Information and Advice note

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for birds
for people
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The future of reedbed management.

Introduction

Conservation action for reedbeds and Bitterns over the last 15 years has been highly successful. Not only have large areas of existing, but ageing, reed been restored to an earlier successional phase but the creation of over 1,000 hectares of new reedbed is in progress – all to be in conservation management. However, after the euphoria of meeting targets comes the hard question – how will we be able to manage this area of reed in the future? The current, traditional method of wardens cutting with a reciprocating mower and a team of volunteers is clearly unsustainable on all but the smallest of sites; there is a substantial mis-match between the amount of management required and our ability to achieve current prescriptions. Do we need to move towards increased mechanisation? Can, and should, we work more closely with professional reed cutters? Do we need to manage at all?

This Information and Advice Note aims to explore the issues around reedbed management and to suggest answers for the above questions. It is a result of discussion amongst RSPB staff involved in reedbed management, as well as the experience of partner organisation and individuals. In presenting an up-to-date summary of the techniques and ideas involved in managing reedbeds, it aims to shape RSPB policy and inform management plan reviews, both internally and externally.

Why manage reedbeds?

Reedbed management is primarily concerned with two issues: the water regime and the vegetation. Reed cutting, or vegetation removal by other means, is traditionally undertaken for one or all of the following reasons:

- To slow, or reverse, the natural succession of reedswamp to scrub and woodland , primarily by reducing the rate of litter accumulation, and at the same time stimulating the production of new reed.
- To provide ideal conditions for wildlife through the creation of structure, including open, wet habitat, pools, glades, reed edge etc.
- To supply reed for commercial purposes (Hawke and Jose 1996).

In addition, reedbed management may now also be undertaken on nature reserves to enhance the experience of visitors; attracting a greater range of species and making typical reedbed birds more visible.

Winter cutting of reed (assuming appropriate water levels) will maintain its dominance. Summer cutting reduces its competitive ability, allows a more diverse mix of vegetation and ultimately eliminates it. No management will allow natural succession to continue, the speed of which is dependant on the water regime.

Water regime

The water regime (the water levels maintained throughout a year) is crucial to the management of a reedbed. Many UK reedbeds were becoming dryer through litter build-up and the associated processes of natural succession. One of the simplest ways of rehabilitating such a degraded site may be to alter the hydrology by raising water levels. On some sites, water levels had been kept relatively high and stable with the understanding that this not only benefits Bitterns but also slows natural succession. However, the wisdom of such an approach is open to question due to the effect it may have on the quality of the reed, the effect on a range of reedbed species, and ultimately, on the Bittern itself if it leads to reedbed degeneration.

The promotion of reed health by reducing the build-up of organic material has already been referred to. Water regime is clearly a key issue. Reed-cutters have long argued that stagnation of water is detrimental to reed and that the firm bed of a reedbed will break up. More recently, there is ample evidence of reed die-back due to unnatural water table and eutrophication (eg. van der Putten 1997). It has been shown that phytotoxins released during the decomposition of reed litter reduce the vitality of the reed. Eutrophication and stagnant water may be a key factor in die-back by promoting both litter production and anaerobic conditions. Reed degeneration results in fewer panicles, lower seed production and lower stem and rhizome density. At the water margin, continuous vegetation changes to clumps, with increased exposure to waves and erosion (Belgers and Arts 2003). Such effects have been shown to be a causal factor in the decline of the Great Reed Warbler in The Netherlands (Graveland 1998), a bird that favours the outer fringe of wet reed. Lack of seasonally dry littoral zones also prevents seed germination, leading to a decrease in genetic diversity and monoclonal reed stands.

Where mowing is required, either for conservation or commercial reasons, water drawdown to ground level or below is often required to enable access. Conservation cutting to maintain reed dominance is undertaken anytime during the non-growing season, while commercial cutting is generally January-February after the reed stems have dried and the leaves have dropped. The rapid raising of water levels after cutting can slow, or even kill, reed growth if cut stems are flooded, and care is taken by reedcutters to avoid this. However, on conservation sites, deliberate flooding after cutting, combined with the natural topography of a bed, can create structure, variety and foraging areas, including bare ground, for a variety of species from invertebrates to birds.

