is also listed under Annex II of the European Habitats Directive and Appendix I of CITES, making it a priority species. It is rare within the Broads, but its numbers are being boosted through a reintroduction programme.

STATUS	SPECIES COMMON NAME	HABITAT REQUIREMENTS	RECOMMENDATIONS WITHIN THE FEN MANAGEMENT STRATEGY
<i>Annex IV of the EC Habitats Directive (a = also Annex II)</i> <i>and the UK Biodiversity Action Plan (* = priority species)</i>	- Whiskered bat <i>Myotis mystacinus</i> - Natterer's bat <i>Myotis nattereri</i> -Daubenton's bat <i>Myotis daubentonii</i> -Noctule bat <i>Nyctalus noctula</i> - Pipistrelle bat <i>Pipistrellus pipistrellus*</i> - Barbastelle bat	In general, bats feed over open water and fen, and roost in woodland. The brown long-eared bat requires open mature woodland for feeding as well as roosting.	Increase open water habitat by creating shallow turf ponds and dykes. Allow some areas of mature scrub and woodland develop. Manage some woodlands by selective thinning or grazing to ensure an open structure is retained.

	<i>Barbastella barbastellus</i> (a) -Brown long-eared bat <i>Plecotus auritus</i>		
<i>Annex II and Annex IV of the EC Habitats Directive and Appendix I of CITES</i> <i>and the UK Biodiversity Action Plan (* priority species)</i>	Otter <i>Lutra lutra</i> *	Requires areas of undisturbed fen and woodland, with good water quality to support adequate invertebrate, fish and eel populations. The otter is now almost entirely absent from lowland England and Wales, having declined historically from the effects of organochlorine pollutants, persecution and disturbance.	Long rotational harvesting and extensive grazing of large areas of fen to ensure sufficient undisturbed habitat available. Retain areas of mature scrub and woodland. Maintain open water areas which are free from boat traffic. Develop dyke network system, particularly where water quality is good. Retain bankside cover, including trees and scrub.
<i>Other species listed within the UK Biodiversity Action Plan</i> <i>*priority species</i>	*Water vole <i>Arvicola terrestris</i>	In very wet conditions, water voles may nest in tussocks of vegetation. They are a vegetarian species, taking green shoots of reeds, rushes and reedmace in preference to seeds, fruits and roots.	Ensure that management is sensitive to tussock structure and that if mown or grazed, some areas are left undisturbed.
	Water shrew <i>Neomys fodiens</i>	Associated with clean water courses, ponds and ditches. Favoured habitat is water-cress beds. Invertebrates form main food source (both aquatic and terrestrial), with occasional fish and amphibians. The broadland fens support the highest recorded density.	Excavate turf ponds and clean ditches on a rotation, ensuring some areas of aquatic vegetation remain intact and undisturbed. Improve water quality wherever possible.
<i>Of local importance:</i>	Harvest mouse <i>Micromys minutus</i>	Prefer dense reed-dominated fen, with some undisturbed areas. The Broads may be a national stronghold for the harvest mouse	Favour a double wale and longer rotations for reedcutting. Leave small pockets of reed unmanaged, where they are not in commercial regimes.

Summary - Most mammals, particularly the rarer species indicated above are favoured by maintaining substantial blocks of open fen, with a variety of structure and mosaics of associated habitat types, including open water, scrub and woodland.

Birds - Wetland habitats with the Broads support a diverse assemblage of breeding and wintering populations, including a number of nationally and internationally important species. Decisions affecting the proportions of fen, woodland, scrub, open water and grazing marsh affect the entire range of associated species. Provision of additional fen habitat to benefit one species for instance the bittern, may involve compromises for others. Over 50 species of birds listed on the UK Biodiversity Action Plan occur within the Broads.

Breeding: Fen provides an essential habitat for nesting and foraging by three birds listed under Annex 1 of the European Birds Directive, the marsh harrier, bittern and crane.

ANNEX 1 SPECIES	Number of breeding pairs	UK Population	Habitat Preferences
Marsh Harrier <i>Circus aeruginosus</i>	20	15%	Nests within extensive reedbeds, <i>Cladium</i> and tall herb fen, although some nest in small patches and reed ronds. Hunts over large areas of adjacent managed fen habitat, arable land and grazed marshland.
Bittern <i>Botaurus stellaris</i>	2	10%	Extensive wet reedbed and fen. Long length of open water to reedswamp margin. Ref. - Bittern Action Plan
Crane <i>Grus grus</i>	?	100%	Large area of reedbed, fen and grazing marsh, with minimal disturbance Ref. - Crane action plan

The fens also support successful breeding by nationally important populations of pochard, shoveler, Cetti's warbler, Savi's warbler, bearded reedling, garganey and gadwall.

NATIONALLY IMPORTANT BIRDS	UK BREEDING POPULATION	HABITAT PREFERENCE & MANAGEMENT PRESCRIPTIONS
Pochard <i>Aythya ferina</i>	10%	Breed in fen vegetation close to large pools, lakes or slow flowing rivers.
Shoveler <i>Anas clyptea</i>	4.5%	Breed in marshland adjacent to shallow open water.
Cetti's Warbler <i>Cettia cettia</i>	10%	Favours sallow scrub adjacent to open water as a nesting habitat.
Savi's Warbler <i>Locustella luscinioides</i>	35%	Breeds in large wet reedbeds, favouring reeds with a thick groundlayer of sedges, rushes and with scattered bushes.
Bearded Reedling <i>Panurus biarmicus</i>	18%	Feeds/breeds in fen vegetation and ronds.
Gadwall <i>Anas strepera</i>	5%	Breeds in marginal reedy vegetation close to lakes and slow flowing rivers.

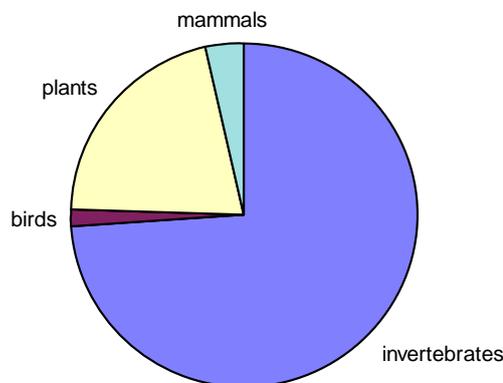
In addition, regionally important numbers of water rail *Rallus aquaticus*, grasshopper warbler *Locustella naevia* and reed warbler *Acrocephalus scirpaceus* breed in the fens.

Wintering: The Broads wetland supports a notable assemblage of wintering wetland birds. The table below indicates three species that occur at nationally or internationally important numbers and are closely associated with fens. Fen habitat is most important during the winter as a roosting and feeding ground for hen harrier, bittern, and Britain's only population of cranes.

WINTERING BIRDS	BRITISH POPULATION	NW EUROPEAN POPULATION	HABITAT PREFERENCES within Broadland
Gadwall <i>Anas strepera</i>	9.7%	4.0%	Marshes and fen close to water.
Teal <i>Anas crecca</i>	1.8%		Shallow water, marshes, dykes. Feeds in cut fen vegetation.
Hen harrier <i>Circus cyaneus</i>	3%		Communal roosts in reedbeds and on marshes.
Bittern <i>Botaurus stellaris</i>			A great range of mixed fen, reed and sedge beds.
Crane <i>Grus grus</i>	100%		Undisturbed areas of fen and grazing marsh.

Invertebrates - The Broads are no exception to the universal balance of species, in that the number of invertebrate species greatly out-number the combined totals for plants and vertebrates.

Nationally Rare or Scarce Species in the Broads

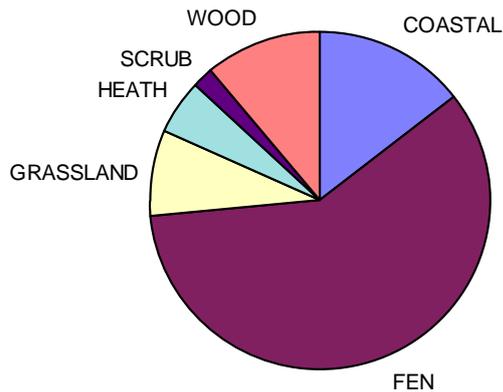


In spite of this, invertebrates are often overlooked in management, in part because of the difficulties of identification and also the uncertainty as to what their requirements are. Many

invertebrates are highly specialised, with complex life cycles and very specific habitat requirements.

The rich invertebrate fauna of the Broads includes 190 nationally rare, 368 nationally scarce and many hundreds of other species, reflecting the quality and diversity of wetland habitats present. Although these figures include all of the Broads wetland, a comparison of numbers for all habitats indicates that fen supports the greatest proportion of invertebrate species. (Natural Area Profile, 1996).

Distribution of invertebrate species within different habitats



The historical evidence available suggests that a serious decline has taken place since the 1950's within well recorded invertebrate groups in the Broads. The species that have been lost over the past decades highlight the environmental changes that have occurred during this period. Changes in water quality, such as increasing pollution and tidal influences are considered responsible for the demise of many species. Other factors may include neglect, changes in land use and over-zealous management.

The following general requirements of invertebrates (Kirby, 1992) have been considered in developing the Fen Management Strategy:

- Many invertebrates have precise habitat requirements, such as the need to feed/breed in association with a single species of plant; this is particularly the case with rarer species. e.g. swallowtail butterfly *Papilio machaon* and the Norfolk hawker dragonfly *Aeshna isosceles*
- Most invertebrates have annual life cycles and so need suitable breeding conditions every year, unlike many plants which have long vegetative states enabling them to survive adverse conditions
- Many invertebrates are very small, with limited mobility and powers of dispersal. They may live within a microhabitat which may seem a very trivial feature of the site, such as a tussock of grass. A change in management which retained the grass species but prevented it forming tussocks, could have a profound effect on the fauna.
- Invertebrates are cold blooded. Some need cool shaded environments; others require warm and sunny conditions.
- An invertebrate species may become extinct at a site if its population becomes very small, as it may become difficult to find mates and breed. Small populations are vulnerable to loss from a site through adverse weather or predation.
- A gradual transition between two habitats is better than a sudden change as this provides a greater number of niches, although there may not be any benefits to the vegetation to have this transition area. e.g. there are benefits to invertebrates in providing a scrub margin between woodland and open fen.
- Juxtaposition of habitats (e.g. open water and fen) may be important if an invertebrate requires more than one habitat type to complete different stages of its life cycle;
- Mosaics of habitat are of great value to invertebrates as there will be numerous transitions and hence numerous niches available

The UK Biodiversity Action Plan report has identified a number of invertebrates which are tabulated below, along with habitat requirements where they are known:

INVERTEBRATE SPECIES OF PRIORITY FOR CONSERVATION IN BROADS FENS	SPECIFIC REQUIREMENTS and DISTRIBUTION	HABITAT PRESCRIPTIONS
Large brown hawker dragonfly <i>Aeshna isosceles</i>	Adults stay near water. Larvae found in well vegetated ditches in grazing marshes (and possibly fens). Restricted to Norfolk Broadlands.	Maintain mosaic of fen vegetation and open water (turf ponds). Extensive grazing may be beneficial fen management for this dragonfly.
Water beetle <i>Agabus striolatus</i>	Adults found in spring and autumn in relict fen carr and wet woodland that dries out in summer. Recorded only from Norfolk Broadland.	Retain carr and wet woodland in a mosaic with fen areas.
A snail <i>Anisus vorticulus</i>	Occurs in unpolluted, calcareous waters in well-vegetated marsh drains. Is usually found with a number of other molluscs which are rare and vulnerable, including <i>Segmentina nitida</i> .	Clean ditches carefully, on long rotations, and ensure some well-vegetated areas are left within cleaned sections. Maintain high water table and avoid changes in drainage which could lead to nutrient enrichment.
Rush wainscot <i>Arachnara algae</i>	Inhabits Broadland, freshwater ponds and old water-filled gravel workings.	Encourage development and appropriate management of marginal

	Larva in the stems of <i>Scirpus lacustris</i> , <i>Typha latifolia</i> and <i>Iris pseudacorus</i> . Occurs locally in the Norfolk Broads and a few ponds in Southern England.	swamp communities surrounding broads. Create opportunities for vegetational succession to occur e.g. turf excavations.
A small money spider <i>Baryphyma gowerense</i>	Recorded from fens in Wales and Norfolk, and from saltmarsh in Gower. Ecological requirements not understood. Distribution uncertain.	
A bug <i>Hydrometra gracilentia</i>	Recorded only from Norfolk Broads and New Forest. Found amongst dense emergent vegetation at the margins of standing or gently flowing water.	Ensure semi-redundant ditches are cleaned out carefully and from one side only, leaving dense areas of emergent vegetation.
Large darter dragonfly <i>Libellula fulva</i>	Occurs adjacent to ponds and lakes with abundant marginal vegetation. Females hunt amongst tall grasses and emergent vegetation	Ensure a mosaic of open water with fen and fen meadow vegetation, with various stages of succession along the margins of open water.
The large copper butterfly <i>Lycaena dispar</i> (also under Annex IV of the Habitats Directive)	Breeds in open fenland habitat. Larvae feed exclusively on <i>Rumex hydrolapathum</i> and overwinter on the dead leaves at the base of the plant. <i>Rumex hydrolapathum</i> is mainly a dyke edge plant. Adults are on the wing by the following July/August after being laid as eggs the previous July/August.	Maintain open fen to encourage food plants in open sunny positions; use extensive grazing or biannual mowing. Maintain open dykes to provide suitable habitat for the food plant. Ensure a network or mosaic of suitable sites is managed to allow for dispersion
A snail <i>Oxyloma sarsi</i>	A semi-aquatic snail on semi-emergent vegetation such as <i>Glyceria</i> in fens, marshes and drainage ditches. Almost impossible to tell from a common relative <i>Oxyloma pfeifferi</i> without dissecting.	Develop a ditch management cycle that allows the recolonisation of cleaned stretches from adjacent sections. Maintain high water table and avoid changes in drainage which could lead to nutrient enrichment
Swallowtail butterfly <i>Papilio machaon britannicus</i>	Larvae feed on <i>Peucedanum palustre</i> , which must be visible for the adult butterfly to lay eggs upon. Widespread in Norfolk Broads	Manage areas on a 3-5 year rotation to ensure plants have the opportunity to flower, without becoming dominated by more vigorous tall fen species
The dotted fan-foot <i>Pelosia muscerda</i>	Encourage development and appropriate management of marginal swamp communities surrounding broads; Create opportunities for vegetational succession to occur e.g. turf excavations	Encourage development and appropriate management of marginal swamp communities surrounding broads; Create opportunities for vegetational succession to occur e.g. turf excavations
Fenn's wainscot <i>Photedes brevilinea</i>	Inhabits fenland and reedy ditches. Larva lives in the stems of	Allow some ditches to gradually colonise with <i>Phragmites</i> and clean

	<i>Phragmites australis</i> . Adults fly from mid-July to mid-August. A very local and rare species confined to Norfolk and Suffolk; also rare on the continent.	out ditches on a long rotation, or from one side of the ditch only; Manage fen on rotation; late summer cutting preferred to enable larvae to complete life cycle
Reed leopard moth <i>Phragmataecia castaneae</i>	Larvae feed in the stems of <i>Phragmites australis</i> . Very local Cambs., Norfolk and single locality in Dorset.	Ensure rotational management of reed-dominated vegetation leaves a mosaic of undisturbed vegetation for the larvae to complete life cycle.
Shining ram's-horn snail <i>Segmentina nitida</i>	Lives in unpolluted, usually calcareous water in ponds and drains of grazing marshes (and possibly fens). It is often associated with a rich variety of freshwater molluscs, including other rare species.	Develop a ditch management cycle that allows the recolonisation of cleaned stretches from adjacent sections. Maintain high water table and avoid changes in drainage which could lead to nutrient enrichment.
A freshwater snail <i>Valvata macrostoma</i>	Aquatic snail in well oxygenated and richly vegetated marsh and fen drains. Very vulnerable to agricultural change.	Develop a ditch management cycle that allows the recolonisation of cleaned stretches from adjacent sections. Maintain high water table and avoid changes in drainage which could lead to nutrient enrichment.
A snail <i>Vertigo moulinsiana</i> (also Annex II of the Habitats Directive)	A small snail occurring in calcareous fens and marshes, often on <i>Phragmites</i> . Confined to southern England and East Anglia. Once much more widespread.	Change management on calcareous fens and marshes gradually; particularly when this involves water management.

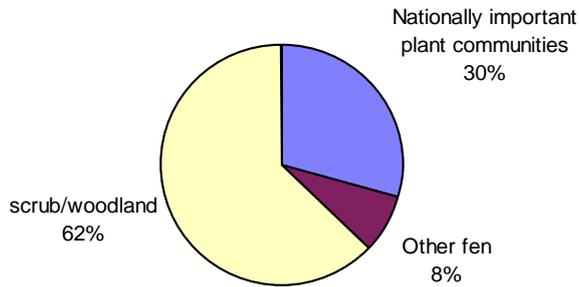
Summary of special features for each valley

Ant Valley

Birds - The Ant valley, along with the Thurne and Yare, forms one of the most important areas in the Broads for breeding marsh harriers. The large expanses of undisturbed reedbed provide nesting sites and the mosaics of fen habitat offer extensive hunting grounds. Breeding and wintering populations of pochard also occur in significant numbers in the Ant valley.

Vegetation resource - Within the Ant valley, the fen resource survey considered a total area of 809 hectares, 62% was classified as being woodland or scrub of unknown status. The Ant fens are some of the most diverse and botanically important in the Broads and nationally rare vegetation communities comprise some 79% of the 302 hectares of open fen.

Ant Valley



Most notable are the extensive areas of species rich fen, co-dominated by *Cladium mariscus* and *Phragmites australis*. Some of the best examples are no longer managed and are deteriorating in their interest. The Ant valley is also important for supporting acid heath, mire and transitional fen meadow communities which are otherwise rare in the Broads. Notable in this valley is the significant losses of rare mosses, and their replacement with more common and less specific species.

Historically, parts of the Ant valley were cut for peat, these were colonised by fen vegetation and then harvested for a range of products. Many of the fens also appear to have been pump-drained and grazed, and since this has ceased they have redeveloped fen vegetation. These areas generally support the 'rare in Broadland' communities mentioned above. Some areas which were formerly grazed now support extensive *Phragmites australis* dominated fen, although these areas may not have been so wet in the past.

Evidence from the aerial photographs indicates that although only one-third of the Ant valley is currently open, most of the scrub and woodland appears to have developed relatively recently (in the past 50 years), and so there is great potential for fen restoration. These young woodlands are unlikely to be of great conservation importance.

Of the 15 nationally rare and scarce plant species, 10 have their stronghold within the Ant Valley, including the fen orchid *Liparis loeselii*, and crested buckler fern *Dryopteris cristata*.

Environmental variables - Soil fertility in the Ant Valley is very low throughout, except towards the upland margins of the fens. Soil conductivity is lowest in the upper reaches, but slightly higher over parts of Catfield Fen and further downstream. A range of pH occurs; however most fens have acidic soils towards the upland margins and circumneutral soils over the general fen area.

ANNOTATION FOR CURRENT MANAGEMENT IN THE RIVER VALLEYS: ANT

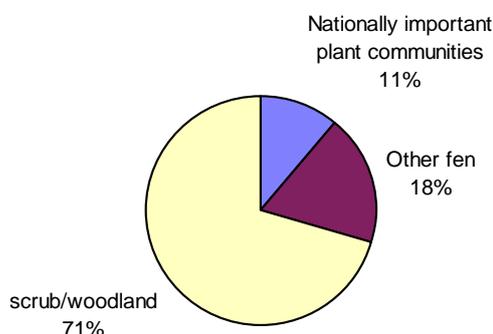
Management in the Ant valley has concentrated on the harvesting of commercially viable reed and sedge. Botanically important areas are also being managed for conservation by non-commercial mowing and considerable areas which were covered by scrub have been cleared to favour open woodland. Grazing occurs only in the upper valley on reclaimed fen.

Bure Valley

Birds - This valley supports the highest number of breeding shoveler (a nationally important breeding population). They are a widespread species favouring marshes adjacent to open shallow broads, but they also breed in drainage dykes. Along with the Ant, the Bure is also one of the most important locations for wintering pochard (a nationally important wintering population).

Vegetation resource - Within the Bure Valley, the fen resource survey considered a total area of 1090 hectares, 71% is classified as woodland or scrub. The status of most of the woodland communities is known following a detailed study by Kennison and Burrows (1994/5), and a significant proportion is of national or international importance. However, of the existing open fen, just over one-third comprises nationally important vegetation communities.

Bure Valley



The most extensive communities in the Bure valley are dominated by *Phragmites australis* with *Peucedanum palustre* as a frequent associate. Approximately 50% of these herbaceous communities have developed over former peat cuttings and significant proportions are harvested commercially. The *Phragmites-Peucedanum* communities also occur over solid peat, where conditions are often drier and grasses become an important constituent of the sward. Depending on the type and frequency of management, these communities may become either a reed monoculture or develop a species-rich sward.

As with the Ant valley, the Bure supports a significant proportion of species rich fen co-dominated by *Cladium mariscus* and *Phragmites australis*. As well as being important for herbaceous plants, these communities are also notable for their diversity of bryophytes (mosses and liverworts), sedges and pteridophyte (fern) species.

The Bure valley supports a number of communities which are otherwise rare in the Broads. These include fen meadow and swamp communities, unlike the wet acid heath and mire communities found in the Ant. However, the Ant and the Bure are both important as the only location for *Sphagnum* spp-*Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub.

Although a significant proportion of the woodland in the Bure valley is of national or international importance, the opportunity for fen restoration is considerable (170 hectares - identified by the woodland survey as having potential for clearance)

The Bure valley provides a stronghold for only one nationally scarce species, marsh pea *Lathyrus palustris*, but also provides the third location for the nationally rare fen orchid, *Liparis*

loeselii. With the exception of one species, all of the other 5 nationally rare/scarce species are represented within this valley.

Environmental variables - Fertility of soils is variable throughout the Bure valley, but generally quite low. Higher fertility occurs on areas either directly adjacent to the River or closest to the upland margins. Soils at Upton Fen are of quite high fertility. pH levels are generally circumneutral, except for one or two slightly acidic areas, which are mainly on the upland margins. Conductivity levels are generally low, although they measured slightly higher adjacent to the river, at Upton Fen and parts of Woodbastwick (at Putticks Green).

ANNOTATIONS FOR CURRENT MANAGEMENT IN THE RIVER VALLEYS: BURE Grazing occurs on fen meadow communities within the upper Bure valley, whilst most management in the middle Bure has focused on commercial reed. Substantial areas of fen are also maintained by non-commercial conservation mowing. At least 200 hectares of the woodland in this valley is of international importance will be retained.

Muckfleet Valley

Birds - A wide range of birds use the Trinity Broads and surrounding fen within the Muckfleet Valley. The Broads are of particular importance for tufted duck, pochard and shoveler, but also regularly support wintering bittern, as well as more unusual passage migrants such as smew and Slavonian grebe.

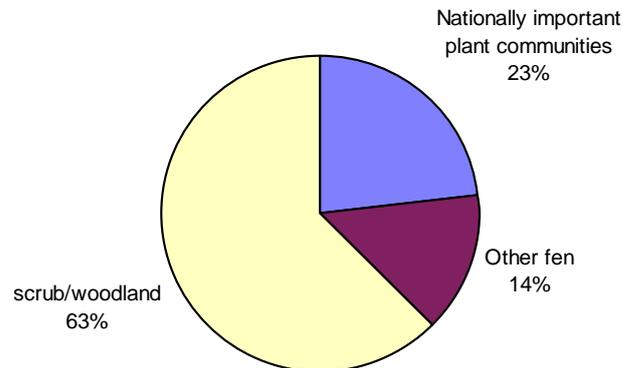
Vegetation resource - Within the Muckfleet valley, the fen resource survey considered a total area of 325 hectares, 62% is classified as woodland or scrub of unknown status. The Muckfleet Fens support a diverse mosaic of species-rich fen meadow and transitional communities. Nationally rare vegetation types account for 61% of the open fen; the valley is also important for supporting a range of communities which are otherwise rare in Broadland.

Currently, most of the open fen interest is confined to Burgh Common, but historical information suggests there is tremendous potential for expansion of acid heath, fen meadow and transitional communities which have become rare and threatened in the Broads. The areas of greatest potential are currently covered by woodland or scrub.

Of considerable importance are the marginal swamp communities which have developed around each of the Trinity Broads in the Muckfleet valley. Marginal vegetation is limited in development elsewhere in Broadland due to boat wash from motorised traffic, combined with water quality problems.

Of the 15 rare or scarce plant species in the Broads, 7 occur scattered throughout the Muckfleet valley.

Muckfleet Valley



Environmental variables - Soil fertility and conductivity levels are low throughout the Muckfleet valley. Soil pH is generally neutral, although some areas of higher acidity were recorded towards the upland margins of Burgh Common.

ANNOTATION FOR CURRENT MANAGEMENT IN THE RIVER VALLEYS: LOWER BURE

Most management within the lower Bure system comprises extensive grazing of fen meadow communities. Some non-commercial mowing of botanically diverse areas also occurs.

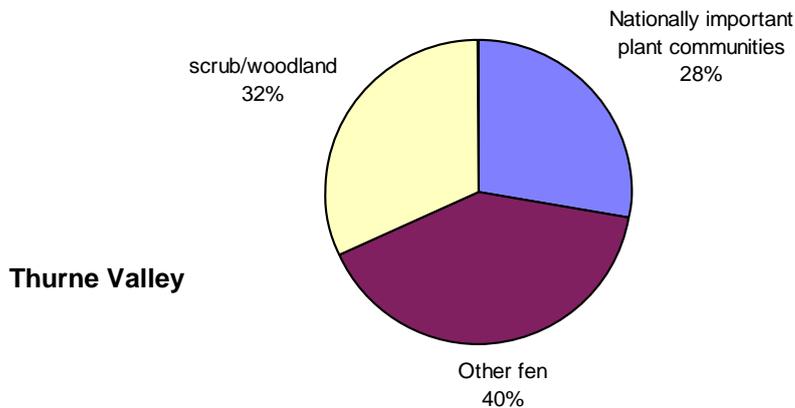
Thurne Valley

Birds - The Thurne valley stands out from the other valleys for its ornithological importance. Within the Broads the bittern, a species of critical UK concern, breeds only at Horsey and Martham with a single booming male at each site, representing more than 10% of the UK population. The Thurne valley has always been the stronghold for bitterns in the Broads with 20 pairs estimated from the Hickling/Horsey area in 1954. The Thurne is also the most important area in the Broads for the bearded reedling, with about 40 pairs (10% of the UK population) in the 1992 national survey.

The Thurne valley, along with the Ant, is also one of the most important areas within the Broads for marsh and hen harriers. The large mosaics of open fen provide a large hunting ground for both species during the winter, and suitable nesting and feeding habitat for the marsh harrier for breeding. Savi's warblers have also been most successful in breeding in the Thurne valley in recent years.

Apart from the fen habitat, Horsey and Hickling Broads support the greatest proportion of teal in the Broadland SPA, and in recent years the grazing marsh at Heigham Holmes has supported the highest numbers of European white-fronted geese. Both are nationally important wintering populations.

Vegetation resource - The fen resource survey considered a total area within the Thurne valley of 713 hectares, only 32% is classified as woodland or scrub. The aerial photographs indicate that with the exception of a few small blocks of mature woodland, most has developed since 1946. Of the existing open fen, 40% supports nationally rare communities.



The Thurne valley is important for a range of features. Around the margins of the Broads, swamp fen dominated by *Phragmites australis* and *Typha angustifolia* have developed, where *Peucedanum palustre* is a constant associate. Further away from the waters edge, extensive areas of fen dominated by *Cladium mariscus* have developed, and towards the upland margins wet acid heath, mire, and fen meadow communities occur.

All features are important: the marginal swamp habitat is a declining feature of the Broads, a result of a variety of causes including river embankment, water pollution and boat wash; extensive *Cladium* beds are an internationally rare feature; and wet acid mire and heath communities are a scarce feature in the Broads.

The Thurne fens are also distinctive from the other valleys in that they are affected by brackish conditions. This is reflected in the presence of halophyte or salt tolerant species which are otherwise unusual in the Broads, but present in many of the Thurne vegetation communities. Saltwater seepage from the North Sea may be responsible, but there is no evidence for this. The brackish conditions are more likely to be the effect of underlying estuarine clays dating back to higher sea levels.

Ten of the fifteen nationally scarce/rare plants occur within the Thurne valley, which is a stronghold for two species. These are marsh-mallow *Althea officinalis* and marsh sow-thistle *Sonchus palustris*, both of which are tolerant of brackish conditions.

Environmental variables - Soil fertility is low throughout the Thurne fens, although it is higher within some of the previously drained and grazed areas, and particularly towards the upland margins. Most of the fens have a pH around neutral. In a similar pattern to fertility levels, more acid conditions occur around the upland margins and on areas which have been previously drained for grazing. Conductivity is high throughout the Upper Thurne fens, except for one or two areas furthest from the river system, where it is slightly lower.

ANNOTATIONS FOR CURRENT MANAGEMENT IN THE RIVER VALLEYS: THURNE

Commercial harvesting of reed and sedge has been the main focus of management in the Thurne valley, which supports relatively small amounts of woodland and scrub. Extensive grazing also occurs on some areas towards the valley margins.

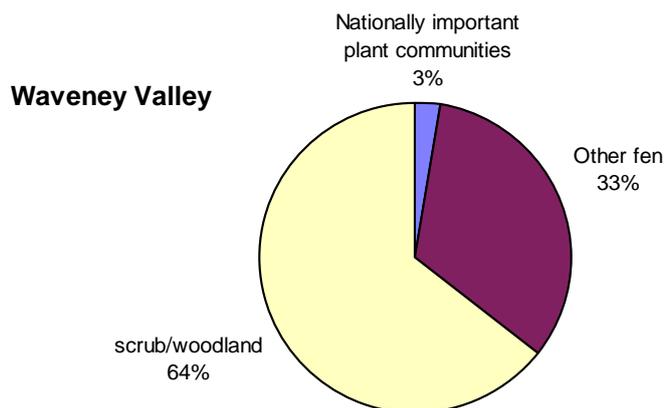
Waveney Valley

Birds - In recent years part of this valley has become a regular breeding site for marsh harriers and an important winter roosting area for hen harriers. Much of the fen vegetation has been lost from this valley.

Vegetation resource - Within the Waveney Valley, the fen resource survey considered a total area of 608 hectares, of which 64% is classified as woodland and scrub of unknown status. The Waveney Valley is the most affected of all the valleys in terms of loss of fen through agricultural activities; the majority of fens are isolated and fragmented, unlike other valleys where the wetlands occur predominantly as large blocks.

The main feature of the Waveney Valley is its range of fen meadows and poor fen communities which are often small in extent. A number of communities of limited distribution throughout Broadland are represented within this valley. Only 3% of the existing fen vegetation resource is nationally rare.

Six nationally scarce species occur within the Waveney valley, but with the exception of *Sonchus palustris*, which is common, all nationally scarce plants within this valley are declining.



Environmental variables - Chemical data gathered for the Waveney Valley was limited in extent. However, soil fertility levels appear variable, ranging from very low around Barnby Broad, to higher a short distance away from the Broad. Conductivity levels are low, except on grazing marshes near the coast. Most areas have a pH just below neutral.

ANNOTATIONS FOR CURRENT MANAGEMENT IN THE RIVER VALLEYS: SOUTH WAVENEY The majority of management in this valley is focused on the fen meadow communities which are summer grazed. Non commercial mowing also occurs to a limited extent on areas of high botanical interest.

Yare Valley

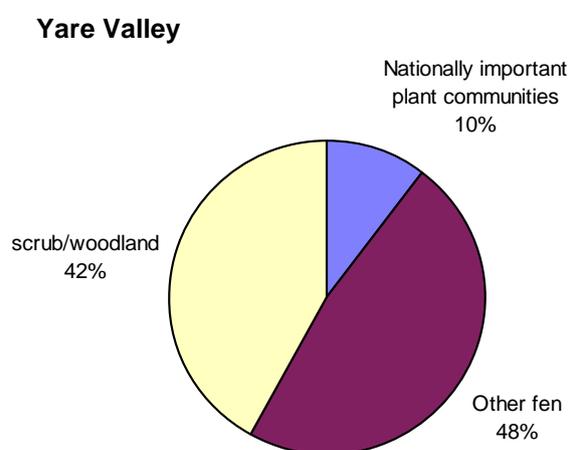
Birds - Along with the Ant and Thurne valleys, the Yare fens provide one of the most important areas in Broadland for breeding marsh harriers. The large undisturbed reedbeds offer ideal nesting sites and together with the adjacent wetland habitats, provide extensive

hunting grounds. The Yare valley is also the Broadland stronghold for the Cetti's warbler, with about 30 pairs (10% of the UK population), and is also important for bearded reedling, with about 18 pairs.

Vegetation resource - The fen resource survey considered a total area of 857 hectares within the Yare Valley, of which 42% is classified as woodland or scrub of unknown status. With the exception of a few blocks of mature woodland, the aerial photographs indicate that the development of fen to scrub has mainly occurred since 1946.

Until recent years, the Yare valley was considered one of the most floriferous areas in Broadland (Ratcliffe, 1976). Now the majority of the Yare fens currently support *Phragmites australis-Urtica dioica-Epilobium hirsutum* tall herb communities, which are relatively degraded.

However, some areas within the Yare Valley possess species rich fen meadow communities which are otherwise rare within the Broads and in a wider context, one-tenth of the Yare fens support nationally rare fen.



Of the 15 nationally scarce plant species, 9 occur within the Yare valley. After the Bure valley, the Yare provides the next most important location for marsh pea, *Lathyrus palustris*. Most other nationally scarce species occur in relatively low and declining numbers.

Environmental variables - Soil fertility levels are low throughout the Yare Valley. Conductivity is generally low and although there were some higher recordings, these did not appear to show any consistent trend or pattern. Throughout the Yare Valley the pH is neutral.

ANNOTATIONS FOR CURRENT MANAGEMENT IN THE RIVER VALLEYS: YARE

The predominant management in the Yare is summer grazing, non-commercial summer harvesting of species-rich fen meadow and winter mowing of reed-dominated fen.

The Fen Resource for the Future

The over-riding aim of the fen management strategy is to restore the fens to a favourable nature conservation state, thereby delivering commitments under European Directives and the Biodiversity Action Plan (see appendix 1).

General aims and objectives

- 1) Expand existing open fen and optimise conservation value of all open fen habitat
- 2) Retain all internationally important woodland
- 3) Develop a mosaic of habitats and vegetation types
- 4) Maintain and increase areas of open water
- 5) Maintain and enhance populations of all nationally rare species
- 6) Maintain and increase existing biodiversity
- 7) Develop sustainable management techniques

Specific aims and objectives:

HABITATS

- Maintain all nationally important fen communities; where possible expanding and linking areas of open fen together;
- Retain all internationally important woodland and consider possibilities for expansion or development of additional areas
- Maintain, enhance and expand transitional and fen meadow communities, particularly where they occur on the floodplain margins
- Remove scrub and woodland from areas of low conservation status to maximise open fen communities
- Create a series of shallow turf ponds to recreate all successional stages of fen development and ditch habitats
- Maintain and expand all existing fringing reed swamp

SPECIES

- Maintain within the Broads the full complement of RDB, notable and threatened invertebrate species into the future, and strengthen those populations confined at present to a few sites. Secure extant populations through appropriate management, the restoration and recreation of suitable habitats and positive programmes of re-introduction where appropriate.
- Priority for species action will be for those species identified in European Directives and the Biodiversity Action Plan.
- Maintain and enhance all bryophyte rich communities. In recent decades there is evidence for change in species of moss. For example, *Calliergon cuspidatum* which is a common and less specific species which copes easily with more nutrient rich conditions is replacing *Calliergon giganteum* which requires base rich conditions.

WATER MANAGEMENT

- Although the principle is to allow 'natural' hydrological regimes to affect fens, short term measures may be necessary to ensure consistent and adequate water supplies to prevent decline in fens from desiccation
- Improve water quality wherever achievable and sustainable
- Develop an infrastructure of dykes in keeping with the Broadland environment to facilitate fen management, provide wet fences and to allow flow within the fen system.
- Ensure areas of open water remain free from heavy boat traffic, providing habitat for species such as otter, water vole and breeding/wintering water fowl.

Environmental constraints and opportunities

Whilst the main aim of the strategy has been to consider the Broads fens in totality and to restore them to a favourable nature conservation state, there are a number of issues, threats and constraints which may arise outside of the fens, but which have a significant influence on the future of this habitat. The main ones include nutrient enrichment, water supply, land drainage and salinity. The following summary of these issues is based on an extract from the Natural Areas Profile (Holve, 1995).

Fen and freshwater pond habitats are particularly vulnerable to the impact of nutrient enrichment, particularly when flooded on a regular basis by fluvial waters which contain high concentrations of nitrates and phosphates. In some situations enriched upland water from agricultural fertilisers may also be influencing fen communities. There is a clear relationship between increased fertility and a reduction in nature conservation value, although the importance of this impact on the fen vegetation of Broadland is not known.

Each fen system is a unique entity within its own complex hydrology, often receiving water from a number of sources. Drainage of land adjacent to fen habitats and water abstraction can easily upset this established balance, either through desiccation or by affecting the overall chemistry of water irrigating the fen. Over time, the water balance within a large proportion of fen sites will change as a consequence of sea level rise. Impacts likely to be of significance include changes in water quality, both salinity and nutrient status, and changes in flooding regimes.

An increasing trend in the Broads will be for brackish water to penetrate further up the river system in the daily tidal cycle and during storm conditions. In the lower river valleys, this trend to an increasingly saline regime is likely to result in areas of reed dominated pond gradually transforming into saltmarsh. In the middle and upper valleys of the northern rivers the trend for the saline limit to move upstream can be offset in the short term, by increased river flows. Lack of information on the hydrology of the fen resource, the way it will change over time and the impacts of salinity on freshwater habitats make it impossible to know how the fens will change in the future and what proportion are sustainable in the longer term.

Environmental variables

During the fen resource survey, chemical variables of the substratum associated with various plant communities were measured (Parmenter, 1995). The purpose of these measurements was to provide some indication of the importance of substrate to the plant communities. Electrical conductivity and pH were measured off-site using water drained from the soil samples. Phytometric fertility was estimated by growing reed canary grass, *Phalaris arundinacea* in the substrate samples collected. However, the results can only be used as a

guide, as the number and distribution of soil samples was too small to provide statistically significant results.

Fertility - There appears to be no significant difference in the distribution map for soil fertility between each valley; all were low, except when approaching the upland margins and in occasional random locations, where slightly higher levels were recorded. The Ant valley supported consistently low recordings.

However, the Yare valley is the stronghold for the most extensive community in the Broads (*Phragmites-Urtica-Epilobium*), and an abundance of nettles tends to be associated with increased nutrient levels. This community is most frequently associated with the highest soil fertility measured.

By contrast, the majority of unusual and species rich plant communities within the Broads were associated with low/average soil fertility. The number of soil samples for rare communities were fewer and so this may provide part of the cause for this correlation.

Conductivity - This measurement provides an indication of salinity. Soil conductivity levels were low, except in the Thurne valley where they were generally very high due to the saline influence from the nearby sea. Despite higher conductivity levels, the Thurne continues to support a suite of communities that are also present elsewhere in Broadland. However, the most extensive communities were those showing tolerance to a greater range of soil conductivity.

A plot of average conductivity for each of the Broadland communities indicates that most of those which are extensive in Broadland show considerable tolerance to a range of conductivity levels, including the nationally rare *Phragmites-Peucedanum* tall herb fen types.

Localised high soil conductivity also occurs despite the absence of brackish irrigating water. This is usually associated with soils which contain clay and were presumably formed in the past by previous brackish water intrusion.

Almost without exception, the communities which are rare within the Broads were confined to soils with low conductivity.

pH - As with fertility, pH levels were fairly uniform throughout the fens. Variations from circa-neutral occurred predominantly in parts of the Ant, Thurne and Muckfleet valleys towards the upland margins of fens, where acidity increased significantly. pH values ranged from 3.8 to 7.8.

Discussion

The environmental variables measured by the resource survey are considered to be a significant factor in determining the distribution of fen communities. These all related to soil types which in turn are a factor of historical circumstances.

Peat is a vital pre-requisite to the development of species rich fen. Deep peat is probably a scarce resource and so where it exists, management priorities should be directed towards the botanical potential, particularly if there is historical evidence that a site may have been botanically rich.

Deep peat without clay layers is unlikely to have been affected by saline conditions (salt water incursion) during previous sea level rises. These areas are of particular importance for

maintaining high quality freshwater fen habitat, particularly with present day predictions concerning sea level rise.

Peat is inherently fertile, particularly if it becomes oxidised as a result of drainage. With a lack of management, potentially diverse fens frequently become dominated by tall, nutrient loving species, at the expense of a more diverse lower growing flora. Localised high soil fertility recordings along the upland margins of some river valleys may be attributed to this release of nutrients from oxidised peat. There is no evidence for localised seepage of agricultural drainage occurring at these places.

Flooding of fens by eutrophic river water may have a similar effect on the vegetation as a dose of fertiliser; however, provided inundation is an occasional event, the effects of eutrophic river water may be alleviated by regular management to reduce the vigour of nutrient loving species. Soil fertility through oxidation is likely to be a far more significant factor affecting the long term development of vegetation than occasional inundation.

Oxidation of peat soils and subsequent rewetting may produce localised acidity. Water levels towards the upland margins of peat fens are often affected by adjacent agricultural drainage. When rewetted, for example by rainwater, sulphuric acid is produced by hydrolysis of the iron sulphates within the oxidised peats, and acidiphilous vegetation communities are likely to develop. This localised acidity has often been described as seepage water from the Norwich Crag. There is little evidence that this is the case, with one or two exceptions, as the rate of water seepage is so slow that other sources such as precipitation, would be far more significant.

Some of the areas of fen which have become isolated from the main wetland areas are calcareous in character. Recent thinking (Wheeler, Van Wirdum et al, pers comm.) is that when the land surrounding an area of fen has improved drainage, this land shrinks away from the wetland area. This shrinkage creates cracks through which calcareous water from the underlying chalk aquifer is then able to percolate to the surface, producing calcareous conditions. Areas of fen where this process may be occurring include Poplar Farm Meadows and Ducans Marsh.

Some deep peats which appear never to have been cut are higher and therefore drier than surrounding areas. These areas are often botanically uninteresting but have great potential to develop a species rich flora if made wetter, for example by turf ponding. Great care and consideration should be given before excavating as deep peat is a rare resource, which can be of archaeological importance and may in some cases play a vital hydrological role.

Clay soils are unlikely to develop a diverse flora; fen vegetation which occurs on clay should be managed to the maximum benefit of other aspects of biodiversity. Particular consideration could be given to the creation of extensive wet reedbed managed on rotations suitable for species such as the bittern. These areas may also be suitable for allowing scrub communities to develop.