In summary, a water regime cycle that follows a natural cycle, with a drawdown in late summer/autumn, is likely to be better for reedbeds than a regime with constantly deep water, which increases the exposure of reeds to the negative effects of litter accumulation. A throughput of water, combined with increased winter water levels is also beneficial, assisting with the flushing of organic material.

Current management - mowing

Traditionally, reedbed management on nature reserves has been undertaken with hand-held machines, either brushcutters or walk-behind mowers. Brushcutters have the advantage of being versatile, easy and quick to get to site and can cope with varying ground conditions. However, even though they are relatively cheap to purchase and several may be operated at a site, they are the slowest method of cutting, can break down frequently and are dependent on the operator's energy levels! They are used to best advantage in small, difficult or awkward situations. Walk-behind mowers (such as the Bucher, BCS or Iseki) have the advantage of cutting larger areas quicker. However, they are often heavy and slow to get onto site, have a low ground clearance and can be time-consuming to extract from soft, muddy ground. They are best used on larger areas of flat, firmer ground. Both brushcutters and mowers are weather and water-level dependent. Traditionally, the arisings are raked, stacked and/or burnt. Wet autumns make litter burning difficult.

Using these methods, costs have been calculated as £1200-1600/ha (Leighton Moss), £2200-5600/ha (Minsmere) or £3000-7000/ha (Ham Wall), or varying from 10-60m^2/'man' hour. These variations are accounted for by site wetness, length of rotation, amount of litter and degree of clearance. The mowing is usually achieved with one paid land-manager working with several volunteers. Cutting takes around 15% of the time, gathering and/or burning 85%. Annual machinery maintenance or renewal costs add an extra £500-1000. Overall, the operation is very labour intensive and can only realistically cope with small areas of reedbed. On average, reserves will only manage around 3 hectares of this type of work each winter.

Does this traditional mowing management hold succession?

A traditional 'conservation' rotation may be 7-15 years. This type of management is largely undertaken under the assumption that it will hold or slow succession. In practice, the effect on succession is likely to be minimal. If it does slow succession, the scale of the work can clearly only cope with smaller reedbeds. In addition, there is also a serious health and safety issue related to RSI and back complaints with hand-held machines. Severe restrictions are likely to apply in the future, making many of these machines obsolete. Within 10 years, the RSPB alone may have 1700 ha of reedbed to manage and the scale of this work demands a more efficient, sustainable approach.

Does it have other ecological benefits?

There is plenty of evidence to show that there are less breeding birds, such as Reed and Sedge Warblers, within cut areas of reed in the following summer (eg Baldi and Moskat 1995). On the face of it, it is obvious – there are no reeds to nest in until they grow again. The same is true for Bitterns and in addition, cutting may delay breeding over a wider area if water levels are lowered (Gilbert in prep). Cutting affects small mammal

populations, with virtually none persisting in the short term after management but recovery is relatively rapid, especially if refuges are left (Perrow and Jowitt 2003). Invertebrate communities also change following cutting and clearance. Conservation management of reedbeds therefore tends to steer away from short-term rotational cutting, particularly over extensive areas.

However, there is evidence that many reedbed birds favour 'edges' or younger, more open reedbeds, either for feeding or breeding. Cutting can create such structural variations. Baldi and Kisbenedek (1999 & 2000) found that certain reedbed passerines bred at greater densities close to reedbed edges, notably Great Reed, Reed Warbler, Sedge Warbler and Bearded Tit. They also showed that a collection of small reed islands held more species than a large reedbed of the same total area. However, some species, notably the larger rarer species such as Purple Heron, Spoonbill and Great White Egret, but also Savi's Warbler, favoured large areas of reed and may be considered 'interior' reedbed birds rather than the 'exterior' edge specialists. The reason for edge preference may to be connected with food availability and/or predation. There is a variation in reed height and density across an edge, and differences in invertebrate species, abundance and availability. Further to this, reed stubbles will attract a number of non-reedbed birds such as Snipe, Water Pipit and duck.

Bearded Tits, for example, favour a mix of older and younger reed, with plenty of wet edges, and have been seen to decline where cutting ceases. At Blacktoft Sands, a declining Bearded Tit population has been successfully restored by employing a rotational cutting regime creating different age mosaics of reed with a high degree of reed/water interface. This provides a range of feeding opportunities throughout key periods.

Reed cutting over the longer rotations dictated by conservation management therefore may not be as effective for slowing succession as claimed, while short rotation cutting is not as bad as claimed, being a means of putting structure into a reedbed to favour a range of 'exterior' species. It further follows that a carefully designed rotational pattern of cutting can benefit a variety of species, but also have a minimum effect on 'interior' reedbed birds, mammals and key reedbed invertebrates. Differing cutting patterns may benefit different species.

Commercial reed cutting – is there a conflict?

Professional reed cutters may be employed for several reasons: a) to take a short rotation (single/double wale) commercial cut, b) to take a longer-term rotation 'conservation' cut, with either burning or removal, or c) summer cutting to achieve plant diversity or for ditch management. The benefits of working with professional cutters include:

- to help a struggling industry,
- for longer term sustainability and perhaps some income,
- to bring conservation together with local people/industry, and
- to use their professional expertise and skill to get a job done efficiently.

The potential conflicts are seen as:

- a perceived loss of control,
- the availability of cutters,
- problems with site access, and
- conflict over the timing and area of cutting.

There appears to be a view amongst some conservation managers that commercial reed cutting and conservation do not mix. Clearly some conflicts do exist, notably over the extent of cutting and the management of water levels, but perhaps we are asking the wrong questions. In our larger, new reedbeds, a variety of conditions will exist. Commercial cutting could create structural diversity in some of the dryer areas, with single/double wale cutting being implemented over periods of 6-7 years, before being moved to a new patch. Such an approach could achieve both structural and successional benefits.

How much reed can you cut annually without damaging the conservation value? A study in The Netherlands (van de Winden 2003) found that 'exterior' reedbed birds only declined significantly when 50% or more of the reed was cut in any year. Jose and Hawke (1996) suggest similar proportions as a compromise between conservation and commercial interests. Therefore, with conservation as the priority, removal of up to 30% of the reed annually would seem unlikely to present problems. However, the cutting pattern is important in creating the high degree of desired edge habitat.

Other methods of reedbed management

Other methods of reedbed management may prove to be more effective in controlling succession, or in providing biodiversity benefits. The following options are discussed below: larger and more effective machines, burning, grazing and bed lowering.

Larger-scale management by machines

There has been investigation into a number of different machines capable of large-scale management. The following options are currently available:

The Aquaclear 'Truxor'

This machine is now regularly used at a number of reedbed sites, including Ham Wall, Strumpshaw Fen, North Warren and Minsmere. It is essentially a floating cutter, using a broad cutter bar that can be raised or lowered. A rake attachment can be fitted in less than a minute. Other attachments can also be used on the machine. It is easily transported on a trailer towed by a Landrover and works most efficiently in a water depth of 30-50cm. The Truxor costs c £90K or around £500-£600 per day to hire including operator.

Early estimates suggested that the Truxor (operated by a contractor) could cut a hectare of reed in about 40 hours (250m^2/hr) for a price of £2-3K/ha. Detailed costings prepared by Mike Douglas during work at Ham Wall in 2004 varied between 166m^2/hr (£3,700/ha) and 62m^2/hr (£9,900/ha), with the greatest costs on a compartment of 8-year old reed with dense litter. By contrast, Ian Hawkins at Minsmere calculated work rate and costs to vary from 275m^2/hr (£2,400/ha) to 187m^2/hr (£3,500/ha). Clearance of 5m wide ditches was calculated at between £240 and £625 per km.

The varying costs need to be carefully evaluated not only against the condition of the area to be cleared (notably the amount of litter and the distance it needs to be moved) but also the end result. Where the Truxor is working in ample water, the cutting and raking operations are liable to be quicker. However, when working in water of around 30cm depth, the machine retains some contact with the underlying bed. This increases its speed and power but also crushes and breaks up rhizomes, and in consequence, increases the rake-up time and overall cost. This action is likely to set back the reedbed succession significantly and the costs should be compared more with restoration techniques such as bed lowering rather than management that is more regular. The Truxor may therefore have more flexibility than currently appreciated, with depth of water being critical to the management objectives. Although there are concerns that the Truxor lacks power and is not robust enough for the job and disposal of the arisings after raking is another issue, this has proved to be a versatile machine for regular reed and ditch maintenance as well as minor restoration projects.