The balance of habitats

Vegetation which colonises and develops on peat is generally of high conservation importance. Both managed open fen or unmanaged carr woodland are highly valued. It is possible that there may not have been a phase of mature wooded within the Broads peatlands, perhaps because conditions were too wet so that reedswamp was the climax vegetation (Well, 1988). There are also suggestions that raised bog may once have been a climax condition, although since these areas have been removed by peat excavations there is no indication that bog will form again.

Now, most areas of fen, except the wettest and most brackish, are succeeding rapidly to woodland. This is a phenomenon mainly of the last two centuries and so to accept the current course of succession as 'natural' is an over-simplification. It is also likely that this course of succession is changing due to changes in water availability and quality, and with sea level rise and climate change (induced by human activities), a further skewing in the direction will follow.

From analysing information gathered during the fen resource and the Bure woodland surveys, it is recognised that in general, the older the woodland the more valuable it becomes for wildlife. In addition, to maintain and enhance natural biodiversity it is also beneficial to have mature woodland areas within a mosaic of other fen habitats, as well as in large blocks. Accordingly, in some areas of good fen, woodland needs to be allowed to develop and likewise, some good woodland should be cleared from fen.

There is also a need to target areas to allow woodland types of the highest conservation value to develop. For instance, woodland will tend to first colonise the drier areas, but one of the most important woodlands to be identified in the Bure valley survey (W5b Alder-greater tussock sedge) develops over former turf cuttings. So to ensure continued opportunities for the full range of woodland types to develop, some of the wetter areas and new peat diggings should also be considered for woodland.

Within the fen management strategy, the preference has been to recommend clearance of young scrub whilst allowing more mature woodland to develop, particularly in areas which would be difficult to maintain as open fen from a practical point of view. Aerial photographs from 1946 were used to identify scrub and woodland, and in general most areas which were already woodland at that time have not been suggested for clearance. The main exception is in the Bure valley, where good mature woodland is extensive and the historical information for some of the fen areas indicates they were formerly of exceptional botanical interest. Large areas have been recommended for restoration to fen within this valley.

Excluding the rivers and broads, and land which has been agriculturally improved, approximately 5000 hectares of wet and dry fen, scrub and woodland habitat remain in the Broads. Open fen currently accounts for less than 2000 hectares of this total. The fen management strategy proposes that in addition to bringing the existing fen resource into favourable nature conservation state, an additional 1000 hectares could be restored, leaving approximately 2000 hectares as woodland habitat. The open fen will also incorporate a considerable proportion of scrub aged between 5-15 years, to provide transitional habitat between fen and woodland.

The table below summarises the proposals for each valley.

	ANT VALLEY	BURE VALLEY	MUCK-FLEET	THURNE	WAVENEY	YARE
Total area of fen /woodland (hectares)	810	1090	324	713	607	857
Existing open fen (hectares)	302	321	121	486	216	498
Existing scrub and woodland (hectares)	508	769	203	227	391	359
Scrub and woodland proposed for clearance (hectares)	398	199	69	114	307	42

Proposed area of woodland (hectares)	110	570	134	113	84	317
Proposed area of fen (hectares)	700	520	190	600	523	540

Tradition and the future

Knowledge of traditional management is important because whatever wildlife we have today, evolved from the past. The recorded and detectable patterns of management in the Broadland fens reflect to a large extent the activities of only the last two centuries of exploitation. Despite this, there is a temptation to follow past patterns. In ecological terms, continuity of management can be good since it encourages a maturation of particular communities, and rare or specialist species can benefit.

In the past, particular management methods were used for reasons other than nature conservation and the scale of management units was organised according to particular human needs. It is also probable that management of sites varied over the years and generations according to local needs and personalities. Hence it is often difficult to find any reference point in terms of “tradition”.

Furthermore, what is traditional is not always necessarily best, and it may be that in some instances, the wildlife we have is there in spite of past management rather than because of it. There is also the possibility that had things been done slightly differently the fens would be even more diverse and valuable for nature conservation.

The future of the fens is at a turning point. There are a range of options, one of which is to do nothing. However, the fens are no longer a natural system. Human intervention in the past and present means that the processes which once created diversity are absent and the areas remaining are now too small to operate naturally under the pressure of external influences.

Investigation into alternative future visions for the fens is a challenging course of action. Changing our approach to fen management in a way which benefits biodiversity and improves ecological stability requires careful consideration, innovation and experimentation. It also requires a better understanding of the current and future environmental constraints, such as those affecting water supply and quality, as well as an improved understanding about the functional role of groups of species within habitats.

A good example is the development of brown moss communities over former peat excavations. We know that a number of rare herbaceous species are associated with these communities, and that they frequently occur over old turf diggings. However, only a minority of recent turf ponds seem to be developing brown moss communities, and so we have a need to understand both the environmental circumstances under which turf ponds and brown mosses are colonised, and the importance of the brown mosses to certain rare species.

Despite the uncertainties, there are some basic ecological principles, such as the need for habitat heterogeneity and the importance of treating the fens as one resource, which will help guide the direction of fen management. Habitat diversity will also be enhanced by using a variety of management methods in various rotations along with a commitment to work with the wishes of individual landowners. On a smaller scale, the use of extensively grazing animals should also improve the structural variety of the fen habitat, so benefiting a variety of plants

and animals and offering a more natural pattern of management than results from harvesting methods.

Management methods

Grazing

Conservation management is often designed to benefit specific plants or animals. For instance, annual mowing of fen meadow can encourage a botanically diverse sward, whilst a 4/5 year mowing regime may be more suitable for plants such as saw sedge and a range of invertebrates. However, many other important species within an ecosystem depend upon ecotones, the interfaces between one vegetation type and another, and most habitat management encourages abrupt transitions from one vegetation type to another.

Grazing is one method whereby we can alter the natural vegetation dynamics and interrupt the process of succession. Low grazing densities, particularly over large areas can encourage the whole range of seral stages in a continuously changing mosaic of habitats, from short grass and heath vegetation, through taller vegetation and scrub to mature woodland. This can be a desirable conservation objective since it would perpetuate a diversity of habitats within a given area in a sustainable way.

Pre-enclosure (late 1790-1880) the fens were essentially viewed as commons and the emphasis of use was for mowing, complemented by grazing with sheep in the early middle ages, and subsequently by cattle. Historical dossiers compiled during the fen resource survey (Parmenter, 1995) dating mainly from 1797 indicate that grazing occurred on many of the fens after enclosure. Peat stripping occurred on a larger scale during these times and may have made many areas unsuitable for grazing. The table below lists some of the areas surveyed during the fen resource survey where there is some historical evidence of grazing.

YARE	BURE	WAVENEY
Whitlingham Marshes Thorpe Marshes Surlingham Church Marshes Kirby Marshes Surlingham Broad Marshes The Outmeadows Strumpshaw Marshes Bradeston Marshes Strumpshaw Common Surlingham Marsh Wheatfen and Rockland Ducans Marsh Buckenham & Hassingham Carrs Poplar Farm Meadows Limpenhoe Meadows Hardley Flood	Crostwick Common Dobbs Beck Belaugh marshes Wroxham Marshes Hoveton Marshes Sedge Fen Putticks Green Horning Hall (parts of) Ward Marsh Ranworth Flood South Walsham Fen Upton (parts of) Acle Carrs Decoy Carr	Belton Bog Barnby Broad and Marshes North Cove Wadehall Marshes Oulton Marshes Spratts Water and marshes Beccles Marsh Stanley and Alder Carrs Wild Carr Worlingham Geldeston Meadows
THURNE	MUCKFLEET	ANT

Long Gore Marsh Horsey Marshes Skoyles and 100 Acres Hickling Broad Marshes Mrs Myhills Marsh Mere Farm Marshes Potter Heigham fen	Hall Farm Fen Ormesby Common Burgh Common	Barton Fens Catfield (eastern side) Reedham Water & Marshes Snipe Marsh
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These areas include both the upland margins of fens and large expanses of floodplain, some of which were partially drained by windpumps. However, without more detailed information about historical water levels on fens and the efficiency of windpumps, it is almost impossible to know how significant this is to the current situation. Accessibility and regular management may be prime reasons as to why the upland margins often support a range of unusual fen meadow, mire, heath and transitional communities. Some of these transition communities are on poor, acid soils and low productivity makes them more suitable for grazing than mowing.

However, particularly since the Second World War, changing agricultural economics resulted in many aspects of fen management ceasing, including grazing. Traditional breeds of livestock were replaced by more productive, but less hardy varieties which are poorly adapted to tough vegetation and harsh environmental conditions. Many small farms were amalgamated and the trend has been towards highly mechanised, large scale intensive production.

Fen grazing has probably always been a marginal activity supporting low numbers of animals for variable time periods in any one year. However, with the dramatic changes which occurred in the agricultural economy after the war, those fens which were not drained and agriculturally improved became completely uneconomic to graze. In a very short time period, grazing of fen communities within the Broads has become virtually non-existent, except on the drier upland margins where, with one or two exceptions, the end objectives have been to produce a uniform, grass-dominated sward. Much lower densities of animals are proposed for future grazing of fens than may have been used traditionally, to ensure a diverse vegetation structure and to maintain a variety of fen communities.

From analysis of the vegetation resource and the available historical information, approximately 1255 hectares of fen has been identified which may be suitable for grazing. In addition, another 835 hectares could also be grazed, although other management methods may be more suitable. This depends on factors such as technological innovation, availability of suitable large herbivores, and our growing understanding of the effects of the different management options. The table below illustrates the distribution of areas suggested for grazing within the Broadland fens.

	SUMMER GRAZING	EXTENSIVE ALL YEAR ROUND GRAZING	TOTAL AREA FOR GRAZING (*denotes additional areas for which grazing may be applicable)
ANT	190 ha	70 ha	260 ha (+130*)
BURE	100 ha	60 ha	160 ha (+140*)
MUCKFLEET		100 ha	100 ha (+30*)
THURNE		240 ha	240 ha (+100*)
WAVENEY	120 ha	120 ha	240 ha (+255*)
YARE	200 ha	55 ha	255 ha (+180)
TOTALS	610 ha	705 ha	1255 ha (+835)

The aim of using extensive grazing as a means of fen management is to develop and maintain a dynamic mosaic of vegetation structure, leaving some areas undisturbed and others closely grazed. Some areas are small, isolated or subject to flooding during the winter months and in the absence of adjacent dry land, could only be grazed during the summer months. Other areas are very extensive, and have the potential to develop into semi-wild ecosystems grazed by a low number of resident large herbivores. This latter option has considerable benefits for achieving long-term sustainable management.

Larger areas will inherently be more variable than smaller sites. Local variation in soils and hydrology, and low densities of free-ranging, large herbivores provide the potential for great benefits to biodiversity through enhanced habitat heterogeneity. Practical experience of extensive all year round grazing on wet peatlands with large herbivores is limited. Few examples exist in this country and most of our information is based on conservation grazing projects elsewhere in Europe.

One difficulty is how to estimate grazing densities for extensive systems. To sustain animals more or less independently on fen throughout the year, sufficient dry land and varied vegetation needs to be available. At different times of the year, animals have changing food requirements. For example, in the Oostvaardersplassen in Holland, during the summer months, fresh reed leaves form an important component of the diet for the wild Konik ponies, but as the season progresses, reed leaves become less valuable as food, and the ponies eat the reed seed heads instead. By January/February when other food is sparse and environmental conditions are harsh, the ponies dig up and eat reed rhizomes.

Grazing densities for a semi-natural system can only be estimated by extrapolation from current experience. On low productivity heath vegetation, one sheep per hectare for the summer months produces a diverse structure in ground cover. On lowland grassland, a summer grazing density of one cow or horse per hectare produces a varied medium to short sward. If the grazing density was halved, the structure would become more varied. So for cattle or ponies, a suitable summer grazing density for a fen meadow may be 2 hectares per animal.

Another crucial factor affecting the vegetation structure is the length of grazing period. At low densities in mid-summer, grazing animals might seem to have made little impact; however, a month or two later, the impact may be very noticeable. The gradually increasing impact of grazing through the growing season may be quite significant for invertebrates, allowing them a greater opportunity to complete important parts of their life cycles, as well as leaving some untouched areas as refuges.

For year-round extensive fen grazing, which is likely to maximise wildlife benefits whilst not compromising the welfare of animals, it is suggested (Wigbels, pers. comm.) that grazing densities are calculated on the basis of productive dry grassland available for winter grazing. If one hectare would normally provide sufficient sustenance for one equine or bovine during the summer months, it is suggested that during the winter months when plant growth is minimal, the nutritional content of the vegetation is low and the animals' food requirements are highest, three or four hectares of dry grassland per animal may be necessary as winter keep. Many of the fens may also become very wet at this time of year and whilst some primitive breeds of cattle and ponies will wade in water in search of food during the warm summer months, they will be unwilling to risk the loss of body heat by doing so whilst it is cold.

Most grazing of fen vegetation could then occur during the summer months at densities ranging between three to eight hectares per animal, depending on a number of variable factors, such as amount of scrub cover, length of time that site is accessible (e.g. not flooded) and type of fen vegetation available.

Whatever densities we start with are likely to need adjustments as the ecosystem evolves over time and as the animals learn to exploit the vegetation. A truly non-intervention system would require very large areas to ensure genetic viability within breeding populations of large herbivores and predators at the top of the food chain. This is not achievable in the Broads context due to the geography and ownership of the fens and surrounding land. However, the need for dry grassland to support extensive fen grazing has obvious implications for adjacent land and it is possible that ESA tier 1 grassland or valley margin land may have a valuable role in the future grazing of fens.

Breed and type of animal is also an important consideration. As outlined above, most commercial bovine and equine breeds do not cope well with fen conditions. Essential adaptations include: an ability to do well on poor vegetation; tolerance to biting insects; low husbandry requirements; placid steady temperament; and the mental and physiological ability to cope with wet, swampy conditions. In general, these characteristics are more readily attributable to primitive breeds than those that have been domesticated and changed through breeding to suit mans' requirements.

Within the UK, the Broads may be the first wet peatland where extensive grazing is being considered. On the continent, there is a growing wealth of experience in the use and benefits of grazing with large herbivores. A study (in prep) by the Broads Authority and English Nature will compile information about the use of grazing animals in conservation management projects both here and abroad. Early investigations indicate that certain breeds are particularly promising, including Highland, Galloway and Heck cattle; Konik, Camargue and Exmoor ponies; Elk, Red Deer and Bison. Many of the British rare breeds may also once have been suitable, but because of their endangered status, rare breeds tend to be kept in less harsh environments than their ancestors and may have lost much of their original hardiness.

Mowing

Many of the Broadland fens have a long history of mowing. Since the First World War, with changing social aspirations, intensification of agriculture and the replacement of human-power with machinery, commercial management of the fens has become very limited. Rough estimates indicate that about 190 hectares are currently mown commercially for reed and sedge.

Fen products once supported a thriving rural industry; marsh litter was used for hay and bedding, reed for thatching, turves for fuel. These products now have equivalent replacements: alternative bedding materials such as straw have removed the need for marsh litter, thatched roofs have largely been replaced by tiles, and alternative sources of fuel such as gas, oil, electricity are cleaner and more energy efficient than peat turves.

Working on fens is physically strenuous, and because traditional uses of fen products have largely been replaced by cheaper alternatives, there has been no incentive to develop machinery capable of working in difficult conditions. These difficulties may have also saved the fens from damage through over-exploitation.

Through analysis of the communities mapped by the fen resource survey, approximately 500 hectares of wet fen supporting high densities of reed (*Phragmites australis*) have been identified. These areas may be suitable for management as reedswamp, although it is impossible to know how much would achieve commercial quality for thatching.

The same analysis identified 200 hectares of saw sedge (*Cladium mariscus*) dominated vegetation suitable for restoration to commercial management and the market for this product

is good. Maps 8-13 show identify wet fen where reed or saw sedge are currently dominant or abundant. Available information suggest that sedge dominated communities are best sustained through cutting by hand as most evidence indicates that use of large or heavy machinery can be very detrimental to a commercial sedge bed. Hand cut sedge is now rare as it is very labour intensive and instead, small reciprocating blade cutters are used which minimise any possible damage. Four or five years is recognised as the ideal rotation for its commercial harvesting.

Over the past few years, tracked machinery with low ground pressure has been developed which is capable of mowing vegetation in wet, soft conditions. The main outstanding problems for fen harvesting is the removal of cut material from site and the development of a market for fen products. Initial trials into the feasibility of 'blowing' different types of shredded fen materials down a long (1500m) pipeline have proved very promising.

Conversion to biofuels is one option which has been considered for use of the shredded fen produce, although the transportation distance to the nearest power station is likely to make this option costly and perhaps unsustainable. However, feed manufacturers have indicated that the shredded fen produce may form an excellent source of roughage for usage in pelleted animal feeds. The financial return and much reduced transportation distances for this use, suggest a possible sustainable and viable marketing option for the future.

Analysis of the fen resource survey indicates that approximately 1000 hectares of mixed tall herb fen with dense or scattered scrub could be optimally managed for conservation by mowing if appropriate technology were available.

It seems likely that annual or biannual harvest for marsh hay or litter was traditionally a very extensive practice in the fens. In general, frequent mowing will encourage the development of a species rich sward. However, on an area of tall herbaceous fen which has previously been irregularly managed, it may take several years before the diversity increases significantly, whilst in other areas the change can be quite dramatic.

The timing of cutting can be important to the species composition of a regularly mown area. In general summer mowing takes place between July and September. The problems with cutting in July is that although most plants will have flowered, they generally will not be able to set seed. This is not an over-riding problem as most flowering plants are perennial and can reproduce vegetatively. However, it is good practise every few years to cut these areas later in the year to allow plants to set seed. Mowing late may create problems by allowing a build up of litter which may have detrimental effects on seed germination.

Although most plants benefit from some cutting, if only to keep them physiologically young, some species are detrimentally affected by annual mowing. For example, milk parsley (*Peucedanum palustre*) will become absent or very scarce in a hay meadow. This plant performs well amongst fen vegetation which is cut no more frequently than every three or four years. This is also an ideal rotation for the swallowtail butterfly, which lays eggs on milk parsley when it flowers during the second year after cutting. Therefore, a four year mowing rotation will allow two generations of swallowtails to be reared. Whilst the swallowtail butterfly and milk parsley are only two of many fen species, they demonstrate an intricate relationship common within the fen ecosystem.

Mosses and bryophytes seem to flourish under a regular cutting regime. Some monitoring work (Kennison, 1983-87) indicates that a two or three year mowing regime may be most beneficial for these plant groups. Tussock forming species such as black bog-rush (*Schoenus nigricans*) are difficult to mow and can be damaged or killed by this management, particularly if on a regular basis. Mown on a five to ten year rotation, tussock structure, which

can be of particular value to invertebrates, is retained. It is suggested that tussock areas are managed either on a very long rotation or by other methods, such as grazing.

Some areas may be harvested in patches or big blocks on longer rotations ranging from 5-15 years to ensure that areas of young scrub, undisturbed fen and deep litter are retained in a mosaic throughout the Broadland fens. Big blocks should be shaped to provide the maximum interface between adjoining habitats, so a long thin block with sinuous edges is more beneficial than a square block of the same area. The longest rotations are of particular benefit for invertebrates, but also a range of other wildlife, including lichens and fungi; birds such as Cetti's and Savi's warblers and a number of mammals.

By developing interlinked mosaics of small and large areas on different mowing regimes, benefits for biodiversity can be maximised, whilst reducing the risks of inadvertently causing extinction of species whose requirements we may be unaware or have incomplete knowledge of. If possible, areas with similar management regimes should be linked together to allow for migration and colonisation of species, and thus, increased stability within the ecosystem.

Burning

In general, burning has not been proposed as a major management technique within the strategy. This is largely because of the uncertainties amongst ecologists about possible deleterious effects on certain plants and invertebrates.

Historically, there is little evidence to suggest that burning was routinely used for managing large areas of fen, probably because the vegetation was valuable for thatching or as forage, marsh hay or litter for animal bedding. However, burning probably had been used for a long time, and still is, to rejuvenate reedbeds and 'tidy up' areas that are not of use for commercial cropping.

By contrast, there is considerable evidence that both mowing and grazing were important historically. Although the limitations of following the example of traditional practises are recognised, there is concern about using new techniques where the effects are relatively unknown.

The effects of burning fen vegetation which support a diverse invertebrate fauna have long been subject to controversy amongst ecologists. A research paper (Ditlogo, James and Sutherland, 1992) has indicated that burning a standing crop of fen vegetation may be little different in its effects on invertebrates from mowing, raking and then burning that vegetation in piles.

It has also been suggested in the above paper that mowing may be more damaging to invertebrates than burning, as mowing often takes place during the summer months when many species are in the middle of their life cycles and therefore most vulnerable. By comparison, burning of standing vegetation is generally a winter occurrence and at this time many invertebrates are dormant. Carried out correctly, the litter layer is largely untouched; this can be advantageous to invertebrates, although it may not be such a benefit to plants.

The limitations of the above research include the short timescale over which the experiment was carried out; the small size of plots in comparison with the sorts of areas which may be proposed for burning on fen sites; the use of only one vegetation type, commercially managed reedbed; and not considering the whole range of invertebrates which were associated with the area. If small areas are burnt, recolonisation by invertebrates from adjacent areas is easier and detrimental effects may be short-lived. However, burning small areas involves mowing long lengths of fire break relative to the area managed by burning and is very labour intensive.

Subsequently and after lengthy consideration it was agreed by the Broads Authority and English Nature, that because of the immense diversity and variability of both invertebrates and fen vegetation types in the Broads, it would be impossible to devise meaningful burning and monitoring experiments to provide guidance on fen burning. Each area would therefore require a detailed study of the plants and invertebrates to establish the existing interest, and on this basis, burning would no longer be a cheap option.

Through the Broads Research Advisory Panel, a policy was established which considered burning as acceptable in the following cases:

- where fens have traditionally been burnt annually or biannually for a long period, so as to maintain them in an open condition;
- where small areas of inferior product remain after commercial reed and sedge harvesting. This includes the periphery of existing beds so as to expand the commercial area. Ideally however, areas of standing crop would remain after each harvest.
- where areas have been cleared and are ultimately destined to be turf ponded, burning is appropriate to maintain the site in an open condition prior to turfing. This is because, the fen invertebrate interest will be destroyed by the excavation in any case;
- mown material may be piled and burnt on recognised fire sites in all but the most sensitive areas;

However, it is recognised that if in the future, management by grazing and mowing cannot maintain the fens in an open condition, burning may become the only remaining option to ensure retention of the fen habitat.

Scrub clearance

During the past few decades, large extents of fen have been kept open by scrub removal without necessarily mowing the remainder of the fen vegetation. This is generally considered useful to prevent the development of scrub into woodland, whilst allowing fen vegetation to persist, but does not maintain the fen community in its most favourable condition. Deep litter tends to inhibit germination of rare plants and gradually causes an increase in soil fertility. Accumulating fen vegetation gradually raises the soil surface, and on many areas is associated with drying out of the substrate and successional development into woodland.

Where scrub clearance is carried out, stumps should be killed with an appropriate herbicide, although this is less important where grazing is to be re-introduced. If an area is to be mown after scrub clearance, grinding of stumps is particularly beneficial to facilitate the use of future machinery.

Effective removal of scrub is expensive and although the odd wood pile is beneficial for invertebrates, mammal and fungi, the volume of material produced is immense. Presently, because of the difficulties associated with transportation and marketing of wood produce from fens, most is burnt in situ. Where this method of disposal for the wood is used, bonfire sites should be as few as practicable. Alternative methods such as production of wood chip and transportation by blowing along the pipeline have yet to be assessed and tried.

Water level control

For a significant part of the history of the Broads, this region has operated as a naturally functioning wetland, with the whole of the floodplain acting as a single unit and demonstrating a complete transition of habitats from sea to freshwater. Within the fen management strategy, there is a presumption that we will seek to restore the natural hydrological dynamics of this system, thereby enhancing its ability to respond to long-term environmental changes.

Inherent within this approach is the need to accept that the Broads wetland will change. If we wish to preserve the present interest, there will be the increasing need for artificial control of hydrological processes, including improved channel management, river flow augmentation, isolation of fens from the rivers and eventually tidal barriers and barrages. This is unlikely to be sustainable into the future.

In general, all water control structures interfere with the natural functioning of wetland systems. However, human society lives and works in the Broads and so there is a need to prevent extreme flooding. At the other end of the spectrum, our demands for water can cause desiccation and damage to fens. Wet fen is a particularly valuable resource for wildlife as it supports a range of specialised species which are unable to persist in drier areas. A high water table can also be useful as it inhibits the colonisation and growth of woody species and may provide opportunities for further peat accumulation. Whilst in the long term we need to address the causes of desiccation, water control structures which help to maintain a higher minimum level can be helpful. Thus, within the two extremes of water control, the hydrological system may then be allowed to fluctuate naturally.

Sluices which maintain a minimum water level in dykes that are connected to rivers with a large tidal range can also be helpful to stabilise a fen system sufficiently for management to take place. However, we currently have poor understanding of the effects of interrupting patterns of ebb and flow caused by a tidal system under which most of the Broads fens originally developed. Accordingly, the management and conservation objectives on any site affected by tidal waters must be considered carefully before closing dykes to the river, and it would be unwise to adopt this as a general practise.

There is also considerable controversy as to whether overgrown dykes which were originally connected fens to rivers should be re-opened or not. This mainly relates to the uncertainties associated with the role of dykes in influencing water supply to fens. Where dykes have a strong influence in water supply (through seepage or flooding) there is a concern about enhancing the supply of nutrient enriched water. In other situations, dykes can cause a significant drainage effect and may disrupt water movements within the peat.

For the present, it is prudent to maintain the existing system. Dyke restoration should also be limited to reopening the old lines because of possible implications for disrupting water movements and where it is essential to connect a fen area to the river use of a series of interconnected dykes may help to minimise any possible damaging effects from river water.

Peat excavations

Historically there were two periods of extensive peat cutting in the fens. The first occurred during medieval times when large volumes of peat were extracted and used for fuel. The deepest excavations occurred during this period, which may be at least partly due to the better combustible quality of the peat at lower levels (Lambert, Jennings and Smith, 1965). These diggings later became flooded due to subsequent changes in the relative levels of land and sea and the Norfolk Broads were formed.

The second period of turf cutting followed the Enclosure Act (late 18th/early 19th century), when the fens fell into private hands or become doles. At this time, peat was extracted on a

large scale, both for fuel and to increase the area available of wet reedbed (Wells, 1988). Many of these former shallow peat diggings or “turf ponds” now support some of our most diverse and important fen communities.

The creation of new turf ponds has become an established method of imitating traditional activities, and experiments have shown that plant and invertebrate species richness can increase dramatically by this method. (Kennison, 1987 and 1995). However, experimental turf ponds which have been excavated over the past twelve years are not yet of a sufficient age to be certain that they will develop a flora which favours the true Broadland rarities, such as the fen orchid (*Liparis loeselii*). It is possible that we may not be exactly mimicking the early environmental influences affecting traditional turf ponds which could have significant effects on later stages of succession. One aspect of this is that historical turf ponds may have re-vegetated during a dry phase before becoming reflooded, and this may be a particularly important factor for larger turf ponds (Wheeler, pers. comm. 1996)

The main disadvantages associated with modern day turf ponds is the expense of excavation and the requirement of large areas to be sacrificed for spoil. The expenses may be partly offset against the lifetime of each project, as the costs of alternative management may exceed those of excavation. However, the speed of recolonisation is very variable, according to a number of factors such as depth and size of diggings and indications are that the time period for non-intervention may be shorter than first calculated.

At present there is no market for irregular amounts of peaty spoil with a high root content, and although the excavated areas may not require further management for several decades, this is not the case for the resultant spoil banks which are prone to becoming heavily infested with thistles and saplings and need regular active management.

There can be a number of reasons for excavating turf ponds and these are detailed elsewhere (Kennison, 1995). However, the main justifications include: (a) to create new opportunities for rare and highly valued plant communities to develop; (b) to restore open fen in areas which have become covered by dense scrub; (c) to replace existing plant communities with ones that are more highly valued.

The fen management strategy has identified 1130 hectares of scrub/woodland to be cleared in favour of open fen. Within this area there is tremendous potential for creation of turf ponds. This management technique is important as it can be used to help achieve two of the primary objectives of the fen management strategy: to “develop mosaic of habitats and vegetation types” and “maintain and increase areas of open water habitat”.

With one or two exceptions, specific locations for turf ponds have not been suggested within the fens strategy, as each site should be considered on the basis of a number of factors (Kennison, 1995). However, removal of mature trees and scrub using large machinery often creates lots of mini ponds where the root systems are extracted and in these areas, mini-turf ponds may be created on an opportunistic basis.

Experience from the experimental turf ponds which were excavated in the early 1980's indicates that the most successful ponds, in terms of those that revegetate quickly with valued plant communities, are those which were created over solid peat. However, deep uncut peat is a rare and valuable resource both in archaeological and historical terms, but also in its hydrological function. In general there is now a presumption against excavating deep peat. An exception may occur where there is a need to create slightly wetter conditions and rejuvenate an existing community. In this instance ‘scraping the surface’ to remove a 0.1 - 0.3 meters of litter and topsoil is unlikely to be damaging.

Some of the original 1980's turf ponds were obtained by excavating over old cuttings and small broad basins. These have been slower to revegetate with the more valued plant communities than those over solid peat, but because they are wetter and more unstable, invasion by scrub has been slower, and now they are of similar quality to those over solid peat (Kennison, pers. comm.) Sites adjacent to species rich areas can also be valuable. Future experiments with turf ponds should incorporate a range of depths, sizes and shapes, followed by monitoring of the colonising vegetation. It is also necessary to choose locations where different environmental regimes can be tested, such as the possibility of a dry phase followed by higher water levels. Excavations should generally avoid exposing estuarine clay, although some valuable bog moss/birch communities probably prefer a clay substrate.

A Vision for the Broadland Fens

Management maps were derived from an analysis of the vegetation resource within each river valley (appendix 2), and used in combination with our current knowledge on the requirements of bird, mammal and invertebrate species. The table below has been constructed from approximate area measurements for the main types of management described on each of the management maps. Although of importance, areas for peat excavation, water level control and burning have not been itemised and listed within the tables, as these are considered to be opportunistic techniques to be used within the framework of the fen management strategy.

	Existing open fen (hectares)	Scrub/woodland to be cleared (hectares)	Potential open fen (hectares)
Ant	300	400	700
Bure	321	199	520
Muckfleet	122	68	190
Thurne	486	114	600
Waveney	216	307	523
Yare	498	42	540
TOTALS	1943	1130	3073

From the management maps it is possible to estimate the areas proposed for mowing or grazing or a combination of both within each valley. This information has been tabulated below.

	Grazing	Mowing	Mowing/grazing	TOTAL POTENTIAL OPEN FEN
Ant	260	310	130	700
Bure	160	220	140	520
Muckfleet	100	60	30	190
Thurne	240	200	160	600
Waveney	240	28	255	523
Yare	255	105	180	540
TOTALS	1255	923	895	3073

Annotations for the SUGGESTED MANAGEMENT MAPS

The Ant valley supports the greatest area of species rich fen, co-dominated by *Cladium mariscus* and *Phragmites australis*. Many of these fens occur over former peat cuttings with a long history of mowing management, and the majority have been identified as areas suitable for mechanised fen harvesting on a variety of rotations. Extensive summer grazing is recommended for acid heath, mire and transitional fen meadow communities which are otherwise rare in the Broads. Unless adjacent upland is included within the management areas, all year round grazing is unlikely within most of the Ant fens, as they are subject to periodic winter flooding. The largest proportion of woodland and scrub recommended for clearance occur within the Ant valley.

The Bure valley - the majority of woodland within this valley which is not of international importance has been recommended for restoration to fen. Follow up management is likely to involve mechanical methods of fen harvesting on a variety of short rotations (1-5 years). Grazing would probably not be suitable in the short term on these areas due to the unstable ground conditions following scrub removal. Extensive all-year round grazing is proposed for large blocks of fen and scrub communities, particularly on solid peat and on upland margins.

The Muckfleet valley The larger areas of transitional fen, fen meadow and scrub within this valley are suggested for an extensive all year round grazing regime. Smaller, isolated areas of fen, marginal swamp vegetation and reed/sedge which is commercially viable for thatching have been identified as suitable for mechanical harvesting. The scrub removal proposed will allow a 50% increase on the current area of open fen.

The Thurne valley Large blocks of mixed herbaceous fen, acid mire, heath and fen meadow communities have been identified within this valley for permanent extensive grazing management. Where *Phragmites australis* or *Cladium mariscus* are dominant, particularly around the broad margins, mechanical or hand harvesting of the vegetation is suggested, using a variety of rotations.

The Yare valley The majority of the Yare fens have developed an impoverished *Phragmites australis-Urtica dioica* community supporting species indicative of eutrophic conditions. Although subject to periodic winter flooding, these fens are generally quite dry. Extensive summer grazing has been suggested to develop a mosaic of floriferous fen communities over a large area. Some areas are also suitable for annual summer harvesting.

The Waveney valley The predominant future management suggested within the fen management strategy for this valley is extensive grazing. This relates to the main feature of the Waveney valley which are its range of fen meadows and poor fen communities. Extensive grazing is likely to enhance this diversity by developing a mosaic of structure within the vegetation. Clearance of large areas of scrub and woodland may allow expansion of the rare Broadland communities.

Priorities for research, monitoring and experimental management

The Broads Research Register (1989-1994) outlines the current research and who is doing it and a research and monitoring strategy is shortly to be produced for the region, which will consider a future programme for the region as a whole and will prioritise the issues that have arisen during the fen management strategy production. However, the following table lists some of the key aspects for research and monitoring which were identified in the process of producing the fen management strategy and suggests possible priorities.

PRIORITY	TOPIC	PROPOSED METHOD	FORM OF INFORMATION/ OUTCOME	PRACTICAL APPLICATION
1	Peat distribution and depth within river valleys	Collation of historical information (maps, records etc.), and field work (core bores)	Maps identifying deep peat and former turf diggings	To identify areas for turf ponding and restoration of fen. Also identify potentially important hydrological features
2	Ongoing peat formation	Investigate the type and rate of peat accrual or degradation, and main species associated with peat formation	Process information relevant to present conditions	Help compare past to present and estimate long-term management needs and perspectives.
1	Turf ponds	Investigate and monitor the process of recolonisation	Understanding of key factors, including hydrology, form and depth	Helpful in providing guidelines relating to design and management practises after excavation.
3	Turf ponds	Investigate the effects of grazing recolonised turf pond vegetation	Vegetation community monitoring data	Helpful in providing guidelines relating to management practises after excavation.
3	Phytometric sampling	Further samples of fertility, pH and conductivity in fens, particularly near the river	To provide a more complete overall picture of these variables within the fens	Improved understanding of factors affecting fen vegetation communities. This may affect water management decisions, such as nutrient control and river flows.
3	Soil chemistry	Study of distribution of rare species and functionally important groups of species in relation to chemometric fertility, soil pH, base status of soil	Correlations of plant distribution, phytometric fertility, water pH	Understand key factors better, and estimate hydrological requirements
3	Water chemistry	Test some or all major ions on site, and in all water sources	Understand role of water from various sources to maintain site	Help realistic planning and water management
3	Acidiphily	Use of GIS to plot acidic sites and	Determine why acidiphilous	Help to understand key factors, possible

		soils and suggested water movements, plus local eco-hydrological studies	communities occur locally, including a consideration of peat oxidation, more rain-water influences and other sources of acidity	vegetation successions and so to plan management
1	Hydrology of fens	Investigation of the supply and movement of water within fens	Site based data on hydrological pathways	Improved understanding of the likely effects of changes in water supply and quality. Improved ability to make informed decisions concerning changes in the management of water resources
3	River water	Chemical and physical measurements of water at different distances along dyke systems from the river	Understanding of how far the influence of river water affects dyke water	Decisions concerning opening abandoned dykes to the river
2	Local and regional hydrological issues	Maps showing extent of river influence, tidal regimes, location of drainage dykes	Importance of different water sources on plant communities	Development of buffer zones; where to open dykes to rivers
1	Woodland and scrub communities	Survey work of all woodland and scrub communities within the river valleys	Maps and survey report, identifying important woodland types	Targeted scrub clearance and identification of locations where there woodland should be left to mature
1	Fen meadows	Botanical studies of all unsurveyed fen meadows	To provide a more complete picture of the botanical resource	Improved targeting of management in context of fen management strategy
1	Extensive fen grazing	Field trials of fen grazing with a range of large herbivores	Establish advantages and disadvantages of this management technique	Resource targeting and fen restoration
3	Invertebrates	Investigate the effects of mowing on invertebrate populations and rare species	Define management systems which enhance and maintain rare species and biodiversity in invertebrates	Establish management regimes which benefit biodiversity of invertebrates and ensures rare species are

				maintained
2	Fen by-products	Investigate means for disposing of unwanted fen materials, e.g. wood, stumps, roots, peat	Possible markets for products associated particularly with scrub clearance and turf pond excavations	Significant landscape and ecological benefits associated with removal of these by-products off site

Summary Recommendations of the Fen Management Strategy

1 Expand existing resource of open fen by clearing 1130 hectares of woodland/scrub. This will provide a 58% increase in the current area of open fen. In the context of the wetland resource available, nearly two-thirds of the area will then be managed as open fen. Scrub clearance should be preceded by a survey to establish status. Areas proposed for recovery to fen should generally only have recently developed a scrub layer.

2 (a) Establish extensive grazing systems, incorporating large areas and a range of habitats. Use large herbivores adapted to the wetland environment, with minimal husbandry requirements. On sufficiently large areas, roving herds of breeding animals could be established; elsewhere, non breeding groups could be used and allowed to live and grow old on these areas. The lifespan of many large domesticated herbivores can be 20-30 years or more, and so a one-off purchase may solve the management situation on a particular area for a quarter of a century.

(b) Consider extinct fen species and whether their loss has had an impact on the system. Investigate the benefits and constraints of reintroducing natural herbivores, e.g. elk, beaver, wild boar, red deer, chinese water deer.

3 Summer graze areas which are small and isolated, or which are subject to periodic winter flooding, using either a 'mobile' conservation herd or a commercial grazier with a suckler herd of cows. Adjacent land may need to be allocated as a winter holding ground to reduce transporting difficulties and expenses. Feed, which could be marsh hay, may need to be made available for these animals. However, as with the extensive systems, the breeds used should still be hardy and well adapted to fen vegetation in their husbandry requirements.

4 Develop appropriate technology to harvest fen vegetation on a large scale from areas with a long history of mowing or where conditions may be too treacherous for animals to graze, such as over former turf cuttings. A variety of harvesting rotations, where possible imitating any historical evidence, should be used.

5 Maintain annual/biannual mowing in areas of high botanical diversity or with potential to become floristically rich. Regular mowing for marsh hay was a large scale practise in the past and substantial additional areas should be managed on this shorter rotation. The potential to develop a diverse flora is likely to be associated with a peat substrate. These areas may also be suitable for summer grazing, and the two options are interchangeable. Opportunities for marketing marsh hay or via a fen harvester for animal feed should be explored, although it is likely to have a role as emergency food supply for grazing animals on the fen.

- 6 Survey and map the depth and extent of peat throughout broadland, including areas outside of the current fen resource, to ascertain the possibilities for restoration of fen.
- 7 Retain areas of uncut tall herb vegetation close to dykes as feeding habitat for small mammals such as the water shrew and ensure some areas of dense undisturbed reed-dominated vegetation for invertebrates and small mammals such as harvest mice. These areas also provide protection for small mammals from predators.
- 8 Remove scrub from margins of all broads to a width of 20-30 meters to encourage the restoration of marginal swamp, and provide additional fen habitat suitable for rare species such as the bittern. Manage some bankside habitat on a long rotation to provide undisturbed areas for otters.
- 9 Retain strips of scrub around woodland margins to provide transitional habitat between mature trees and fen habitat. These areas may be suitable for coppicing or as part of a long rotation of harvesting fen produce.
- 10 Retain stands of mature carr and valley margin woodland for their own interest and for roosting bat species.
- 11 Expand rare transitional fen and wet heath communities occurring on the floodplain margins by removing scrub and limiting effects of drainage. Expand the existing geographical limits of the upland freshwater margins into areas which are currently reclaimed for agriculture, particularly to benefit heath, fen meadow and transitional fen communities.
- 12 Consider benefits of expansion of the existing geographical limits of fens or reedbeds into areas which may currently support grazing marsh or arable. The underlying substrate will be crucial in the type of community which recolonises these areas. Alluvial marshes are most suitable for reedbed recreation; peat substrate has potential to develop species rich fen.
- 13 Create a series of turf ponds as an integral part of scrub clearance. Future turf pond excavations should be varied: some small and in strips, with sinuous edges and of differing depths, both within each pond and between different excavations; other ponds should be deeper and larger.
- 14 Reinststate dyke infrastructure to provide additional open water habitat and a network for transporting fen produce. Re-open some existing dyke systems; new dykes in peat should only be excavated after careful consideration due to the possible implications to invertebrates and of disrupting spring flows or causing damaging local drainage. Some dykes should be reprofiled with long sloping edges to encourage the development of transitional communities and to provide suitable bittern habitat; other edges should be left abrupt and steep for the benefit of species such as the water vole.
- 15 Where river water quality is an issue, a network of dykes may be created from one connecting dyke, to minimise the effects of river water on the fen communities.
- 16 Develop substrate maps to indicate the depth and extent of peat throughout the fens. Include areas outside the existing fen area, particularly where flooding would occur without regular pumping. Areas with deep peat may have potential to develop species rich fen and may be of archaeological significance.
- 17 Encourage the employment of marshmen over large areas to carry out routine tasks associated with fen management, including checking livestock and managing water flow and levels.

18 Investigate the potential benefits and opportunities for semi-natural vegetation on valley margins, for example, as buffer zones to reduce nutrient and pesticide inputs, or as part of a grazing system.

The benefits of implementing the Broads Fen Management Strategy in relation to the UK Biodiversity Action Plan and the EC Habitat and Birds Directives

Introduction

It must be stressed that the Fen Management Strategy has taken a holistic approach, aimed at maintaining a range of functioning habitats and assemblages of species. The major aim has been to maintain biodiversity in its widest definition, including diversity between and within ecosystems and habitats; diversity of species, and variation within species. However within this context, priorities have been identified and set out in the UK Steering Group Report and the Broads Special Area of Conservation and Special Protection Area status under the EC Habitat and Birds Directives. The Following section highlights the Benefits of implementing the Fen Management Strategy for those identified priorities. It must be stressed that this recognises but a small fraction of the nature conservation benefit of implementing the Fen Management Strategy.

The benefits of the Broads Fen Management Strategy in the delivery of biodiversity priorities presented in the UK steering group report

The Fen Management Strategy will deliver the following elements of the UK biodiversity costed action plans for priority habitats and species within the Broads, (the national targets being emboldened);

Reedbeds

Rehabilitate by the year 2000 the priority areas of existing reedbed and maintain there after by active management. In the Broads this translates to 290 hectares of open reedbed and a further area, estimated at 110 hectares, presently covered in dense scrub. This target, according to the RSPB research could support 20 pairs of bittern and provide optimum conditions for other reedbed species. In addition we would expect that further pairs of bittern would utilise the areas of restored wet fen communities.