Softrak

The Softrak is a multi-purpose, rubber-tracked all terrain vehicle, with a very low ground pressure (1.2psi). Provision for front or rear-mounted 3-point linkage allows ancillary machines eg a flail, to be operated. Although not amphibious, it can cope with very wet ground, although cutting in such conditions may be slow. The basic machine costs £40K.

As with other machines, cutting rates vary with the ground conditions. At Ham Wall, an average cutting rate is one hectare of reed in about 40 hours (250m^2/hr). However, wetter, denser sections take

up to four times as long. By contrast, dryer, sparser reed at Radipole Lake was cut much quicker. The Softrak is a flexible machine capable of dealing with dryer, older stands of reed typical of later stages of succession. It has the distinct advantage of collecting as it cuts. However, repeated tracking to remove the arisings requires a firm access route. An attachment that cuts and bundles reed is currently being trialled.

The Seiga Harvester

The Seiga is a self-propelled amphibious machine with a 3m long reciprocating blade mounted on a cargo rig with a deck area of 4m x 3m and a capacity of 1-2.5 tons. Two-three people are required to operate the machine. It is capable of cutting and tying 2,000 bundles of reed daily (1-1.5ha). A new machine will cost c£100K and annual maintenance may be around £9K A low-loader is required to transport it between sites and a movement order is required.

The 6-wheeled Seiga Harvester is a specialised and efficient reed cutter, seemingly working best on flatish, firm ground in large single/double wale reedbeds. In such conditions, costs may range from £600-800/ha, a contractor would charge up to £100/hr. It is unsuitable for reed stands over 4 years since cutting present problems to the blade and bundling mechanisms due to the accumulated litter. Although amphibious and with low ground pressure (<1.5lbs/sq inch), it appears that this blade/rig combination would not be ideal in very wet sites. The Seiga may hold succession where single/double wale is employed but will not reverse succession, nor remove litter.

Seiga's are commonly used in Europe where there are 8-wheeled versions which have a different transmission design and may have greater potential in a wider range of conditions. These merit further investigation.

Olympia mower binder

Olympia mowers are the favoured machine for reedcutters due to their cutting and bundling ability. They have a 9HP diesel Lombardini engine, pedestrian operated, with a mowing width of 1.37metre. The weight is 435 kgs. The Olympia can work in up to 9" of water but requires reasonable ground conditions. It can cut 1,000 bundles a day (0.75 ha) and costs £8,500 + VAT. Like the Seiga, it can cope with beds up to 4 years since previous cutting.

Other machines that may be suitable

- Fen harvester: 1.5 psi, cuts 5m strips, in up to 10cm of water, blows material out to trailer.
- Modified piste basher: 1.5 psi, cuts and blows to trailer or cuts and bales.
- Floating rotary ditcher: a 360^{o} excavator modified onto floatation tracks.
- Swamp devil: a boat that cuts and opens channels in marshes.

What do we do with cut material?

Disposal of the cuttings is a key issue. At the present time, most cut material is burnt, with some stacked to rot. This does not send out a positive message to members/visitors or to the general public and as larger reedbeds are created, the problem will increase. Consideration may be given to the following uses of the material.

Commercial crop

The taking of a commercial crop of reed, for thatching or other end-uses, is the traditional use of reed. This requires a short-term rotational cut, but may be rotated around a reedbed by undertaking a restoration cut and then a number of years of single/double wale. A hectare of reedbed may produce around 1,000 bundles of

thatching reed, which may be sold for c£2.00. Although there is an increasing demand for reed as thatch in the UK, there are questions about the viability of the UK industry, with cutters struggling to compete against cheap imported reed (due to reduced transport and labour costs) from eastern Europe. However, the UK industry is trying hard to maintain its position and maintain local 'heritage' links between the cutter and the thatcher. Only 20% of the UK demand is met locally; it would require an additional 2,000 ha of cut reed to meet the demand.

Where reed can be cut locally to supply thatchers, the operation may be more viable. However, the availability of cutters outside East Anglia is an issue, for example, there is a growing demand for thatch in the south-west, yet no local supply. Discussions between reserve managers and thatchers may help resolve this by developing new local working practices. Suitable reed for thatching is determined by genetics and by environmental factors, including management. Consideration should be given to this when establishing new reedbeds. Surely it would be ridiculous for thatched cottages in villages close to new large reedbeds to be covered in reed from eastern Europe?

Composting

The possibility of composting material is being actively considered, notably at Ham Wall. There are numerous techniques for composting material, including 'open windrow' and 'in vessel'. The most common concern with the operation is the possible by-products, such as smell, bio-aerosols and leachate. These by-products are commonly associated with open windrows, where the material is laid in rows, which are turned regularly and are 'open' to the air. However, in the 'in vessel' method, the material is put into a container or bag. An energy source is then needed to regularly aerate the material, the equivalent to the turning carried out with open windrows.

The location of the composting site will largely depend on the method used. There are restrictions on the location of an open windrow-composting site in relation to dwellings and work places, due to the by-products. For 'in vessel' composting proximity to neighbours is not an issue, due to the lack of by-products. There is potentially also scope for this type of process to be carried out on-site near to where the material is being produced.

The open windrow process would be best undertaken by a contractor who has mobile units that can be moved around. Once the material had been shredded, turning could be undertaken with a front loader, Hymac or equivalent. 'In vessel' can also be done by a contractor, but also by reserve staff, as it is a straightforward operation once a 'bagging machine has been acquired. A machine would be required to move material to the composting site and load the bagging machine. For windrow composting, infrastructure such as a 50m x 50m of accessible hard standing, settlement pit for run-off, and means of disposing of and recycling water back into the process, will need to be constructed. For 'in vessel' composting an area 80m x 20m of accessible solid ground is needed, no run-off needs to be catered for and no water is needed.

An in-vessel composting trial at Ham Wall; a tractor feeding material to a machine that creates a 60m long 'pod' resulting in 50 t of compost after 8-12 weeks.

Ideally, the composted 'product', could be used and even sold as a soil conditioner. A range of waste materials has been used at Ham Wall without much variation in the product. Initially at Ham Wall, bagging was undertaken by working with a neighbouring peat processor. Latterly, people have been encouraged to bring their own bags to fill. Careful consideration is required when working with the peat industry but it also allows opportunities for highlighting important sustainability messages. Results from Ham Wall suggest that sales from each batch come close to covering the cost of the process. However, larger operations will have a better chance of recouping their costs than smaller ones.

There is a lot of legislation related with composting. On the scale that would be required on reserves, it is possible that a licence would not be required. However, this legislation is due to change very soon, reducing the amount you can legally compost at one time, without a licence, from 1,000 cubic metres to 300 tonnes. It is predicted that a reedbed may produce 600cubic metres from 1ha. The need for planning permission is not cut and dried and will largely depend on the method of composting that we seek to employ. Planning permission would be required to install permanent infrastructure such as a hard standing needed for open windrow composting. The key is discussion with the local planning authority and Environment Agency.

Biofuel

The use of reed material as a biofuel has been investigated, notably at Old Moor nature reserve, where a wood-burning boiler heats the offices and visitor centre. Conversion of the reed into a suitable form for burning is a key issue, but pelletising or processing into large bales are possible options. Moisture content is important, but will decline in standing reed to below 20% (suitable for burning) by January-February. Although there are remaining issues with the technology, including the ash quantity and the silicon content of the reeds, suitable burners are available. Another problem is the cost of any transportation of the material and there are currently very few plants in the UK capable of making biofuel pellets. However, mobile pelleting mills may be the answer. Reedbeds can produce 2-5 tonnes of reed per hectare per annum. Reed cut and processed into bales may be increasingly in demand from power stations, with current values at £27-45 per tonne. Research and development continues, and it is hoped that at some stage in the future it may be possible to develop a system whereby reed is cut, processed and used as biofuel within a single site.