Create (nationally) 1,200 hectares of new reedbed on land of low nature conservation interest by 2010. In the Broads, although it is outside the scope of this strategy, it is estimated that some 400 hectares of new reedbed could be created on presently arable areas within the drained marshes. Alternatively, this area could also be restored to lowland wet grassland. The new reedbed should be in blocks of at least 20 hectares with a priority for creation in areas near to existing fen or reedbed habitat, and linking it wherever possible. The Broads target if achieved could provide, according to RSPB research, habitat for an estimated 20 breeding pairs of bittern.

Fens

Identify priority fen sites in critical need of, and initiate, rehabilitation by the year 2005. All rich fen and other sites with rare communities should be considered. The Broads Fen Strategy identifies the priority sites for rehabilitation, this equates in total to some 2700 hectares. This figure includes the restoration of 1000 hectares of rich fen currently covered in dense scrub, and the bringing into ongoing favourable management the total of 2700 hectares of rich fen.

Water Vole (*Arvicola terrestris*)

Maintain the current distribution and abundance of the species in the UK. Ensure that water voles are present throughout their 1970's range by the year 2010. The present strategy would bring about the restoration and ongoing management of dyke systems within the 1945 hectares of open fen, in addition to the creation of new dyke habitat within a further 1130 hectares to be cleared of scrub. Such habitat creation and ongoing appropriate management will be likely to strengthen and expand the water vole population in the Broads considerably.

Otter (*Lutra lutra*)

Maintain and expand otter populations. The strategy through the restoration of open fen and dyke systems and maintenance of extensive blocks of alder carr will provide a significant improvement in potential otter habitat in the Broads.

Bittern (*Botaurus stellarus*)

To arrest the decline of bittern, maintaining at least 20 booming birds over the present range, and start to increase the population and range before the year 2000. Increase the population to about 50 booming males by 2010, by ensuring appropriate management of the existing 22 large reedbeds where bittern once occurred. The Fen Strategy will secure the present population of bittern in the Broads. Restoration works on both fen and reedbed habitat including networks of dykes and turf ponds could increase the Broadland population, according to RSPB research, to 20 booming birds. Creation of new reedbed areas within the drained marshes could also support a further 20 pairs, if undertaken.

Large copper butterfly (*Lycaena dispar*)

Identify areas of suitable habitat in which to re-establish this species, encouraging restoration and maintenance of habitat as required. If suitable habitat is located, consider further strategic re-introductions. Research aimed at identifying the suitability of the Broads fen series as a possible re-introduction site is ongoing. Should it prove suitable, then the restoration of fen sites and dykes, and importantly dyke margins is seen as an essential prerequisite. The results of the research on the detailed habitat requirements for the large copper butterfly are already informing fen management at particular sites.

The Snails (*Anisus vorticulus* and *Segmentina nitida*)

Enable existing populations to increase in size and spread in range. Management of aquatic habitats at extant sites will benefit these species while the restoration and creation of new aquatic habitat throughout the fen series will provide opportunities for these species to expand their range.

Desmoulin's whorl snail (*Vertigo moulinsiana*)

Maintain viable populations of the snail across its current range to ensure favourable conservation status. This species requires open fen conditions dominated by tall growing

wetland plants. The strategy will secure open fen conditions in extant sites and through restoration dramatically increase the habitat available to this species.

Fen orchid (*Liparis loeselii*)

Maintain existing populations and where feasible, re-establish at 4 sites where it has recently become extinct. The above target will be met through the restoration and ongoing management of extant and possible reintroduction sites. The Broads Fen Management Strategy aims to achieve this.

Holly-leaved naiad (*Najas marina*)

Maintain at its known sites. Recolonise five waterways adjacent to existing sites by 2004. Recently this species has been recorded as an early coloniser of new deep turf ponds. It is unknown if the populations will persist or form a transitory element of the succession. However the Strategy does highlight the importance of creating new aquatic habitat, both dykes and turf ponds. Such habitat in the fens, where water quality is relatively high, is likely to be important in the achievement of the national target for this species.

Slender green feather-moss (*Hamatocaulis vernicosus* formerly *Drepanocladus vernicosus*)

This species has been recorded from Catfield Fen and Smallburgh Fen. Maintenance of this species, and indeed moss-rich communities, are reliant upon maintaining an open short sward. At present only a very small area of fen is managed to achieve such a condition. The Strategy recognises this fact and addresses it through the implementation of widespread extensive grazing regimes and a greater area coming into regular mowing.

The benefits of implementing the Fen Management Strategy on the Broads Special Area of Conservation and Special Protection Area interests

The Broads Special Area of Conservation recognises seven internationally important features; three fen features, alder woodland, aquatic communities rich in pondweeds, fen orchid and Desmoulin's snail, while the Broads Special Protection Area recognises eight species associated with fen habitats, of international importance; bittern, marsh harrier, hen harrier, gadwall, shoveler, pochard, teal, Savi's warbler and bearded tit.

The Fen Management Strategy will restore and bring back into active management the present open fen area, including 825 hectares which is recognised as internationally important. The Strategy will also recreate open fen conditions on a further 1130 hectares of presently dense scrub and woodland. We expect that an estimated 500 hectares of this will support fen vegetation of international importance in time. This would increase the area of internationally important fen by some 60%. The improved management and greater area of fen habitat will enhance populations of all nine internationally recognised bird species associated with fens.

The Strategy will retain a representative series of alder woodlands within the Broads fen series. Much will be maintained through non-intervention management, although a significant area will be returned to a coppice rotation, thereby diversifying the range of woodland types.

The Fen Management Strategy will also bring about the restoration and maintenance of the dyke systems within the fens and within areas to be cleared of scrub. In addition the creation of new turf ponds will increase the habitat available for assemblages of aquatic plants. The increase in aquatic habitat and improved management will benefit bittern, shoveler, pochard and teal.

The benefits to fen orchid and Desmoulin's snail are covered in the previous section.

ANALYSIS OF FEN VEGETATION RESOURCE SURVEY & SUGGESTED MANAGEMENT

ANT VALLEY FENS

Categories of fen & appropriate management

The majority of the Ant Fens are sump wetlands; these are characterised by extensive areas of *Cladium mariscus* & *Phragmites australis* fen vegetation

Includes the Barton Fens, Sutton Fen, Catfield Fen, the Barton Hall Fens & Reedham Marshes.

In the upper reaches of the Ant, at Barton & Sutton Fens, the dominant community is B17; downstream at Catfield B17 becomes co-dominant with B32; downstream further, the Reedham Marshes are dominated by B32 & B27.

A study of pH & fertility data available for the Ant valley fens show that there is little variation between the areas. Fertility is generally higher towards the upland margins, and pH tends to be lower. This may be caused by oxidation of the peat through drainage, with associated nutrient release & acidification on wetting. There is a pattern in soil conductivity, which may be significant in determining communities within the fens.

B17 is dominated by *Cladium mariscus* & *Phragmites australis* with a diverse herb, bryophyte & pteridophyte flora. B17 is an extensive community within the Ant, but unusual in the other river valleys except for the Bure. B17 has affinities with the nationally important S24d, f & g *Phragmites australis*-*Peucedanum palustre* fen.

A wet community with a good bryophyte flora, B32 generally develops over old turf cuttings & is dominated by *Phragmites australis* & *Typha angustifolia*; *Agrostis stolonifera* is often also present in abundance, and may form a dense mat. Management to maintain B32 involves harvesting the reed on a double wale, but if succession is allowed to continue it is possible that this community may develop into B19, dominated by *Phragmites australis* & *Agrostis stolonifera* and with *Juncus subnodulosus* as a constant associate; B27, a drier reed-dominated community, or B17, as described above. B32 has affinities to S4 reedswamp & the nationally important S24 *Phragmites australis*-*Peucedanum palustre* fen & is scarce outside of the Ant valley.

B27 represents a generally species-poor, reed-dominated community with few other constant associates. This is a widespread community within Broadland & large proportions are managed commercially for reed. B27 is closest to S4 reedswamp. Although this is not a botanically impressive community, it provides valuable invertebrate habitat when either left unmanaged or harvested on a long rotation, & when managed on a more regular basis may have great potential as bittern habitat, provided the water management is appropriate.

Most of these sump fens (see above) have a long history of harvesting by mowing, either for reed, sedge or marsh litter. The abundance of *Cladium mariscus* dominated habitat & the unstable nature of many of these fens due to former peat excavation supports the case for continuing a mowing-dominated harvesting regime. However, some of the areas which were formerly drained and used for rough grazing, particularly parts of the Barton Fens, Hall Fen &

Sharp Street Fen, may benefit from being managed through use of an extensive grazing system.

There are also opportunities for further turf pond creation; however, deep peat is a rare resource, is of archaeological importance and in some cases may play a vital hydrological role. Compilation of information on peat depth & extent should be a requisite before further turf excavation occurs.

As the Ant valley fens form some of the most diverse & botanically important in Broadland, tree & scrub habitat which has developed relatively recently is likely to be comparatively less important & depending on result of a survey, the majority should be cleared to favour open fen. A notable & important feature of the Ant valley are the areas of birch woodland, growing on *Sphagnum* spp-*Dryopteris* spp tussocks; these should be retained, with the exception of rotational clearing of big birch & as the birch forms an important component of these communities. All nationally or internationally important woodland or scrub communities should be retained.

Abstraction of substantial volumes of water occurs adjacent to Catfield Fens & Sutton Fens, and anecdotal information suggests that they may be drying out. Water levels may require monitoring and if scientific evidence of damage becomes evident, abstraction licences & alternative sources of water may need to be considered.

One area of fen in the upper reaches of the Ant is fully influenced by fluvial processes & may be termed a waterfringe wetland

Sutton Broad Fen provides the only (?) example of vegetational succession through colonisation of the former Broad, the majority of which appears to have taken place during this century. Other areas provide small examples, but for much of its length, flood protection works along the River Ant & erosion by boat traffic have limited the development of waterfringe habitat.

The main community type close to the water is B32, dominated by *Phragmites australis* & *Typha angustifolia*. As a wet community which develops over old peat cuttings, B32 is often good for bryophytes & may be maintained by a double wale cut. Some of the vegetation adjacent to the channel has developed through succession into B19 which is dominated by *Phragmites australis* & *Agrostis stolonifera*, with *Juncus subnodulosus* as a constant associate.

B29 occurs landwards of the B32 swamp, is dominated by *Phragmites australis*, with *Peucedanum palustre* as a constant associate, and has close affinities with the nationally important S24e(i) fen. B29 may be quite species rich & generally support a number of nationally rare or scarce species, including *Cicuta virosa*, & *Sium latifolium*.

Further away from the water, between B29 & the drier tall herb fen & scrub communities are combinations of species rich communities, such as B15, B16 & B17, characterised by *Cladium mariscus*, *Juncus subnodulosus*, *Schoenus nigricans* & *Phragmites australis* as dominant species.

In the absence of intervention, this area will provide a good example of hydrosere succession for a limited time period, the climax vegetation being a woodland community. However, the fen is important for a number of rare species and is too highly valued to allow woodland develop in favour of open fen.

New opportunities for hydrosere succession could be created in some areas and managing the vegetation to maintain the sere stages in other areas. Following a survey to establish the status of the woodland communities which have developed, areas of the former Sutton Broad could be excavated. Mowing management of some of the existing communities forming part of the hydrosere development could maintain the current interest; whilst other areas could be left as non-intervention fen to allow the process of vegetational succession to develop to its natural conclusion. As a suggestion, half of the north side could be a possible location for excavation; the other half being left as a non-intervention zone for some time into the future; the south side could be managed by mowing. Specific requirements for rare species will need to be taken into account.

The influence of river water is likely to decrease towards the margins of the sump fen and for those areas which are more isolated from the main fen area

These fen areas include Smallburgh Fen, East Ruston Common, Honing Common, South Fen & the Holmes, Broad Fen, marginal areas of the Barton Fens & the Sutton Fens, Barton Hall Fens & Catfield Fen, & Hulver Ground.

These fens provide the main location for the communities which are rare in Broadland. Nine of the fourteen rare communities found in the Ant valley are confined to the upland margins where external influences become important. The majority of these communities are low-growing, transitional in character between fen meadow, mire & sedge beds & support acidiphilous plants. The acid nature of areas of fen on the upland margin is probably a consequence of better drainage and associated oxidation of the peat, which then generates acidic conditions when re-wetted, or as a consequence of adjoining bedrock which may be base poor.

The development of species-rich, transitional communities which are rare in Broadland may be a consequence of location. Due to their marginal location & good access, these areas have a long history of regular management, often by grazing animals. However, because of the intensification & expansion of agriculture, these transitional communities have often been reclaimed for more intensive use, making them rare.

The rare Broadland fen communities characteristic of the upland margins are B8, B11, B16, B21, B22, B23, B31, B35, & B36. Most of these communities are species-rich and support abundant & diverse bryophyte flora. Two other communities which are rare in Broadland but which are not considered to be particularly valuable are B37 & B34.

B8 is a diverse heath/mire transition community; B11, a fen meadow community characterised by an abundance of *Carex disticha*; B16, a species rich community with *Juncus subnodulosus* & *Schoenus nigricans* as constant & often abundant components; B21 a transitional & diverse community with a strong mire element characterised by species such as *Potentilla palustris* & *Carex rostrata*; B22, a community rich in low growing sedges, and characterised by an abundance of bryophytes (a calcareous/alkaline community); B23, a community rich in bryophytes & low sedges, but dominated by a mixture of *Juncus subnodulosus* & *Carex disticha*; B31 a community characterised by a mosaic of low growing areas dominated by *Juncus subnodulosus* & sedges, and taller vegetation dominated by *Phragmites australis* & *Typha angustifolia*; B35 is a transitional tall herb fen community where grasses and herbs are prominent; B36 is a mire community characterised by the presence of *Carex rostrata* & *Eriophorum angustifolium*.

Wherever possible, these rare & diverse transitional communities should be given an opportunity for expansion. Clearance of woodland & scrub communities may allow expansion within the existing fen area; reversion of agricultural land may, in some instances allow

landward expansion. This latter option may be of particular importance with rising sea levels, as the transition communities will then be squashed from both sides.

An extensive grazing system, using suitable large herbivores is most likely to encourage the expansion of transition communities. Grazing will also maintain open fen & enhance the development of a mosaic of structure within communities. Where possible, grazing systems on the fen areas should also incorporate high dry areas of land which may either currently be woodland, or agricultural. Large areas with a mixture of wet & dry habitats may then be suitable for very extensive near-natural grazing systems, where animals may remain on site all year round. Such systems could become sustainable & eventually require minimal intervention & small on-going financial commitments.

Some areas of former fen have been so altered by management or surrounding activities that they may best be classified as grassland or woodland; however, depending on factors such as substrate, water supply, past history & landownership, the full potential for restoration to fen requires exploration. Some areas are already under grazing management, although this may often be too intense to support fen vegetation, or may involve such a small area that the effect on the vegetation is uniform. Reducing grazing densities and enlarging the grazing unit would allow more variety of structure & habitat to develop.

Areas of woodland require surveying to establish status & then clearance, particularly of areas which have potential for restoration to a rare transitional community.

ANT VALLEY FEN SITES

1 Honing & East Ruston Commons

This area includes East Ruston Common (encompassing East Ruston Allotment, Mown Fen & Kings Fen), Honing Common & Dilham Broad

East Ruston Common - A large area of unimproved wet heathland & fen situated in the valley of the Hundred Stream, which is a tributary of the River Ant. The high ground is composed of sand & gravels & supports a dry acidic grassland, which grades through wet acidic grassland into fen vegetation at Mown Fen. Much of the northern area of the Common has been damaged by water abstraction (dating from the 1970's) & a fire in 1990. Now, much of Kings Fen remains as bare oxidised peat, and damp acidic grassland occurs only locally.

Over the past 50 years the proportion of the Common which is covered by scrub & woodland has increased dramatically, from circa 35% coverage in 1946 to approximately 85% in 1995. Due to the disturbed condition of the site & the extent of scrub & tree invasion, only a small proportion of the site was classified during the fen vegetation survey, the rest is described by target notes. Most of the open vegetation has been classified as MG1 grassland (no equivalent broadland category), whilst a small area of the nationally important S24 *Phragmites-Peucedanum* (B19) fen vegetation occurs at Mown Fen.

Peat was extracted from Mown Fen during the 19th & early 20th centuries & the area was once of great botanical interest. Cessation of fen harvesting practises has allowed extensive scrub encroachment to occur, but historical information indicates that this site was very wet in the past & the effects of abstraction are likely to be far more damaging & permanent than vegetational succession.

However, it has recently been agreed between the water authorities & conservation bodies that the amount of water abstracted from the East Ruston borehole is to be reduced by 50%, which may allow the partial recovery of Kings Fen. Peat stripping is also to take place to

remove the damaged surface layers of peat (the damage is a consequence both of oxidation and burning), & improved site management is also to take place.

Management suggestions: (a) survey woodland areas to establish status; remove scrub & woodland if area occupied is on peat, unless of importance within own right; (b) secure area with perimeter fencing & establish a system of extensive grazing (either summer or all year round), with the objective of creating and maintaining a mosaic of habitats, including wet & dry acid grassland & heath, fen, open water, scrub & woodland.

Honing Common - appears to have been a former site for *Liparis* (until 1968 or thereabouts), this area is now 80% covered by scrub & woodland, about half of which has developed during the past 50 years. A small area of rough grassland MG1 (no equivalent broadland classification) occurs to the south of the site. During the first half of this century, the site was rough grazing marsh with heath on the higher ground and large areas of acid flush vegetation.

A combination of the lack of grazing & desiccation appear to be responsible for the changes that have taken place. The historical information shows, however, that some areas were still herb rich and of interest as recently as 1971 (see site dossier, fen resource survey)

Management suggestions: (a) Survey of woodland to establish status; (b) Clear woodland & scrub from area between road & disused railway line, as this area was recently described as still being of botanical interest (similar to Smallburgh Fen ?); (c) If water resources are assured into the future, this area may be worth trying to restore to a fen vegetation;

Vision: Consider the possibility of joining the two Honing Commons, north & south of the disused railway line & Dilham Broad, by heath/semi-natural vegetation; and managing the whole unit as an extensively all year round grazed area, to achieve a large area supporting a mosaic of habitat

Dilham Broad - The pattern & extent of terrestrialisation of this peat cutting area suggests that Dilham Old Broad may have dated back to medieval times. By the mid-19th century the site had been drained for grazing land; the area is surrounded by a ditch & bank, with the remains of a weir in the channel. There is no historical information available concerning any former botanical interest. This site is approximately 7 hectares in size, about half of which is woodland.

Suggested management: (a) carry out a soil survey to establish depth & extent of any peat substrate; (b) if water levels can be easily & sustainably raised, consider allowing site to become gradually wetter to restore wet species rich fen/fen meadow; this may only be worthwhile if peat is shown to be present; (c) if it were possible to make the site substantially wetter, this site may be of value as part of a potential bittern area, although the 7 hectare size means that it would need to be linked in with other areas of fen vegetation to be considered as worthwhile. (d) if water levels cannot be easily & sustainably raised, consider encouraging a more extensive grazing system, allowing a mosaic of woodland, scrub & grassland to develop. (e) consider the possibility of turf pond creation, especially if water levels can be raised;

2 South Fen & The Holmes

These include five fragmented areas of land form part of a once-continuous strip of fen stretching from East Ruston to Wayford Bridge. This area may never have been cut for peat, and there are very few species records for the site, although there is a long history of grazing. The total area is approximately 35 hectares.

South Fen is still used for grazing & is virtually scrub free - the main community recorded is MG10. There is no equivalent broadland classification, as South Fen is no longer really a fen. Two of the smaller areas are dominated by woodland.

Management suggestions: (a) carry out a soil survey to establish whether peat occurs, and if so to what extent & depth; (b) consider feasibility of sustainably raising water levels; (c) if site is peaty & water levels can be raised, then some surface stripping of oxidised soils maybe necessary to reduce nutrient levels; (d) if site cannot be made easily wetter, and peat is not present, then continue to manage by grazing, maintain dykes and consider creating a series of shallow footdrains to improve the habitat for birds such as snipe;

Vision: Recreate a linked & hydrologically intact mosaic of fen, acid grassland, heath, woodland & scrub from East Ruston to Wayford Bridge; manage by grazing large herbivores extensively.

3 Broad Fen & Smallburgh Fen

Broad Fen - an area of floodplain fen (approximately 40 hectares), which has developed through terrestrialsation of former peat cuttings. With the exception of the newly created turf ponds, very little of the former broad is still open. The site has a history of regular mowing & burning.

The area of greatest botanical interest lies over the basin of the extinct broad, where the vegetation is fairly short in stature & there are areas of species rich *Cladium mariscus* dominated fen, as well as more diverse small sedge communities described by the broadland communities B16 & B17. Elsewhere, the vegetation is dominated by tall herb fen, some of which is species-poor reed-dominated fen.

The main community types found at Broad Fen are B19, which is fairly species poor & dominated by *Phragmites* & *Calamagrostis*; B20, a diverse transitional fen meadow community dominated by *Juncus subnodulosus*; & B16 a species rich, low growing sedge bed community, with abundant *Juncus subnodulosus* & *Schoenus nigricans* (all with affinities to the nationally important S24 *Phragmites-Peucedanum* fen).

B16 is a rare community in Broadland (< 10 hectares), as are B34, a wet, grass-dominated community in which *Glyceria*, *Sparganium* or *Phragmites* tend to be dominant, and *Peucedanum* is frequent, & B35 a herb rich transitional tall herb fen community, dominated by *Juncus effusus* & *Agrostis stolonifera*.

Broad Fen was a former location for *Liparis loeselii* & was last recorded in 1957.

Woodland & scrub now cover at least two-thirds of this site; 50 years ago, this figure was about one-third. Surrounding the fen, the semi-mature alder carr has an interesting ground flora.

Abstractions of water in the immediate vicinity of the Broad are of concern.

Management suggestions: (a) Establish a groundwater monitoring system and ensure water supply does not decline/deteriorate; (b) survey woodland to establish status; (c) encourage restoration of *Cladium* beds and commercial removal for thatching (d) summer mowing of low growing communities over former Broad basin on a regular basis (every 2-4 years); (e) removal of majority of woodland & scrub communities, followed by harvesting of other fen vegetation on a rotational 4/5 year basis; (f) retain some marginal woodland & clumps of scrub for bird & invertebrate species; (g) monitor development of new turf ponds & consider possibility of creating further shallow scrapings over a period of years; (h) carry out a soil

survey, and if deep peat occurs in areas which currently support impoverished or species poor vegetation, consider creating shallow turf ponds (NB deep peat is a rare resource, so this must be done in a balanced way). (i) reinstate any old dykes, but install sluices & dams to retain good water levels; no new dykes to be created due to the possible danger of diverting spring flows away from the fen areas;

Smallburgh Fen - a small area of spring-fed calcareous valley fen & carr woodland bordering a tributary of the River Ant. The site has a long history of grazing & mowing management until the second world war, when apart from mowing of the central area for shooting purposes, management ceased. Large local abstractions may now be threatening the interest of the site.

Much of the site is now covered by woodland, except for the central area which is mown annually and is of exceptional botanical interest and supports abundant *Schoenus nigricans* within a species-rich bryophyte lawn. This community was classified as B22, which is rare in Broadland (< 10 hectares) and is of particular importance, as bryophyte-rich communities are rare & declining.

Management suggestions: (a) reduce regularity of mowing to allow fuller development of vegetation components & a greater variety of vertical structure (see comments in historical dossier in fen resource survey); (b) carry out a woodland survey to establish status; (c) depending on the results of the woodland survey, all scrub and most woodland should probably be removed, concentrating initially on expanding any species rich clearings & on the woodland surrounding the main opening area; (d) this area should be considered for a possible very extensive grazing regime; otherwise, management is likely to be dependent on a specialised input of mowing every 3/4 years. (e) ensure continued sufficient water supply to the site.

4 Barton Fens, Common Fen & Stalham Fens

In the Fen Resource Survey, Barton Fen refers to the whole of the western side of the River Ant, from Wayford Bridge in the north, to Barton Turf in the south. The Barton Fens include Common Fen, Barton Fen, Berry Hall Fens, Mallow Marsh, Barton Turf Fens & Barton Hall Fens. Just downstream of Wayford Bridge to the east of the River Ant is a block of marsh/fen known as Stalham Fens. The total area of this block is approximately 134 hectares.

A large proportion of this area of fen was drained in the past & grazed, and much has been cut for peat. The areas which were grazed are now vegetated by *Calamagrostis canescens* & *Juncus subnodulosus*, whilst some of the open sedge & reedbeds correspond to 19th century turf ponds.

The main vegetation type is B17, which is species rich & codominated by *Cladium mariscus* & *Phragmites australis*. B14 is also a frequent community and is very similar to B17, but slightly less species rich and generally corresponds to commercially managed sedge beds.

B18 & B19 are quite extensive within the Barton Fens and both are co-dominated by *Phragmites australis* & *Calamagrostis canescens*; however, *Juncus subnodulosus* is also a constant species in B19, whereas B18 frequently supports *Cladium mariscus* & *Myrica gale*, & may be a later successional stage than B19. Both B18 & B19 have affinities with the nationally important S24d & g.

An area of *Holcus lanatus*-*Juncus effusus*-*Agrostis stolonifera* rush pasture occurs as part of the Stalham Fens (this may also be classified as M27c *Filipendula ulmaria*-*Angelica sylvestris* swamp).

Towards the western edge of the Barton Fens is a narrow band of acid-heath vegetation, dominated by birch, heather & gorse, with wet mire areas supporting species such as *Sphagnum*, *Eriophorum angustifolium*, *Erica tetralix* & *Carex rostrata*. These mire communities are typified by B36, B21 & B8, which are rare Broadland communities (< 10 hectares). This area is thought to overlie glacial drift.

The aerial photographs indicate that as recently as 50 years ago, this fen complex was virtually free from scrub or woodland. Scrub & woodland currently account for 60% of total area on this site; about half of which is mature woodland, the rest is fairly open or low-growing scrub.

Management suggestions: (a) survey all woodland and scrub to establish status; (b) clear all scrub as a priority, unless of international importance; (c) encourage development of rare transitional communities by clearing scrub & woodland along upland margins, & consider possibility of grazing these areas extensively; (d) encourage & support commercial management of sedge beds, whilst recognising that a slightly longer rotation of mowing than is usual may encourage the development of a more species rich sward (B17 instead of B14); (e) Consider very extensive (summer) grazing systems for the Stalham fens to maintain & enhance the components of the nationally important S24 *Phragmites-Peucedanum* fen community; summer grazing could also be considered for parts of the Barton Fens, in particular Mallow Marsh. (f) Carry out a soil survey to establish location, extent & depth of peat. (g) Consider creating turf ponds either on areas dominated by B18/B19 or on areas which are currently covered by woodland or scrub; this may encourage development of species-rich *Cladium* communities for future years. This may particularly apply to the Stalham Fens, Common Fen, the Berry Hall Fens & south of the Berry Hall Fens. NB Uncut peat is a rare commodity; the evidence suggests that B18 & B19 occur on deep uncut peat; if this is the case, the possible floristic benefits must be weighed against the loss of a deep peat resource. If deep peat is to be cut, archaeological importance must first be looked at. (h) encourage & support any commercial harvesting of reed, to favour double- over single-whale rotations. (i) Harvest remainder of fen vegetation on a 3/4 year rotation using biotechnology. (j) Reinstate & maintain all dyke systems. Avoid cutting new dykes, due to the possibility of interrupting & diverting spring flows. (k) Make dykes of a double width where possible, with bittern friendly edges. (l) leave small clumps of woodland or scrub to provide a mosaic of fen habitat.

5 Sutton Fen, Sutton Broad & Hands Marsh

This area includes the Sutton Broad Fens (encompassing Hand Marsh & Gnat Hill), Sutton Fen (encompassing Big Bog, Little Bog, Middle Marsh, Alder Carr & Sutton High Fen) & the Chapelfield Marshes, which are located between the junction of Stalham Dyke & the main channel of the River Ant. The total area of this site is approximately 180 hectares.

Sutton Broad Fens - The Sutton Broad Fens & Chapelfield Marshes occupy the basin of the extinct Sutton Broad, a medieval peat cutting which progressed from open water to fen at the beginning of the 20th century.

Sutton Broad is considered a valuable example of vegetational succession, from *Phragmites* & *Typha* dominated reedswamp (32) adjacent to the channel, through species-rich tall herb fen, to low-growing sedge dominated communities which grade into scrub & carr at the boundaries of the site. However, this interest will only remain if new opportunities for hydroseral succession are created, for example, by re-excavating a part of the Broad, or by management which will arrest the hydroseral development.

The main community types at Sutton Broad are B32 & B19. B19 is generally species poor tall herb fen which is dominated by *Phragmites* & *Calamagrostis*. B32 is dominated by *Phragmites* & *Typha*.

Three communities which are rare in Broadland are found at Sutton Broad; these are B16, B23 & B24. B16 is species rich sedge bed with *Juncus subnodulosus* & *Schoenus nigricans* as constant & often abundant components. B23 is rich in bryophytes, sedges of low stature & rushes, & is typically dominated by a mixture of *Juncus subnodulosus* & *Carex disticha*. B24 *Sphagnum* spp-*Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub, may also be classified into nationally important mire communities M13 & M5, with potential to develop into nationally important W2b.

Sutton Fen - Despite lack of cartographic evidence, it seems likely that much of Sutton Fen was also cut for peat. Much of the fens were cut for sedge until the mid 20th century; these sedge beds still exist but are rather species poor & are being invaded by scrub.

The main community on the open areas of Sutton Fen is B17, which is species rich sedge bed, dominated by a mixture of *Cladium* & *Phragmites*. Most of these areas could be restored to commercial harvesting, although the resultant communities are likely to be less species rich if managed on a 3/4 year rotation (B14). B18 & B19, the communities which are co-dominated by *Phragmites* & *Calamagrostis* also occur, but over quite a small area, as does B27, which is a *Phragmites* dominated stand & generally commercially harvested.

The whole site:

Most of these open fen areas may also be described as various sub-communities of the nationally important S24 *Phragmites-Peucedanum* fen.

The Sutton Fen complex is one of the strongholds for *Liparis loeselii*.

Anecdotal evidence indicates that the whole of this site may be under threat from water abstraction.

Only 50 hectares (about one-third of the site) remain free from scrub or woodland. The aerial photographs indicate that the majority of tree & scrub invasion has occurred since 1946, which would coincide with the general decline in fen harvesting associated with the post war years.

Management suggestions: (a) survey woodland & scrub habitat to establish status; (b) collate & improve information available on peat distribution & depth; (c) remove woodland & scrub (100 hectares ?), unless of national or international importance; (d) manage majority of fen vegetation by harvesting on a 5-10 year rotation, with the objective of developing species-rich open fen communities; (e) where possible, consider use of light summer grazing, particularly on the upland margins to encourage the development of transitional fen meadow communities; (f) consider possibility of creating a series of small turf ponds, to provide a mosaic of pools within fen vegetation; (see criteria for creating turf ponds). (g) avoid burning outside of the Hands Marsh area, where it is an established method of management; (h) encourage continued commercial harvesting of reed/sedge, but favour double whale cuts for reed & >5 year rotations for sedge where possible. (i) reinstate dykes & drains, but maintain water control structures to ensure no reduction in water levels. Dykes should be cut in a profile favourable to Bitterns & should not be connected to the River except by a network system, until it is established what influence river water has on the fens. No new dykes should be created because of the danger of diverting subsurface/spring flows. (j) ensure continued supply of water for site by installing dipwells & agreeing highest possible minimum levels; (k) where possible, incorporate agricultural land on upland margins into fen system;

particularly where extensive grazing is being considered as the most sustainable management option.

6 Barton Turf & The Heater

The Heater is a triangular-shaped island situated at the north end of Barton Broad, which has developed by the gradual encroachment of swamp vegetation over the basin of the Broad. The island is stable, but in places the mat of vegetation is no more than 30cm thick. The tree cover over the Heater was thinned several years ago. It supports a diverse pteridophyte & rich bryophyte community.

The Barton Hall Fens have also developed over the Broad basin, but to the western side. For a period of time these fens were used as a source of marsh hay and reed, and at the beginning of the century the area was swamp with islands of higher ground supporting an acidiphilous vegetation. This area may have great potential for the development of species rich fen.

Previous to being cleared of scrub The Heater was characteristic of W2b *Salix cinerea*-*Betula pubescens*-*Phragmites australis* woodland *Sphagnum* spp. sub community. The fen resource survey found this area difficult to classify because of recent scrub clearance work, and most of The Heater has surprisingly been classified as B18, a *Phragmites-Calamagrostis* dominated community, indicative of quite dry conditions, and generally not a bryophyte rich community. This area has alternatively been classified under various subcommunities of S24 & as W2b. **Q** Should the broadland code for this area be something else e.g. B24 ? i.e. is there a mistake with the data ?

The open areas of the Barton Hall Fens are dominated by B21 & B17. B17 is a species rich community dominated by a mixture of *Cladium* & *Phragmites*, with a diverse & abundant pteridophyte & bryophyte flora. B21, a rare community in Broadland (< 10 hectares) is typified by a sparse open canopy of *Phragmites australis* & mire species such as *Potentilla palustris*, *Carex rostrata* & *Sphagnum* species. B21 supports a diverse flora, has a varied structure, & is transitional between fen meadow, mire & tall herb fen.

Another community found at this site which is rare (but not particularly valued) in Broadland is B37, characterised by *Phragmites*, *Carex acutiformis* & a dense mat of sprawling climbers. However, this is an impoverished community type which has affinities to S26 *Phragmites-Urtica* fen & S4 *Phragmites* reedswamp.

Some areas within the Barton Hall fens may support quite mature woodland, as aerial photographs indicate that approximately half of the site was already dense woodland in 1946. In 1995, less than 20% of the total area remained as open fen.

Recent mowing management to restore some of the open areas on Barton Hall Fens has proved successful.

Management suggestions: (a) carry out a woodland & scrub survey to establish status; (b) remove all woodland not of national or international status within the main block of the Barton Hall Fens; (c) obtain information on peat depth & extent; (d) maintain clearings within the isolated blocks of woodland, and clear back scrub 20-30 meters from the edge of Barton Broad, to encourage the development of marginal vegetation & to provide additional habitat for birds such as the Bittern. (e) reinstate dykes to recommended profile for Bitterns; no new dykes should be created because of the dangers of diverting spring/seepage flow away from the fen areas; (f) consider criteria for turf pond creation, and if site meets requirements, these may be excavated as part of the clearance of woodland/scrub. (g) manage existing open fen areas by mowing on a 4/5 year or longer rotation, particularly the

Cladium rich communities, with the possibility of encouraging development of more extensive areas of B17 (with affinities to S24g & f); the areas of transitional fen, B21, may require more regular harvesting to develop their full species potential. (h) introduce mowing of the *Sphagnum* communities on the Heater; mow some areas annually, other areas on a longer rotation & monitor the effects; also mow the *Phragmites* dominated communities on a 2/3 year rotation. (l) there may be potential for development of transitional acid heath communities on the upland margins, which may require grazing management.

7 Catfield Fen & Irstead Holmes

This area includes a total of 36 compartments which are described in the fen resource survey under three main areas: (1) Great & Little Fen & Moores Head Marsh (which also includes Sedge Marsh, Fenside & Main Reed Marsh); (2) North, Middle & South Marshes, & Rose Fen (which also includes Mill Dyke & Catfield Broad); (3) Irstead Holmes (which also includes The Shoals).

North, Middle & South Marshes, & Rose Fen - are located to the eastern side of Catfield Fen. A large proportion of this area was formerly drained by windpump for use as grazing land. A bank separates this outer area of Catfield from the inner fens. There is little historical information relating to this part of Catfield, but when the pump fell into disuse, the marsh became progressively wetter until it reverted to fen.

These areas are on solid uncut peat; however, because of the drainage, the surface layers of peat have been oxidised. As a consequence of oxidation, nutrients are released & the soil fertility on these areas is higher than the rest of Catfield which has not been drained. When re-wetted oxidised peat is also self-acidifying, & the acidic communities which develop are often [mistakenly] attributed to acidic seepage water from Norwich Crag arising from the margins.

Irstead Fen - This area of Catfield is of considerable botanical interest, although rather degraded through scrub invasion. Cartographic evidence indicates that the area was cut extensively for peat in the late 19th century and the resultant turf ponds became terrestrialised, although parts of this area may still support uncut peat. There is little other historical information about the site.

The area is considered as most important for its colonies of the nationally rare *Dryopteris cristata*, although scrub communities have developed on approximately one-third of the site since 1946, including some of the botanically interesting communities.

Great & Little Fen, & Moores Head Marsh - much of this site was extensively cut for peat during the late 19th century and is of particular importance as an area for rare plants. The reed & sedge beds are also of importance although scrub has invaded much of Little Fen & the western side of Great Fen since 1946, with the reduced harvesting of fen products since the Second World War.

Moores Head Marsh, adjacent to Barton Broad, has developed on solid peat & may act as a buffer to the fen areas away from the river. Sedge Marsh also appears to be on solid, uncut peat.

Communities:

The main vegetation type is B17, characterised by a species rich sward & co-dominated by *Cladium* & *Phragmites* (affinities to S24f). This is an extensive community in Broadland, but has its stronghold in the Ant Valley, and approximately one-quarter of the total area of this vegetation type is found at Catfield. It is interesting to note that a fair proportion of this

community is managed commercially, and in general, the fen resource survey noted that commercial sedge beds were less species rich and were more suitably classified as B14. Could this be because the mowing is on a longer rotation ?

The next most frequently occurring community is B32 (affinities to the nationally important S24e(i)). Again this community is rare outside of the Ant, and one-third of the total area occurs at Catfield. This is generally a wet community formed over old peat cuttings and in which bryophytes are quite abundant. It is co-dominated by *Phragmites* & *Typha* & generally grows in conditions of low nutrients. It is considered likely to develop through succession into B17, or to drier reed or reed/grass dominated communities such as B19 or B27.

Five communities rare (< 10 hectares) & important in Broadland are found at Catfield; the most extensive of these are B24 *Sphagnum* spp-*Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub (which has affinities to M13, M5 & W2b) & B16 a species rich community in which *Juncus subnodulosus* & *Schoenus nigricans* are constant and often abundant components (affinities to the nationally important S24f).

Lesser amounts of the other three communities occur: B8 a diverse poor fen community, dominated by *Molinia* but supporting a number of acidiphilous species & a rich bryophyte layer (B8 has affinities to the nationally important M22d); B21, a diverse transitional fen meadow/mire/tall herb fen community of diverse structure & species composition (affinities to the nationally important S24d); & 36, a mire community characterised by the constant presence of *Carex rostrata*.(affinities to S24d)

Management suggestions: (a) survey woodland & scrub communities to establish status; (b) clear all scrub & woodland unless of national importance; (c) reinstate all dykes, profiling them favourably for Bitterns; no new dykes to be produced because of the uncertainty related to spring & seepage flows; dyke endings to remain closed to the river in the short term, until water quality improvements and/or more information on influence of river water entering sites via dykes; (d) ensure continued favourable water supply for whole site; in the long term, allowing slightly enriched water into the dyke system may be a better option than allowing the site to dry out - but this needs careful examination; (e) consider creating turf ponds, particularly on the eastern area of Catfield at South Marsh, where there is currently woodland; this area may benefit the removal of surface oxidised peat & lowering of soil fertility; other areas could concentrate on communities which are currently covered by scrub; (f) Support commercial management of sedge, retaining some areas which are managed on a longer rotation than the normal 4/5 years, to ensure continued existence of B17, favour of B14 (normal for commercial rotation); (g) support & encourage commercial harvesting of reed; avoiding where possible single-wale cutting; (h) harvesting of remaining fen vegetation on a 4-10 year rotation, although some areas may need annual or biannual mowing to encourage survival/expansion of particular key species. (i) clear all scrub from dyke edges & the edge of Barton Broad; mow dyke edges in accordance with recommendations favourable to Bitterns; (j) ensure that management encourages the survival and expansion of the rare Broadland communities; (k) consider extensive (summer) grazing for parts of the eastern block of Catfield Fen, where the vegetation is predominantly by fen meadow & poor fen communities. This may encourage the development & expansion of transitional & rare fen communities.

8 Reedham Marsh, Sharp Street, Hall Fen & Alderfen

An extensive area (circa 150 hectares) of floodplain mire situated on the River Ant immediately south of Irstead village. The area encompasses Reedham Marshes, Snipe Marsh, Clayrack Marshes, Little Reedham & Hall Fen. Alderfen, located in a small tributary valley of the Ant to the West of Reedham Marshes, is also included within this site.

Much of the fen area has developed from former grazing marsh which became inundated through cessation of active drainage. Some areas were formerly cut for peat, including Reedham Water itself, parts of Reedham Marsh, Little Reedham & Alderfen. Clayrack Marshes is the only area which is currently grazed, although some compartments are mown commercially for reed & sedge.

Woodland & scrub account for approximately one-third of the total area of this site. The aerial photographs for 1946 indicate that most of this woodland & scrub was already present 50 years ago.

The most extensive fen community is B27, which occupies approximately 15% of the site. B27 is dominated by *Phragmites* & represents much of the commercially managed reedbed in this area; it has affinities with S4 reedswamp & S24 *Phragmites-Peucedanum* fen.

Other quite extensive communities include B32, dominated by *Phragmites* & *Typha*, which develops over former peat cuttings; B19 which is co-dominated by *Phragmites* & *Agrostis*, with *Juncus subnodulosus* as a constant species, & generally occurring over solid peat; & B28 which is dominated by a dense mat of *Agrostis* with *Phragmites* or *Typha angustifolia* as associates, but very rarely with rushes, and is generally found over peat cuttings. Both communities have affinities to S4 reedswamp & S24 *Phragmites-Peucedanum* fen.

In addition, seven communities which are rare (< 10 hectares) in Broadland are found at this site; these are B7, B11, B37, B21, B24, B34, B35 & B36.

B7 & B11 are both most notably found on Clayrack Marshes & represent low growing fen meadow communities (affinities to M23a & nationally important M22d). B37, despite being rare in broadland, is not a particularly valued community, being dominated by *Phragmites*, *Carex acutiformis* & a dense mat of sprawling climbers (affinities to S4); B21 is a diverse, transitional sedge fen community (affinities to S24d); B24 is *Sphagnum spp-Dryopteris spp-Thelypteris thelypteroides* open birch scrub (with affinities to the nationally important woodland community W2b); B34 is an enriched *Glyceria* swamp community (with affinities to S24 & S5), which with improved water circulation may develop into more highly valued communities such as B35 or B36. B35 is a transitional tall herb fen community (with affinities to S24d) & B36 is a mire community characterised by the presence of *Carex rostrata* (affinities to S27b).

However, *Glyceria* swamp is very important for the snail killing fly, so areas should be maintained.