Biodiversity benefits of stacked reed

Litter-heaps in wetlands are well known to be valuable habitats, for example for specialist invertebrates and reptiles such as Grass Snakes. Mark Telfer studied the invertebrates of reed heaps at Radipole Lake, with the following conclusions. Reed litter heaps can support an impressive abundance and diversity of invertebrates, even in mid winter. These invertebrates include litter-heap specialists (including some of high conservation value) and more generalist wetland species using the heaps as hibernation sites above the flooding level. The best heaps for invertebrates should be added to year after year to provide a continuity of habitat from fresh outer layers to well-composted inner cores. A mix of vegetation appears to be better than pure reed. Finally, it seems best to create tall domes rather than lower ridge-shaped heaps.

Management by burning

Burning is a traditional management technique undertaken in late winter when the reed is dead and dry. Burning may be used to remove already cut and raked material, or to remove standing reed. The technique is well described in Hawke and Jose (1996). Currently, burning appears to be avoided as a regular technique by (most but not all) conservation managers, although it is regularly used as a restoration technique by reedcutters. It retains a negative association with loss of reedbed invertebrates.

Research indicates that large scale burning will have an effect on the breeding birds in the following summer (Baldi and Moskat 1995), but in this it is no different to cutting. Regarding invertebrates, it is clear that burning will remove stem-dwelling species and have a varying effect on the litter fauna, depending on the severity of the burn. However, there appears to be no literature that shows an impact worse than cutting if the burn is carefully controlled. Ditlhogo et al (1992) showed that burning small plots had no long-term detrimental effect on invertebrate populations as rapid re-colonisation occurs from unburned areas.

Cowie et al (1992) showed that burning led an increased diversity of plants and greater flowering and seed production of the reed itself. Burning reed is also known to increase early shoot emergence and density (Haslam 1969) and assists the dominance of reed (van der Toorn and Mook 1982). The precise effect may depend on timing, frequency and water regime.

So it follows that the effects of burning to restore older reedbed may be no worse than comparable methods. However, there would be limited successional gain without combining this with other forms of management. As

a carefully controlled operation within a longish rotational management, and ensuring adequate re-colonisation potential, there seems little to dissuade land managers against burning as a cost-effective tool within a reedbed restoration plan.

Management by grazing

Grazing of wetlands, including reedbeds, is still in its infancy in the UK. However, it is a widely used method of management on the continent.

In the Netherlands, a distinction is made between 'natural' grazing and 'seasonal' grazing. Natural grazing is based on the principal of year-round grazing, with carrying capacity determined by times of food scarcity, generally late winter. The animals develop and retain a social structure, which brings with it knowledge of the terrain (location of water, location of food sources, swimming routes to higher refuge areas). This creates a natural mosaic of habitat, abundant growth in summer but eaten back in winter. In seasonal grazing, the number of animals relates to the maximum amount of food to be removed. The grazing density is generally much higher than natural grazing and habitat mosaics do not develop.

Summer seasonal grazing by cattle will convert a reedbed to grass pasture in 3-4 years at relatively low grazing densities (c0.5/ha), however, natural grazing over larger areas will see reedbed grazed seasonally, mostly in winter/spring but also in relation to water levels. The Dutch frequently combine natural grazing with water level control to produce a cyclical pattern of habitat renewal. However, management by grazing is imprecise. It depends on the individual site characteristics and the type of grazing animal used. It may be beneficial to use a combination of animals, eg ponies, cattle, sheep, deer, as each has its own grazing characteristics. Natural grazing can rarely ever be totally 'hands-off' as it requires large areas of land supporting a diverse range of habitat, and where these conditions are not met, is likely to lead to a 'boom and bust' cycle as the number of herbivores overwhelms the resource and then crashes.

The 'blue-zone' of continental wetlands, a transitional habitat where the annual water regime allows summer grazing before winter flooding, may provide a dynamic and productive reedbed edge. It can provide an important spawning area for amphibians or fish. The habitat may also support birds such as breeding waders and crakes.

Current RSPB initiatives include:

- Experimental grazing of 28 ha (50% reedbed, 50% grazing marsh) of the North Levels at Minsmere with Konik ponies. Combined with a dynamic water regime, this has proved successful at creating an area of open pools that drawdown in summer with a variety of vegetation types and structures. This has been beneficial for breeding and passage waders, breeding and wintering wildfowl, and as a feeding area for Bittern, herons and egrets.
- Experimental grazing with Highland cattle and Water Buffalo at Ham Wall has enabled comparisons to be made. The cattle have performed best, creating an excellent mosaic of different vegetation structures, particularly along the ditch margins.
- Fen/reedbed grazing at Mid-Yare reserves using Highland cattle, aiming to benefit structural diversity and invertebrate assemblages. There appears to have been an impact on bird species using the grazed areas, namely spotted crake, snipe and a variety of waterfowl. The cattle are very good at disturbing the ground layer, which can lead to germination of herb species and speeding up of the break down process. The cattle seek shade in warm conditions and tend to linger around scrub and can over time kill scrub selectively as a result of constant grazing.

Grazing of reedbeds, ideally combined with water level control, is a potentially valuable tool for the maintenance of early succession reedbed and diverse habitat mosaics. Further work is required to develop the skills and knowledge of this technique in the UK.

Management by bed lowering

With current reedbed management practices being very labour intensive and weather dependent, and in many sites only marginally, if at all, contributing to slowing succession, a more drastic approach may be appropriate. Bed lowering by excavation reverses succession, is relatively quick, not labour intensive and the result can create a varied open water/reed mix. Bed lowering may involve the removal of the surface litter, promoting a strong growth from the rhizomes, or may be deeper, removing rhizome and returning to open water.

Bed lowering has been particularly successful at Minsmere in increasing the Bittern population. At Lodmoor, the 5ha lowered in 1999 is still showing good vigour and florescence. Lowered areas contain pools and channels. Bearded Tits have colonised the newly lowered areas (after 2 years). The average cost for bed

lowering is c£10K per ha, however, work may not need to be repeated for 30 years and the area can be allowed to progress through a natural succession. In theory, rotational bed lowering around a site would allow a range of successional stages. The principal drawback is the disposal of arisings, particularly in floodplains, which would become increasingly difficult in successive rotations.

Similar, but smaller scale, techniques have included rotovation and the burying of rhizome in 'upside down holes' (UDH). Rotovation of patches will temporarily create a more open structure. UDH involve excavating the rhizome layer, then a layer of material from below. The rhizomes are replaced first, followed by the lower material. This creates a lower, wetter area (pool) that takes a few years to re-vegetate, and has been used successfully at Titchwell by Norman Sills to create additional variation within the reedbed.

Management for visitors

Extensive reedbeds can be very dull places for visitors, with many of the typical species being very difficult to see well. The following points may be borne in mind when designing new reedbeds, or access routes within reedbeds.

- It is important to create viewpoints that provide both high, long overviews of the habitat and low, short and medium views into the habitat. This may include tower hides in appropriate locations and low level hides at ditch and pool edges.
- Views should be provided along ditches and into pools (designs may have to take this into account) and also into and along the ecologically important edge habitats; scrub, pools, ditches and mud.
- Cutting to create gaps, glades, shallow water and reed stubbles will be desirable for the reedbed ecology. Paths and viewpoints should be located to view into such areas. Strips may be cut in front of viewpoints to view Bitterns, Water Rails, Bearded Tits etc.
- Lowered water levels to reveal muddy pools and islands is beneficial both to the ecology and to the visitor – such areas will attract a range of wading birds and waterfowl. Grazing margins to create 'blue-zone' also creates a good visitor feature due to the range of species attracted.
- Path routes should be as varied as possible, including sections through the reed habitat and under reed/scrub canopy.

Conclusions

- Is management of reedbeds required at all? Without management, natural succession will progress and the reedbed will be lost, so some form of management will be required at some stage if the reedbed is to be retained. However, with the creation of new and larger reedbeds, the current small-scale, labour intensive and costly management practices undertaken on many reedbed nature reserves are clearly unsustainable. There is a mis-match between the amount of management that will be required and the ability to achieve. New methods, ideas and/or equipment are needed. In the larger sites, small-scale works will need to be replaced with larger-scale, more dynamic management, perhaps using water levels and other measures to set succession back. Overall, the design and establishment of new sites must be carefully considered in order to accommodate effective management methods.