Management suggestions: (a) survey woodland & scrub to establish status; clear all woodland & scrub unless of national or international importance; (b) establish depth & extent of peat via a substrate survey; (c) Raise water levels where this is sustainable (i.e. by gravity or sluice control), particularly on Reedham Marshes where there is already and extensive *Phragmites-Peucedanum* dominated community, as well as areas of *Cladium* dominated communities, which may benefit from higher water levels; (d) Reinstate dyke system, taking into account the most favourable profile for birds such as the Bittern; no new dykes should be created without an understanding of water movement (particularly telluric waters); (e) introduce summer grazing where possible, particularly on Hall Fen & possibly the Sharp Street Fens, using suitably adapted large herbivores; where necessary, this may involve creating higher areas of land by using dyke dredgings as refuge areas in times of unexpected high water levels; ideally, though, upland should be incorporated as dredgings create loss of fen habitat; (f) where possible incorporate adjacent upland into any grazing system, and wherever possible, explore the option of an extensive all-year round system. (g) Harvest fen vegetation on a rotational basis; encouraging double rather than single-wale mowing for reed; 4/5 year or longer rotations for sedge dominated communities; & all other fen vegetation on a 5-15 year rotation. A long rotation for some areas is particularly important

because of invertebrate species such as the Reed Leopard Moth which require undisturbed areas of deep litter. Communities where *Phragmites* & *Cladium* may be co-dominant should be managed on a rotation to favour the sedge community, as these are potentially more diverse than reed dominated areas. (h) Consider possibility of creating turf ponds in the areas that are currently scrub dominated; alternatively, the areas of B19 representing dry tall herb fen could be targeted, although this community may be on uncut peat, and this in itself is an important resource. (l) mow dyke edges on a one/two year rotational basis; (j) clear all scrub back from waters edge (dykes, river, Alderfen and Cromes broads) (k) link fen habitat at Alderfen & Snipes Marsh to the main block of fen.

Many of these grazing/mowing/dyke edge management suggestions will be important for the Large Copper as this area is a key area for *Rumex hydrolapathum*.

Site 25 Hulver Ground

Hulver Ground - parts of this 7/8 hectare site are almost completely covered by dense scrub & open carr woodland. About half of the site may be classified as B27 & the other half as B18 (both communities have strong affinities with S24) The site is important for its areas of species rich *Cladium mariscus* beds, and at the time of the survey, there was a small colony of *Dryopteris cristata*. This site has been completely cut for peat & is of enormous potential, but in urgent need of management.

Suggested management: (a) survey of scrub to establish status, and dependent upon the results, urgent removal of scrub, from most open areas to start with; (b) maintenance of open fen communities by grazing with appropriate large herbivores; (c) restoration of *Cladium* sedge bed onto 4 year+ rotational mowing;

RIVER BURE FENS

Categories of fen & appropriate management

The upper reaches of the Bure support soligenous sloping fens dominated by rush pasture and fen meadow communities

These areas include Horstead, Coltishall & Belaugh Marshes, Crostwick Common & Dobbs Beck, Belaugh, Wroxham & Jubys Farm Marshes.

The main community types are B10 *Holcus-Juncus effusus-Agrostis stolonifera* rush pasture (with affinities to MG10 & M22d); B9 *Juncus articulatus-Holcus lanatus-Lotus uliginosus* fen meadow (with affinities to M22c) & B12 *Filipendula ulmaria-Carex acutiformis-Juncus subnodulosus* fen meadow (with affinities to M27 & M22a).

B10 is one of the most extensive communities in Broadland, & is dependent upon grazing to maintain the structure & floristics of the sward. Grazing density is important to the herb component of this community, higher densities encourage the vegetation to become closer to a typical MG10 mesotrophic grassland; lighter densities encourages a sward more similar to the internationally important M22d community.

B9 is a rare community in Broadland, extending to less than 10 hectares in total, of which over half occurs in this section of the Bure valley. Grasses, small sedges & abundant small herbs characterise the sward & is maintained by light grazing or occasional mowing.

B12 also has its stronghold in the Bure valley and although not considered as rare in broadland, only covers a total hectareage of 15 hectares. It is a community characterised by recently abandoned grazing, having the appearance of tall herb fen, but retains elements of a fen meadow. This community is usually co-dominated by *Carex acutiformis* & *Holcus lanatus*, but *Glyceria maxima* & *Juncus subnodulosus* may also be dominant. *Filipendula ulmaria* is a notably abundant tall herb species occurring within the sward.

More than half of the total area of these sites has developed into woodland or scrub communities. The 1946 aerial photographs indicate that much of this has developed in the past 50 years, although a good proportion of the Belaugh Broad & Marshes site was already covered with woodland at this time. There is no information on the status of these woodlands.

These areas seem most appropriately managed in the future by a continued grazing regime, although different grazing densities to those already in place may encourage more diverse communities. As Crostwick Marshes provide the main location for the rare broadland community B9, it may be most appropriate to continue the existing grazing regime, or to introduce any changes slowly, whilst observing the effects. The woodland areas should be surveyed to establish status.

These sites are probably limited from extending in size by the topography of the valleys and the presence of road & urban development. However, extensive grazing systems could ultimately be considered for these areas which incorporated woodland & encouraged near natural 'wildwood with fen' systems to develop. Grazing in the woodlands would encourage the development of and maintain clearings. The resultant mosaics of habitat could provide valuable habitat for a range of invertebrate, plant, amphibian & bird species.

The majority of the Bure fens may be classified as firm sump wetlands (with solid peat infill) & have some stands of species rich tall herb fen of national importance S24

Including Sedge Fen, Hoveton Marshes, Hall Fen & Blackcurrant Carr, Salhouse Marshes (to the south of Wroxham Broad), the area surrounding Snapes Water, Woodbastwick Fens & Marshes, Hoveton Little Broad & the Lows, Cockshoot, Ranworth, Horning Church, Horning Hall, Ranworth & Ward Marshes

NB Ranworth Flood & Leists Marsh

This large area of fen, woodland & scrub covers approximately 560 hectares. Open fen is dominated by the broadland communities B18 *Phragmites australis-Calamagrostis canescens-Myrica gale* tall herb fen, B19 *Calamagrostis canescens-Peucedanum palustre-Lysimachia vulgaris* tall herb fen, B17 *Phragmites australis-Juncus subnodulosus-Lysimachia vulgaris* sedge bed, & B27 *Peucedanum palustre-Calystegia sepium-Solanum dulcamara* reedbed, all of which have affinities to the nationally important community S24.

B18 tends to represent rather dry fen habitat, which if wetter would probably support B17. It is usually co-dominated by *Phragmites* & *Calamagrostis*, although in some stands *Cladium mariscus* may be prominent. A few tall herbs occur frequently, including *Peucedanum* & *Filipendula*, but otherwise, the sward is generally not rich in herbs or sedges. Whilst not a rare community in Broadland, B18 has its stronghold in the Bure. It is most closely related to S24 d & g.

B19 is closely related to B18. However, B19 is slightly drier than B18, sedges are not common, *Cladium* is absent, and species such as *Myrica gale* occur only at a lower frequency. This community is closest to a dry version of S24d. In the absence of management, this community is likely to succeed rapidly to a scrub community.

B17 is codominated by a mixture of *Cladium mariscus* & *Phragmites australis*, usually with *Juncus subnodulosus*. It is most closely related to S24g and has a vegetation type which is species-rich, supporting abundant sedges, herbs & bryophytes, and with good fern populations. Bryophyte-rich communities are particularly scarce and declining within the Broads & should be recognised as being particularly of value. Although this community is quite extensive in the Broads, it is mostly associated with the Ant valley.

B27 is the second most extensive community type in the Broads & is widespread in all the valleys, although it has its stronghold in the Bure. This community is dominated by *Phragmites* & large proportions are managed commercially. When managed on a single whale, a very species poor reedbed may develop as at Ranworth Flood; if management becomes less frequent, other species, such as *Cladium* may develop as co-dominates, with a more diverse groundflora. This community is most closely related to S4 reedswamp, but also has affinities to S24 *Phragmites peucedanum* tall herb fen & S26 *Phragmites-Urtica* fen.

Apart from the fen communities which dominate this complex are several community types which are rare & important in Broadland. These include B22 *Juncus subnodulosus-Valeriana dioica-Calliargon cuspidatum* sedge fen, characterised by an abundance of bryophytes & close to the nationally important M13c & S24f community types; B24 *Sphagnum* spp-*Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub (with affinities to the nationally important communities W2b, M13 & M5); B13 *Filipendula ulmaria-Juncus subnodulosus-Phragmites australis* transitional tall herb fen (with affinities to M22 fen meadow); & B16 *Schoenus nigricans-Juncus subnodulosus-Hydrocotyle vulgaris* sedge bed (close to nationally important S24eii/S24f & M13c).

This whole area has also been subject to a carr woodland survey (1995 Burrows & Kennison) and found to contain extensive areas of nationally & internationally important woodland stands.

Management suggestions for this fen, woodland & scrub complex are as follows:

- 1) Retain nationally important W2a/b & internationally important W5 and W6 woodland. On the management plan, this woodland is indicated by blue hatching; where underlain by brown shading, the woodland has been recommended as non-intervention. The clearance of nationally important woodland could be acceptable if (a) the community produced by clearing the woodland is itself nationally or internationally important. It is proposed that clearings be maintained within the Woodbastwick area on a long term (10-20 year) basis, as these clearings when restored have proven themselves to form species rich oases; or (b) if the woodland has developed in a 'seepage zone' along the upland margin & has potential to develop into one of the more restricted/rare transitional communities.
- 2) All other woodland is recommended for restoration to fen. Based on the extent of scrub at the time of the fen resource survey, analysis of the GIS and areas considered suitable for clearance, the fen resource could be increased by approximately 200 hectares. Maintain strip of scrub around woodland edge; manage by rotation clearance - approximately 10 years per section.
- 3) Establish a 15-20 metre scrub-free zone adjacent to all rivers & broads to encourage the expansion of marginal vegetation. This would improve bank protection and provide additional valuable habitat for bird species such as the bittern.
- 4) To encourage a full range of fen types, a combination of management proposals are recommended:

- a) areas on the upland margins - light summer grazing or an annual summer mowing regime, to encourage a fen/hay meadow type of vegetation.
- b) mowing and removal of vegetation on a range of longer rotations between 5-15 years - to ensure open fen is retained, although the longer rotations will contain larger proportions of scrub. This applies to the majority of the 200+ hectares proposed for scrub clearance and is dependant upon technological development & marketing for bioproducts. On the map, these areas are defined by an orange shading.
- c) the only alternative on some of these areas proposed for a 4/5 year rotational management if appropriate technology is not developed, is an extensive grazing system. Where this may be possible, the areas shaded orange have a red hatching overlay. Very extensive grazing would control new scrub encroachment and would maintain a mosaic of tall and short grazed vegetation. It is likely that a grazing regime will change the structure of communities which are currently managed by a mowing regime, and produce a more variable or less homogenous sward. However, if grazed extensively, the components of communities will persist.
- 5) Recent turf ponding will require follow up management sometime in the next 5-20 years depending on the rate of terrestrialisation. At Woodbastwick, the turf ponds excavated in 1995 are on the upland margin, and following their successional development either grazing or mowing annually or on a 4/5 year rotation using low ground pressure machinery are likely to be suitable follow-up management options. There are limited proposals for new turf ponds until. Possibly at Woodbastwick due east of Decoy Broad at the intersection between non intervention woodland, grazing/annual mowing and longer term mowing. A turf pond at this point would increase the mosaic of fen, open water, woodland available, and would be situated along a potential flight path for birds. Any turf ponding should be preceded by a peat survey to ensure that only previously cut peat is used in the future. New turf ponds to be discreet. Other potential turf pond sites could also take place in the areas proposed for biofuels if they fulfilled the other location requirements.
- 6) Areas currently managed commercially for reed and sedge to be maintained as such as long as possible with the exception of Ranworth Flood (see g below). However, it is likely that the commercial value of the sedge may decline where grazing takes place, but the pay-off is that species richness may increase. (see further Burgh Common). If commercial management ceases, then management of those areas should be incorporated within that occurring on the surrounding areas.
- 7) Potential experimental burning area on the Ferry Road Fen; the community under consideration is B18 - a reed dominated community with abundant *Myrica gale*. This area was burnt in the late 1970's.
- 8) Ranworth Flood is embanked and stands higher than the adjacent grazing meadow Leists Marsh. Water is let on to Ranworth Flood at high tides to maintain sufficiently high levels to grow commercially viable reed, and moves off by gravity to Leists Marsh, where summer grazing takes place. Historically, both of these sites were thought to originally have supported species rich fen. The main remaining interest are the species rich dykes on Leists Marsh. Ranworth Flood should be allowed to develop into a more species rich fen, by either introducing a longer rotation of mowing, or by extensive grazing. Extensive grazing should also be considered for Leists Marsh, and the area allowed to gradually become wetter and fen meadow develop.

In the lower reaches, the fens become isolated from the main river system & are most easily described as general topogenous wetlands which may support botanically

diverse fen, impoverished tall herb fen, scrub or woodland depending on water supply & management regime

These areas include Panxworth Carrs (Sotshole Carrs & South Walsham Fen), Acle (probably a percolating fen) & Fishley Carrs, Decoy Carr, Halvergate & Freethorpe Carrs & Marshes & the Fleet Marshes.

Upton Fen & the Doles is also a topogenous wetland, but may be more accurately classified as a percolating wetland

Surrounded by agricultural and urban land these fen areas are vulnerable to external influences, particularly water supply, but also neglect and as a result succession to scrub & woodland has taken place over extensive areas. On the two largest isolated sites: Upton Fen & Doles (circa 110 hectares) & Decoy Carr (circa 92 hectares) succession has been rapid. In 1946, 25% of Upton & 75% of Decoy Carr were open fen; by 1995 only 10% of fen at Upton & 20% at Decoy Carr remained free from scrub & woodland. Upton Fen & the Doles has been subject to a woodland survey (Sue McQueen, 1995) & although incomplete, this survey has indicated that some areas are of national/international importance & in general this relates to woodland which is mature.

At Upton, the fen areas are dominated by the B27 *Peucedanum-Calystegia sepium-Solanum dulcamara* reedbed, and the *Phragmites-Calamagrostis* communities B18 & B19 (all with affinities to S24). Impoverished B42 *Phragmites-Urtica-Epilobium* tall herb fen is also frequent (similar to S26), with two communities rare in Broadland B13 (which has affinities to the nationally important fen meadow community M22d), and B24 (equivalent to nationally important W2b woodland).

Where managed by mowing, Decoy Carr supports the fen communities B18 *Peucedanum-Calystegia-Solanum* reedbed & B17 *Phragmites- Juncus subnodulosus-Lysimachia* sedge bed (both communities having affinities to the nationally important S24) & the bryophyte, herb & sedge-rich community B22 (like the nationally important M13c & S24). Other areas of open fen which may be drier, unmanaged, or enriched by agricultural runoff support the dry tall herb fen community B41 (similar to S26).

Upton Fen & Doles is rated as one of the most important fen communities in Broadland, with tremendous potential for restoration of fen which is currently scrubbed over. Decoy Carr also has great potential, although this site seems more likely to suffer from drought. Survey work should be undertaken on both sites to fill in any gaps in the 1995 woodland survey, and once the status of the woodland and scrub have been established, any areas not of national or international importance should be cleared as a matter of priority.

Decoy Carr & Upton Broad have tremendous potential for consideration as extensive wild areas using a mixture of large herbivores to maintain the fen interest by extensive grazing. Both sites could be relatively easily secured and an extensive grazing system, once in place would require little other management input, and be sustainable. Grazing would prevent scrub development on open areas and encourage the formation & maintenance of clearings, which may act as oases for fen species.

At Upton, because of the extremely sensitive nature of some areas, a precautionary measure may be to temporarily/permanently fence off the vulnerable fen communities to ensure they are not damaged; these areas would then need mowing & scrub clearance to continue by hand. If species rich fen communities developed as a result of grazing, the sensitive areas could be considered for inclusion. At Decoy Carr, areas which are commercially viable for reed & sedge harvesting best be excluded from this grazing system until monitoring has taken place. Careful monitoring of the effects of grazing would be a vital part of any natural system

For Decoy Carr, an alternative to extensive grazing management would be to clear scrub and retain open fen by harvesting the fen vegetation on a 3/4 year rotation. At Upton, the sensitive nature of the fen areas may mean that the area will have to be managed either by hand or by very lightweight machinery (e.g. small mowing machines) into the future, in the absence of a grazing regime. However, this site rates highly enough to warrant extra resources of time & labour.

The other sites in this category are much smaller and with a limited interest. They may have most value to be left to develop as wildwood; however, clearings could be created to add diversity and to provide oases for fen flora & fauna. A detailed survey of the current status of these areas would be valuable.

South Walsham Fen is an exception. The majority of this area is free from scrub & due to a partially blocked & redundant IDB drain, the site is quite wet. The main communities are *Juncus*, *Phragmites* & *Carex nigra* and *Carex acutiformis* dominated and are maintained in an open condition by conservation mowing. The fen meadow areas support good populations of orchids. Conservation mowing could continue, or if the availability of labour to manage this site declines, then the introduction of water control structures, reinstatement of dykes and light summer grazing by a few cattle may be a more sustainable option.

BURE VALLEY FEN SITES

19 Horstead, Coltishall & Belaugh Marshes

This area covers approximately 50 hectares & includes Coltishall Marsh & Blackman's Fen. These marshes have developed over a mineral rather than a peaty substrate and have a long history of grazing. Approximately 50% of the area is mature alder carr, with the remainder of the open areas being wet meadows. A comparison of the 1946 & 1995 aerial photographs shows that in 1946, only about 10% was affected by woodland or scrub, so most is relatively recently established.

The majority of the open areas comprise rush pasture (B10 OR MG10/M22) or impoverished tall herb fen (B41, B42, B40 OR S26). There are only very small areas of nationally important S24 *Phragmites-Peucedanum* present, although on Coltishall Marshes there is approximately one acre of B11 *Carex disticha-Festuca rubra-Angelica sylvestris* fen meadow, a community which is rare (< 10 hectares) in Broadland.

Suggested management: (a) survey woodland areas to establish status; (b) establish perimeter security, re-establish shallow drains & ditches and introduce an extensive grazing system with large herbivores over whole site including woodland areas; (c) in absence of grazing, remove recently grown scrub & harvest fen vegetation on a 4/5 year rotation; (d) maintain a mosaic of habitat of particular value for invertebrate, bird & amphibian species;

20 Crostwick & Dobbs Beck Marshes

This is an area of unimproved meadow, species rich fen meadow & carr woodland, situated in a tributary valley of the Bure. In places the valley is quite steeply sloping, which has encouraged the development of a series of intergrading vegetation types, from dry calcicolous vegetation on the upper slopes, through damp grassland, species rich fen meadow & tall herb fen in the valley bottom. The valley bottom tall herb fen is a 'topogenous sump wetland', and the remainder are 'sloping soligenous wetlands' (Wheeler & Shaw, 1995) as they are thought

to be predominantly fed by calcium rich spring water seeping from the exposed Upper Chalk on the valley slopes.

The dominant community on Crostwick Marshes is B9 *Juncus subnodulosus-Cirsium palustre* fen meadow. This community is rare in Broadland, and Crostwick Marshes supports approximately half of the total hectareage. Grasses, small sedges & abundant small herbs characterise the sward & has affinities to M22. Much of Dobbs Beck Marshes comprise B12 *Filipendula ulmaria-Carex acutiformis-Juncus subnodulosus* transitional tall herb fen. There are only 15 hectares of this community in total in Broadland, of which nearly all (13 hectares) occurs at this site. B12 also has affinities to M22. The other significant community on Dobbs Beck Marshes is B10 *Holcus lanatus-Juncus effusus-Agrostis stolonifera* rush pasture which has affinities to MG10/M27.

Approximately one-third of the area is woodland or scrub, most of which has developed since 1946.

Suggested management: (a) survey to establish status of woodland areas; (b) extensive grazing system over whole area, to maintain existing plant communities, encourage development of transitional communities & prevent further scrub encroachment onto currently open areas

21 Belaugh Broad & Marshes

This area of approximately 72 hectares includes Belaugh, Wroxham & Jubys Farm Marshes, and has developed through a long history of grazing, but without any significant improvements in drainage. These marshes also appear to be more peat rather than mineral based, unlike the sites upstream. These areas appear to have been of some interest in the past, but are now mainly carr woodland. Approximately half of this area appears to have been either woodland or scrub in 1946. Currently, only 6-7 % is fen/unimproved grazing.

The main communities are B43 *Phragmites-Glyceria-Carex riparia* tall herb fen (with affinities to S26) and B10 *Holcus-Juncus effusus-Agrostis* rush pasture (close to M22), although there is a small area of the rare in broadland community B9 *Juncus articulatus-Holcus lanatus-Lotus uliginosus* fen meadow, which may also be classified as the nationally important M22d community. B19 dominated by *Phragmites* & *Calamagrostis* occurs over a small area & this community is very close to the nationally important S24d & g.

Management suggestions: (a) survey woodland to establish status; (b) remove most recent scrub or woodland and use an extensive grazing system to control future scrub invasion, maintain the nationally rare communities and encourage development of diverse fen vegetation on areas that are currently woodland;

22 Hoveton Marshes, Sedge Fen & Wroxham Broad

This area includes Sedge Fen, Hoveton Marshes, Hall Fen & Blackcurrant Carr, Salhouse Marshes (to the south of Salhouse Broad), Wroxham Marshes (to the south of Wroxham Broad) & the area surrounding Snapes Water.

Snapes Water - this is an area of carr woodland with several remaining open areas dominated by impoverished fen B44 *Phragmites-Glyceria-Epilobium* (S26) & marsh vegetation, and is of no particular botanical interest at present. At the beginning of the century there were records of the site supporting species rich fen meadow communities, although these may relate to a more extensive area of fen which has since been destroyed by building. *Suggestions:* survey mature woodland to establish status. Experimental mowing of open

areas to establish any species interest; otherwise allow area to develop as wild wood, perhaps maintaining a few clearings.

Sedge Fen - is dominated by carr woodland and mature scrub. Classified during a recent woodland survey in the Bure as nationally important (NVC type ?), this area has been recommended to be retained as woodland, but not necessarily non-intervention. Some management may be appropriate or necessary to enhance the interest.

Hoveton Marshes - Unsurveyed by the fen resource survey, this is an area of reflooded grazing marsh, which was reclaimed from fen at the end of the 19th century for a short time & grazing was eventually abandoned on the area during the 1940's. The community is very wet, with permanent pools/open water and dykes, in places dominated by *Cicuta virosa* and *Iris pseudacorus*, although there are some patches of sedge & litter fen remaining. In 1995 turf ponds, scrub clearance & other management works were carried out on the site as a potential area suitable for bitterns. This is a very undisturbed area and would probably be most suited to a very long term management regime of rotational 4/5 year mowing of some areas, & operations such as turf ponding & scrub clearance on a longer term basis, perhaps every 20 years.

Wroxham & Salhouse Marshes - these are sites which have developed on boggy ground and were probably once used for grazing. They are not of any great interest at present from a botanical viewpoint & there is no historical evidence to indicate that this may have once been the case. Salhouse Marshes are dominated by B44 (S26) *Phragmites-Glyceria-Epilobium* with a fringe of woodland around the edges; Wroxham Marshes is dominated by a mixture of carr woodland & mature scrub, B42 (S26/S24) *Phragmites-Urtica-Epilobium* & B44 (S26/S24). As there is very little scrub at Salhouse marshes, and due to the location of being in a much visited area, this could easily and most beneficially be cleared and maintained as open fen by volunteers.

23 Woodbastwick Fens & Marshes

This area includes Woodbastwick Fens & Marshes, & also Hoveton Little Broad & the Lows (area to the north and south of Pound End). The total area considered by the fen resource survey within site 23 amounted to circa 160 hectares.

Woodbastwick - a large area of floodplain fen originally situated on deep peat, much of which was exploited for fuel in the 19th century. Approximately one quarter of this area is open fen - the remainder is woodland or mature scrub. The dyke system has been isolated from the river; however, the entire area is subject to winter flooding by overtopping.

The open fen is dominated by B19 *Calamagrostis-Peucedanum-Lysimachia* tall herb fen & B17 *Phragmites-Juncus subnodulosus-Lysimachia* sedge bed. Less extensive but still significant are the communities B23 *Juncus subnodulosus-Galium palustre-Mentha aquatica* sedge fen; & B18 *Phragmites-Calamagrostis-Myrica* tall herb fen. All four of these communities have been alternatively classified within the NVC as the nationally important community S24 *Phragmites-Peucedanum* tall herb fen. Most of these areas are managed either by commercial harvesting for reed & sedge, or conservation mowing.

Small areas of the rare (i.e. total extent in Broadland is less than 10 hectares) Broadland communities B13, B16, B37, B22 & B24 also occur within the open fen areas. These communities have probably developed under an annual mowing regime. It is important to continue a regime of hay cutting to create and maintain these areas.

The ride system at Woodbastwick, mown more frequently than the adjacent fens has encouraged a diverse fen meadow B2 *Holcus-Lotus-Angelica* fen meadow to develop. This

community has strong affinities to the NVC M22d *Juncus subnodulosus-Cirsium palustre* fen meadow, sub community ?, which is nationally important.

Approximately half of the woodland in this area has been classified (Burrows & Kennison, 1995) as being of either national (W2 a/b) or international importance (W5, W6) with a significant proportion recommended as non-intervention woodland. Within some of these woodlands are clearings which form oases for species-rich fen & these should be maintained. The woodland has developed up to the edge of the Bure, except for one or two narrow stretches, where B27 *Peucedanum palustre-Calystegia sepium-Solanum dulcamara* reedbed (similar to S26 *Phragmites-Urtica* fen) occurs.

Management suggestions: (a) retain a proportion of nationally important woodland; (b) maintain clearings within nationally important woodland & consider creation of one or two other clearings; (c) clear all woodland which has not been classified as being nationally important & maintain any subsequent fen community which may develop by harvesting of the fen vegetation on a 4-10 year rotational basis; (d) introduce extensive grazing on marginal fen areas to encourage the development of fen meadow vegetation & transitional communities; (e) Maintain a mosaic of fen structure by rotational 4/5 yearly mowing regime; (f) manage some of the fen communities as fen meadow by a regular summer mowing regime; (g) possible creation of further turf ponds - but these should be much smaller than the ones recently created at Woodbastwick; (h) establish a 15-20 metre scrub free zone adjacent to the river & around Decoy Broad, to encourage the expansion of marginal fen vegetation, and to provide additional valuable habitat for birds such as the Bittern; (i) encourage all areas currently managed commercially for reed & sedge to be maintained as such, & where possible expanded; (j) ensure large copper requirements are considered;

If alternative technology does not become available soon, it may become necessary to extensively graze some of the fen areas which are recommended for mowing. This would control the scrub, but may also change the community types, although this depends to a large extent on the grazing density, and also to the type of animal used.

Hoveton Little Broad & the Lows - This area is mostly dominated by alder swamp carr, and although it was not included within the fen resource survey, it was looked at during the Bure valley woodland survey.. A few small areas are maintained as open litter fen as part of a nature trail. Parts of the southern area have been used to deposit spoil from the mud-pumping of Pound End. Until the 1960's *Liparis loeselii* had been recorded from this area, along with other species of interest; however, these have been lost through the development of alder carr woodland. A narrow band of the tall herb fen communities B19 *Calamagrostis-Peucedanum-Lysimachia* (S24) & B42 *Phragmites-Urtica-Epilobium* (S26) fen vegetation occur adjacent to the River Bure.

Suggested management: Would benefit from open up of clearings and felling around the Broad to expand the tall herb fen communities currently present in a narrow band.

24 Cockshoot, Ranworth & Horning Church Marshes

Ranworth Broad Marshes (including Cockshoot Broad Marshes), Horning Church Marshes & Ferry Road Fen are included within this site.

Ferry Road Fen - situated between Ferry Road & Ranworth Broad Marshes, this fen comprises three compartments, two of which are species poor and is dominated by reed, but also characterised by the constant presence of *Calamagrostis canascens* & *Myrica gale* - B19 (which is similar to S24d & g) most of which is commercially managed; the third compartment is also reed-dominated but supports *Cladium mariscus* beds B18 (affinities to

S24d & g) and an area dominated by *Carex lasiocarpa* where mown annually. Both of these community types (B18 & B19) have their stronghold in the Bure valley.

Two other communities B16 (S24/M13) *Schoenus nigricans*-*Juncus subnodulosus*-*Hydrocotyle vulgaris* sedge bed & B17 (S24) *Phragmites australis*-*Juncus subnodulosus*-*Lysimachia vulgaris* sedge bed occur within this third compartment. Both of these communities are species rich & are important for bryophytes. B16 is also a rare community within Broadland (less than 10 hectares).

Historical evidence suggests that the vegetation in this compartment has developed over former turf cuttings (the *Carex lasiocarpa* may have developed due to the presence of clay where the turf cutting came close to the bottom of the peat? - cf. Bryan Wheeler).

Suggested management: (a) maintenance of commercial reed; (b) possible burning management on a small area of 18 - for experimental purposes (this area has been burnt in the past); (c) 4/5 year rotational harvesting of fen vegetation, although some areas such as the *Carex lasiocarpa* vegetation may require annual mowing to maintain. (d) keep parts of Cockshoot and Ranworth Broads free of scrub to encourage marginal communities;

Ranworth Broad Marshes - this is an area of floodplain fen underlain by deep fen peats, which were exploited for fuel in the 18th & 19th centuries. The resultant turf ponds were colonised by *Cladium mariscus* which is still very abundant at this site. Much of the area has been covered by scrub & woodland, but the remaining open fen areas are of exceptional botanical interest.

A large proportion of the open fen is dominated by species-rich *Cladium mariscus* beds - Broadland community B17 (S24f & g), although there are also large areas of *Phragmites australis* dominated fen B19 (also closely related to S24f & g). B17 occurs over former peat cuttings and is generally diverse in sedges, herbs, ferns & bryophytes. B19 is generally drier & more species poor, but generally located over deep peat. The Bure is the stronghold for this community.

The woodland to the north of Cockshoot Broad & the west of Ranworth Broad has been identified by the Bure woodland survey as being nationally/internationally important

Suggested management: (a) maintain internationally important woodland, except for maintenance/creation of clearings; (b) clear all trees & scrub from remainder of the currently wooded area and reinstate a 4-10 year mowing regime (c) maintain all commercial reed and sedge management; (d) consider mowing existing open area on an annual basis as hay meadow (except for the commercial reed & sedge areas); (e) explore the possibility of creating small turf ponds on areas of peat which have already been cut in the past;

Horning Church Marshes - Once a huge block of fen which was probably historically cut for peat, this area is now about 40 hectares in size. The main plant community is B19 dominated by *Phragmites* & *Calamagrostis* (affinities to S24g & d), but the fen areas from which scrub has recently been cleared were difficult for the fen resource survey to classify. Some areas of B18 occur, which is also dominated by *Phragmites* & *Calamagrostis* but supports quite an abundance of *Cladium mariscus*. B17 (S24f & g) is also found, characteristically co-dominated by *Phragmites* & *Cladium* and quite species rich. The bryophyte fauna associated with this vegetation type is relatively diverse.

This area supports one community that is rare (<10 hectares) in Broadland B24 *Sphagnum*-*Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub (most affinities to M5 or M13). This vegetation type seems to occur in only one small area and without management would soon become birch dominated W2b woodland.

The site contains three blocks of mature carr woodland which have been identified by the Bure Valley Woodland Survey as being of national/international importance.

Suggested management: (a) maintain the block of nationally/internationally important woodland; (b) remove all scrub other than odd patches & the mature alder carr as identified above; (c) introduce extensive grazing or a 4/5 year rotational harvesting of the fen produce; (d) encourage commercial reed & sedge management where possible; (e) ensure that the B24 community remains as an open fen community; mowing may be necessary, or grazing will maintain it free from scrub;

25 Horning Hall Marshes

Horning Hall Marshes - Like Horning Church Marshes, this was once part of a huge block of fen which was extensively cut for peat & is now about 45 hectares in size. The main plant community is B19 dominated by *Phragmites* & *Calamagrostis* (affinities to S24g & d), but the fen areas from which scrub has recently been cleared were difficult for the fen resource survey to classify. B17 (like S24f & g) a species rich community in which *Cladium* & *Phragmites* co-dominate also covers a significant part of the site. B27 also occurs quite extensively, and this is a widespread community in Broadland, dominated by *Phragmites* and typical of slightly dry, unmanaged fen vegetation. This community has most affinities with S4 reed swamp, but has similarities to S24 & S26.

This area supports one community that is rare (<10 hectares) in Broadland B24 *Sphagnum-Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub (most affinities to M5 or M13). This vegetation type is scattered over several small areas and without management would become birch dominated W2b woodland.

Suggested management: (a) maintain the two southern blocks of nationally/internationally important woodland; the northern block should only be considered for clearance if there is reason to believe that a transitional fen community may develop instead; (b) introduce extensive grazing or a 4/5 year rotational harvesting of the fen produce; (c) encourage commercial reed & sedge management where possible; (d) ensure areas of the rare community B24 survive and not succeed to woodland;

26 Ranworth Marshes & Ward Marsh

Ranworth Marshes - this is an area of approximately 110 hectares, of which scrub & carr development have obliterated some 90% of the formerly extensive open fen. The areas which remain open are of exceptional botanical interest and support a range of broadland communities. Most extensively occurring are B17, B18 & B19, all with strong affinities with S24d, g & f. A lesser amount of the *Phragmites*-dominated B27 also occurs; this community is generally managed for commercial reed & has most affinities with S4 Reedswamp.

Perhaps most notable is Mills Marsh an area of fen which is annually mown & where the bryophyte & herb rich B17 vegetation type occurs (affinities to S24 g & f). This community is dominated by a mixture of *Phragmites* & *Cladium* & occurs over former peat cuttings. A few small isolated areas of the rare in Broadland community B24 occur; these may also be classified as the nationally rare woodland community W2b.

This site was formerly of great botanical interest, much of which is retained in the oases of Mills Marsh & in the fen areas of Beggars' Oak which is rapidly becoming scrubbed over. A comparison of the 1946 & 1995 aerial photos indicate that about 50% of the site was either

wooded or covered with scrub in 1946. The Bure woodland survey (1995) identified about 40% of the area as being covered with nationally or internationally important woodland.

Suggested management: (a) maintain all nationally/internationally important woodland, except for when W2b may also be classified as the B24 *Sphagnum* spp-*Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub; (b) consider creating or maintaining clearings within this woodland, to act as additional oases for rare fen plants; (c) restore all fen areas which do not support nationally/internationally important woodland;

Ward Marsh - this is an area of fen about 40 hectares in size, and supporting two main broadland communities: B19 & B27. B27 is dominated by *Phragmites* and B19 is dominated by a mixture of *Phragmites* & *Calamagrostis*. Both communities are generally rather herb & bryophyte poor, & have affinities with both the nationally important S24 community and also with S4 Reedswamp.

Approximately one-quarter of the site is now woodland or scrub - from the 1946 aerial photographs we know that there was no woodland at that time. The alder carr survey did not identify any nationally/internationally important woodland stands.

There is evidence that this fen was once of great botanical interest, and it also seems likely that the site may have been grazed in the past.

Suggested management: (a) restore reed community to commercial viability if possible; (b) clear all scrub and maintain open fen either by an extensive grazing system with appropriate herbivores; or harvest the fen vegetation on a 4/5 year rotation;

27 Ranworth Flood, Leists Marsh & Panxworth Carrs

Ranworth Flood & Leists Marsh - Ranworth Flood & Leists Marsh are both thought to have originally been species rich fen. By the end of the 19th century Ranworth Flood was drained & used for grazing, and in the 1920s a decision was taken to relood & use it for reed cultivation. It is now virtually a reed monoculture B27 *Phragmites*-dominated reedbed (S4 reedswamp). This area is bunded/embanked & water is allowed to flood onto the area during high tides to maintain sufficient water levels to support commercial reed.

Leists Marsh apparently remained as fen until 1945 when it too was drained. This area may have been a fen orchid site, but it is now species poor B10 *Holcus lanatus*-*Juncus effusus*-*Agrostis stolonifera* rush pasture (M22), although the dykes support an interesting flora. Water is pumped off of Leists Marsh to retain as grazing marsh.

Management suggestions: **Leists Marsh** - water levels be allowed to slowly rise, with the intention of allowing species rich fen to redevelop; grazing management with suitable animals should be maintained, although the period of grazing may become shorter. Alternatively a 3/4 year rotational harvesting of fen vegetation for bioproducts could be suitable. The dykes should be monitored to determine any changes in interest. **Ranworth Flood** - either (a) maintain as reedbed, but cut on a double or longer rotation to allow more botanical interest to develop; or (b) encourage reversion to species rich fen - this may involve allowing a more natural water regime, & managing the vegetation on an extensive grazing system or a 4/5 year rotational harvesting.

Leists Marsh & Ranworth Flood may both have potential to develop into species rich fen & whichever option is decided, any reduction in the intensity of management would be a bonus. The potential to develop species rich fen is reflected in the presence of peat, a reasonable water supply & a long history of being wet areas, which despite efforts to drain have probably remained relatively waterlogged. It is possible that if these areas have remained waterlogged,

then only the very surface layers of peat may be oxidised - it may be necessary to scrape the surface off to encourage rare fen plants to colonise.

Panxworth Carrs - this area is also called South Walsham Fen & Sotshole Carrs. Sotshole Carrs is a predominantly wooded site, with some species of interest - many of which have been introduced or moved from other locations. Historical records indicates that this area developed from the Broad basin into carr woodland and was never managed as fen.

South Walsham Fen is an area of former grazing marsh which had a long history of drainage & grazing, but which was allowed to reflood as the IDB drain was abandoned in the early 1980s. This area now supports *Phragmites*, *Carex riparia* & *Juncus* dominated communities. B42, B44, B9 & B12 (S26, M27). Current mowing management of the fen vegetation is carried out for conservation purposes.

Suggested management: Reinstate any redundant dykes on South Walsham Fen and introduce control structures, such as sluices so that water levels can be maintained. Install perimeter security & introduce large herbivores to graze the site extensively. Over a period of time, a more diverse flora may develop. The communities B42 & B44 are indicative of higher nutrient levels & grazing would gradually reduce these levels. Community information from the fen resource survey indicates that if lightly grazed B12 could become the more species rich B1/B2 fen meadow.

Sotshole Carrs require further survey work to establish the woodland status. The 1946 aerial photographs indicate that at this time only a small proportion was mature woodland, although much of the remainder was scrub. This may be an appropriate site to allow to develop as 'wildwood' due to the small area involved. Some clearings could be maintained to provide oases for fen plants, and to mimic a near natural system. Grazing on a very extensive basis would also allow some fen species to persist.

28 Upton Fen & The Doles

Upton fen is a large area of species rich fen & fen meadow, with extensive areas of carr woodland. The site is isolated from the river system & is fed entirely by spring water, which is predominantly calcareous, and this has led to interesting zonations of species along the pH gradient. Peat extraction has taken place from the 13th to the 19th centuries, with extraction of marsh crops from the fen areas.

The site was once continuous with Upton Marshes to the north, but at some point the marshes were drained, the fen was embanked and left at a higher level from the surrounding drained areas which shrunk. Management was abandoned in the 20th century, apart from very limited grazing and small scale conservation management. In 1946 from the aerial photos it is apparent that circa 75% of the site was already mature woodland with some of the open areas beginning to scrub over. The 1995 aerial photos indicate that only about 10% of the site remains open.

Most of the open fen is dominated by nationally/internationally important communities. The areas of nationally important S24 are considered better described by the broadland classification as B27 which is a reed-dominated but not particularly diverse community; & B18 & B19 which are *Phragmites-Calamagrostis* dry tall herb fen communities, but which tend to be diverse in sedges. Smaller areas of M22d are classified as B13, a transitional tall herb fen community dominated by grasses & tall herbs, which is a rare in Broadland (< 10 hectares). W2b also occurs & this nationally important woodland stand is classified as B24 '*Sphagnum* spp-*Dryopteris* spp-*Thelypteris thelypteroides* open birch scrub, which is another rare community in broadland. Tiny areas of the nationally important M13c occur, which is classified as B22, rich in small herbs, sedges & bryophytes.

Although this area was not included in the Bure Valley Woodland Survey, areas within the woodland were surveyed by a student in 1995, and areas of woodland were classified and a report produced (McQueen, 1995/6).

Management suggestions: (a) Subject completion of the existing carr woodland survey to establish status, as much woodland and scrub which are not of national / international importance should be cleared as soon as possible. (b) Harvest fen vegetation to produce a mosaic - some areas to be mown annually, others on a 3/4 year rotation. (c) Consider the possibility of this whole area being perimeter fenced and maintained through grazing with appropriate large herbivores (e.g. Konik ponies) - this would maintain open fen & clearings within the woodland. (d) clear back a 5-10 metre strip of woodland adjacent to the broad; manage vegetation to encourage the development of marginal vegetation, particularly with respect to the unusual fringing *Cladium* swamp, which is unique to this site and Rollesby Broad.

29 Acle & Fishley Carrs

Acle Carrs - an area of woodland and disturbed ground east of Acle. The fen resource survey state that this site no longer contains any fen and so was not surveyed. However, the maps produced by the fen resource survey indicate that about one third of the site is dominated by community types B10 rush pasture (affinities to MG10) & B41 tall herb fen (affinities to S26). A comparison of the 1946 & 1995 aerial photographs indicates that approximately one-third of the area was woodland or scrub in 1946, so most has developed during the past 50 years.

Indications are that the woodland may be of the nationally rare/scarce types W2 & W2a.

Fishley Carrs - this area comprises woodland and grazing marsh over an extinct broad and as with Acle carrs the fen resource survey states that this site no longer contains any fen and so was not surveyed. However, the fen resource survey did classify the southern end of the site as supporting B41 tall herb fen (S26). The aerial photos indicate that in 1946 about one-third of the site was woodland, one-third scrub & one-third open vegetation. The 1995 photograph indicates that two-thirds are now woodland.

Indications are that the woodland may be of the nationally rare/scarce types W2 & W2a.

Suggested management: (a) survey of woodland and open areas to establish status & interest. (b) consider soil types, and if peat, consider whether this area could be reinstated as a fen site. Although occurring as 'islands' in an arable & urban jungle, it is often these sites which become fed by calcareous spring water (percolating wetland) - for example, Upton, Poplar Farm Meadows, Ducans Marsh - believed to be related to the shrinkage of surrounding land & formation of cracks through which ground water from the chalk aquifer moves upwards. (c) consider mowing open areas of fen to see if management could improve the vegetation; this may also help any decision as to how worthwhile fen restoration on the other presently scrubbed up areas would be;

30 Decoy Carr

An area of approximately 92 hectares, of which only some 12 hectares are currently open fen. The site was once part of an extensive area of fen & bog stretching from the heath at Damgate to a bog at Moulton St Mary, much of which has since been converted to grazing marsh. The site is isolated from the main river system. It supports a number of nationally rare tall fen species.

The aerial photographs indicate that although approximately one-quarter of the site was either woodland or scrub in 1946, the remainder of the site was open fen. The main open areas are now to the north of the site, where they have been managed primarily to enhance the shooting interest.

The open areas of mixed tall herb fen vegetation are dominated by *Cladium mariscus* & *Juncus subnodulosus*, with *Phragmites australis*. *Schoenus nigricans* is very abundant in some areas. The *Cladium* dominated areas tend to be botanically diverse. The main broadland communities described are B22 which is rare in Broadland & rich in herbs, bryophytes and low growing sedges, B17 which is dominated by a mixture of *Cladium* & *Phragmites* and is species rich, & B18 which is dominated by *Phragmites* & is generally quite species poor. B18 is considered as having potential to be similar to B17 if it were wetter. All these communities have affinities to the nationally important S24.

Other areas of open fen are described as being either B41 *Phragmites-Urtica-Epilobium* or B42 *Phragmites-Glyceria-Carex riparia*, which have affinities to S26.

The majority of the woodland is sump alder carr W2 or W2a which are nationally important stands (**check Burrows & Kennison survey**) on fen peats.

Management suggestions: (a) establish status of woodland; retain nationally & internationally important stands. (b) maintain clearings within retained woodland to act as oases for fen plants; (c) remove all woodland or scrub which has not developed to interesting woodland and manage for species rich fen. Link fen areas across the whole site and manage to provide a mosaic of age and structure. Some areas to be harvested annually, some every 4/5 years; (d) consider grazing for poorer fen areas or to reclaim from scrub; (e) maintain dyke system

31 Halvergate & Freethorpe Carrs & Marshes

This area includes Halvergate & Wickhampton Marshes. The site consists of a few scattered compartments, most of which are rough grazing marsh rather than fen, but which includes some dry reedbed and dry woodland. The dry woodland may be remnants of fen along the seepage zone which were too wet to be reclaimed for agriculture. The principle botanical interest of the site is now represented by the dyke vegetation which supports three nationally scarce species. The main plant community is B42 (S26).

RIVER MUCKFLEET FENS

Categories of fen & appropriate management

A fringe of marginal swamp vegetation has developed around each of the Broads within the Muckfleet valley; these areas may be classified as topogenous water fringe wetlands, as fluvial waters are the predominant hydrological influence.

This vegetation occurs around the margins of Ormesby, Rollesby, Ormesby Little, Lily, Filby & Filby Little Broads.

The intact fringe of *Phragmites australis*, *Schoenus nigricans* & *Typha angustifolia* swamp with frequent patches of *Cladium mariscus* are almost unique in Broadland. Boat wash from

motorised traffic combined with water quality problems may have lead to the loss of this community from most of the other Broads.

However, the potential for expansion of the swamp communities are limited as the Broads are some of the deepest in Broadland, having been cut down to over 4 metres in depth in places, with steeply shelving sides.

The main vegetation community is B28, with affinities to S4 reedswamp. Where the swamp vegetation becomes dominated by *Cladium mariscus* the community is classified as B14, a species rich community typical of commercially managed sedge, and with affinities to the nationally important S2.

The transition between woodland & the swamp fringe is abrupt. Clearance of scrub back from the edges of all the Broads would allow a transition from swamp fen to tall herb fen to develop. Harvesting of the swamp fringe on a 4-10 year rotation may increase species diversity whilst maintaining the existing dominants, prevent scrub encroachment & reduce the build up of litter.

On some land surrounding the Broads which is currently wooded, there is great potential to restore diverse acid heath, mire & fen meadow communities.

This may include all the undeveloped land surrounding the Trinity Broads. However, areas with particular potential include the Lily Broad Marshes & the area to the north west of Ormesby Broad.

Lily Broad Marshes are one of the few areas surrounding the Broads which is currently free from dense scrub or woodland. The two main communities: B8, which is acid poor supporting diverse herb, sedge, bryophyte & heath species; & B20 which is a diverse transitional fen meadow community dominated by *Juncus subnodulosus* are rare communities in Broadland.

The land to the north west of Ormesby Broad is underlain by glacial sands & will naturally have acidic tendencies, but it is also the largest block of land in this area and has only recently become woodland. The 1946 aerial photographs indicate that 50 years ago, approximately half of this area was woodland, and most of the remainder was only scrub. Now, the majority is mature woodland.

In the lower reaches of the Muckfleet the fen complex is influenced by a range of hydrological influences; the wetter areas closest to the channel form sump wetlands, whilst the sloping & slightly higher land away from the Muckfleet may be classified as a soligenous wetland.

These areas include most of Burgh Common.

The sump wetland is mainly vegetated by reed-dominated fen communities B43 & B19, although where wetter, species such as *Glyceria maxima* & *Carex riparia* become more important; on the drier areas grasses such as *Calamagrostis canescens* increase in abundance. Both communities are fairly extensive & widespread within Broadland.

The soligenous wetlands are of high value as they support a number of transitional & fen meadow communities which are of limited extent in Broadland, including B4, B6, B21, B22 &

B23. Of particular importance is B6, a bryophyte rich community found only at Burgh Common, where it covers approximately 10% of the site.

MUCKFLEET VALLEY FENS

16 Hemsby Common & Ormesby Broad

This site comprises two main areas of Ormesby Broad (including Decoy Wood, Wet Carrs, Ormesby Common, Decoy Carr & Horsemill Plantation) & Hemsby Common (also known as Hall Farm Fen).

Ormesby Broad - the Broad was once very much more extensive than it is at the present. The waters irrigating this site are low in nutrient status & the area is underlain by sands & gravels. Much of the marginal land has been planted with broadleaved & coniferous trees & so much of the fen vegetation has been lost. It seems likely that much of the marginal areas may have once been grazed & that there would have been a transition of vegetation from marginal swamp, through acid fen & wet heath, to dry heath with acid grassland. Currently, there is an abrupt transition in most areas from marginal swamp to woodland. The woodland in places may be of international importance.

The swamp fringe of *Phragmites australis*, *Schoenoplectus lacustris* & *Typha angustifolia*, with frequent areas of *Cladium mariscus* swamp (which occurs nowhere else in Broadland) is one of the most important features of the Broad. This vegetation has been classified as B28, with affinities to S4 reedswamp.

The precise location of Ormesby Common, a site of considerable botanical interest according to historical records, is unknown. However, the most likely location is underneath the waterworks, which were first built in the 1850s.

Hemsby Common - is an area of wet grazing marsh & species-rich fen meadow at the north east corner of Ormesby Broad. The site has a long history of grazing - the first records date from 1797. At the turn of the century drainage improvements allowed the intensification of grazing pressure, although this probably slacked off after World War II.

The main community is B10 *Holcus lanatus*-*Juncus effusus*-*Agrostis stolonifera* rush pasture (with affinities to MG10 & the nationally important M22d), with small areas of B28. Two communities rare in Broadland (< 10 hectares) are also found at this site; these are B9 *Juncus articulatus*-*Holcus lanatus*-*Lotus uliginosus* fen meadow (affinities to M22a), & B6 *Juncus subnodulosus*-*Carex panicea*-*Cirsium dissectum* fen meadow, which is rich in bryophytes & has affinities to the nationally important M22d.

The aerial photographs provide evidence that there was very little open vegetation even in 1946, although about 50% of the area was only covered in scrub communities at that time; in 1995, with the exception of the grazed area of Hall Farm Fen, the whole area was covered in mature woodland.

Management suggestions: (a) survey woodland & scrub to establish status. As a priority clear scrub & woodland from all marginal areas; (b) depending on the results of the survey, consider reopening fen to the north of the Broad, particularly the areas which were most recently open fen to the north western area; (c) manage this large block as a mosaic of woodland, scrub, fen, heath & grassland communities, by using large herbivores to create & maintain the transitions; (d) leave some areas of woodland (apart from adjacent to the margins of open water), to provide cover, shelter & a variety of habitat for the range of bird

species which use this site to winter upon; (e) manage marginal communities by mowing on a 1-4 year rotation;

17 Rollesby Broad & Lily Broad

This area includes the open water & semi-natural vegetation surrounding Rollesby, Ormesby Little & Lily Broad. As with Ormesby Broad, much of the land surrounding the open water has become vegetated or planted with trees & scrub. The marginal swamp communities occur as a narrow band surrounding the open water & there is a small area north of Lily Broad which remains as open vegetation & is of exception botanical interest. The sand & gravel substrates may be responsible for acidic nature of the site.

Most of the swamp vegetation has been classified as B28 & supports *Phragmites australis*, *Typha angustifolia*, & *Schoenoplectus lacustris* (affinities to S4). In the southern part of the site *Cladium marsicus* also grows as a swamp species and the community has been classified as B14, a species-rich community which is generally assigned to areas of commercially managed sedge (is these areas commercially managed) & with affinities to the nationally important S2.

The main communities on the open area to the north of Lily Broad are: B8, which is an acidic poor fen (rare in Broadland), supporting diverse herb, sedge, bryophyte & heath species (like M5/M24c); B20 dominated by *Juncus subnodulosus* but with a high species diversity & transitional between tall herb fen & fen meadow (like nationally important S24d & M22d); & B10 *Holcus lanatus*-*Juncus effusus*-*Agrostis stolonifera* rush pasture (affinities to MG10 & nationally important M22d).

In 1946, circa 50% of the area was mature woodland, with additional small areas of scrub. The 1995 photographs indicate that the only areas free from mature woodland are small compartments to the north & south of Lily Broad, although even these areas are becoming covered by scrub.

Management suggestions: (a) survey woodland communities to establish status; (b) clear scrub from the compartments surrounding Lily Broad (about 8 hectares) & maintain communities by summer grazing; (c) clear scrub 10-15 metres back from margins of broads to provide additional open fen habitat for birds; (d) manage marginal communities on a 4-10 year mowing rotation, to maintain free from scrub & to avoid litter build up; (e) retain woodland & scrub communities (except for the 20-25 meters adjacent to the waters edge) to provide shelter & variety of habitat for invertebrates & wintering/breeding birds;

18 Filby Broad & Burgh Common

Filby Broad - Historically, the margins of Filby Broad were probably used for rough grazing. Now, some areas along the edges of Filby Broad have been reclaimed as garden, but much of the remaining fen has developed into woodland. Aerial photographs indicate that there was minimal wood or scrub growth in 1946; but by 1995 only a fringe of vegetation around the Broad edge remained open. Many of the species recorded at this site in the past are still present.

The swamp vegetation is classified as B28 which is characterised by a dense mat of *Agrostis stolonifera*, with *Phragmites australis* & *Typha angustifolia* as associates (affinities to S4, S13 & S24). In places, the swamp vegetation is dominated by *Cladium marsicus* and has been classified as B14 (affinities to S24).

Burgh Common - this site has developed on peat which has accumulated as the result of the high water table in this area. It is probable that the common has a long history of grazing and a mosaic of species rich flush vegetation, acid grassland & fen meadow communities have developed.

Much of the common is vegetated by fen meadow communities, the most extensive being B20, B6 & B10, all of which are generally dominated by *Juncus subnodulosus*. B20 is very species rich; B6 supports an abundant bryophyte flora & is a rare community in Broadland. (These communities all have affinities to various subcommunities of M22).

Tall herb fen grows on the lower lying wetter areas, and is mainly represented by B43 *Phragmites australis-Glyceria maxima-Carex riparia* tall herb fen, or B19 which is dominated by *Phragmites australis* & *Calamagrostis canescens*. Where areas of turf have been cut in the past *Cladium mariscus* beds have developed & are represented by B14, B15 & B17. These were probably cut for thatching material in the past; some cutting still occurs.

Burgh Common supports five communities which are rare in Broadland: B4, an orchid rich fen meadow community, dominated by *Molinia caerulea*; B6 as mentioned above; B21 a mire community which is characterised by species such as *Potentilla palustris*, *Carex rostrata* & *Sphagnum* spp; B22 a *Juncus subnodulosus* dominated community, rich in sedges & bryophytes; & B23 dominated by a mixture of *Juncus subnodulosus* & *Carex disticha*, and rich in bryophytes. Burgh Common is the only site where B6 occurs.

In 1946 the Common was virtually free from woodland, with only a few small patches of scrub growing adjacent to the Muckfleet, and one area of woodland on some drier land to the north of the site. Approximately 50% of the Common is now woodland.

Management suggestions: (a) Survey of woodland to establish status; clearance of scrub on areas adjacent to the Muckfleet - much of this land is currently not managed. (b) reinstate dykes to act as wet fences & to provide additional open water habitat; high water levels should be maintained within the dykes to ensure waterlogged conditions are retained; (c) increase the grazing density on the areas between Filby Broad & Little Broad, and to the far west of the Common; (d) introduce an extensive grazing system over the southern half of the site to control scrub & encourage the development of a mosaic of communities;

RIVER THURNE FENS

Categories of fen & appropriate management

Much of the fen vegetation surrounding the open water areas associated with the Upper Thurne system may be classified as forming a topogenous waterfringe wetland, as fluvial waters are the predominant hydrological influence.

(Wetland classification see Wheeler & Shaw, 1995)

This category includes much of the marginal/swamp fen vegetation surrounding Hickling Broad, Pleasure Hill & Rush Hill, Deep Dyke & Meadow Dyke, Heigham Sound, Duck Broad & Blackfleet Broad, White Slea & much of Martham Broad Marshes.

The majority of this marginal swamp is dominated by a mixture of B27 *Peucedanum-Calystegia-Solanum* reedswamp & B28 *Typha angustifolia-Agrostis stolonifera-Galium palustre* reedswamp. (Both of these communities have affinities to S4 *Phragmites* reedswamp & the nationally important S24 *Phragmites-Peucedanum* tall herb fen). Both

B27 & B28 are widespread in Broadland, although the Thurne provides the stronghold for B28.

Other Broadland community types which are quite common within these water-fringe fens are B39 & B40 (affinities to S26 *Phragmites australis-Urtica dioica* fen) & B14 (affinities to the *Cladium* sub-community of S25 *Phragmites-Eupatorium cannabinum*).

B39 is a rather degraded community type co-dominated by *Phragmites* & *Arrhenatherum elatius*, whilst B40 is co-dominated by *Phragmites* & *Carex riparia* - both community types have their stronghold in the Thurne. Generally these communities are located further away from the river behind the B27 & B28 (S4/S24) vegetation types, sometimes occurring on embankments. These areas have the potential to become more species rich if managed more regularly, although disturbance created by management should be offset against any decision to increase mowing regularity.

The B14 community is dominated by *Cladium mariscus*, with *Phragmites* & *Juncus subnodulosus*. An interesting community within its own right and quite diverse with fen species according to management. It may be possible that management which favours sedge over reed could encourage the development of a more species rich sward, or possibly the nationally important S2 *Cladium* swamp? This community occurs in middle regions of the waterfringe fens and is generally surrounded by either S4/S24/S26 and tends not to occur either close to the embankment or too close to the water's edge.

The water fringe fen communities have developed over the basins of former Broads or medieval peat cuttings & because they are not protected from fluvial processes form near-natural systems. There is a strong saline and tidal influence on these communities - which has meant that despite the virtual absence of management, scrub development has been minimal.

Some commercial reed and sedge are mown by hand & this should continue and be expanded - but as this area is relatively undisturbed because of its inaccessibility, being too treacherous by foot and in an exclusion zone for boat users, this whole area between the flood embankment and the river system is of high ornithological value, and should be subject to continued low disturbance management.

Scrub and areas of fen vegetation which are not mown commercially for reed & sedge, seem most appropriate to being harvested by mowing on a 10-20 year rotation, always leaving some areas undisturbed, which may be particularly vital for some invertebrates, but also for birds sensitive to disturbance.

Outside of the Thurne wall, there are extensive areas of sump fen; this topogenous wetland has developed through terrestrialisation of former peat cuttings and has generally high water levels maintained by a variety of water sources

Includes most of 'The Hundred Acres Marshes', Brayden Marshes, the fens at Warbush (north of Catfield Dyke) and most of the fens to the south of Catfield Dyke round to Swim Coots and Heigham Corner, except for Mrs Myhills Marsh & Catfield Common.

The most extensive communities occurring within these areas are B14, B15 & B27. All three communities are extensive throughout Broadland, although the Thurne valley is the most important location for B14 & B15.

B14 is dominated by *Cladium mariscus*, *Juncus subnodulosus* & *Phragmites australis*. This is quite a species rich community and is important for bryophytes (has affinities with the

nationally important communities S24f & d *Phragmites-Peucedanum* tall herb fen, and S2 *Cladium mariscus* swamp).

B15 comprises species-rich tall herb fen, dominated by *Juncus subnodulosus*, which grows as a thick mat. This community has affinities with (S24 d & f).

B27 by comparison is a relatively species-poor *Phragmites* dominated community (most similar to S4 reedswamp, but with affinities to S24 & S26).

With the exception of north & south of Catfield dyke, and an area within The Hundred Acre Marshes, woodland & scrub are not widespread. The 1946 aerial photographs provide evidence that the existing woodland has developed from open fen and scrub over the past 50 years, with the exception of narrow bands along the upland margins.

However, target notes from the fen resource survey indicate that some of this woodland has already developed to the nationally important woodland W2b *Salix cinerea-Betula pubescens-Phragmites australis* woodland *Sphagnum* spp. subcommunity, which has also been classified as B20. B20 is transitional between tall herb fen & fen meadow, and often quite diverse in structure & species composition.

It seems possible that the high conductivity levels in this valley may be at least partly responsible for the slow rate of scrub establishment within the fens. An early survey of woodland and scrub habitat should be carried out to establish status. As most of the existing open fen is of national importance, areas of scrub & woodland without national/international status should be cleared to maximise the fen area. The open fen should be maintained wherever possible by commercial mowing of reed & sedge for thatching. Any other areas of fen vegetation could be harvested on a rotation of 4-10 years.

Towards the upland margins of the sump wetland, the vegetation is characterised by, impoverished fen, transitional fen meadow, mire & poor fen communities. In some instances, isolation & the introduction of drainage systems has occurred, altering the fen character

These areas include Mrs Myhills Marsh & Catfield Common; Bygraves Marsh & the fens surrounding Chapmans & Deary's scrapes; most of the grazing marsh, fen & scrub/woodland on the Potter Heigham level to the south of White Slea; Mere Farm Marshes; Long Gore Marshes and the northern-most section of 'The Hundred Acres Marshes', Shallam Dyke Marshes, Womack Water Marshes, Martham Marshes.

Potter Heigham Fen, Ludham Marshes & Heigham Holmes could also be included if water levels were slowly allowed to rise on these areas and a fen/fen meadow vegetation allowed to develop.

The peripheral location of these fens and historical evidence of grazing management distinguishes these areas from the sump fens. Areas of commercial reed B27 (with affinities to S4 reedswamp) are an integral part of these sites and consideration needs to be given to individual areas as to whether grazing is appropriate for these communities.

Apart from the areas of commercial reed, a range of fen, transitional fen meadow & mire communities occur within this category. Some areas of fen which were formerly grazed have developed a grass dominated tall herb fen vegetation, characterised by communities such as B28, B39 & B40, which all tend to be generally species impoverished. Other peripheral fens, also currently unmanaged, are rush dominated & tend to be more diverse; these include B20, B10, B15 & B7.

B28 is characterised by a dense mat of *Agrostis stolonifera* with a fairly open canopy of *Phragmites* in association. The vegetation has affinities to the nationally important S24 community, but differs in having a lower species richness. B28 is also generally associated with stagnant water conditions, over old peat cuttings. An extensive community (>100 hectares) the majority of which is located in the Thurne valley.

B39 is a grass dominated degraded community type (affinities with S26) - which tends to develop where grazing has been abandoned, but where the site is too dry to develop into a true reflooded habitat. Soil fertility is generally high, as a result of peat oxidation. B39 is found almost exclusively in the Thurne valley.

B40 is a community co-dominated by *Phragmites* & *Carex riparia* (affinities with S26d), with quite abundant tall herbs. Generally found in slightly wetter, lower nutrient conditions than B39, this community is very similar to S26. An extensive community (total 62 hectares), B40 has its stronghold in the Thurne.

B20 is transitional between fen meadow & tall herb fen and so stands may be of quite diverse appearance & species composition. *Juncus subnodulosus* is the dominant species, with a diverse range of sedges and herbaceous species, and is considered as having affinities with the nationally important tall herb fen & mire communities: S24d & M22d. At Mrs Myhills marsh, this community has also been classified by the fen resource survey as the nationally important woodland type W2b. B20 occurs over a total of 28 hectares and is most extensive in the Thurne.

B10, which has affinities to MG10, was recognised by the fen resource survey as having two subcommunities, both of which had grasses as a major component, but each subcommunity supporting a high frequency of either *Juncus effusus* or *Juncus subnodulosus*/*Juncus articulatus*. Both subcommunities supported a range of herbs & sedges. The indications are that if B10 communities are managed by light grazing, they are likely to develop into a vegetation similar to B6 (similar to M22d), which is a rare community in broadland, and only represented at Burgh Common in the Muckfleet Valley. This community is species rich and supports an abundant bryophyte flora. B10 is an extensively occurring community (> 100 hectares), but has its stronghold in the Thurne.

B15 is a community in which *Juncus subnodulosus* is usually the dominant species, although *Cladium*, *Phragmites* & *Calamagrostis* are frequently co-dominant, and *Schoenus nigricans* is an occasional associate. This community is quite species rich, with a fairly frequent bryophyte flora, and has affinities with S24d & f. B15 occurs over a total of 35 hectares & has its stronghold in the Thurne.

B7 is superficially similar to B10, but is more species rich and generally occurs on a more acidic substrate. The structure & composition of these communities is varied, probably related to the chemistry of irrigating waters. In places, the vegetation supports heathland species, elsewhere base-loving species are abundant. This community is particularly diverse in sedges & rushes, with an important herb & bryophyte component. It is likely that in the continued absence of management, this community would become ranker & more species impoverished due to shading out to B4 or B8. B7 has strong affinities with M23 *Juncus effusus/acutiflorus*-*Galium palustre* rush meadow. B7 is a rare broadland community (occurs on <10 hectares), the majority of which occurs in the Thurne.

All of these communities are distinctive in that they occur most extensively in the Thurne valley. This may be related in part to a tolerance of generally higher conductivity's. A bar chart showing average conductivity for each of the communities (see appendix) indicates that this may well be an important factor for all the communities except for B10, which showed the lowest average conductivity for all communities found in Broadland. However, the

inconsistent numbers of samples taken during the fen resource survey may partially explain this anomaly. Or it maybe that B10 is irrigated predominantly by fresh water from the uplands.

The historical and botanical evidence gathered by the fen resource survey indicates that extensive grazing management of all of these community types is likely to be beneficial, and may result in the development of a greater area of the unusual transitional fen meadow communities which are currently rare in Broadland.

THURNE VALLEY FEN SITES

9 Horsey Mere, Brayden Marshes & Long Gore Marsh

The majority of this site is included in Brayden Marshes. Other sites around Horsey Mere are Lady's Hill, Hog Hill & Horsey Marshes. Long Gore Marsh is isolated from the rest of site 9. There are 17 compartment numbers for site 9.

Brayden Marshes & Horsey Mere - Horsey Mere was dug for peat in the 13th & 14th centuries. Part of this area has terrestrialised with *Betulo-Dryopteris cristata* scrub communities & brackish *Schoenoplectus lacustris* ssp. *tabernaemontanii* swamp. The vast expanse of species-poor *Cladium* beds have developed over 19th century turf cuttings. These areas are virtually scrub free despite a long period of over 40 years of being unmanaged. The limited development of scrub may be attributable to the strong saline influence within this area.

To the east & south east of Brayden marshes are small areas of acid fen B29 & B21 (also classified by the fen resource survey as W2b & S24) which are of importance as they are rare communities in Broadland and support nationally rare & scarce species such as *Dryopteris cristata* & *Thelypteris thelypteroides*. B21 in particular is a rare, species diverse transitional sedge fen community occurring on only 7 hectares within the broads, the main valley being the Thurne.

As the soil fertility is low throughout Brayden Marshes & Horsey Mere, there is great potential for restoration to species rich *Cladium* fen through appropriate management. The area is currently dominated by B14 (S24f & d), and there may be potential for development to B17 (S24 g & f) However, this site is of great importance to birds and so management should take into account the need to minimise disturbance.

Management suggestions: (a) Encourage sensitive commercial management of sedge on a 4/5 year rotation where possible; (b) Where commercial mowing is not carried out, the remaining fen vegetation should be harvested on a varied rotation for different areas which ranges from 4-20 years, thus ensuring continuity of habitat, which is of particular importance for invertebrate species, but maintaining undisturbed areas for birds.; (c) Carry out survey of depth of peat & consider possibility of creating discrete turf ponds; (d) Encourage management of rare acidic transitional fen meadow community B21 (& B29), by more regular mowing or by including within an extensive grazing system; (e) Maintain integrity of site is ensuring that a large uninterrupted expanse of *Cladium* fen is maintained; (f) Improve site for Bitterns by the above, but also ensure maintenance & possible widening & sloping of dyke banks; (g) Consider possibility of extensive grazing system on one or two compartments on an experimental basis

Long Gore Marshes - An area of mixed open woodland, acid grassland & dry fen, with relict communities of *Cladium* & *Phragmites*. The site was formerly quite wet, but the drainage of the surrounding land during the period 1960-80 has lowered the water table in the area, resulting in deterioration of the fen vegetation at this site.

The dominant open fen communities are B14 (with affinities to S24) & B10 (with affinities to MG10). The target notes indicate that much of the remainder of the area comprises either dry acidic grassland dominated by *Festuca rubra*, dry *Phragmites australis* dominated fen, with abundant *Chaemerion angustifolium* & *Rubus fruticosus* or Carr woodland & mature scrub. Unfortunately, information on the age of woodland present is missing, although the historical dossiers from the fen resource survey indicate that the area was virtually free from scrub & woodland 50 years ago.

In recent months, the internal drainage board have allowed a sluice to be constructed allowing higher water levels to be maintained on Long Gores. This increase has been promising, allowing some areas of fen to be entered into Tier 3 of the ESA scheme; other areas are in tier 2 & tier 1. The whole area of Long Gores is circa 70 acres; half of which is currently under grazing management by the owner.

Suggested management: (a) higher water levels in the surrounding areas should be pursued via the water level management plans; although this site has deteriorated the potential for restoration of its fen interest remains, although this may be a long process. (b) extensive grazing over the whole area to maintain a mosaic of fen, scrub, woodland, and grassland; (c) a peat depth survey could be carried out and if other criteria are met and higher water levels achieved, this site could be considered for creation of discrete turf ponds. (d) reinstatement of dyke system & maintenance of a high water table; (e) if water levels are successfully raised, *Cladium* beds may be gradually brought back into a mowing regime - these areas may need protection from large herbivores during the first months after mowing.

Vision: continuous mosaic of fen, wet & dry grassland, woodland & scrub incorporating Long Gores & Cottons Marsh (NWT ownership), grazed by large herbivores (cattle or ponies) & deer.

10 Bygraves Marsh, Skoyles Marsh & 100 Acre Marsh

In the fen resource survey, the sites included in the descriptions for site 10 are Skoyles Marsh, 100 Acre Marsh, White Sleas & Meadow Dyke. Bygraves Marsh is not given an individual description but must be considered as an integral part of the description for Skoyles & 100 Acre Marsh. There are 16 compartment numbers for site 10.

Bygraves, Skoyles & 100 Acre Marshes - these areas are vegetated by a mosaic of grazing marsh, acid grassland communities, unmanaged species poor-fen & reedbeds. An embankment runs to the south of the area, separating this drier area from the wet unreclaimed fen adjacent to Hickling Broad. It seems likely that these drier areas have been used for grazing throughout the 19th & 20th centuries. During the 20th century parts were deliberately allowed to flood & commercial reedbeds were developed; much of the site remains dry.

B27, a reed-dominated community, is the main vegetation type occurring on the 100 Acre Marsh & Bygraves Marsh (B27 has affinities in parts to the nationally important S24 *Phragmites-Peucedanum* community, whilst other areas are more similar to S25 *Phragmites australis-Eupatorium cannabinum*).

Skoyles Marsh supports a range of acidic communities including a nationally important stand of W2b *Betula pubescens-Sphagnum* to the NW of Skoyles Marsh. The rare in broadland (i.e. < 10 hectares) communities B21, B35 & B7 occur on Skoyles. B7 is a species rich rush meadow community with affinities to M23 *Juncus effusus/acutiflorus-Galium palustre* rush meadow; there are circa 6 hectares of this community Skoyles marsh; the total area of this vegetation type for Broadland is just over 8 hectares. B21 is a very diverse transitional sedge

fen (with affinities to M25/S24) & B35 which is a herb rich transitional tall herb fen with affinities to S24d.

Other communities which are quite extensive, if not so notable, are B19 & B20. B19 is dominated by *Phragmites* & *Calamagrostis* with a number of tall herbs, although generally not a species-rich vegetation (with affinities to S24d & g). B20 is a very diverse transitional fen meadow community, important for a variety of bryophytes (similar to the nationally important communities S24d & M22d).

Management suggestions: (a) Secure perimeter & allow a very extensive grazing system with large herbivores to maintain a mosaic of fen communities, scrub & woodland; if commercial reed communities are required as part of this mosaic, grazing densities will need to be sufficiently low to ensure that reed is not a necessary component of the diet; early evidence suggests that in extensive systems, reed will mostly be grazed in times of hardship or during the winter months. (b) Allow the 100 Acre Marsh to become wetter & encourage tall fen vegetation. Harvesting of the fen vegetation could take place on a 4-10 year rotation, which may enhance the species diversity of the sward. Some areas may benefit from a more regular mowing regime (e.g. 4 years); other areas should be left undisturbed for 10 years. Undisturbed areas should be linked to help ensure that less mobile invertebrates which require deep litter or particular age of sward, have a corridor along which they may migrate; (c) reinstate dyke systems, taking care when considering creation of new dykes, to ensure that any spring flow to the fen areas is not diverted; (d) consider the possibility of creating turf ponds; a peat survey would help in the feasibility of this. (e) before clearing any woodland from these areas, carry out a survey to establish status.

Additional ideas:

- Consider making the small northern section of the 100 Acre Marsh into a 'super-wet' area, with lots of shallow footdrains, a high water table & an extensive grazing system to maintain a tussocky sward;
- Consider feasibility of linking Long Gores, Cotton Marsh & Skoyles/Bygraves/100 Acres & incorporating the whole into a semi-natural wild area, maintained by a combination of commercial harvesting & large herbivore grazing;

Whiteslea & Meadow Dyke - this area forms a distinct hydrological unit from the area to the north of the embankment, and is irrigated by brackish water from fluvial sources. Much of these fens were cut for peat (probably in the 13th & 14th centuries) and is now vegetated by *Cladium* & *Phragmites* beds which are fairly species-poor. However, a number of species of interest do occur in these areas, including *Schoenus nigricans*, *Dryopteris cristata*, *Peucedanum palustre* & *Sonchus palustris*.

The rond communities, dominated by *Typha* & *Phragmites* and which fringe Meadow Dyke & Heigham Sound have developed over medieval peat cuttings. Boat erosion causes serious erosion of these ronds.

Small areas of a range of Broadland communities occur including B14, B15, B26, B27 & B29 (all with affinities to S4 Reedswamp & S24 *Phragmites*-*Peucedanum* tall herb fen).

Management suggestions: Due to the fluvial & saline influences, these communities may be quite self-sustaining, and so it seems appropriate to leave all water fringe communities as little disturbed as possible, to allow for refuges for invertebrates & birds. Many of these areas are very treacherous by foot & zoning to exclude boats helps to maintain this low disturbance area. (a) Encourage harvesting of commercial reed & sedge to continue; (b) Rotational harvesting of remaining fen vegetation on a 10-20 year rotation;

11 Catfield Common, Pleasure Hill & Mrs Myhills Marsh

In the fen resource survey this area is actually split into two. The majority is referred to in the description as Hickling Broad Marshes, which includes Catfield Common, Pleasure Hill, Eastfield Marshes, Warbush, Sedge Marsh, Tubby's Hill, Swim Coots, Balls Rand and Poor Rand. Mrs Myhills is a relatively smaller area to the west of Hickling and in the fen resource survey is mentioned separately. There are 19 compartment numbers for site 11.

Hickling Broad Marshes - This is an area of *Typha* & *Phragmites* swamp, managed & unmanaged *Cladium* beds, litter fen & *Betula pubescens* swamp carr, much of which has developed over the basin of Hickling Broad. A variety of factors have affected development of the fen vegetation, including a decreasing pH from east to west, variations in conductivity, former peat cuttings, the management history & the height above the water table.

Historically, the fen vegetation of these marshes has been mown for marsh hay, reed & sedge. This has declined and although due to the influence of the brackish water scrub invasion has been minimal over much of the fen area, towards the margins and on the drier areas this is not the case & succession is occurring, often at the expense of the fen meadow & transitional communities.

The predominant vegetation types are B15 (with affinities to S24 & S25) and B14 (with affinities to S2). The two other main communities are B20 (like W2b) & B28. With the exception of B28 which is *Typha angustifolia*-*Agrostis stolonifera*-*Galium palustre* reedswamp (and is similar to S4 reedswamp) most of the open fen & W2b woodland is of national importance.

Management suggestions: (a) survey of all woodland; maintain any nationally important stands; (b) clear all scrub & woodland which is not of national/international importance, prioritising the potential fen meadow & transition areas, as these tend to support communities which are rare to Broadland. (c) support continued commercial extraction of sedge & reed; harvest remaining fen vegetation on a 4/5 year rotation, leaving areas nearest the river on longer rotations of 10-20 years. (d) reinstate any former dykes to improve facilities for removal of fen vegetation;

Mrs Myhills Marsh - an area of acid poor-fen surrounded by mature carr and oak woodland. The site is very wet, nutrient poor and supports a wide range of species. In the wettest, most acidic parts of the site, the vegetation has the appearance of a pool & tussock swamp, with species such as *Calluna* and *Erica tetralix* occurring on the highest ground and *Eriophorum*, *Carex curta* and a number of bryophytes, including an extensive carpet of *Sphagnum* surrounding the pools. This community was described as B20 *Phragmites australis*-*Juncus subnodulosus*-*Hydrocotyle vulgaris* transitional fen meadow.

Previous to the summer of 1995 only a small area of Mrs Myhills marsh, surrounding the pool, was free from scrub. The remainder of the fen area, classified as B20, was also identified as supporting the nationally important woodland/scrub community W2b. However, during 1995, the majority of the site was cleared of scrub. The stumps were treated but this is likely to have been largely unsuccessful due to the small diameter of many of the stumps. It is essential that if this site is to remain open that grazing takes place to control regrowth.

A comparison of the 1995 aerial photographs with those taken in 1946 provides evidence that apart from a narrow band of mature woodland on the northern edge of the site, and an area of scrub in the south-east corner, the existing scrub & woodland have developed in the past 50 years. On the drier areas the trees have developed rapidly, although there are indications of a former acid heath vegetation, such as the presence of gorse in the understorey, and on the drier margins of the 'bog' area, elderly *Calluna* persists. However, in the wet areas, where standing water is present most times of the year, tree growth has been very slow indicating a

low productivity site. Slow growth is also likely to be connected to the brackish conditions in this valley.

Management suggestions: (a) Establish a very extensive grazing system; this should incorporate the woodland and scrub communities on the drier margins. Due to the boggy nature of this site & the low productivity it seems unlikely to be suitable for mechanical harvesting for bioproducts; (b) Clearance of some woodland vegetation where it seems likely that an acid-heath transitional community may develop; this could include much of the woodland between the road & fen; (c) reinstatement of footdrains to provide open water habitat and to encourage some circulation of water; (d) Survey of all woodland to establish status & either clear or incorporate into the extensive system of grazing.

Vision: incorporate Catfield Common, Mrs Myhills Marsh & the intervening arable, woodland, scrub & fen into one management unit. Establish a near-natural system using large herbivores to control scrub and maintain the transitional fen communities. Encourage the harvesting of commercially viable reed & sedge within this framework.

12 Heigham Sound & Rush Hill

On the fen resource survey map this includes all of the fen & scrub areas south of Deep Dyke, Deep-Go Dyke & Meadow Dyke, from Rush Hill in the west to Blackfleet Broad in the east.

By name, the areas for which there is survey information include Rush Hill, Heigham Poor Rands, Wet Spurlings, Meadow Dyke, East Rands, Bonings Rand & Jim's Dream Hole.

Within the fen resource survey report, this area is all described under Heigham Sound & Meadow Dyke, or under Sound Marshes. There are 12 compartments for this site.

The majority of this area is continuous with White Slea & Meadow Dyke Marshes (north) & mainly comprises waterfringe swamp fen, the hydrology of which is predominantly influenced by fluvial processes. The Thurne wall to the south of this area separates the Sound Marshes from the swamp vegetation and supports dry fen, carr woodland & scrub.

The Meadow Dyke, Blackfleet Broad & the north western part of Heigham Sound were all cut for peat in the 13th, 14th & 19th centuries, & the south eastern areas of Heigham Sound were excavated for clay to support local pottery industries. An interesting stratification of communities have developed, influenced by historical and present day conditions, which include the effects of salinity & eutrophication.

The swamp vegetation is described by a range of broadland communities, the most frequently occurring are B28 & B27, both of which are most similar to S4 Reedswamp, but also have affinities to the nationally important community S24 *Phragmites-Peucedanum* tall herb fen. B28 is dominated by *Phragmites* & *Typha angustifolia*, whilst B27 tends to be dominated by *Phragmites* & *Agrostis stolonifera*.

Also notable are B14, a species rich community dominated by *Cladium*, *Juncus subnodulosus* & *Phragmites* (with affinities to S24 & S25); B29 which is closely related to the nationally important S24d, and in which both *Phragmites* & *Peucedanum* are constant species; B15 which is dominated by *Juncus subnodulosus* & is quite a species-rich community (affinities to S24); & B26 which is dominated by *Phragmites* & *Carex riparia* (also with affinities to S24). Small areas of *Thelypteris* swamp & *Sphagnum-Betula* woodland (20 ?) also occur back from the waters edge & on the slightly drier areas of fen close to the embankment, bands of degraded B39 & B40 occur, both dominated by grass species & similar to S26d

When the vegetation is ascribed National Vegetation Classification communities, it is interesting to see that although most of the community types have affinities with nationally important S24, over half of this area was considered as more appropriately ascribed to the communities S25 & S4.

To the south of the Thurne embankment, Sound Marshes were either pumped or gravity drained and used as grazing marsh until after the Second World War, when they were abandoned and allowed to develop into dry fen with scrub. In the past, this area was mostly vegetated by acid grassland & heath. A comparison of 1946 & 1995 photographs, indicates that prior to 1946 this area was virtually free of all woodland, with the exception of Wagonhill & Sound plantations. Now approximately two-thirds of the area surveyed is covered by woodland or scrub.

Management suggestions: (a) Maintain area as a low disturbance, near natural system, harvesting fen vegetation on a 10-20 year rotation, except for any commercial harvesting of reed & sedge which is likely to be on a shorter rotation. Within the 10-20 year rotation, undisturbed areas should be linked to ensure a migration route for invertebrates. (b) The Sound Marshes which were included within the fen resource survey, and the surrounding grazing marsh & woodland, could be allowed to develop into a mosaic of wet & dry fen, marsh land, scrub & woodland, maintained as a semi-wild system by extensive grazing with large herbivores, such as deer, Konik ponies, old breeds of cattle. Such a system would have particular benefits for amphibians, invertebrates & a variety of birds (Guestimate of area involved is circa 120 hectares) (c) Redirect the IDB drain so that it follows the Thurne wall, construct sluices at the ends of dykes adjacent to the IDB drain, with the intention of allowing this whole area to become wetter; (d) allow woodland to develop into a natural system, with clearings being maintained by grazing activities of large herbivores. (e) Survey all woodland to establish status. Include areas which were outside of the fen resource survey boundary, including Colls plantation & the woodland to the east of Colls Plantation. Maintain all nationally & internationally important woodland.

Vision: Removal of the Thurne wall, allowing all grazing marsh to flood & become an extensive low-productivity fen, grazed by a few large herbivores.

13 Starch Grass & Martham Broad

On the fen resource survey management maps, this area is referred to as Starch Grass and Martham Broad Marshes. In the description, the descriptions are for Mere Farm Marshes, Starch Grass, and Martham Broad Marshes. There are 20 compartments for this site.

Mere Farm Marshes: - A large area of unmanaged species-poor, dry fen, reedbed & woodland. The majority of the area is vegetated by the broadland communities B39 & B40, which have their stronghold at this site. B39 & B40 are indicative of communities which were formerly grazed, but once management ceased were not wet enough to return to true fen. These communities both have affinities with S26 *Phragmites australis-Urtica dioica* fen

B39 is grass dominated, with little occurrence of either low growing or tall herb species; B40 is often co-dominated by *Phragmites* & *Carex riparia*, is also species poor, although tall herbs such as *Eupatorium cannabinum* are usually abundant. Only limited areas of this vegetation could be alternatively considered as close to the nationally important S24 community.

Both communities are thought to be indicative of eutrophic conditions, which may be due to oxidation of underlying peat. The fen resource survey indicates that peat is the underlying substratum; however, the National Trust Warden, Robin Lang believes that the site is on clay with 2/3 feet of litter on top. The more diverse communities describe below are indicative of a peat substrate.

B27 is the main type of fen vegetation covering the northern compartments of Mere Farm Marshes; this reed dominated community has affinities to S4 reedswamp. The northern compartments also support small areas of B21, B33 & B35. B21 represents diverse transitional sedge fen (with affinities to M25c, S24, S27), and is a rare community in Broadland (<10 hectares); B33 is a *Phragmites* dominated community, but which supports a range of sedges; & B35 is a transitional tall herb fen community, with a prominent herb & grass component. B35 is also a rare Broadland community.

Some scrub & woodland development has occurred on this site since 1946, at which time there was none apparent except on the wall between Mere Farm Marshes & Starch Grass. The Fen Resource survey has identified a central area of this woodland as being of national importance, W2b. The total area of this site is approximately 70 hectares, of which about 10 % is currently woodland/scrub.

Vision: To create and maintain a mosaic of habitat, including a range of fen types, open water, scattered scrub and mature natural woodland.

Management suggestions: (a) Raise water levels if sustainable to do so (i.e. - if this just involves pumping less off; if the underlying substrate is peat, of which the surface layers are oxidised, re-wetting the area is likely to generate acidic conditions which may lead to some interesting communities developing; (b) reinstate dyke network to provide a greater variety of habitat and wet fences; (c) introduce a system of extensive grazing with large herbivores; if primitive hardy breeds of cattle or ponies were used and at a sufficiently low density, this area has potential to be managed in a low input way, with year round grazing. (d) carry out a peat survey to establish depth & location of peat & establish potential for development of species rich fen; (e) consider the possibility of creating discrete turf ponds if all criteria are met. (f) maintain nationally important woodland; grazing density may be crucial here. Leaving the woodland open to grazing would help maintain structure within the woodland; but in a hard winter, or if overstocked the woodland communities may be reduced in extent. (g) allow the development of scattered scrub, provided that the overall scrub cover does not increase greatly.

An alternative option: for the whole area in the absence of availability of suitable animals, or with the development of suitable fen harvesting technology, the whole area could be considered for wetter fen, with a 4/5 year rotational mowing regime. This would also encourage species diversity, although the community development would be likely to be more uniform.

Starch Grass - This is an area supporting commercial reedbeds of low botanical interest. The main communities are B28, a dense *Agrostis-Typha-Phragmites* community (affinities to S4) & B15 a *Juncus subnodulosus* dominated community, which can be quite species rich (affinities to S4/S24). Anecdotal evidence suggests that this area once supported a large colony of *Schoenus nigricans*.

Management suggestions: (a) maintain & encourage commercial harvesting of reed; (b) consider allowing the extensive grazing system proposed for Mere Farm Marshes to incorporate the southern area dominated by B15 *Juncus subnodulosus* dominated vegetation. The fen resource survey indicated that there appeared to be an increase in acidity towards the south of the site; if this is the case, grazing may encourage the development of some interesting transitional fen communities.

Martham Broad Marshes - the fens surrounding Martham Broad are mostly situated over peat cuttings which date from the 13th or 14th centuries. The vegetation is mostly *Cladium* dominated (B14), which is managed commercially & supports a diverse flora, including some

unusual species associated with the strong saline influence. (This community has also been classified as nationally important S24).

B15 & B29 also cover a reasonable area; B15 is a species rich *Juncus subnodulosus* dominated community; B29 is a community where *Phragmites-Peucedanum-Typha angustifolia* are constant species. B28 *Typha angustifolia-Agrostis stolonifera-Galium palustre* reedswamp is the main vegetation type fringing Martham Broad.

Only small areas of scrub and unmanaged fen occur on this area; these are periodically burnt to prevent litter build-up.

Management suggestions: (a) support & encourage continued commercial harvesting of reed & sedge; (b) leave small areas not suitable for reed or sedge harvesting unmanaged, to provide a refuge for invertebrates & small mammals.

14 Bastwick Marshes, Mustard Hyrn & Potter Heigham Marshes

On the management maps the following areas are referred to: Potter Heigham Fen, Bastwick Tower Marshes, Martham Marshes & Mustard Hyrn Marshes. Within the fen resource survey report, the only sites referred to are Potter Heigham Fen & Martham Marshes. It must be assumed that the description for Martham Marshes includes Bastwick Tower Marshes & Mustard Hyrn Marshes. There are 16 compartments in this site.

Potter Heigham Fen - This is a small site (< 10 hectares) lying amongst the grazing marshes south of the Hickling Broad Nature Reserve & north of the River Thurne. The fen has had along history of grazing management, and during WW2 an unsuccessful attempt was made to plough part of the area (the ridge & furrow effect is still evident). After the war, grazing was largely abandoned, the surrounding level drained, which had a drawdown effect on the fen causing it to dry out, and birch scrub began to develop. In the late 1980's, the site was purchased by English Nature, water levels raised, and in the past three years grazing management reinstated.

About half of the site is covered by B10 *Holcus lanatus-Juncus effusus-Agrostis stolonifera* rush pasture; brambles are commonplace within this community. However, the other half of the site, nearest the upland margin, supports an unusual wet heath & acidic grassland mosaic, with clumps of sedge, *Cladium mariscus*.

The deeper peats support B8, a community dominated by *Molinia caerulea*, *Erica tetralix* & *Sphagnum* spp. and this grades into a type of fen grassland B7 dominated by *Juncus effusus* & *Anthoxanthum odoratum* (similar to M23) where conditions are drier & less acidic. This community is herb rich.

Both of these communities are rare in Broadland, as are B25 & B16, which also occur on the Fen. B16 *Schoenus nigricans-Juncus subnodulosus-Hydrocotyle vulgaris* sedge bed is a species rich community, which is important for bryophytes (& elsewhere is a community in which *Liparis* grows). B25 *Juncus subnodulosus-Eriophorum angustifolium-Sphagnum* spp. acid mire is extremely limited in distribution, occurring at only two other sites in Broadland; this community is very important for bryophytes.

Management suggestions: (a) Allow extensive grazing over the whole area, carefully monitoring the effects. At present, B8 & B27 are unmanaged communities as they are excluded from the grazed areas. Alternatively, these areas could be considered for a summer mowing regime. (b) Encourage raising of water levels over this whole level, & more extensive grazing regimes, to help re-establish the acid-heath fen vegetation which is very characteristic of these marshes;

A vision: Gradual raising of water levels over the whole of this area & the Ludham Marshes NNR, to encourage restoration of potentially species-rich fen. Monitor dyke system & create new dykes on upland edges to ensure oases for dyke species are retained.

Martham Marshes - a series of dry grassland, woodland and abandoned grazing marshes on the south side of the River Thurne. Much of this area was drained at the turn of the century for use as grazing land, but was abandoned just after WW2. The area is now used as waste land and for fly tipping.

The open areas are dominated by B10 *Holcus lanatus*-*Juncus effusus*-*Agrostis stolonifera* rush pasture, with some B41 *Phragmites australis*-*Arrhenatherum elatius* dry tall herb fen. Over half of these marshes have developed into scrub or dry carr woodland. The 1946 aerial photographs provide evidence that apart from one or two clumps, most scrub and woodland has developed in the past 50 years.

Management suggestions: The fen resource survey indicated that there was potential for some of the dry acid grassland to develop to a wet heath flora if water levels were raised, so: (a) carry out a soil survey to establish the extent & depth of peat; if the substratum is peat, then there is potential for development of botanically interesting communities; (b) survey woodland to establish status; (c) consider possibility of joining the four areas of marsh, by incorporating the areas in-between into a common management regime. If this is possible, raise water levels over the whole area, & reinstate dyke system, using sluices to maintain good water levels: (d) Establish an extensive grazing system to allow a mosaic of fen, acid grassland, heath, woodland & scrub communities to develop. Ideally, use large primitive herbivores.

15 Womack Water & Shallam Dyke

This description covers Womack Water Marshes & Shallam Dyke Marshes. No compartment map has been produced for this site and so there are no compartment numbers associated.

Historical evidence indicates that both Womack Water Marshes (which were cut for peat in the 19th century), & Shallam Dyke were once species rich fen & fen meadow areas. In particular, Shallam Dyke was a site where species such as *Liparis loeselii* was present.

Both sites are now covered with woodland and scrub except for very small areas of B41 *Phragmites australis*-*Arrhenatherum elatius* dry tall herb fen & B42 *Phragmites-Urtica-Epilobium* tall herb fen. The 1946 aerial photographs indicate that at this time, approximately 50% of both areas were already covered with mature woodland or scrub.

Shallam Dyke has been particularly damaged by desiccation through reclamation of surrounding arable land.

Management suggestions: (a) Carry out a detailed woodland survey to establish status of woodland; it seems likely that for Shallam Dyke the site may be too dry to support one of the nationally important woodland stands associated with other areas of the Broads. If any woodland is of national/international importance, appropriate management should be considered. (b) Obtain more information on soils; deep uncut peat being a rare resource (Shallam Dyke ?); (c) Consider the feasibility of raising & maintaining higher water levels around Shallam Dyke; and also around Womack Water Marshes. (d) If funding were unlimited, if it were possible to raise water levels, if these sites were on deep peat, if the woodland which has developed is not of particular importance, these areas may have potential for recreation of rich fen. Because of surface oxidation of the peat, any community is likely to be quite acidic, and may be quite fertile. Turf ponding could be considered, & most

efficiently, the fen vegetation could be removed by grazing or a regular mowing regime (at least initially), to reduce fertility levels.

RIVER WAVENEY FENS

Categories of fen & appropriate management

Several areas of fen along the River Waveney may be classified as topogenous waterfringe wetlands, as fluvial waters are the predominant hydrological influence

These areas of fen include all of the Ronds, Glebe Marshes, the majority of Stanley & Alder Carrs, & Whitecast Marshes.

Most of the areas of open fen on these sites comprise Impoverished, reed-dominated communities, where *Glyceria maxima* & *Carex riparia* often become co-dominant depending upon factors such as proximity to the river or degree of habitat stability. The most extensive communities are B40, B43 & B30, although where the river water influencing the site is saline, brackish reedswamp (B50, B51 & B49) become common.

The Rond communities are largely unmanaged at present, although in the past these would have been cut or grazed. Their main function in the past & now, is flood defence, and although botanically they are generally species poor, the Ronds are important habitat for birds. For more information on ronds see reference by Harris (1992).

The fen vegetation of the Ronds could be beneficially harvested on a 2-4 year rotation, with some areas left unmanaged to form a mosaic. If mown in the winter, this would favour a reed-dominated community, which is more tolerant to erosion from boat traffic. Some areas could be harvested during the summer months, which may encourage greater botanical diversity, particularly further upstream away from saline influences.

Stanley & Alder Carrs, & Whitecast Marshes, provide two large washland sites, the former supporting a predominantly woodland habitat with some areas of open fen, & the Whitecast Marshes providing a fen habitat which is currently open, but developing scrub & woodland. These areas form relatively undisturbed habitat, which may be of particular interest for ornithological reasons.

The main community at Stanley & Alder Carrs is B43 *Phragmites-Glyceria-Carex riparia*, (with affinities to S26), although mowing management appears to be encouraging increased species diversity. The existing areas of open fen should be maintained by mowing to provide oases for fen species; the rest of the area may be of most benefit for conservation to allow it to continue development to a wet wildwood.

Whitecast Marshes is of established ornithological interest, and as this site provides the only large example of waterfringe wetland fen within the Waveney, it is suggested that the area would benefit from rotational harvesting. Mowing of some areas could be on a shorter rotation (1-4 years), whilst other areas could be left undisturbed for a longer time span (4-10 years), to benefit both birds & invertebrates. As this site is of importance for Warblers, some areas of scrub should be left undisturbed.

Some areas of botanically diverse fen vegetation occur away from the direct influence of the river.

Includes Spratts Water, Barnby Marshes & Oulton Marshes. Barnby Broad is a waterfringe wetland, and probably a percolating fen (Wheeler, pers.comm.).

The fen vegetation on these sites is represented by impoverished/species-poor reed-dominated communities (B41, B42 & B40), all of which have affinities with S26 *Phragmites australis-Urtica dioica* fen.

Fen meadow communities are important on these sites, the most extensive being B10 *Holcus lanatus-Juncus effusus-Agrostis stolonifera* rush pasture (with affinities to MG10 & the nationally important M22d). B1 & B2 are species rich fen meadow communities which are also quite extensive at Oulton Marshes & Spratts Water.

These three sites also support seven communities which are rare in Broadland (< 10 hectares), of which six are considered as important. (B37 is rare, but represents impoverished tall herb fen). These communities include B9, species rich fen meadow; B13 transitional tall herb fen; B4, an orchid-rich fen meadow community dominated by *Molinia caerulea*; B7 a species-rich acidic community dominated by rushes; B23, bryophyte-rich, & dominated by a mixture of *subnodulosus* & *Carex disticha*; & B25 an acid mire community of great importance for bryophytes.

If the Broadland overview is considered most important, then some of the areas which currently support impoverished reed-dominated communities could be considered as areas for potential expansion of the fen meadow communities. Extensive grazing & summer mowing management are most likely to encourage the development of a mosaic of communities & an increase in species diversity.

There may also be potential for B10, one of the most extensive communities which occurs in Broadland, to be enhanced by subtle changes in the existing management regimes. For example, a more extensive grazing regime, occasionally alternated with late summer mowing (instead of grazing) may encourage beneficial changes to the community & species composition.

Many of the sites considered by the resource survey no longer support any significant amounts of fen vegetation; however, some of these areas may have potential for restoration.

The areas that no longer support any significant amounts of fen vegetation include Belton Fen, Bradwell Doles, Fritton Decoy, Ashby Warren, Wheatacre Marshes, Geldeston & Barsham Marshes, Wild Carr Worlingham, Flixton Decoy & Summerhouse Marshes.

The resource survey described most of these sites as appearing dry and from the description of vegetation from within the historical dossiers, restoration of these areas to tall fen communities seems unlikely. However, there does seem to be potential for some areas to develop valuable heath, mire or fen meadow communities.

Wheatacre, Geldeston & Barsham Marshes are areas which have been directly reclaimed for agricultural use, mainly grazing. The remaining sites have mainly lost their fen vegetation through development to woodland, either via successional processes, or by planting.

Extensive grazing systems along with selective clearance of areas most recently covered by trees may provide the most sustainable & economical way to determine the potential for restoration of these woodland sites. Information on the extent & depth of peat could also provide guidance as to areas with most chance of developing species rich communities.

Although little scientific evidence exists, it seems likely that many of these areas were wetter in the past. Lower water levels may be a combined consequence of improved drainage of surrounding land, & the possible effects of groundwater abstraction. If opportunities arise to improve/restore better water supplies to these sites, the restoration of fen habitat is more likely to be successful.

WAVENEY VALLEY FEN SITES

44 Glebe Marshes & Burgh Castle Ronds

The site consists of saltmarsh vegetation with areas of reed. In the past these areas were possibly cut for reed or grazed. This site is important for birds.

Glebe Marshes is an area of former grazing marsh which was flooded in the 1970's, following failure of the flood embankments, it developed reedswamp & open water habitat. The Burgh Castle ronds originated in the 13th & 14th centuries when the Broadland rivers were embanked & they provide washland areas for floodwater.

In close proximity to Breydon water & the open sea, the irrigating waters are brackish & tidal. The main fen community is B27, dominated by *Phragmites australis*, but with one or two interesting large herbs, but the most commonly occurring habitat is impoverished salt marsh B52 & B53 (affinities to SM13 & SM16).

Management suggestions: Mow rond vegetation on a 2-4 year rotation, except on Glebe Marshes which are non-intervention, preferably during the winter months to favour a reedswamp community. Reedswamp is likely to be more resistant to erosion.

45 Belton Ronds

An area of saltmarsh vegetation & reedbed, some of which is still cut. Ronds originated in the 13th & 14th centuries when the Broadland rivers were embanked & they provide a valuable washland area for floodwaters. Most of the ronds were either grazed or cut for reed in the past.

The most commonly occurring vegetation types are impoverished salt marsh B52 & B53 (affinities to SM13, SM14, SM16), & the brackish reedswamp communities B51 & B49 (affinities to S4d).

Management suggestions: Mow rond vegetation on a 2-4 year rotation, preferably during the winter months to favour a reedswamp community; some areas should be left as non-intervention. Reedswamp is likely to be more resistant to erosion.

46 Belton Fen & Bradwell Doles

This site does not now include any vegetation that could be described as fen, but historical information indicates that this area may in the past, have been one of the most botanically rich valley fens in East Anglia. There is no evidence of peat cutting, but the site has a long history of grazing.

The area is now mainly dry woodland. The remaining fen at the site is very dry & of low quality & has been described as B42 *Phragmites australis-Urtica dioica-Epilobium hirsutum* tall herb fen (with affinities to S26). The vegetation resource survey considered this site as having potential for restoration to fen, although the information in the historical dossier for the site indicates that restoration to acid grassland & heath may be more likely.

However, the site does have historical records (particularly for the last century) for a great range of species, including a number of bryophytes; although presumably these may relate to areas which no longer exist.

Management suggestions: (a) survey depth & extent of peat to establish potential for development into species rich fen; (b) survey woodland to establish value and status; (c) consider creating rides & glades to act as oases for fen/grassland species; (d) where possible use extensively grazing large herbivores to maintain a mosaic of habitats; (e) consider feasibility of raising water levels on site by use of sluices;

47 Fritton Ronds

This area includes both the Fritton & St Olaves ronds, and comprises both saltmarsh vegetation & brackish reedswamp. The main community is B50, a brackish reedswamp (with affinities to S4diii).

Ronds originated in the 13th & 14th centuries when the Broadland rivers were embanked & they provide a valuable washland area for floodwaters. Most of the ronds were either grazed or cut for reed in the past.

Management suggestions: Mow rond vegetation on a 2-4 year rotation, preferably during the winter months to favour a reedswamp community. Some areas should be left as non-intervention. Reedswamp is likely to be more resistant to erosion.

48 Fritton Decoy & Ashby Warren

Fritton Decoy & Ashby Warren lie in a small tributary valley of the River Waveney. Apart from a few small areas of fringing reedswamp around Fritton Decoy, this area can no longer be classified as fen. The Decoy originated as a medieval peat cutting & has similarities to the Trinity Broads.

Pre-1970, species rich swamp surrounded the Decoy, but these have virtually disappeared. The cause of this loss is unknown, but could be related to water quality, water quantity, neglect & boat use.

Ashby Warren was originally heathland, which has been largely covered with plantation woodland (both conifers & mixed).

Management suggestions: (a) clear areas of plantation woodland & allow some of the heathland vegetation to regenerate; (b) use extensive grazing by large herbivores to create & maintain a near-natural mosaic of woodland, scrub, acid heath & grassland;

49 Herringfleet Ronds

Ronds originated in the 13th & 14th centuries when the Broadland rivers were embanked & they provide a valuable washland area for floodwater. Most of the ronds were either grazed or cut for reed in the past. The Herringfleet Ronds support *Phragmites australis* dominated fen, swamp & reedbed, some of which is still cut.

The main community is B30, dominated by *Phragmites australis* with *Agrostis stolonifera* & *Carex riparia* as constant associates. This is a species poor communities with affinities to S4b.

Management suggestions: Mow rond vegetation on a 2-4 year rotation, preferably during the winter months to favour a reedswamp community. Some areas should be left as non-intervention. Reedswamp is likely to be more resistant to erosion.

50 Wheatacre Marshes

This site does not now include any vegetation that could be described as fen, although there are some patches of reed & *Arrhenatherum* dominated vegetation occurring along the edge of the upland. There are also a few areas of dry woodland which may correspond to former fen sites. This site appears to have been reclaimed for grazing towards the end of the 18th century.

51 Flixton Decoy & Summerhouse Marshes

Flixton Decoy, Summerhouse Water & Wicker Well are small broads surrounded by plantation woodland & carr woodland, in small tributary valleys of the Waveney. Flixton Decoy was apparently produced by the removal of peat from a small acid bog. A small area of fen meadow community persists at Flixton Decoy, and there may have been acidiphilous fen communities in the past. However, the majority of land surrounding these small broads is now plantation woodland & carr.

The fen meadow community is B2, dominated by *Juncus articulatus* & *Juncus effusus* (affinities to M22a).

No aerial photographs were found pre-dating 1970, but at this time most of the areas surrounding Flixton Decoy were already covered by mature woodland. The scrub and woodland development at Summerhouse Water & Flixton Decoy have occurred more recently, and now cover approximately 50% of the site.

Suggested management: (a) clearance of woodland from around the broad margins to encourage development of marginal swamp; (b) clearance of trees from areas of most recent woodland development & in the vicinity of the fen meadow community. (c) consider use of large herbivores grazing very extensively to create & maintain a near natural system, with a mosaic of habitats.

52 Blundeston & Somerleyton Ronds

The Ronds originated in the 13th & 14th centuries when the Broadland rivers were embanked & they provide a valuable washland area for floodwater. Most of the ronds were either grazed or cut for reed in the past.

This site supports fen & swamp vegetation, represented by B43 *Phragmites australis*-*Glyceria maxima*-*Carex riparia* tall herb fen & B30 *Phragmites* dominated fen (both with affinities to S24). B45 dominated by *Carex riparia* & *Glyceria maxima* is also quite common.

The main interest of this site is ornithological.

Management suggestions: Mow rond vegetation on a 2-4 year rotation, preferably during the winter months to favour a reedswamp community. Some areas should be left as non-intervention. Reedswamp is likely to be more resistant to erosion.

53 Burgh St Peter & Barnby Ronds

The Ronds originated in the 13th & 14th centuries when the Broadland rivers were embanked & they provide a valuable washland area for floodwater. Most of the ronds were either grazed or cut for reed in the past.

This site consists of fen vegetation represented mainly by species poor reedswamp B43 (S4a), with extensive scrub invasion.

Management suggestions: Mow rond vegetation on a 2-4 year rotation, preferably during the winter months to favour a reedswamp community. Reedswamp is likely to be more tolerant to erosion.

54 Barnby Marshes & North Cove Marshes

An area of species-rich fen meadow, dry fen, plantation woodland & carr on the floodplain of the River Waveney. Barnby Broad was dug for peat in the 13th & 14th centuries and has partially terrestrialised. There are also 19th century workings which now support some interesting plant communities.

Carr woodland & scrub surround the open water of Barnby Broad. Adjoining the Broad & woodland are areas grazing marsh, dykes, fen & fen meadow. A range of plant communities are present, some of which are unique to this area. Many of the communities present are species rich & support a number of nationally & locally rare or scarce fen species.

To the west of the Broad is an area of floating *Sphagnum* fen, which supports a number of important fen plants. This area is currently covered with young woodland, which in the 1970's was visible in aerial photographs as scrub. This area has great potential for restoration.

The most extensive open area is grazing marsh habitat, dominated by B10 *Holcus lanatus*-*Juncus effusus*-*Agrostis stolonifera* rush pasture (with affinities to MG10). B41 *Phragmites australis*-*Arrhenatherum elatius* dry tall herb fen (affinities to S26) also is quite frequent, particularly towards the margins of the site.

However, there are also areas of botanically diverse fen meadow B1, which supports a variety of calcicolous species such as *Briza media*, *Anagallis tenella* & *Anthoxanthum odoratum* (affinities to the nationally important M22d), as well as four communities which are rare in Broadland: B13, B4, B7 & B37.

Although B37 is rare in Broadland (< 10 hectares) it is an impoverished community with affinities to S26 *Phragmites australis*-*Urtica dioica* fen & so is not particularly important. However, B13 *Filipendula ulmaria*-*Juncus subnodulosus*-*Phragmites australis* is a transitional tall herb fen/fen meadow community, which if grazed could develop into B1. B4 is an orchid rich fen meadow community, dominated by *Molinia caerulea*, but is transitional & unstable in the absence of either grazing or mowing management; & B7 *Juncus effusus*-*Luzula multiflora*-*Anthoxanthum odoratum* rush meadow is found, and also is dependent upon light grazing or summer mowing to be maintained.

Apart from the area of floating *Sphagnum* carpet to the west of Barnby Broad, most of the existing woodland was already mature in the early 1970's, and the areas which were then developing as scrub, are now wooded. Approximately 50% of the site is covered by woodland or scrub.

Seven Mile Carr - is also included within this site, although found on the opposite side of the River Waveney. This is an area of Carr woodland and does not contain any fen & so was not

surveyed. From the aerial photographs, most of this site was woodland by the 1970's. There is minimal historical information available for this site.

Management suggestions: (a) clear woodland from *Sphagnum* carpet, unless woodland of international importance; (b) survey extent & depth of peat; consider creating shallow turf ponds, particularly on areas currently dominated by dry fen; (c) consider extensive grazing or summer hay mowing for all areas of fen/fen meadow currently unmanaged; (d) clear woodland & scrub communities in favour of species rich fen communities (see peat survey) which may develop instead; (e) maintain all dykes; no new dykes to be excavated because of the risk of diverting spring flows away from fen communities;

55 Oulton, White Cast Marshes & Carlton Marshes

Oulton Marshes - an area of grazing & mowing marshes, & dry fen on the Waveney floodplain. At one time the whole area was grazed, but some areas are now unmanaged, and some areas have been planted with broad-leaved trees (poplars). Some of the fen meadows now support a rich flora, particularly those which are horse grazed.

Historical records indicate that the species interest present on these marshes 150 years ago still persists, although the total extent of species rich habitat has declined dramatically. Most of the important areas occur on a thin layer of peat close to the upland margin.

The most extensive habitat is dry tall herb fen represented by B41 *Phragmites australis-Arrenatherum elatius* & B42 *Phragmites-Urtica-Epilobium* (both with affinities to S26). B10 *Holcus lanatus-Juncus effusus-Agrostis stolonifera* rush pasture (affinities to MG10 & nationally important M22d) is also extensive.

Other important fen meadow communities are B1, a *Juncus subnodulosus* dominated community with affinities to M22d, & B9 & B13, which are both rare in Broadland. B9 is a species rich community, dominated by *Juncus articulatus* & *Holcus lanatus*; B13 is *Filipendula ulmaria-Juncus subnodulosus-Phragmites australis* transitional tall herb fen, which if grazed could develop into B1.

Whitecast Marshes - this site has developed on estuarine mud & clays over part of the former basin of Oulton Broad. Species poor communities have developed which are dominated by *Phalaris palustris*, & *Glyceria maxima* closest to the Broad, where the tidal influence is greatest. The water influencing the vegetation is slightly saline, eutrophic & tidal. However, the treacherous nature of the site makes it virtually inaccessible. Whitecast Marshes is of considerable ornithological interest.

The most extensive community is B40 tall herb fen, being dominated by *Phragmites australis* & *Carex riparia*. Areas of B42 *Phragmites-Urtica-Epilobium* tall herb fen also occur, particularly close to the floodbank; & B44 *Phragmites-Glyceria-Epilobium* tall herb fen, closest to the open water.

Until the middle of this century the reedbeds were managed more intensively, and as a result, quite large areas of scrub are developing.

To the north of Oulton Broad is a small area of fen meadow B10 *Holcus lanatus-Juncus effusus-Agrostis stolonifera* rush pasture, with B45 *Glyceria maxima-Galium palustre-Iris pseudacorus* tall herb fen.

Spratts Water - a diverse mosaic of mixed fen, open water, alder carr & wet grazing marsh on deep peat. Much of this area was pump drained for several centuries, but during the past 50-100 years grazing was abandoned on some areas & drainage deteriorated. Where

management by grazing or mowing has continued, a diverse fen meadow flora has developed; other areas support a coarse tall herb fen vegetation.

The most extensive fen communities are B40, dominated by *Phragmites australis* with abundant climbing species making the stands of vegetation dense & impenetrable, and B42 *Phragmites australis-Urtica dioica-Epilobium hirsutum* tall herb fen.

B1 & B2 are the most abundant fen meadow communities. B1 is generally dominated by *Juncus subnodulosus*, and supporting a range of sedge species; B2 is grass dominated (*Holcus lanatus*), with few sedges except for *Carex disticha*. (Both communities have affinities to M22).

Three communities which are rare in Broadland (< 10 hectares) also occur; these are B7 which is quite a species-rich acidic community, in which rushes are prominent; B23 which is typically dominated by a mixture of *Juncus subnodulosus* & *Carex disticha*, but is also rich in bryophytes & sedges of low stature; & B25, an acid mire community of great importance for bryophytes.

Management suggestions: (a) ensure continued summer mowing management currently practised, to maintain existing variety of species & communities; (b) consider very light extensive summer grazing of coarse tall fen communities; (c) encourage 4-10 year rotational harvesting of tall fen on Whitecast marshes; (d) encourage more extensive grazing on grazing marshes, particularly those which may be on deep peat, to allow more fen species to develop;

56 Stanley & Alder Carrs, & Wild Carr, Worlingham

This site includes Stanley & Alder Carrs, Wild Carr Worlingham & Beccles Marshes.

Beccles Marshes - an area of grazing marsh, parts of which have been abandoned or converted to arable land. Beccles Marshes no longer contain any significant fen vegetation, although historical information indicates that this area was once more extensive & supported botanically diverse fen.

Wild Carr, Worlingham - this area is now mainly dry carr woodland with small areas of tall herb fen vegetation. Until the beginning of the 20th century it was a bog of considerable botanical diversity. The decline in interest may be partly due to the effects of eutrophication by drainage waters from adjacent arable land, although lack of management is also an important aspect.

Stanley & Alder Carrs - this is the only extensive area of regularly flooded alder carr woodland & fen in the Waveney Valley. The Waveney is tidal & so the whole site is regularly flooded when river levels are high, some areas being influenced by nutrient rich, saline water. Most of the area supports carr woodland of unknown age & status, although some areas have developed into woodland from scrub over the past 50 years. The majority of open fen is characterised by B43 *Phragmites australis-Glyceria maxima-Carex riparia* tall herb fen (with affinities to S26 & the nationally important S24). This area was probably drained & grazed until WW2. There appears to be no historical evidence of Stanley & Alder Carrs supporting botanically diverse fen vegetation, which may be due to the substrate and flooding conditions.

Management suggestions: (a) survey woodland & establish status; (b) survey depth & extent of peat; (c) consider the feasibility of raising water levels on Beccles Marshes, particularly in areas of deep peat, to encourage the regeneration of fen vegetation; these areas may need removal of surface oxidised layers. (d) depending on status of woodland & location of peat, consider removal of woodland from Wild Carr & management to encourage development of

fen vegetation; alternatively, this area could be allowed to remain as a “wild wood” & a few clearings maintained to provide oases for fen species. The area could also be grazed by a small number of large herbivores. (e) Stanley & Alder Carrs is unique within its own right, and probably has most potential in being allowed to continue its development as a “wild wood”. Maintenance of existing fen areas & creation of occasional clearings, particularly along the upland margins & away from the influence of the river water, could provide oases for fen species.

57 Geldeston & Barsham Marshes

The site included Roos Hall Marsh, Barsham Marshes & Low Meadows, & Geldeston Marshes. Geldeston Meadows SSSI is not included within the fen resource survey, as this area had been covered by the Norfolk Valley Head Fens survey by Simon Smart.

These areas no longer support much fen vegetation. The most extensive community is B42 *Phragmites australis-Urtica dioica-Epilobium hirsutum* which is an impoverished fen type which is affiliated to S26. Roos Hall Marsh comprises plantation woodland & mowing marsh; Barsham Marshes & Low Meadows are mainly grazing marsh & carr woodland; & Geldeston Marshes are mainly grazing marsh with some plantation woodland.

There is no historical evidence available which suggests that these areas were botanically diverse in the past.

Management suggestions: (a) carry out a survey to establish the extent & depth of peat; (b) raise water levels & either consider creating reedbed habitat maintained by winter harvesting on a 1-4 year rotation, or if deep peat is present, botanically diverse fen meadow, maintained by extensive grazing or summer mowing;

RIVER YARE FENS

Categories of fen & appropriate management

Most of the Yare fens, where open to the regular tidal & flooding regime of the river have developed an impoverished S26 *Phragmites australis-Urtica dioica* community, often with a significant development of sallow scrub (Topogenous Alluvial wetland - clear evidence of silt deposition - Wheeler & Shaw, 1995)

These fens include Kirby, Whitlingham, & Surlingham Broad Marshes, Bargate & the Outmeadows, parts of Surlingham Marsh, much of Wheatfen & Rockland Marshes, & Hardley Flood.

Much of the vegetation within these areas falls into the B42 (close to S26d *Phragmites-Urtica*) or B45 (close to S5 *Glyceria maxima* swamp) communities, both of which have their strongholds in the Yare valley. The distribution & extent of these vegetation types nationally and in Broadland is widespread.

B42 (S26) tends to be a dense impenetrable community type, with *Phragmites australis* as the usual dominant species & with varying amounts of *Urtica dioica*. A range of tall herb plants occur, but at low constancy's and smaller herbs are very uncommon. Bryophytes are scarce or absent. B45 (S5) can be dominated by either *Glyceria maxima* or *Carex riparia*. As with B42, a range of tall herbs occur but at low constancy's & small herbs are rare. Both communities are considered indicators of eutrophic conditions, although the B42 community

may also be indicative of lack of management and the B45 community may have developed through the relatively recent onset in tidal conditions along this stretch of the Yare. *Glyceria maxima* is also known to be tolerant of unstable silty conditions, and once established tends to discourage colonising seedlings of other species.

These areas can either be brought back into some form of management or left to develop as a tidally influenced system. It seems reasonable, that over time these fens may develop into areas similar to Stanley & Alder Carrs, or in the shorter term to Hardley Flood; these are not considered to be highly valuable botanical value, although of undoubted interest as wetland systems & for ornithology. However, Brundall Carrs & Marshes, an area of former grazing marsh which has been unmanaged for some time is now largely covered with woodland, provides an ideal opportunity to leave some 'wildwood' in this part of the Yare.

For most of these fen areas, however, the introduction of management to prevent succession & reduce the vigour of some of the tall growing dominant species, could result in the development of a more floriferous & diverse habitat.

Historical information indicates that most of these sites were grazed in the past; some of them being actively drained by windpumps. On several of these areas, including Whitlingham, Kirby, Surlingham, Rockland & Wheatfen Marshes, the reintroduction of grazing could take place almost immediately if the dykes were restored and their endings closed to the river to remove the tidal effect & provide wet fences for livestock. This has taken place over other areas and the immediate effect has been suppression of species such as *Glyceria*, *Phragmites* & *Carex riparia*, allowing the possibility for other less vigorous small herbs to grow. As reed grows best under conditions of winter cropping, grazing management, unless carried out on a very extensive basis, may favour a grass- rather than reed-dominated sward. However, on the restored fens on the southern edge of Surlingham Broad Marshes, the S24 community appears to have developed under a grazing regime. Grazing also favours the development of transitional fen/fen meadow communities.

Similarly, if the dykes were to be reinstated, isolated from the river and the fen vegetation cropped for bioproducts, it seems likely that the S26 community may gradually develop into the nationally rare S24 *Phragmites australis*-*Peucedanum palustre* fen. This habitat could also be beneficial to birds such as the Bittern & Bearded Reedling, and invertebrates, most notably the Reed Leopard Moth and the Swallowtail butterfly. Areas could be mowed in rotation, providing a mosaic of different aged stands.

A combination of the two forms of management could be the best option; the driest areas perhaps being grazed, & the wetter with the reedbed community encouraged by a mowing regime. However, a soil survey would reveal any areas of deep peat - which potentially may develop into a species rich fen meadow if grazed or mown as hay/litter marsh. Managing for reedbed could suppress this species interest from developing.

Where the tidal influence has been removed from the fen system, management introduced and in some cases the dominant water influences altered, changes to the S26 impoverished fen community occur (Topogenous Sump Fens - hydrological classification by Wheeler & Shaw, 1995)

With grazing management: diverse fen meadow communities develop, including parts of Surlingham Broad Marshes (south area), Surlingham Marshes, Thorpe Marshes

Each of the above three examples are quite different and so must be looked at individually.

At least part of Thorpe marshes appear to be located on deep peat & support a botanically diverse flora. These areas were thought to be former grazing marsh/hay meadow. The rest of this area is S26 (B42). The dyke system & summer grazing management has recently been reinstated with the immediate effect of reducing the vigour of the dominant tall growing plants & introducing a more varied vegetation structure. Over time, nutrient levels should decline and the sward become more open allowing a more diverse flora to develop. A peat survey would indicate the likelihood of the potential for botanical improvement.

On Surlingham Broad Marshes, the area to the south has been relatively recently restored to fen. Management, which includes grazing by Soay sheep, was reinstated around 1989 & on a part of this site the nationally important S24 (B43) *Phragmites australis*-*Peucedanum palustre* has developed. It is likely that burning was also used to reinstate this site although it is unclear as to whether this occurred on the area which is now S24, or on the area which remains as S26 (B42) *Phragmites australis*-*Urtica dioica* fen.

Surlingham Marshes were notified as an SSSI at least partly because they formed an extensive area of *Glyceria* swamp. Since the spring of 1995 the RSPB have purchased this part of the Yare fens, removed the tidal influence of the river by closing the dyke ends with sluices, and introduced a regime of summer cattle grazing and dyke & scrub clearance. The change in appearance has been dramatic, appearing more as a fen meadow than B43 *Phragmites australis*-*Glyceria maxima*-*Carex riparia* tall herb fen which was dominant before grazing began.

Grazing has compacted the unstable silty deposits and underneath the soils are peaty. With continued management to reduce the litter layer & nutrient levels it seems likely that a more diverse flora will develop. However, the fen resource survey indicated there were several patches of B43 *Phragmites australis*-*Urtica dioica*, sub-community *Epilobium hirsutum*, which has affinities to S24 *Phragmites australis*-*Peucedanum palustre* on these fens. The grazing density may be too great for certain components of this community to survive - both structurally and species. The overall benefits may be worth the loss - but it is suggested that a lower grazing density is adopted in the future, leaving more of a mosaic of vegetation with some clusters of vegetation more intact.

It is recommended that grazing management is extended to other areas of fen mentioned in the previous section, but also to the area of Strumpshaw & Bradeston Marshes, currently a reedbed requiring expensive water management to keep it wet enough, but which has potential to become species rich fen under grazing or summer mowing management. See below.

Grazing should be used to produce a mosaic of structure, not an extensive evenly grazed sward. This will ensure areas of cover for invertebrates & birds. Lower grazing densities will also ensure that palatable herb species are not all eaten. Clumps of scrub should also be retained as grazing will prevent its spread.

With mowing management: development of nationally important fen communities, predominantly S24 *Phragmites australis*-*Peucedanum palustre* tall herb fen, but also S2 *Cladium mariscus* swamp & M22d *Juncus subnodulosus*-*Cirsium palustre* fen meadow. These fens include Bradeston Marshes, parts of Strumpshaw, Surlingham, Rockland & Wheatfen Marshes, Surlingham Church Marsh & a small part of Whitlingham Marshes

Areas of managed S24 *Phragmites australis*-*Peucedanum palustre* fen often occur intermingled with or adjacent to areas of unmanaged S26 (B42/B43) *Phragmites australis*-*Urtica dioica* fen. So it is possible that mowing may encourage development of the nationally important community. However, a comparison of the broadland community types and the NVC label given to various compartments, indicates that only about one-third of the S24 at

Strumpshaw, for example, is truly S24, the remainder being either very impoverished S24 or closer to fen meadow.

At Bradeston & Strumpshaw Marshes there is a history of grazing & evidence to suggest that this site has potential for restoration to botanical diversity, particularly along the margins furthest from the river which support deep peat. Any areas of fen in this part of the Yare which are too dry to support a good reedbed without pumping on extra water, and with the potential to be botanically diverse (i.e. with deep peat) should be considered either for an extensive grazing scheme or for summer mowing on rotation (e.g. for bioproducts).

Many of the other areas in this category should be considered for a summer mowing or grazing regime, particularly on the upland floodplain margins where silt-free peat is most likely. Extensive grazing management, in particular, would encourage the development of transitional communities, as well as a greater range of fen habitat. Reedbed creation could be targeted to areas of grazing marsh which are prone to flooding and currently need year-round pumping to prevent flooding; these areas are particularly extensive downstream, although there are one/two possibilities upstream.

The potential gain of species rich fen needs to be offset at the possible loss or reduction in extent of the nationally important S24 community. However, it is important to remember that much of the vegetation shown as S24 is not considered typical S24. Also there is insufficient evidence to determine whether or not *extensive* grazing would damage or enhance this community type.

The nationally important S2 *Cladium mariscus* swamp community will require mowing on a rotational basis to maintain age structure in its sward. Grazing is unlikely to damage this sedge except at times of mowing when new shoots may be palatable, although it may limit the expansion of this species. Summer mowing for bioproducts would also be more acceptable than reedbed management, although it may not produce the same mosaic of fen types.

Where the fens in the Yare have water sources which are independent of the river & if management is introduced, the S26 fen changes to a more species rich transitional fen/fen meadow/mire community

These fens include Poplar Farm Meadows, Strumpshaw Common, Limpenhoe Meadows, parts of Ducans Marsh, & parts of Buckenham & Hassingham Carrs

All these species-rich sites are suited to annual management which may be either a summer hay cut or extensive grazing. With the exception of Buckenham & Hassingham Carrs, most of these areas are currently scrub free and maintained mainly by grazing. They are also generally 'islands' of botanical diversity within areas of drained grazing marshes, many of which may have the potential either for reversion to fen, or creation of reedbed.

Any decision to recreate fen/reedbed needs to be preceded by a soil survey. Because of the rarity of deep peat & also its potential for the development of an interesting botany, any such areas should first be considered for restoration to fen. Removal of the surface oxidised peat to create shallow turf ponds may be helpful, and water levels should be raised gradually. Alluvial or clay soils generally support good reedbeds and are unlikely to develop a diverse flora.

There is great potential at Buckenham and Hassingham Carrs to expand the existing open fen into areas which have relatively recently become invaded by scrub. A woodland survey is urgently needed to assess the interest of this area, followed soon after by reinstatement of management in currently neglected areas and removal of scrub. This site may also be

suitable for creation of turf ponds, possibly on the site of former open water or on areas which have become heavily scrubbed over.

Miscellaneous

Some areas included within the fen resource survey have been reclaimed for agricultural use, mainly grazing. These areas are: parts of Ducans Marsh & Carleton Broad, Chedgrave & Loddon Commons & Thurlton Beck Marshes. Some S26 fen remains at Ducans Marsh & Carleton Broad & for this area suggested management would be grazing or summer mowing. However, the vision for all of these areas if they were to be of maximum benefit to wildlife would be to manage each of the areas mentioned as a unit. In this way, water levels could be raised, perimeter security & an extensive grazing system established. This would ensure the pockets of fen remained as open fen, and would allow a diverse mosaic of fen, grazing marsh, woodland and scrub to develop. If each unit is looked at in isolation, then with the exception of the Ducans Marsh area, the other sites could not be managed beneficially and sustainably as fen any longer.

Where the Yare fens/former fens have become pump drained or isolated so that they are not permanently wet, they may retain potential for reclamation to fen or swamp habitat with a return to a more natural hydrological system

Sites which should be considered include the Postwick, Rockland, Langley & Hardley Marshes to the south of the river, and the Buckenham, Cantley & Limpenhoe Marshes to the north of the river.

These areas have been highlighted here as being in close proximity to the existing fen system, and as areas which all have to be pumped to prevent them flooding. Ironically, some of the driest areas of the Yare are being managed as fen, and some of the wettest as grazing marshes. Where peat persists, there is the potential to recreate species rich fen/fen meadow over a long term period; water levels would need to be raised gradually, to allow colonisation of fen plants. In some places, it may be appropriate to 'scrape the surface' of the peat to remove some of the oxidised layer & reduce fertility levels. However, recreation of species rich fen on these areas would probably be a long term project, possibly taking decades to develop. Likewise, areas of grazing marsh on alluvial or silty soils may present a perfect opportunity for the development of reedbed habitat. Development of either option will inherently be dependent upon viable cost-effective sustainable management being available

YARE VALLEY FENS

SITE 33 Whitlingham & Thorpe Marshes

Thorpe Marshes - Approximately half of this block of grazing marsh/fen is to be lost through gravel extraction. The north and eastern marshes have been restored - partly as a form of compensation for the gravel extraction. Some of this area is thought to be deep peat and botanically, some of the marshes (unimproved meadow) are quite species rich. The current management of summer grazing by cattle and rotational clearance of dykes should continue, with high water levels being maintained. There should be some concern to ensure water levels are maintained on this area whilst gravel extraction takes place on the adjacent compartments, thus ensuring the peat remains waterlogged, to avoid oxidation & increases in fertility. There is very little scrub on this site & grazing is likely to prevent any significant encroachment.

TARGET NOTE 1 - This area, north of the river & to the east of the main block of Thorpe marshes is approximately 10 hectares (GIS). Disturbed by the building of the Norwich southern bypass, it is now a mixture of waste ground dominated by thistles & dry grassland. There is also an area of B42 fen - dry fen dominated by reed, nettles and willowherb. A return to grazing or summer mowing would benefit the area, although access may now be difficult and there may also be security problems if stock were used.

Whitlingham North Marshes - north of the Norwich bypass requires a site visit, although this area is a Norwich Urban Fringe public access site with boardwalks and special facilities for handicapped people, so it is likely that summer mowing & raking will remain the primary management method.

Whitlingham Marshes south of the bypass, & Kirby Marshes have been considered as one management block and are described under 'Kirby Marshes' in the next section.

**SITE 34 (a) Surlingham Church Marshes, (b) Postwick Marshes
(c) Kirby Marshes**

Surlingham Church Marsh (south/upstream) - Surlingham Church Marsh is wetter than other fen habitat along this stretch of the River Yare by an apparent quirk of fate. Formerly grazing marsh, this area has developed into fen vegetation which for much of the site is dominated by rank species such as *Glyceria*, *Phragmites*, *Phalaris* and *Carex riparia*. Closer to the upland are more botanically interesting communities.

Previous to the RSPB owning Surlingham Church Marsh, the former owner was a farmer who grazed the area. When the River Authority at that time came to clean silt from the river, the landowner agreed they could pile the silt on the banks in the hope it would help to keep out the river at times of flood. Ironically, the resulting wall prevents water from draining off the site into the river, and grazing had to be abandoned. The site is irrigated by runoff from the upland and from water being held on from high river levels in the winter. No water is pumped onto the site. (Pers. comm. Peter Bradley, RSPB, Surlingham)

Management: as the situation is artificial sustainable management becomes difficult to prescribe. Should the flood wall ever be removed the site will become drier and at that time could be best suited to a very extensive summer grazing system. However, under current circumstances this area is valuable for a number of bird species and may be best suited to a mixture of management techniques such as burning of rank vegetation in the wettest areas, late summer mowing of the species-rich, nationally important communities, or possibly use of large herbivores such as the Konik on the marginal species rich areas at certain times of the year when quietest and least damaging to the ornithological interest. Movements could be controlled by electric fencing. Another option would be to leave some areas as non-intervention, and following a peat survey, possible creation of turf ponds, or development of a network of footdrains to create a 'super-wet' fen area.

Surlingham Church Marsh (north/downstream) - This area comprises a drier area of fen outside of the existing RSPB reserve (owned by Mr Simon Mitchell). The most cost effective management of these marshes may be the introduction/continuation of grazing (may have already started). A peat survey may indicate a potential for a more species-rich communities to develop under a management regime which suppresses the more dominant tall growing species. All dykes should be maintained on rotation & separated from the river by sluices.

North of the river is an area described as a mix of species-poor alder & rough fen being grazed. This area should be included in an extensive grazing system to maintain an open fen

with trees. It may be more valuable to leave this area as a wood-marsh to provide a variety of habitat.

Also north of the river, the fen resource survey describes an area as alder carr woodland, open and species-poor with frequent small areas of nettle, willowherb, canary grass and occasionally Reed Sweet-grass & Norfolk Reed. From the 1946 aerial photos, much of this compartment was already mature woodland. Further survey of the woodland required, but this area is probably best left as non-intervention woodland.

Postwick Marshes - The fen resource survey describes this area as former grazing marshes which have been abandoned and are now a mixture of rough grassland, *Carex riparia* marsh or Phragmites/Phalaris dominated species-poor dry fen, & plantation woodland. Most of the site is said to be unmanaged & not botanically rich. However, at the time of writing, the marshes had been quite intensively grazed. From the 1995 aerial photographs and a site visit, the grassland seems to be improved. All dyke endings to the river appear to have been closed - presumably to stop the river flooding onto the marshes. The level is presumably pumped as water in the dykes was at a far low level than in the adjacent river. This whole area would benefit from instalment of a sluice system & maintaining higher water levels. If this could be achieved, ESA tier 3 payments could possibly be claimed. If abstraction technology for bioproducts is developed then it may become attractive to recreate fen habitat (reedbed) here. Regular cropping would reduce nutrient levels and if there is a peaty substrate a more diverse flora could develop. Alternately, it may be possible to create a reed bed here. The total area is about 20+ hectares

Kirby Marshes - Kirby & Whitlingham Marshes form an extent of unmanaged fen south of the river and south of the bypass. In the past these areas were used for grazing. Generally species poor and neglected although Kirby Marshes supports some impoverished S24 Milk parsley-Reed community. Kirby Marshes are about 20+ hectares and Whitlingham Marshes between Kirby Marshes and the bypass is probably another 20 hectares. The Kirby marshes are becoming particularly scrubbed up & some older woodland occurs on this site which pre-dates 1946. The target notes from the fen resource survey indicate that the woodland has quite a high proportion of ash as a colonist. The Whitlingham Marshes are dominated by *Carex riparia* and *Glyceria maxima*.

Suggested management: The dominant community is B42 - Phragmites-Urtica-Epilobium (S26) tall herb fen, which indicates fairly dry conditions, although in some spots it is very wet and stagnant with *Glyceria maxima*, *Carex riparia* and *Typha/Phragmites* in some areas. There are two main options most obviously available:

1) Grazing - At the time of writing, biotechnology & fen products are being developed but not in use. Accordingly, the simplest management would be to establish an extensive grazing system, preferably with cattle grazing at a density of one beast per hectare during the summer months. The dyke network should be reinstated with sluices connecting the system to the river. This would prevent the system from becoming tidal whilst allowing higher water levels to be maintained when necessary. Reinstatement of the dykes would also provide wet fences to control movement of cattle and diversify the habitat available for invertebrates and aquatic plants. ESA money may be available. Scrub is quite well developed on the Kirby Marshes and although grazing would control further scrub invasion some clearance work would be beneficial, particularly along the dyke edges. Grazing may remove competitive species to allow a more diverse flora to develop. Woodland to be surveyed, but probably most beneficial to leave as a near natural, possibly grazed woodland.

2) Wet fen creation - pers.comm. with Rob Andrews suggests that this whole area is naturally quite wet. A reedbed has recently been created by clearing scrub, opening the

existing dykes, maintaining high water levels by use of a sluice and the planting of reed rhizomes. If biotechnology became widely available this area could be allowed to revert to wet fen and harvested initially quite regularly, for example, every 2 years, in an attempt to reduce fertility and hence competition from the rank nutrient loving species. A mowing regime may be more suitable for the small area of impoverished S24 fen, although an extensive grazing system would probably also allow the components of that community to survive, if not in a homogenous form.

**SITE 35 (a) Surlingham Broad Marshes, (b) Brundall Carrs & Marshes
(c) Bargate & the Outmeadows**

Surlingham Broad Marshes, Bargate & the Outmeadows - although this area was included in the fen resource survey, the data was gathered from the most easily accessible areas, and so information for the majority of the site is based on interpretation of aerial photos and extrapolation of information collected from around Surlingham Broad itself, and the managed marshes to the south of this area.

The fen survey describes this as an area of very wet and treacherous tall herb fen, *Phragmites* swamp, swamp-carr vegetation and floating *Glyceria* fen, which was once of enormous botanical interest, but has now declined. The cause of this decline has been partly linked with neglect and scrub encroachment, but mainly with the eutrophication associated with the Whittingham Sewage Treatment works. There is also said to be no trace of the former species-rich sedge dominated communities.

Although the area is thought to have been actively drained for a period from the late 19th to the early 20th centuries, it is likely that it was grazed without drainage on an occasional basis for a long period in history. Although nearly all reports of this area cite it as being treacherous, the indications are that people rarely venture beyond the floating marginal vegetation. Personal communication with Mike Blackburn (RSPB) indicates that much of this area is actually quite dry.

However, a consideration of the fertility & conductivity data collected during the fen resource survey indicated low levels of both, and although the flooding of this area with eutrophic river water may have an impact not dissimilar to dosing the fens with fertiliser, it seems likely that other factors may be more important; in particular the tidal regime which is relatively a new occurrence on the Yare and the abandonment of management. The former botanical diversity and other evidence suggests that solid peat is an important substrate in this area. T

Surlingham Broad Marshes & Bargate & the Outmeadows occupies an area of circa 54 hectares, of which some 43 hectares is scrub/woodland. From the aerial photographs, it seems that some 10 hectares may have been mature woodland in 1946, but the rest has developed since then. The fen resource survey has labelled most of this woodland as alder carr, with no additional information.

Future management: the woodland should be surveyed in detail - any nationally important stands to be retained. The remaining scrub should be cleared; the broad excavated to its former size; a sluice to control the tidal influence installed; and either an extensive grazing system or hay cutting or bio technology used to maintain open fen. Alternatively, a feasibility study may show that this area could now be maintained with sufficiently high water levels to sustain reedbed habitat.

Brundall Carrs & Marshes - This is an area of former grazing marsh which has been unmanaged for some time and is now largely covered with woodland. The whole area is about 20 hectares and is naturally confined in extent by the River Yare on one side and a railway track & the town of Brundall on the other. The site is also fragmented and disturbed

by the proliferation of boatyards on this side of the river. Some interesting plants have been recorded in the past; most recently was Marsh Pea (*Lathyrus palustris*) in the 1970's.

Suggested management: As the woodland appears to be quite well developed (a reasonable proportion of mature woodland and scrub were present even in 1946 - from aerial photos) and in view of the confines of the river and urban development which reduce the importance and future potential of this site as a fen, it seems most appropriate to allow this area to develop as 'wild wood'. However, a more detailed assessment of the wood should be carried out to provide a baseline of information from which its' development can be followed. Ideally, the presence of a few large herbivores would help the development of this area into a near natural state. In the absence of such herbivores occasional clearings could be maintained/created within the wood as oases for fen species. A soil survey may be useful to show any peaty areas where this clearance work could be concentrated.

SITE 36 (a) Bradeston & Strumpshaw Marshes, (b) Strumpshaw Common

Bradeston & Strumpshaw Marshes - Currently, this area comprises some 300 acres of reedbed, of which approximately one-sixth are nationally important communities (S24 & S2). The area is managed as a reedbed habitat within its own right, but also for associated species, in particular, its ornithological interest & potential. The reed is good quality & commercially viable. However, because the site is susceptible to drought, winter flood water is highly valued and so retained on the area by the presence of floodwalls and by closing sluices on dykes after a flood event. The consequences of high winter water levels is that it becomes difficult to harvest reed commercially. Most mowing is carried out by RSPB staff and the produce is burned in situ. This method is labour intensive and thus expensive, and although some areas (e.g. around scrapes) are mown more regularly, much of the reedbed is being managed only every several years with a consequent accumulation of litter, invasion of scrub and decline in reedbed quality.

Until the 1920's the area had a long history of summer grazing. After a severe flooding event, the marshes were largely abandoned apart from patchy reed cutting until the RSPB began management in the 1970's. The grazing history and the tendency of the site to drought, thus requiring a regime of holding on winter flood water and supplementing water levels from a borehole indicates that this site may have always had a tendency to be only periodically flooded & may never have been wet enough in recent history to support a reedbed.

The upland margin of the fen area around Strumpshaw Broad appears to be deep peat and before reedbed habitat was created the community structure at the edge was potential fen orchid habitat (pers comm. Bryan Wheeler). The presence of peat is promising as a site for species rich fen under different management.

For *sustainable* management, which is not dependent upon a continuous high financial input to maintain, a very extensive grazing system could be introduced. The benefits would include (a) creation of a mosaic of fen & fen meadow, particularly transitional and more species rich communities; (b) effective control of scrub; (c) much reduced dependency on human labour and therefore far more efficient and sustainable into the future; (d) reduced need for expensive irrigation; The main disadvantage would be the loss of good reedbed, and so this option should not be followed unless an alternative site, such as grazing marsh or arable land which might be naturally wetter, can be converted to reedbed to off set the loss.

The alternative to grazing for this area would be to use biotechnology to harvest the fen produce on a 4/5 year rotation, but leaving some areas undisturbed for a longer time periods.

Strumpshaw Common - this is an area of mixed woodland, tall herb fen, grazing & mowing marshes. Most of the open fen is dominated by M22b/B1, but there are areas of the nationally

important community M22d/B13. The hay meadows are of particular importance because of their botanical diversity & also because of the scarcity of species rich fen meadows in Broadland.

The woodland areas are either quite wet or quite dry - the dry woodland is mixed deciduous & was largely planted by the RSPB in the 1970's. The wetter area of woodland comprises quite mature alder, with nettles and some sedges as ground flora. However, this description was obtained in the winter, so a summer survey is necessary.

Management proposals: the management of this area seems fairly sustainable. Unlike the Bradeston Marshes, water is pumped off Strumpshaw Common, so it may be possible to allow water levels to increase gradually, monitoring the effects on the flora and possibly managing the grazing on a more extensive basis in the long term. The current management regime leaves the fen meadow very short grazed at the end of the season; a lighter grazing density might provide more of a mosaic which would be better for invertebrates. The botanically diverse meadows appear to be on peat, and so it seems likely that even on a less intense management regime, species richness would persist. The exception to this may be that if the site is slightly eutrophic or nutrient rich from peat oxidation, then the current management may be suppressing more dominant vigorous fen species.

Pending a summer survey, the woodland areas could either be left as 'wildwood' or else be incorporated into the extensive fen grazing system to help maintain clearings and encourage a more diverse ground flora.

SITE 37 (a) Surlingham Marsh, (b) Wheatfen & Rockland Marshes

Surlingham, Wheatfen & Rockland Marshes - an extensive area of open herbaceous fen, scrub & carr woodland, which was once of great botanical interest. The virtual absence of management, along with the effects of flooding with eutrophic waters from the Yare have been largely blamed for the decline of these fens. The fens area mostly S26/B43 - dominated by *Phragmites*, *Glyceria*, *Phalaris* or *Carex riparia*. The presence of *Glyceria* fen is largely attributed to the tidal nature of the Yare; until relatively recent downstream dredging works, the Yare was not tidal this far up the system. Some nationally important S24 community occurs near the upland edges.

These marshes have a long history of grazing and traditional management for marsh crops until the second world war when most activity ceased. In recent years with the formation of the Ted Ellis Trust and the purchase or lease of much of the land by the RSPB, there have been considerable changes taking place. The Ted Ellis Trust have been mowing areas using conservation teams & over much of the RSPB controlled land, scrub clearance, dyke restoration and reintroduction of cattle grazing has occurred. The RSPB have also closed most of the dykes to the river to remove the daily tidal influence.

Suggested management: Expand grazing management over as extensive an area as possible. To achieve this, dykes would largely need to be closed to the river to remove the daily variation in water levels in response to the tides & also to provide wet fences and clean drinking water. This would also help prevent erosion/siltation in the dykes. Cattle or Konik ponies appear to be most ideal at low grazing densities of less than one beast per hectare. It seems likely that this management would suppress the more competitive fen species in favour of the more unusual plants. This form of management could, over a period of time reduce fertility and encourage development of transitional fen communities, particularly towards the deeper peat at the upland margins.

In the future, with the development of biotechnology - some areas could be managed by either a summer or winter mowing regime, the former which would allow a more species rich

fen community to develop, the latter a more reed-dominated community. The development of a small baling machine light enough to work on wet meadows could allow some of the drier upland margins to be economically managed as hay meadows.

There are currently tentative plans by the RSPB to pump spring water upstream onto fen meadow with the intention of creating reedbed. This would not be sustainable except in circumstances of continued long-term financial support. It is recommended that grazing marsh downstream on the Yare is considered for purchase, flooding and reedbed creation instead and that these unimproved (except for fertilising effects of eutrophic water) fen areas are given an opportunity to be restored to a more species rich community through management.

There are approximately 15 hectares of scrub still within the fen complex, that could either be cleared, or included within an extensive grazing system and allowed to exist as part of a mosaic of scrub/woodland, fen, fen meadow & dykes. Much of this remaining scrub and woodland appear to have been present as long ago as 1946. The woodland around the northern part of Wheatfen Broad, in particular should be surveyed before any clearance work is considered.

SITE 38 (a) Ducans Marsh, Claxton, (b) Carleton Broad

Ducans Marsh & Carleton Broad - a valley fen complex situated on either side of the Carleton Beck, a tributary of the River Yare, which has been described as one of the richest areas of unimproved wet valley grassland now remaining in East Norfolk. The main area of interest includes two compartments which form Ducans Marsh SSSI dominated by fen meadow and nationally important (M13) mire communities. The biggest threat to these areas appears to be water abstraction, as it seems likely that the communities are dependent upon spring water.

The site has been grazed for much of its history, although this largely lapsed after the war years; in recent years grazing and conservation mowing have been actively encouraged to help restore this site. The remainder of the compartments in this valley have been reclaimed for some form of agricultural use, mainly grazing. Only about 7 hectares have developed to carr woodland, in particular, the woodland which has developed over the former site of Carleton Broad seems to have been present at least 50 years ago and should be surveyed to ascertain interest and appropriate management. Approximately 16 hectares outside of the main area of botanical interest is rough/semi-improved grassland, and another 3 hectares forms tall herb (S26) fen.

Vision: to see this area perimeter fenced as one unit with an extensive year round, grazing regime using primitive ponies &/or hardy ponies, to encourage a mosaic of wet fen, mire, unimproved meadows, scrub and wet woodland.

Suggested Management: Grazing & mowing should be continued on an annual basis to maintain the important botanical areas. However, there is potential for more of this area to become more valuable for wildlife. On the 16 hectares of rough/semi-improved grazing and the 3 hectares of fen and extensive grazing system should be encouraged, or hay making to improve species diversity. Over a period of time the effects of fertiliser would be removed and unless chemicals have been used, species interest may recover. To target sites with the most potential, peat areas which have not been drained may be most likely to develop a species rich flora. Also, where possible, water levels should be raised.

SITE 39 (a) Buckenham & Hassingham Carrs, (b) Buckenham & Hassingham Ronds

Buckenham & Hassingham Carrs - SITE VISIT REQUIRED An area of fen, carr woodland and unimproved grazing marsh, most of which appears to have developed over the basins of Buckenham & Hassingham Broads. The site appears to be on peat and the fen resource survey indicates that it is irrigated almost entirely by calcareous spring water from the underlying chalk aquifer, making it very susceptible to damage from abstractions. The site is isolated a) from the river by the presence of the railway line; & b) from upland seepage by a series of sluices.

Unfortunately, the fen resource survey does not give a full picture of the area, as in some cases it includes woodland that has been there for well over 50 years and for other integral compartments no information is given/available. The indications are that what little fen remains open is of very high conservation value. However, of the eighty hectares surveyed, nearly half is described as carr woodland, and from the 1946 aerial photos at least 20 hectares of this was already mature woodland at that time.

The site was apparently grazed for most of its recorded history, although this has at least partly lapsed since the war. It appears to have retained its species interest for over 200 years, although many areas are now scrubbed/wooded over. The 1825 navigation map showed a series of large areas of open water much more extensive than today.

Suggested management: Urgent survey of the woodland areas to establish their status, possibly giving priority to woodland which has developed since 1946 as this is least likely to be of value. Reintroduction of grazing over the entire site, concentrating pressure initially on the open areas or those areas with little scrub. All post-1946 scrub to be removed (20 hectares+), but probably leaving most mature woodland and allowing large herbivores to graze, which could enhance the rides and help create clearings as oases for fen/grassland plants. A soil survey should be carried out to establish the extent and depth of peat. This may be an excellent site for creation of a series of small turf ponds. Some of the unimproved grazing marshes may benefit from a summer hay cut as an alternative or in addition to grazing.

Other information - the need for clarity on the water supply system - is this a calcareous spring fed mire? In addition, survey information is needed at least for the adjacent and in-between areas to ascertain whether they are semi-natural vegetation and whether these could be included as an integral part of an extensive grazing system.

Buckenham & Hassingham Ronds - these are thought to have originated in medieval times (13th & 14th centuries) when Broadland rivers were embanked. Form a narrow strip adjacent to the river, dominated by *Glyceria*, with patchy *Phragmites*, *Phalaris* & *Carex riparia*. In the past the ronds may have been cut for reed or grazed. Little is known about species composition, or the importance to birds. (see further Harris, 1992)

Suggestions - A more detailed study into the value and development of ronds could be useful. It is possible that they may be important for birds such as snipe, or for invertebrates. Some mowing of ronds could take place and a comparison of the effects carried out.

SITE 40 (a) Poplar Farm Marshes, (b) Limpenhoe Meadows, (c) Cantley Ronds

Poplar Farm Marshes - an isolated fen area, surrounded by a large area of grazed marshland. It is believed to be spring fed by calcareous water (indicated by layers of marl) and is of exceptional floristic diversity. The site has been managed historically by light summer grazing although in recent years this has been neglected. It is also believed to be drier now than formerly. The surrounding marshes appear to have been reclaimed from fen at some point in the 18th century and have been fairly well drained since then.

Suggested management: on such an isolated jewel of a site, special effort should be dedicated to maintaining this botanical oasis, probably by a combination of summer mowing and continued light grazing. In particular, the *Cladium* will be likely to benefit from some summer mowing to maintain age and structure variation. On a more sustainable level, should it ever become feasible, this whole drainage area may be an excellent site for water levels to be slowly raised and a fen meadow vegetation allowed to develop. A soil survey would indicate the extent of peat, and although it would be more fertile because of oxidation, there may be potential to develop a diverse sward. If water levels were raised on these surrounding marshes, it may be beneficial to create a number of turf ponds, as this would help remove an oxidised peat layer. The peat areas should not be considered as a potential site for creating reedbed habitat unless its full potential as a species rich fen has first been explored.

Limpenhoe Marshes - Unimproved fen meadow along the floodplain margins of the Yare. Deep, waterlogged peat occurs at the margins, grading into alluvial clays in the valley bottom. Species rich fen communities occur which are believed to be associated with a springline. The acidic spring flushes are good for bryophytes. Dry fen grassland occurs on the higher ground; but there are also areas of carr woodland, plantation woodland, grazing marsh and arable in close proximity. The site has a history of light summer grazing. A species rich dyke network is associated with the fen meadow areas.

Suggested management: maintain grazing management. Ensure site remains wet and where possible raise water levels as this will provide a buffer from surrounding drained land. The dyke system should be maintained, but no new dykes should be created because of the dangers of disrupting possible spring flows away from the flushes. Care should be taken to ensure that drainage from adjacent arable land is diverted from irrigating the fen area. It seems that as long as the peat is thick and undrained, it will act as a buffer, allowing only very slow movement of seepage waters.

Cantley Ronds - these are thought to have originated in medieval times (13th & 14th centuries) when Broadland rivers were embanked. Form a narrow strip adjacent to the river, dominated by *Glyceria*, with patchy *Phragmites*, *Phalaris* & *Carex riparia*. In the past the ronds may have been cut for reed or grazed. Little is known about species composition, or the importance to birds.

Suggestions - A more detailed study into the value and development of ronds could be useful. It is possible that they may be important for birds such as snipe, or for invertebrates. Some mowing of ronds could take place and a comparison of the effects carried out.

SITE 41 (a) Hardley Flood, (b) Chedgrave & Loddon Commons

Hardley Flood - an area of former grazing marsh which was originally embanked and drained early in the 19th century. In the 1920s the embankment deteriorated and the area now acts as a spillway for the River Chet and has developed shallow lagoons and reedswamp of considerable ornithological interest. Because the river is tidal and the waters are eutrophic, the botanical interest is limited.

This area is also noteworthy for its bat interest.

Suggested management: recommend the washland area as a non-intervention area, although depending on the bird species using the area, it may be beneficial to manage some of the reed, either by mowing or burning. Before any burning occurs an invertebrate survey would be valuable. The main opportunity for management appears to occur on the north side of the flood along the drier margins which are described by target notes in the fen resource survey as being grazing marsh/ plantation woodland. Planting with native deciduous trees such as oak, willow spp - could be beneficial for a range of bird and invertebrate species, but also for

the varieties of bat which occur in this area. Grazing could maintain a wood-pasture type of landscape. Other mature woodland should be left as wildwood.

Chedgrave & Loddon Commons - this area was originally marshland, which was reclaimed mainly for grazing until the 20th century. No extensive stands of fen vegetation remain although there are isolated boggy areas. Most of the land is now used for either grazing or arable, although there are some small areas of mainly dry woodland, which may be the result of succession from fen. The total area included within the fen survey was circa 50 hectares, of which about 20 hectares has been recorded as either fen or grassland.

Suggested management: little historical information is available concerning former species or habitat interest for this area. Changes in management should make the best of what is now present. The most sustainable management system would be one which incorporated areas of land which may currently be agricultural, to form a continuous unit, joining fragmented areas of interest together. Ideally, such an area could be perimeter fenced and extensive large herbivore grazing introduced, allowing the site to return to as near natural a condition as possible, with a mosaic of wet and dry grassland and fen, scrub and woodland.

SITE 42 Thurlton Beck Marshes - this site does not now contain any fen vegetation; the majority is now grazing marsh and some is used for arable and smallholdings. Due to the topography, this area may never have been very wet.

Suggested management: it would only be sustainable to manage this area as fen or fen meadow if all the marshes either side of the Beck were brought under the same management. Extensive grazing could be introduced, with a gradual raising of water levels, allowing a fen meadow vegetation to develop. Site visit would be necessary to ascertain the feasibility of making the site wetter.

SITE 43 Reedham Ronds- the site consists of saltmarsh vegetation & reedbed, some of which is still cut. It is likely that the rond was more extensively exploited for reed in the past, but some areas may have been grazed.

Suggested management: A more detailed study into the value and development of ronds could be useful. It is possible that they may be important for birds such as snipe, or for invertebrates. Some mowing of ronds could take place and a comparison of the effects carried out.

SUGGESTED ACTION POINTS arising from meeting of group on WATER ISSUES AFFECTING BROADLAND FENS - 5 February, 1996

In attendance

Rob Andrews - BA	Geoff Mason - NRA
Charlie Beardall - NRA	Chris Newbold - EN
Louise Bond - NRA	Geoff Philips - NRA
Clive Doarks - EN	Sandie Tolhurst - BA
Mary Gibson - EN	Geert van Wirdum
Jane Madgwick - BA	Simon Wood - NRA
Marion Martin - NRA	

Apologies from: Ros Boar (UEA), Bryan Wheeler (Sheffield University)

Future action points

- Test the link between phytometric fertility & wetness/salinity/iron content. Objective - the iron & moisture content in Broadland soils has a good buffering capacity & can confuse the picture of phytometric fertility.
- More phytometric samples needed especially near the river. Prioritise sites in the Jennings transects - for which we have more detailed soil information.
- Plot deep peat areas Objective - soil properties may have more influence on plant communities than the effect of rivers - although in the long term soils are at least partly a reflection of the influence of hydrology
- Plot acid communities & relate to drainage & soils Rationale: to investigate the theory that the rare acid communities on flood plain margins are on peats which have partially oxidised and are self acidifying, as opposed to being acidic because of acidic irrigating water arising elsewhere - e.g. from the Norwich Crag
- Clarify costs & benefits of managing eutrophic fens Rationale - should we accept eutrophic fen communities within their own right, or should we manage to reduce the effects of eutrophication bearing in mind the possibility that all fens which occur on peats are potentially eutrophic, as if drained they oxidise and release nutrients. Management suppresses competitive species allowing rare species to grow, but this is expensive.
- Are there indicator species of fertility ? - check distribution with fertility data Rationale: so far, fertility distributions obtained from the fen resource survey have only been related to community types but not individual species
- Distinguish between communities to conserve & those to restore - that is, identify communities we value and those we wish to change
- Separate local & regional hydrological issues. Produce a map showing river influence based on fen levels, tidal regime, location of dykes etc. & compare with plant community maps

- Try to make a broad classification of fen communities/areas according to soil type and regional hydrology: marginal/mid/river edge - see further the possibility of using the Wheeler & Shaw hydromorphological classification as a basis. Can we relate this classification to Broadland ?
- Focus on 4-5 community types & their characteristics in terms of water regime, soil, management etc. Objective: to identify the relative influences of management, water, soils on communities.
- Devise a rapid assessment method 'decision-tree' for management based on an understanding of the relative influences of management, water, soils etc. on communities
- Test major ions on sites & compare with ions in rivers and in adjacent peat/soils. See where river influence is maximum Rationale: by testing major ions we have a clearer idea of the effects of salinity than by testing conductivity which could be influenced by the presence of ions other than sodium and chloride (e.g. Calcium). NB conductivity above 500 is probably showing a saline influence.
- Look at communities and see if there is a pattern of sensitive/less sensitive communities associated with the river flooding - *but can we identify what the sensitivity is a result of i.e. salinity/fertility/flooding regimes ?*
- Look at the effects of river water on fens. How far up dykes does river water have an influence. Measure & compare river and dyke water in terms of conductivity, depth of siltation and basic nitrate, phosphate & ammonia levels. Objective: this may help in the decisions concerning whether or not to open a fen dyke system to the river or not. In general use old dyke systems & except on the most sensitive sites water is a priority - so better to let in than let a site be to dry or to become more acidic - but via a long & winding pathway.
- Carry out major ion analysis of groundwater, rainwater and seepage to help determine the relative importance of each on the fen
- Collate historical data on conductivity in rivers & compare to soils in nearby fens
- Look to see if the fertility pattern corresponds with peat baulks & the communities occurring there. Try at one site or in one valley
- Produce a matrix of variables affecting each community type - e.g. pH, conductivity, management, flooding etc.
- Correlate base rich fen vegetation with base rich fen peat Rationale: water on fens is needed for two purposes: (a) to keep it wet; (b) to keep it base-rich. If the supply of river water becomes a problem then rain and seepage become more important and so a system may become either more acidic or eutrophic; and fens will become base- & species-poor.

Further points to note/unanswered questions:

Q Is fertility driven by soils or irrigating water ?

NB The Yare Fens formed in times of low tidal range. Is it right to maintain a non-tidal system, which will also result in the loss of the existing community.

NB Increasing tidal and saline influences are usually harmful for nature conservation, but especially if sudden

Q Conductivity of water can be up to 3m/day in fresh peat ? true/false ?

Q Is crag water moving up or rainwater moving down ?

BROADS AUTHORITY & ENGLISH NATURE

Policy on fen management for nature conservation in Broadland

The Broads Plan has established an overall shared aim for fen management: **to seek to maintain and improve the quality of the fen resource in the Broads area.** The Broads Authority have developed a whole countryside approach, while English Nature has concentrated resources on SSSI's*, and SAC's*, although work on the whole Broads scale occurs where most appropriate. More recently the two organisations have developed close co-ordination in their work, in order to share resources effectively and to maximise the benefits for conservation.

Components of fen management work

- to protect fen and carr woodland areas from inappropriate development;
- to work in partnership with existing landowners, taking account of individual objectives;
- to assist voluntary conservation bodies with the acquisition of key sites where this is important for the continued conservation of those sites;
- to negotiate positive management agreements with fen owners in order to secure a commitment to management for nature conservation and to enable investment in appropriate management;
- through the Fens Team (currently 6 Fen Supervisors, a Fen Project Officer and a Volunteer Co-ordinator) to provide direct assistance with fen management tasks such as scrub clearance, with the assistance of a large number of volunteers (over 5000 worker days per year);
- carry out specialised fen management tasks, for example through the use of the Broads Authority/English Nature JCB excavator for scrub clearance, ditch excavation and turf ponding;
- develop specialised equipment for fen management e.g. fen harvesting machinery, investigation and trialing of suitable grazing animals;
- provide conservation management advice directly to landowners and managers;
- promote and support commercial fen management practices that benefit nature conservation e.g. reed and sedge harvest, directly through fen management and through the British Reed Growers Association and other fora;
- Encourage and support private reed and sedge cutters, for example through advice, loan of equipment, management works, apprenticeship schemes;
- instigate and carry out research and monitoring activities as appropriate e.g. turf pond monitoring, permanent quadrat monitoring of management regimes;
- instigate and participate in species recovery projects e.g. for fen orchid, large copper;
- English Nature is responsible for notifying SSSIs and consulting on SPA, Ramsar and SAC designations.

BROADLAND FEN COMMUNITY TYPES

- B1 *Juncus subnodulosus* - *Lotus uliginosus* - *Galium uliginosum* fen meadow
Blunt-flowered Rush, Greater Birdsfoot Trefoil & Fen Bedstraw **19.8 hectares**
Like M22a. B1 B2(ranker) B12(v rank)
Base rich, wet soils. Low salinity. Lowish fertility. Grasses prominent. Generally dominated by *Juncus subnodulosus* and supporting a range of sedge species. Grazed. Quite bryophyte poor. Found on solid fen peat and alluvium near margins of floodplains of Yare & Waveney - abundant on Strumpshaw Common; also Sprats Water & Oulton Marsh. Hemsby Common and Crostwick Common - spring flushes - valley head fens.
- B2 *Holcus lanatus* - *Lotus uliginosus* - *Angelica sylvestris* fen meadow
Yorkshire Fog, Greater Birdsfoot Trefoil, Wild Angelica **33.61 hectares**
Like M22a. Grass dominated. Species rich although less so than B1. Rushes limited. Meadowsweet, Angelica & *Viccia* quite frequent. Sedges abundant although none dominate. Bryophytes not important. On solid fen peat or alluvium. Largest areas at Barnby & Sprats on Waveney. Also at Flixton Decoy, Ducans, Strumpshaw Common, Woodbastwick. Associated with regular mowing. Associated with seepage. Declining in broadland because of abstraction & neglect. Tolerates higher fertility & pH than B1. Low salinity.
- B3 *Molinia caerulea* - *Anthoxanthum odoratum* - *Carex panicea* fen meadow
Purple Moor-grass, Sweet Vernal-grass, Carnation Sedge **6.96 hectares**
Low growing - abundance of smaller grasses & sedges. Quite diverse. Dependent on grazing/mowing. In absence of management - ranker community B4 ? develops. Bryophyte layer generally poor and of low cover. Acid water seepage. Unlikely to be tolerant to prolonged fluvial flooding, especially if brackish. M24 & B4. Distribution limited: Buckenham & Hasingham Marshes, Poplar Farm Meadows and acidic grassland area at Skoyles Marsh.
- B4 *Molinia caerulea* - *Succisa pratensis* - *Potentilla erecta* fen meadow
Purple Moor-grass, Devil's-bit Scabious, Tormentil **6.28 hectares**
Rare/scarce species: *Carex appropinquata*, *Peucedanum*. Sedges are frequent, but nowhere near as much as in B3. Abundance of tall herbs: *Filipendula*, *Angelica*. Quite orchid rich. Bryophytes scarce. Associated with infrequent management. Light grazing, occasional burning and a long rotation mowing are forms of management where this community persists. Quite tolerant to drying out. Low fertility substrate. Some spring water seepage. A transitional community. Very similar to B3 & M24. Distribution: range of site Barnby, Poplar Farm, Buckenham Fen, Berry Hall, Burgh Common.
- B5 *Juncus subnodulosus* - *Schoenus nigricans* - *Molinia caerulea* mire
Blunt-flowered Rush, Black Bog-rush, Purple Moor-grass **0.19 hectares**
Rare/scarce: *Dactylorhiza traunsteineri*. Large numbers of *Epipactis palustris*. Lots of *Carex* species. No bryophytes in quadrat - but otherwise bryophytes important ? Quite low species richness, but several species of importance at good abundance's. Site irrigated by calcareous base rich groundwater. Acid-neutral pH. Grazed/mown vegetation. Associated with B13 & B10. Similar to NVC M13b/c. Threatened by abstraction & local enrichment of the groundwater.
- B6 *Juncus subnodulosus* - *Carex panicea* - *Cirsium dissectum* fen meadow
Blunt-flowered Rush, Carnation Sedge, Meadow Thistle **9.18 hectares**
Associated with M22d. Abundant bryophyte flora. Light **grazing**. Burgh Common is the only site. Clean water **seepage**. Like B1 & B2.
- B7 *Juncus effusus* - *Luzula multiflora* - *Anthoxanthum odoratum* Rush meadow
Soft Rush, Heath Woodrush, Sweet Vernal-grass **8.52 hectares**

Bryophytes variable - sometimes abundant. Depends on light grazing/summer mowing to maintain. Found at Sprats Water, Skoyles Marsh, How Hill. Close to B6 & B8. No obvious spring line development, but very acidic waters. Quite a species-rich community

B8 *Molinia caerulea* - *Potentilla erecta* - *Hydrocotyle vulgaris* poor fen
Purple Moor-grass, Tormentil, Marsh Pennywort **1.43 hectares**
rare/scarce species: *Thelypteris*, *Peucedanum*. Similar to other *Molinia* communities, except for presence of acidiphilous species. Diverse sedge community. Diverse herbs. Heath species: *Calluna*, *Erica tetralix*. The conspicuous bryophyte layer is unusual for its diversity and abundance. Several *Sphagnum* species. Found on floodplain margins following abandonment of grazing and drainage. Acidic irrigating water necessary. Many sites of this type have been lost to woodland e.g. over much of the marginal area of Barton Fen. Also at Mrs Myhills Marsh. At Upton - not a floodplain site - has developed over turf cuttings and is maintained by regular mowing, which has allowed the *Sphagnum* to proliferate. A transition community. Burning would not be suitable - lead to an increase dominance of *Molinia*. Related to M5, M24c, B6 & B7. Widely distributed in northern Broadland: Barton Fen, Mrs Myhills marsh, Middle Marsh at Catfield, Potter Heigham Fen, Lily Broad Marsh, Upton Fen. Threatened by nutrient enrichment, abstraction & succession.

B9 *Juncus articulatus*-*Holcus lanatus*-*Lotus uliginosus* fen meadow
Sharp-flowered rush, Yorkshire fog, Greater birds-foot trefoil **8.64 hectares**
Like M22a - NVC. Not important for bryophytes. Seepage over quite deep peats. Can survive quite prolonged winter flooding. Light grazing. Found in south Broadland: Jubys, Strumpshaw Common, Buckenham Marshes, Camps Heath, Oulton Marshes, Coldham Hall Meadows. Associated with B1/B2/B10 - differences may be due to management or historical.

B10 *Holcus lanatus* - *Juncus effusus* - *Agrostis stolonifera* Rush Pasture
Yorkshire Fog, Soft Rush, Creeping Bent **168.23 hectares**
Like MG10 & M22d Low sward & tussock structure. Bryophytes very scarce. On mesotrophic solid peat & alluvial soils. pH levels likely to vary: alkaline, calcareous - Dobbs Beck; acidic - Burgh Common & Barton Fen. Seepage important. Light to moderate grazing. The anomalous stands at Hickling & Catfield which are not grazed. Some stands occur next to river in upper Bure & ant - so can tolerate short term alluvial flooding - but not brackish inundation. Neglect - this community to B45/B41. Widespread. Unrecorded because reclaimed to grazing. Examples at Chapelfield marshes, Clayrack, the margin of Catfield Fen, the fen margin at Hickling, Strumpshaw Common, Barnby Marshes & Oulton Broad Marshes.

B11 *Carex disticha* - *Festuca rubra* - *Angelica sylvestris* fen meadow
Brown Sedge, Red Fescue, Wild Angelica **3.7 hectares**
M28 ? Similar to B7. On abandoned and reflooded grazing marshes. Species richness varies. *Carex disticha* is abundant and so are grasses. No bryophytes. High fertility; acid - neutral pH, low salinity. Underlying substratum is peat with alluvium. Not influenced by spring water. Surlingham Church Marshes, Clayrack Marshes, Hickling. (Bure, Ant, Yare)

B12 *Filipendula ulmaria* - *Carex acutiformis* - *Juncus subnodulosus* fen meadow
Meadowsweet, Lesser Pond-sedge, Blunt-flowered Rush **15.26 hectares**
M27, M22q. Like recent abandoned grazing. Bryophytes scarce. Dobbs Beck valley, South Walsham Fen, Ducans, Camps Heath, Oulton. Unstable community. May not be able to tolerate flooding. B12 if lightly grazed would probably become B1/B2.

B13 *Filipendula ulmaria* - *Juncus subnodulosus* - *Phragmites australis* transitional tall herb fen
Meadowsweet, Blunt-flowered Rush, Common Reed **8.61 hectares**

Recently abandoned grazing/mowing marshes. May be occasional mowing. Bryophytes scarce. Major location: Upton Fen & Barnby Marshes. If grazed would go to B1/B2. Scarce species: Thelypteris, Lathyrus palustris, Carex appropinquata.

B14 *Phragmites australis* - *Juncus subnodulosus* - *Galium palustre* sedge bed
Common Reed, Blunt-flowered Rush, Marsh Bedstraw **85.87 hectares**

Rare/scarce species: Peucedanum, Thelypteris, Carex appropinquata, Sium latifolium, Lathyrus palustris, Sonchus palustris. Are two subcommunities, the distribution of which appear to depend on the salinity of irrigating waters. B14 as a whole is dominated by Cladium, Juncus subnod & Phragmites. Except for Phragmites, grasses are not common. Quite species rich. Bryophytes are not uncommon. Associated with peat cuttings in general. 14a Mostly in the Thurne, where conditions are brackish. Very variable pH. Much of the area is managed commercially. Also found on reflooded grazing marsh at Barton Fen. Irrigated by both the river water (higher salinity & pH) & seepage water from the Norwich Crag (the latter which tends to be very acid). Similar to B15 & B17, and NVC S25, S24f & d. Widespread - B14b - many in the Ant valley fens at Barton Fen, Sutton Broad, Catfield Fen & Reedham Marshes; Ranworth marshes on the Bure, and Barnby Marshes on the Waveney. B14a - Brayden Marshes & at Hickling. B14 and B17 are very similar. B17 is the most species rich; B14 tends to relate to commercially managed sedge beds, which if managed more lightly may succeed to B17.

B15 *Juncus subnodulosus* - *Phragmites australis* - *Peucedanum palustre* tall herb fen
Blunt-flowered Rush, Common Reed, Milk Parsley **35.27 hectares**

Rare/scarce species: Thelypteris, Carex appropinquata, Sium latifolium, Cicuta virosa, Peucedanum. Dominated by J. subnodulosus which grows as a thick mat. Quite species rich. Cladium mariscus may occur as a codominant. Bryophytes are not infrequent - and may be quite abundant in wetter stands. Formerly grazed fen areas. Mostly associated with former peat cuttings. High conductivity. Irrigation is part by river water and part by acidic seepage water from Norwich Crag. Fertility low. Similar to B14b and B27. S24f & d. Widespread in northern Broadland: Barton Fen, Sutton Broad, Catfield Fen, Hall Fen, Reedham Marshes, Hickling Broad, Heigham Sound, Martham Broad, Burgh Common and Ranworth Marshes. Most common at Hickling Broad - where it occurs in the areas above the level of regular inundation of brackish water.

B16 *Schoenus nigricans* - *Juncus subnodulosus* - *Hydrocotyle vulgaris* sedge bed
Black Bog-rush, Blunt-flowered Rush, Marsh Pennywort **7.01 hectares**

Rare/scarce species: Thelypteris, Liparis, Carex appropinquata, Potamogeton coloratus, Pyrola rotundifolia, Sium, Cicuta, Peucedanum. Juncus subnodulosus and Schoenus nigricans are constant and often abundant components. Species rich. Many low growing species. Bryophytes are very common, often as a dense mat. Nutrient impoverished conditions & over former turf ponds. pH generally neutral. Salinity very low. NVC affinities to S24eii/ S24f/M13c. B22 & B23 are most similar to B16 but do not have Liparis. Uncommon: found at Sutton Broad, Broad Fen, Catfield Fen, Woodbastwick marshes, Upton Fen, Sutton Broad. Also at Potter Heigham.

B17 *Phragmites australis* - *Juncus subnodulosus* - *Lysimachia vulgaris* sedge bed
Common Reed, Blunt-flowered Rush, Yellow Loosestrife **83.59 hectares**

Rare/scarce: Peucedanum, Thelypteris, Carex appropinquata, Sium, Lathyrus palustris, Sonchus, Cicuta, Liparis, Dryopteris cristata, Pyrola, Potamogeton coloratus. Dominated by mixture of Cladium and Phragmites. Species rich. sedges abundant. Rushes uncommon. Diverse herbs. Good fern populations. The bryophyte flora is diverse. Occurs over former peat cuttings. Low/moderate fertility. Tolerates relatively high salinity and range of pH. Manage as for sedge beds. If managed lighter, B14b will succeed to B17. Related to B14b, B15 & B18. S24g & f. Common & widespread in northern Broadland: absent in Thurne. Sutton Fen & Catfield Fen & Ranworth Marshes. B14 and B17 are very similar. B17 is the

most species rich; B14 tends to relate to commercially managed sedge beds, which if managed more lightly may succeed to B17.

B18 *Phragmites australis* - *Calamagrostis canescens* - *Myrica gale* tall herb fen
Common Reed, Purple Small-reed, Bog Myrtle **29.05 hectares**
Rare/scarce: Thelypteris, Peucedanum, Carex appropinquata, Pyrola, Dryopteris. Small number of constant species. Species often tolerant of dry conditions. Grasses varied. Occasional herbs. A wide range of bryophytes occur, but none are found very often. Found where formerly managed mixed tall herb fen has been abandoned and become drier through the build up of litter. Range of fertility from low to very high. Neutral pH. Salinity low. Distribution: northern Broadland, most common at Upton. Also at Decoy Carr. Very close to B17 if was wetter. S24d & g.

B19 *Calamagrostis canescens* - *Peucedanum palustre* - *Lysimachia vulgaris* tall herb fen
Purple Small-reed, Milk Parsley, Yellow Loose-strife **121.53 hectares**
Rare/scarce: peucedanum, Thelypteris, Lathyrus, Carex appropinquata, sium Cicuta, Dryopteris, Sonchus, Dactylorhiza traunsteineri. Dry conditions. Dominated by Phragmites and Calamagrostis. Number of tall herbs. Grasses are most important constituent. Generally species poor. Occasional sedges. Juncus subnodulosus is dominant rush - others are rare. Bryophytes no common - but a number have been recorded. Generally found over solid peat. Often on spoil. Tolerant of a range of fertility & some salinity. pH neutral. Close to the B18 & B26 communities. S24d & g. Very common. Most frequent in Ant & Bure.

B20 *Phragmites australis* - *Juncus subnodulosus* - *Hydrocotyle vulgaris* transitional fen meadow
Common Reed, Blunt-flowered Rush, Marsh Pennywort
28.31 hectares Rare/scarce species: Peucedanum, Thelypteris, Lathyrus palustris, Dryopteris cristata, Cicuta virosa, Sium latifolium, Carex appropinquata. Dominated by Juncus subnodulosus, with Phragmites as a constant but sparse component. Transitional between tall herb fen & fen meadow. High species diversity. Lower vegetation height than normal tall herb fen. Sedges well-represented. Tall herbs common & diverse. Pteridophytes not abundant. Bryophytes varied but not abundant. Found close to the margins of river floodplains in all the major river valleys and from reflooded meadows at Hall Fen. Tolerates a range of pH - possibly the reason for wide distribution. Found at sites where receives acidic irrigating water e.g. Hickling & Broad Fen; and at sites irrigated by calcium-rich water. Tolerant of a range of conductivity. Low fertility, generally away from nutrient rich river water. Wet sites. S24d & M22d. Close to B21.

B21 *Phragmites australis* - *Peucedanum palustre* - *Potentilla palustris* sedge fen
Common Reed, Milk Parsley, Marsh Cinquefoil **6.69 hectares**
Rare/scarce species: Peucedanum, Thelypteris, Dryopteris cristata. Characterised by a short tussocky sward and a sparse and open canopy of Phragmites. A strong mire element with species such as Potentilla palustris, Carex rostrata and sphagnum. Transitional and quite diverse - both in species and appearance. Grasses common; sedges well represented, but only low constancy. Tall herbs common & constant. Pteridophytes not abundant, but a variety found. Bryophytes quite varied, but not abundant, except for Sphagnum, where acidic seepage occurs. Located at margins of floodplains - seepage zones. Low fertility and conductivity. M25c, S24, S27. Close to B20.

B22 *Juncus subnodulosus* - *Valeriana dioica* - *Calliargon cuspidatum* sedge fen
Blunt-flowered Rush, Marsh Valerian, moss ? **3.23 hectares**
Rare/scarce: Thelypteris, Peucedanum, Lathyrus, Pyrola, Dactylorhiza traunsteineri, Carex appropinquata. Rich in low growing sedges. Two sub communities. B22a is characterised by an abundance of bryophytes. Few tall herbs, possible because of regular cutting. Pteridophytes not numerous. B22a - Smallburgh Fen - cut regularly for litter. Low

conductivity. Seepage important. B22b is more widespread and more tolerant of nutrient enrichment. Also dependent on calcareous seepage water. Cut for peat in the past. M13c, S24f. B22a & B23a uncommon and vulnerable - limited to Smallburgh fen. B22b: Decoy Carr & Upton Fen. Also recorded from Ducans Marsh, Woodbastwick and Ranworth marshes, Burgh Common & Sprats Water. At risk from abstraction.

B23 *Juncus subnodulosus* - *Galium palustre* - *Mentha aquatica* sedge fen
Blunt-flowered Rush, Marsh Bedstraw, Water Mint **2.06 hectares**
Rare/scarce: Peucedanum, Liparis. Rich in bryophytes, sedges of low stature and rushes. Typically dominated by a mixture of *Juncus subnodulosus* and *Carex disticha*. Grasses poorly represented. Occasionally occurring tall herbs. Peucedanum is frequent. Bryophytes abundant in the wetter stands. Hands marsh is particularly rich in bryophytes in the **seepage** zone & Liparis (new location) B23a. No pteridophytes - but only a small sample side. Fertility and conductivity low - likely to be very sensitive to eutrophication & desiccation. B23b Occurs in a regularly mown area of litter marsh at Sprats Water, & the other in a seepage zone as a transitional community at Burgh Common. Similarities with S24/S27 and B22.

B24 *Sphagnum* spp - *Dryopteris* spp - *Thelypteris thelypteroides* open birch scrub
Bog Mosses, Ferns, Marsh Fern **7.65 hectares**
Rare/scarce species: *Thelypteris*, *Pyrola*, *Dryopteris cristata*, *Carex appropinquata*, Peucedanum. Resembles immature birch scrub - 1/1.5m high. Mature trees generally dead in upright. *Sphagnum* dominates with a few birch seedlings. Occasional, uncommon tall herbs. Subcommunity - abundant pteridophytes. Bryophytes are very common and may dominate the understory. Occurs over peat cuttings. pH unpredictable. Would become birch dominated W2b woodland without management. M13, M5. Found commonly at Catfield Fen & Hicling Broad. Also at Reedham Marshes, Horning Hall Marshes. Several places at Upton Fen.

B25 *Juncus subnodulosus* - *Eriophorum angustifolium* - *Sphagnum* spp. Acid Mire
Blunt-flowered Rush, Common Cotton-grass, Bog Mosses **1.36 hectares**
Very important for bryophytes. Abundant sphagnum & a variety of species. No tall herbs except Peucedanum. Irrigating water is highly acidic. Low fertility & conductivity levels at all sites. W2b woodland would probably develop from this community in the absence of management. Most similar to M4 & M5. Also close to B8 & B36, Distribution limited: Mrs Myhills Marsh, Sprats Water & Potter Heigham Fen.

B26 *Carex riparia* - *Peucedanum palustre* - *Calystegia sepium* reedbed
Great Pond-sedge, Milk Parsley, Hedge Bindweed **66.66 hectares**
Rare/scarce: Peucedanum, Sium, Sonchus, Cicuta. Mixed tall herb fen. Moderate fertility, with some extra nitrophilous species. Dominated by Phragmites, with *Carex riparia*. Cladium and Peucedanum may be frequent. Bryophytes are scarce. B26a occurs close to the water margin, and invariably over old peat cuttings. Tolerant of a range of conductivity's. pH acidic. B26b - low fertility and electrical conductivity. Similarities to: S24, B27, B39 & B40. Distribution: 26a - very frequent in Thurne close to the margins of broads. B26b - very uncommon. found at Sutton Fen & Sharp St Fens & Reedham Marshes.

B27 *Peucedanum palustre* - *Calystegia sepium* - *Solanum dulcamara* reedbed
Milk Parsley, Hedge Bindweed, Woody Nightshade **193.63 hectares**
Rare/scarce: Peucedanum, *Thelypteris*, Sium, Lathyrus, Sonchus, Cicuta. Dominated by Phragmites. Bryophytes are very rare, with the exception of *Eurynchium praelongum* which grows amongst reed litter. Moderate fertility, range of conductivity's. Former peat cuttings and solid peat. Close to a source of nutrients: river, dyke, broad. Large proportions managed commercially for reed. Close to B26 NVC - S4, S24, S26. Widespread in Broadland - less common in highly eutrophic Yare & Waveney.

- B28 *Typha angustifolia* - *Agrostis stolonifera* - *Galium palustre* reedswamp
Lesser Bulrush, Creeping Bent, Marsh Bedstraw **103.78 hectares**
Rare/scarce: *Peucedanum*, *Sium latifolium*, *Thelypteris*, *Carex appropinquata*, *Lathyrus palustris*, *Sonchus palustris*. Characterised by a dense mat of *Agrostis*, with *Phragmites/Typha angustifolia* as associates. Rushes infrequent. A wide range of occasionally occurring herbs. Bryophytes are uncommon. Found throughout broadland, but most abundant in the saline Thurne catchment. Conductivity is moderate/high; fertility generally low, pH neutral. Occurs over peat cuttings. This community may develop following the stagnation of irrigating water through impeded drainage. B28b *Phragmites/Typha* - is generally found on the margins of broads & where boat traffic is light - the Trinity Broad and Thurne system. S4/S24. Frequent at Hickling, Heigham Sound, Horsey & Brayden Marshes.
- B29 *Typha angustifolia* - *Juncus subnodulosus* - *Galium palustre* reedswamp
Lesser Bulrush, Blunt-flowered Rush, Marsh Bedstraw **15.4 hectares**
Rare/scarce species: *Peucedanum*, *Sium latifolium*, *Thelypteris*, *Lathyrus*, *Cicuta virosa*, *Dryopteris cristata*, *Sonchus palustris*. Two subcommunities - freshwater (more species rich) & saline (less rich & slightly ranker). *Phragmites* is dominant; *Peucedanum* is constant. Occur over old peat cuttings - sometimes down to marine clay. Conductivity moderate/high. pH circumneutral. Fertility low - although some stands affected by eutrophic water. S4 & S24. Closely related to B28. Found mainly in slightly brackish Thurne - particularly common at Hickling Broad and Horsey Mere. The freshwater subcommunity is more widespread - most common at Catfield Fen & Sutton Broad, also recorded at Buckenham Carrs.
- B30 *Carex riparia* - *Mentha aquatica* - *Galium palustre* tall herb fen
Great Pond-sedge, Water Mint, Marsh Bedstraw **rond community ?**
Two distinct subcommunities: *Phragmites-Agrostis*, and *Scirpus lacustris*. Considerable overlap between the two. Upper ronds of the Waveney. More diverse than other ronds. Probably inundated on the highest tides and during floods. Similar to B43 and B40. NVC - S4b.
- B31 *Juncus subnodulosus* - *Mentha aquatica* - *Sium latifolium*
Blunt-flowered Rush, Water Mint, Water Parsnip **0.03 hectares**
Rare/scarce species: *Peucedanum*, *Sium latifolium*. A mosaic community. Low growing areas dominated by *Juncus subnodulosus* & sedges; taller vegetation dominated by *Phragmites* and *Typha angustifolia*. Found at only one site - Hands Marsh, Sutton. Irrigated by acidic seepage water from Norwich Crag & also by base rich water from Sutton Broad channel. Low fertility & conductivity. S24ei. Shares characteristics with B20, B23, B16.
- B32 *Phragmites australis* - *Peucedanum palustre* - *Rumex hydrolapathum* tall herb fen
Common Reed, Milk Parsley, Water Dock **32.36 hectares**
Rare/scarce: *Peucedanum*, *Sium latifolium*, *Cicuta*, *Thelypteris*, *Sonchus palustris*, *Pyrola*. Dominated by *Phragmites* & *Typha*; *Agrostis* is sometimes abundant. Rushes are scarce, except for *Juncus subnod*, which may be abundant in some stands. Bryophytes are more common in this community than many other communities - possibly because of the wetter conditions. Over old peat cuttings. Some stands grow in eutrophic conditions - but these are rather degraded. Fertility and conductivity generally low/moderate. pH circumneutral. Scarce outside Ant valley. Abundant at Sutton Broad, Catfield fen & Reedham Marshes. Elsewhere in Broadland only at Upton Fen & Hickling Broad. Succession to B19, B17 or B27. Maintained on a double whale cut. Close to B34 and B19. S24.
- B33 *Phragmites australis* - *Lysimachia vulgaris* - *Peucedanum palustre* tall herb fen
Common Reed, Yellow Loose-strife, Milk Parsley **29.04 hectares**

Rare/scarce: *Peucedanum*, *Cicuta*, *Sium*, *Sonchus*, *Thelypteris*. *Phragmites* is dominant. Grasses frequent. Rushes uncommon. Sedges are frequent - range of species. Bryophytes are not common. Range of taller herb species. Reflooded former grazing marsh. Close to river because needs good water circulation. Fertility low/moderate. Conductivity low/moderate. A few stands are commercial reed. Close to S24d. Close to B32 and B19. Fairly common: most abundant at Barton Fen, Hall Fen, Reedham Marshes.

B34 *Glyceria maxima* - *Sparganium erectum* - *Peucedanum palustre* swamp
Reed Sweet-grass, Branched Bur-reed, Milk Parsley **4.99 hectares**

Rare/scarce: *Peucedanum*, *Cicuta virosa*. *Peucedanum* is constant and frequent. Grass dominated; rushes uncommon. No sedges. Reflooded former grazing marshes. Need wet sites with sufficient nutrients to support *Glyceria* and *sparganium*. Indications are that occurs where is some nutrient input from upland and where drainage poor and minimal water circulation. Tolerant of some salinity. Low pH. Only found in Ant valley. Abundant at Hall Fen; also found at Snipe Marsh & Broad Fen. Improving water flow/drainage could cause succession to B36 or B35. Is likely to progress through silt accretion to B32 or B27 reedbed. Close to S26d & S24b.

B35 *Juncus effusus* - *Rumex hydrolapathum* - *Agrostis stolonifera* transitional tall herb fen
Soft Rush, Water Dock, Creeping Bent **2.84 hectares**

rare/scarce species: *Peucedanum*, *Thelypteris*, *Sonchus palustris*. Sedges uncommon. Grasses prominent. Herbs prominent. *Peucedanum* frequent. Bryophytes are not common despite the constantly damp conditions - it may be that they are slow to invade new habitats. This community only found at sites which were previously drained and used for grazing and subsequently abandoned. Stands abundant at Hall Fen. On alluvial silt and mud. Low/moderate fertility. Conductivity quite high. pH acidic. Similar to B36, B34, B33. It may be that an increase in acidity gives B34; and where nutrient levels are lower - B36. Unstable community because of silt accretion. Will change to B32 and B27. Similar to S24d. Found only in the Ant valley fens with two anomalous examples at Mere Farm Marshes & at Hickling.

B36 *Juncus effusus* - *Potentilla palustris* - *Agrostis stolonifera* mire
Soft Rush, Marsh Cinquefoil, Creeping Bent **2.52 hectares**

Rare/scarce species: *Peucedanum*, *Thelypteris*, *Sium latifolia*. Characterised by the presence of *Carex rostrata* and *Eriophorum angustifolium*. *Juncus effusus* and *Phragmites australis* may dominate in places, and *Carex rostrata* may then occur at low constancy's, but is still present. Bryophytes not abundant, but one or two species occur. two subcommunities - one with abundant sedges, the other without. Found on reflooded former grazing marshes on River ant. Base poor, acidic irrigating water. Unstable mud/silt conditions from fluvial flooding. B33, B34 associates. S27 & S24d. Distribution: Hall Fen & Catfield fen, Barton Fen.

B37 *Carex acutiformis* - *Calystegia sepium* - *Solanum dulcamara* tall herb fen
Lesser Pond-sedge, Hedge Bindweed, Woody Nightshade **3.76 hectares**

Easily recognisable by the combination of *Phragmites*, *Carex acutiformis* and dense mat of sprawling climbers. Occurs in response to locally increased nutrient levels. *Peucedanum* occurs. S4 & S26d. Very limited distribution: found only at Reedham Marshes, Sedge Fen (Hoveton) & margins of Barton Broad.

B38 *Phragmites australis* - *Glyceria maxima* - *Urtica dioica* tall herb fen
Common Reed, Reed Sweet-grass, Stinging Nettle **12.12 hectares**

Rare & scarce species: *Sonchus palustris*. Dominated by *Phragmites*. Very wet conditions - swamp like. No sedges or rushes present. Small range of tall herbs, uncommon low growing species. Bryophytes very rare or entirely absent. Occurs over former peat cuttings, in rather eutrophic conditions. Generally unmanaged. High water levels required. Succeed to B42/B43, & then become scrubbed up. Like S4b & S26d.

- B39 *Phragmites australis* - *Carex riparia* - *Arrhenatherum elatius* tall herb fen
Common Reed, Great Pond-sedge, False Oat-grass **47.58 hectares**
Rare/scarce species: *Peucedanum*, *Sonchus palustris*. A degraded community type. Occurs in dry eutrophic fen areas which are neglected. Particularly frequent on reflooded meadows, but where the water levels haven't risen sufficiently to allow proper fen development. Grass dominated. Apart from *Carex riparia* - no other sedges. Tall herbs not abundant - except for *Angelica*. Occasional small herbs. Bryophytes occurred occasionally. *Dryopteris dilatata* also recorded. High in nutrients because of peat oxidation. Low conductivity. Most important site Mere Farm Marshes. Also at Rollesby and as a rond community in the vicinity of Langley. Similar to S26d & b.
- B40 *Phragmites australis* - *Carex riparia* - *Calystegia sepium* tall herb fen
Common Reed, Great Pond-sedge, Hedge Bindweed **62.81 hectares**
Rare/scarce species: *Peucedanum*, *Lathyrus palustris*, *Sonchus palustris*. Dominated by grass species - *Phragmites* being the most common. Dense & impenetrable. Generally species poor. Rushes infrequent. Tall herbs abundant; some rarer species. Abundant climbing species. Low growing herbs not an important component. No bryophytes recorded. Low/moderate fertility & pH. Will grow under slightly brackish conditions. Associated with abandoned grazing marshes, where the water level has only risen slightly: Mere Farm marshes. also found in the tidally inundated White Cast Marshes, which were formerly grazed. It has not been recorded over peat cuttings. Generally unmanaged. B40 with increased nutrients might become B42. Increased flooding- B43. NVC - S26d. Common & widely distributed. Abundant at Wheatfen, White Cast Marshes, Mere Farm Marshes, Strumpshaw Fen. Commonly found growing close to dumped soil, or close to the river where nutrient levels are highest.
- B41 *Phragmites australis* - *Arrhenatherum elatius* dry tall herb fen
Common Reed, False Oat-grass **73.52 hectares**
Dry eutrophic fen areas. Rare/scarce species: *Thelypteris*, *Peucedanum*, *Lathyrus palustris*, *Sonchus palustris*. Frequent where grazing has been abandoned but not flooded enough for the development of more typical tall herb fen. Grass dominant; sedges common. Large & vigorous tall herb species: *Urtica*, *Filipendula*, *Angelica*. Bryophytes and ferns scarce. Substratum is often quite low in nutrients as a result of water level control and limited fluvial flooding, and so mowing management could result in a more interesting sward. Low conductivity. Mowing may produce B1/B2. Similar to NVC M27b & S26b. Also very close to B39. Barnby Marshes is most important site; also near Horsey Mere & in Halvergate area.
- B42 *Phragmites australis* - *Urtica dioica* - *Epilobium hirsutum* tall herb fen
Common Reed, Stinging Nettle, Greater Willowherb **330.7 hectares**
Rare/scarce species: *Lathyrus*, *Sonchus*, *Thelypteris*, *Peucedanum*, Dense & impenetrable. *Urtica* always present & may be dominant. Wide range of tall herbs; low herbs unusual. Bryophytes either rare or absent. Occurs on dry, solid, fertile peat. Range of conductivity tolerance & pH. Nutrient rich. Quickly scrubbed over by scrub, especially *Salix* spp. Close to B44 & B43, although no evidence to suggest succession from one to the other. B43 - generally grows in less fertile soils. Close to S26d - NVC. Common & widespread, except for the Thurne fens. Rarely found on ronds (unlike B44).
- B43 *Phragmites australis* - *Glyceria maxima* - *Carex riparia* tall herb fen
Common Reed, Reed Sweet-grass, Great Pond-sedge **72.93 hectares**
Rare/scarce species: *Lathyrus palustris*, *Sonchus palustris*, *Peucedanum*. More species rich than the other eutrophic tall herb fen communities. Tall herbs & grasses abundant. Rushes uncommon. Only common sedge is *Carex riparia*. Closely related to B40 - although climbing species are less frequent. Not many low growing herbs. Bryophyte *Eurynchium praelongum* was recorded. Low/moderate fertility & pH. Will grow under brackish conditions - when *Aster tripolium* may occur. Very few stands of this vegetation are managed at all, other than

occasional scrub clearance. Increased enrichment, and B43 could become B42. Increased flooding and B43 could become B45. NVC - S26d. Common & widely distributed. Abundant at Wheatfen and on upper Waveney ronds, upper Yare ronds and at Stanley and Alder Carrs.

- B44 *Phragmites australis* - *Glyceria maxima* - *Epilobium hirsutum* tall herb fen
Common Reed, Reed Sweet-grass, Greater Willowherb **24.94 hectares**
Rare/scarce species: *Sonchus palustris*, *Peucedanum*. Two subcommunities: *Carex acutiformis* & *Glyceria maxima*. Vegetation usually dense and impenetrable. Species poor. A number of climbing species occur frequently. *Urtica* usually abundant also. A wide range of tall herbs occur. Herbs uncommon. *Thelypteris* is a very occasional associated species. Bryophytes absent or rare. Occurs on high ronds, deep fertile peats or reflooded meadows. Requires high level of nutrients. Tolerant of slightly brackish water. Most closely associated with B42 and NVC -S5a & S7. Most important habitat is reflooded meadows alongside river Bure near Wroxham and Salhouse Broads. Reflooded pasture at Wheatfen & middle Yare & Waveney ronds.
- B45 *Glyceria maxima* - *Galium palustre* - *Iris pseudacorus* tall herb fen
Reed Sweet-grass, Marsh Bedstraw, Yellow Flag Iris **35.23 hectares**
Rare/scarce species: *Sonchus palustris*, *Carex appropinquata*, *Peucedanum*, *Althaea officinalis*. Many nitrophilous species. Dominated in either of the two subcommunities by *Glyceria* or *Carex riparia*. Lower plants are either very rare or entirely absent. Associated with reflooded meadowland. Fertility moderate/high; pH slightly acidic. Conductivity high. Close to B41 & B42, but no evidence to suggest succession from one community to another. S5a & S6 - NVC. Common along the margins of rivers. Also reflooded marshes at Kirby and Surlingham Church Marshes. Yare & Waveney Ronds.
- B46 *Phragmites australis* - *Juncus gerardii* brackish swamp
Common Reed, Saltmarsh Rush
- B47 *Phragmites australis* - Filamentous algae brackish swamp
Common Reed, Filamentous algae
- B48 *Phragmites australis* - *Aster tripolium* - *Atriplex prostrata* brackish swamp
Common Reed, Sea Aster, Hastate Orache
- B49 *Phragmites australis* - *Atriplex prostrata* - *Triglochin palustris* brackish swamp
Common Reed, Hastate Orache, Marsh Arrowgrass
- B50 *Phragmites australis* - *Scirpus maritimus* - *Agrostis stolonifera* brackish swamp
Common Reed, Sea Club-rush, Creeping Bent
- B51 *Phragmites australis* - *Juncus gerardii* brackish swamp
Common Reed, Saltmarsh Rush
- B52 *Phragmites australis* - *Juncus gerardii* - *Puccinellia maritima* brackish swamp
Common Reed, Saltmarsh Rush, Common Saltmarsh-grass
- B53 *Puccinellia maritima* - *Plantago maritima* salt marsh
Common Saltmarsh-grass, Sea Plantain

NATIONAL VEGETATION CLASSIFICATION

The following table provides a summary of the main communities which are found in the Broadland fens and which may be referred to in appendix 2. It has been constructed by using extracts from 'Guidelines for the selection of Biological SSSI's'.

Fen and Swamp communities

S2 <i>Cladium mariscus</i> swamp and sedge beds	<i>Cladium</i> dominated vegetation. Pure stands common and no other species frequent. Species-poor.	Found in open water transition, flood-plain and especially basin fens. Usually calcareous and base-rich. Shallow standing water tables.
S3 <i>Carex paniculata</i> swamp	Dominated by <i>Carex paniculata</i> tussocks. Species-poor.	Found in open water transition, flood-plain and basin fens and in peat-cuttings. Generally base-rich and calcareous. Able to tolerate a degree of seasonal water table movement.
S4 <i>Phragmites australis</i> swamp and reedbeds	<i>Phragmites australis</i> is the dominant. Generally species-poor, though variable; e.g. <i>Galium</i> sub-community is richer.	Widespread in open water transition and flood-plain fens, usually in hydroseral situations. Management extends the community into drier situations but water regimes can be variable. Does not have strict substrate preferences.
S5 <i>Glyceria maxima</i> swamp	Species-poor vegetation dominated by <i>Glyceria maxima</i> with a variable range of associates, e.g. <i>Epilobium hirsutum</i> , <i>Filipendula ulmaria</i> , <i>Solanum dulcamara</i> .	Mainly found in flood-plain fens, often on substrates containing a substantial mineral component, e.g. mineral alluvium. May develop as a floating raft. Associated with eutrophic, fertile conditions.
S6 <i>Carex riparia</i> swamp	Large tufts of <i>Carex riparia</i> are dominant; hence stands are usually species-poor.	Characteristic of margins of standing or slow-moving water in mesotrophic to eutrophic conditions.
S7 <i>Carex acutiformis</i> swamp	Dominated by <i>Carex acutiformis</i> . No other species constant.	Eutrophic margins of slow-moving water.
S8 <i>Schoenoplectus lacustris</i> swamp	Typically with a somewhat open cover of <i>S. lacustris</i> ssp. <i>lacustris</i> .	Often occupies the deep-water limit of swamp vegetation in mesotrophic to eutrophic waters. Sub-communities are related to water depth and trophic status. Notably uncommon in Broadland.
S12 <i>Typha latifolia</i> swamp	<i>T. latifolia</i> is dominant and stands are often species-poor. May be associated with S9 and grade landward into S25b.	Widespread through the agricultural lowlands of England. Found in water which tends to be mesotrophic or eutrophic.
S13 <i>Typha angustifolia</i> swamp	Dominated by <i>T. angustifolia</i> . Species poor. May give way to S14 in shallower water.	Found in standing or slow-moving water on silt, neutral to basic.

S14 <i>Sparganium erectum</i> swamp	<i>S. erectum</i> is generally dominant, but associates can be important.	Very common in shallow mesotrophic to eutrophic water on a mineral substrate and found both in pools and alongside streams and rivers throughout the agricultural lowlands.
S17 <i>Carex pseudocyperus</i> swamp	Can form almost pure stands or be intermixed with other emergents. May be adjacent to S4 or associated with S24.	Most typical of shallow, mesotrophic to eutrophic standing or sluggish water. Patchily distributed in the English lowlands and most characteristic of the Midlands.
S19 <i>Eleocharis palustris</i> swamp	Dominated by <i>Eleocharis palustris</i> with few other species frequent. Generally species poor.	Found in a wide variety of sites, often over silt, in mesotrophic to eutrophic, standing or running water.
S20 <i>Schoenoplectus lacustris</i> ssp <i>tabernaemontanii</i> swamp	<i>S. lacustris</i> ssp. <i>tabernaemontanii</i> dominates, with a variety of saltmarsh species and species of disturbed and/or moist soils.	Found most frequently in moist, brackish sites with soft gleys of silt or clay.
S21 <i>Scirpus maritimus</i> swamp	<i>Scirpus maritimus</i> swamp	Pure stands of halophytes with <i>Atriplex hastata</i> , <i>Agrostis stolonifera</i> and <i>Potentilla anserina</i> in standing or sluggish brackish water or rarely inundated upper marsh.
S24 <i>Phragmites australis</i> - <i>Peucedanum palustre</i> fen	Composed of tall monocotyledons (e.g. <i>Phragmites</i> and <i>Cladium</i>) and herbaceous dicotyledons with a lower layer of sedges and rushes and a patchy bryophyte layer. Generally species-rich.	Associated with flood-plain fens in England, especially in Broadland, where it occupies an intermediate zone between swamp and carr. Mean water levels are low, though winter flooding occurs.
S25 <i>Phragmites australis</i> - <i>Eupatorium cannabinum</i> fen	Characterised by tall monocotyledons and dicotyledons with variable amounts of small herbs and sedges. Less species-rich than S24.	Found in flood-plain fens, open water transitions and 'sump' areas of valley mires in England and Wales. Generally associated with calcareous, base-rich water and moderately eutrophic. Mean water tables generally low, though higher than in S24.
S26 <i>Phragmites australis</i> - <i>Urtica dioica</i> fen	Generally dominated by <i>Phragmites australis</i> and <i>Urtica dioica</i> but associates are variable. Generally species-poor.	Associated with eutrophic, neutral to slightly basic water margins throughout the lowlands where winter flooding and summer drying occur.
S27 <i>Carex rostrata</i> - <i>Potentilla palustris</i> fen	<i>Carex rostrata</i> may or may not be dominant, but <i>Potentilla palustris</i> and <i>Menyanthes trifoliata</i> are constant. Species-poor.	Almost exclusively a topogenous community in basin and flood-plain mires and may occur as a floating mat. Generally water levels are continuously high.

S28 <i>Phalaris arundinacea</i> fen	<i>Phalaris arundinacea</i> is usually dominant, though associates are variable. Species-poor.	Typical of circumneutral, mesotrophic to eutrophic waters. Marking the upper limit of water fluctuations in open water transition, flood-plain and basin fens and on stream-sides, especially where enrichment has occurred.
M5 <i>Carex rostrata-Sphagnum squarrosum</i> mire	Sedges and scattered poor fen herbs over a carpet of base-tolerant <i>Sphagna</i> . Of medium species-richness.	May occur as a floating raft in topogenous and even soligenous fens which are mildly acid or moderately calcareous but oligotrophic. The two main habitats where it is found are in open water transition and flood-plain fens and where a soligenous influx ameliorates and acid environment. Water levels are usually high.
M6 <i>Carex echinata-Sphagnum recurvum/auriculatum</i> mire	Small sedges or rushes dominate over a carpet of more oligotrophic <i>Sphagna</i> with a variable contribution from higher plants. Of medium species-richness. Regarded as poor fen.	Associated with slopes within M17 and M19 mire systems and over mineral ground. Mainly on peats and peaty gleys irrigated by rather base-poor but not excessively oligotrophic water. Water tables are high.
M13 <i>Schoenus nigricans-Juncus subnodulosus</i> mire	This vegetation is usually distinguished by both <i>S. nigricans</i> and <i>J. subnodulosus</i> and a wide range of low-growing associates. <i>Phragmites</i> , <i>Molinia</i> and sometimes <i>Cladium</i> may be important. The community has a high mean species-richness. When occurring as a hydroseral stage in turf cuttings it grades into S24 and S25.	Predominantly found in soligenous mires (valley and spring fens) on a wide range of soil types. Moderate to high water levels without stagnation appear to be optimal. Sites have a low productivity.
M22 <i>Juncus subnodulosus-Cirsium palustre</i> fen meadow	Variable but usually dominated by a range of grasses, rushes and sedges. Species richness variable. Regarded as rich fen-meadow.	Found in a wide variety of situations. Generally pH, bicarbonate and calcium levels are high. Water level variable. Fertility moderate.
M23 <i>Juncus effusus/acutiflorus-Galium palustre</i> rush pasture	Characterised by both or just one of the rushes with a range of herbs.	Found in both topogenous and soligenous sites on moist, moderately acid or neutral, peaty and mineral soils. Characteristic or relatively unimproved or reverted pasture.
M24 <i>Molinia caerulea-Cirsium dissectum</i> fen meadow	Almost always dominated by <i>Molinia</i> , with <i>Potentilla erecta</i> , <i>Succisa pratensis</i> , <i>Cirsium dissectum</i> and smaller sedges. Species richness fairly high. Regarded as rich fen-meadow.	Often associated with marginal areas of both topogenous and soligenous fens. Mean water levels are low. Fertility levels are very low.

M25 <i>Molinia caerulea</i> - <i>Potentilla erecta</i> mire	Though the community is variable <i>Molinia</i> is usually abundant. Generally poor in species, though rushes and a range of herbs are frequent. <i>Myrica gale</i> can form a patchy or dense over-canopy.	Tends to be associated with seepage zones in mires and generally moist to very wet. Substrates are peat or peaty soils. Fertility's usually very low.
M27 <i>Filipendula ulmaria</i> - <i>Angelica sylvestris</i> mire	<i>Filipendula ulmaria</i> is usually dominant and the associated flora is variable and frequently poor in species.	Generally found in moist relatively nutrient-rich, circumneutral situations protected from grazing, on mineral and organic soils with seasonal water table fluctuations.
M28 <i>Iris pseudacorus</i> - <i>Filipendula ulmaria</i> mire	<i>Iris pseudacorus</i> and often <i>Oenanthe crocata</i> are frequent to dominant, with scattered <i>Filipendula ulmaria</i> . Other tall herbs are found, and rushes and grasses are important in the lower tiers.	Confined to moist, nutrient-rich soils, especially at the upper edges of salt marshes.
SM24 <i>Agropyron</i> dominated communities (<i>Elymus</i>)	<i>Elymus pycnanthus</i> saltmarsh.	<i>Elymus pycnanthus</i> as stiff tussocks, usually without <i>Suaeda vera</i> or <i>Inula crithmoides</i> . Most abundant in south-east England.

Fen Woodland

W1 <i>Salix cinerea</i> - <i>Galium palustre</i> woodland	<i>Salix cinerea</i> dominates the canopy. Ground flora consists of small herbs. May grade into S25 or S26.	Mainly on topogenous sites - floodplain fens, open water transitions and basin mires.
W2 <i>Salix cinerea</i> - <i>Betula pubescens</i> - <i>Phragmites australis</i> woodland	Canopy of <i>Salix cinerea</i> , <i>Betula pubescens</i> and <i>Alnus glutinosa</i> . Ground flora related to previous community, from which this has developed.	Found on topogenous sites, particularly floodplain mires.
W4 <i>Betula pubescens</i> - <i>Molinia caerulea</i> woodland	<i>Betula pubescens</i> forms an open canopy. <i>Molinia</i> dominates the ground layer and <i>Sphagnum</i> is patchily developed.	Associated with moderately acid peats on a variety of mire types.
W5 <i>Alnus glutinosa</i> - <i>Carex paniculata</i> woodland	<i>Alnus glutinosa</i> is abundant with <i>Salix cinerea</i> , both often initially rooted in <i>Carex paniculata</i> tussocks.	Found on topogenous, usually base-rich, mesotrophic to eutrophic sites.
W6 <i>Alnus glutinosa</i> - <i>Urtica dioica</i> woodland	Canopy may be composed of <i>Alnus glutinosa</i> , <i>Betula pubescens</i> and/or <i>Salix</i> species. <i>Urtica dioica</i> is constant in the field layer.	

Lowland grassland communities

MG1 <i>Arrhenatherum elatius</i> coarse grassland	An unmanaged grassland occurring throughout the British lowlands on road verges and railway embankments and in neglected agricultural and industrial habitats.
MG6 <i>Lolium perenne</i> - <i>Cynosurus cristatus</i> pasture	The major permanent pasture in lowland Britain, often brought about by the action of fertilisers, herbicides and drainage on may other MG types or by agricultural rundown of MG7.
MG10 <i>Holcus lanatus</i> - <i>Juncus effusus</i> rush pasture	This is ubiquitous throughout the British lowlands, commonly developing by invasion of <i>Juncus</i> into MG6 and MG7 where drainage becomes impeded.
MG12 <i>Festuca arundinacea</i>	Listed in the biological guidelines as exclusively a coastal community in estuaries and saltmarshes in the south and west of Britain, and on clay cliffs in Dorset, Kent and North Yorkshire.
MG13 <i>Agrostis stolonifera</i> - <i>Alopecurus geniculatus</i>	Widely distributed in lowland areas. In eastern England it forms extensive stands but elsewhere it is fragmentary alongside watercourses and on the edges of ponds. Also occurs in freshwater transitions of upper saltmarshes.

FEN MANAGEMENT STRATEGY WORKSHOP: 26 & 27 October, 1996

Attendees

Allen Field (BA)

Bob Crook (BA)

Cath Wilson (BA)

Eric Edwards (BA)

Gary Kennison (BA)

Jane Madgwick (BA)

Keith Clark (BA)

Maggie Engledow (BA)

Phil Heath (BA)

Rob Andrews (BA)

Sandie Tolhurst (BA)

Clive Doarks (EN)

Andy Brown (EN)

Mary Gibson (EN)

Rick Southwood (EN)

Adam Burrows (EN)

Martin Drake (EN)

Lindsay Moore (EN)

Derek Pye (EN)

Reg Land (NWT)

Harry Bowell (NWT)

Neil Coombes (NWT)

George Taylor (NWT)

John Sharpe (RSPB)

Mike Blackburn (RSPB)

Carl Hawke (RSPB)

Mel Kemp (RSPB)

Geoff Phillips (NRA, now EA)

Pete Barham (NRA, now EA)

Geoff Mason (NRA, now EA)

Tom Bindloss (NRA, now EA)

Dr Martin George (BRAP)

Paul Ashford (BRAP)

Lord Cranbrook (BRAP)

Geert van Wirdum (BRAP)

Eddy Lammens (BRAP)

Richard Hobbs (BRAP)

Tim O'Riordan (BRAP)

Robin Lang (NT)

Matthew Chatfield (NT)

Andrew Pullen (Large Copper project)

Jo Parmenter (consultant, author of fen resource survey)

Martin Perrow (ECON)

Simon Smart (Ecological consultant)

Bill Sutherland (UEA)

Bob James (UEA)

Richard Starling (Warden, Martham)

Ken Saul (Warden, Burgh Common)

John Russell Wells (fen land owner)

Lindsey Russell-Wells (fen land owner)

Henry Cator (fen land owner)

Richard Handley (Francis Hornor)

Access and interpretation guidelines

Summary

Public Access

Existing:

Location	River valley	Organisation responsible	Facilities
Ranworth Broad	Bure	Norfolk Wildlife Trust	- Nature trail - visitors centre
Hoveton Great Broad	Bure	English Nature	- nature trail
How Hill	Ant	How Hill Trust/Broads Authority	- Electric eel boat - How Hill Trust walks - nature trail
Wheatfen	Yare	Ted Ellis Trust	- nature trail
Carlton Marshes	Waveney	Suffolk Wildlife Trust	- visitors centre - nature walks
Hickling Broad	Thurne	Norfolk Wildlife Trust	- water trail - nature walks - visitors centre
Strumpshaw Fen	Yare	RSPB	- nature walks - bird viewing facilities - reception area
Surlingham Church Marshes	Yare	RSPB	- nature trail
Buckenham and Cantley Marshes	Yare	RSPB	- nature trail

Proposed:

Horning Hall - nature trail
Barton Broad (Heron's Carr) - walkway

Local/Parish Access

This occurs at many sites due to Poors Trusts, Parish and Common rights. Examples include: Catfield, Common Fen, Smallburgh Fen, East Ruston Common.

Regulated Access

This occurs on sites which are often too sensitive to allow open access, but where public access is often possible in the form of pre-arranged guided walks. Examples include land owned by the British Butterfly Conservation Society at Catfield; land managed by English Nature at Woodbastwick.

Constraints to Access include:

- disturbance to wildlife
- safety
- suitability for walking (e.g. too wet)
- livestock issues
- intrusive 'furniture' - signs, walkways etc.

Guidelines:

- No new formal access routes beyond that proposed
- Ensure good standards for safety and interpretation where access currently exists
- Encourage local guided events, where possible with wardens, local historians etc.
- Promote conservation volunteering as a form of access/recreation/interpretation

APPENDIX 9

Criteria for the recommendation of the Broads as a possible Special Area of Conservation

The Broads must be considered a composite site, made up of twenty four component SSSI's. It is acknowledged that the different component SSSI's vary in their contribution to the features of European interest. However, it is the sum of the interests present within all of the component SSSI's that is considered to be of European importance.

The fen orchid is present within two of the component SSSI's, however we wish to withhold details of its location due to the sensitivity of this species.

The list below presents the relevant national vegetation communities present within the Broads that have been used in the definition of each of the five European habitat interests.

1 Chalk rich fen

- S2 Saw sedge *Cladium mariscus* swamp and sedge beds
- S24 Reed-milk parsley *Phragmites australis*-*Peucedanum palustre* tall herb fen
- S25 Reed-hemp agrimony *Phragmites australis*-*Eupatorium cannabinum* tall herb fen
- M9 Bottle sedge-moss *Carex rostrata*-*Calliergon cuspidatum/giganteum* mire
- M13 Black bog-rush-blunt-flowered rush *Schoenus nigricans*-*Juncus subnodulosus* mire
- M22 Blunt flowered rush-marsh thistle *Juncus subnodulosus*-*Cirsium palustre* fen meadow
- M24 Purple moor grass-meadow thistle *Molinia caerulea*-*Cirsium dissectum* fen meadow

2 Alder woodlands on flood plains

- W5 Alder-greater tussock sedge *Alnus glutinosa*-*Carex paniculata* woodland
- W6 Alder-nettle *Alnus glutinosa*-*Urtica dioica* woodland
- W7 Alder-ash-yellow pimpernel *Alnus glutinosus*-*Fraxinus excelsior*-*Lysimachia nemorum* woodland

3 Nutrient rich lakes and ditches

Vegetation types typical of waters, both broads and ditch systems, naturally rich in nutrients and supporting a diverse range of aquatic plants.

- A3 Greater duckweed-frogbit *Lemna polyrhiza*-*Hydrocharis morsus-ranae* community
- A4 Frogbit-water soldier *Hydrocharis morsus-ranae*-*Stratiotes aloides* community
- A9 Broad-leaved pondweed *Potamogeton natans* community

The above national classification correlates with endgroups A1 to A5a of the Broadland classification.

4 Very wet mires

- M5 Bottle sedge-bog moss *Carex rostrata*-*Sphagnum squarrosum* mire
- M9 Bottle sedge-moss *Carex rostrata*-*Calliergon cuspidatum/giganteum* mire
- M13 Black bog rush-jointed rush *Schoenus nigricans*-*Juncus subnodulosus* mire

Prepared by:

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English Nature, Norwich
4 April, 1995

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