- Small-scale, rotational management by cutting is currently seen as the norm, and is traditional. Although there are benefits from continuing this form of management, larger, more-efficient machines will be required in the future, at least on the larger sites. In addition, we may currently be undertaking traditional management for the wrong reasons. The objectives for such work may differ from current understanding; looking more to developing structure rather than holding succession. Management may also depend on the priority species, creating different effects for different species.

- Reedbed sites are variable, from very wet with much open water (eg ex-mineral workings) to more uniform landforms with good water level control, and from small sites through to the very large new reedbeds. It is clear that one technique, or one machine, will not be applicable to all sites and situations. Overall, combinations of management tools are likely to be the answer, depending on the local situation. Three types of operation will be required in different circumstances:
    - Cutting and removing young stands of reed on dryish sites to produce an end-product or simply to create structural diversity.
    - Dealing with late succession reedbeds with abundant litter and removing the arisings.
    - Management on tricky wet sites, both large and small, and requiring an amphibious machine.

- **A management strategy.** If two issues are identified - succession and structure - a hierarchy of management strategy develops. At the upper level, a programme of management, probably rotational, maintaining a range of successional states within the site is required. A lower level of management strategy

will principally be involved with habitat structure, adding a finer habitat variation into the broader mosaic. This may involve opening up pools, ditches or other open areas. It may be for specific biodiversity gains or it may be for visitor appreciation (eg sightlines, viewing areas, access 'into' the habitat). A third issue for consideration is sustainability – what do we do with the cut vegetation? These issues are discussed below.

- **1. Natural succession**. The techniques used to slow natural succession will depend on the size of the site, landform and substrate, and the ability to manage water levels. A variety of techniques should be considered. The options will include cutting (but with more efficient machines), raising water levels or bed lowering (but neither are sustainable long-term solutions) or periodic drying-out. The use of periodic drying-out through water level control, combined with intensive grazing (with a variety of species) to set back natural succession should be considered as a means of creating and managing habitat diversity. Occasional cutting and burning should also be seen as part of this process. Re-flooding will result in a highly productive early successional wetland that can be allowed to progress to reedbed again. By varying these factors around the site, and ideally there would be at least two compartments with alternating water regimes, it should be possible to maintain the overall proportions of early-late successional habitat. Individual 'compartments' may be allowed to develop over a number of years (20+?) before drying, grazing and re-flooding. The resulting early succession wetlands will bring both biodiversity benefit and visual appeal (attracting large number of waders and duck) before moving back to reedbed. Where grazing is impossible, the animal's role will need to be fulfilled by large machines.

Time-line (years)										
0	**3**	**6**	**9**	**12**	**15**	**18**	**21**	**24**	**27**	**30**
Reedbed	Wet grass/fen		Open water	Young reedbed					Old reedbed	
Drain	Cut, graze		Re-flood	Re-establish cutting regimes. Rotational 1, 2 & 4 yr cuts. Manage pool edges and ditches. Graze margins.						Drain

- Water level control remains a crucial element in maintaining the habitat, either in combination with other management methods, or even using dynamic management by 'catastrophic' flood to reverse succession. Again, it is a vital element in the initial design of any new reedbed. On small sites with good water control, such rotational management may still be applicable, but is more likely to be undertaken by machine. On uncontrollable wet sites, an amphibious machine would be required for reversing succession on larger blocks of reed where access is difficult, on islands for example.

- Where it is difficult to maintain a range of conditions within one site, it may be better to take a strategic view over a suite of sites, with different conditions being maintained on different sites. Equally, the actual position of 'new' or 'old' reedbed within a wetland mosaic may be irrelevant as long as there is 'x' hectares of 'y' quality reedbed within a given area.

- **2. Structure.** The addition of structure into the reedbed is a crucial part of the management strategy. This may be achieved with smaller machines, but a range of options beyond the walk-behind mower will need to be considered. Working with commercial reedcutters should be seriously considered. On small, wet sites, an amphibious machine such as the Truxor would be invaluable for creating structure, opening ditches and pools etc. On larger sites, grazing should be seriously considered. Where other habitat components of a wetland mosaic such as scrub/woodland and dryer grasslands are present, 'natural' low intensity grazing can be used to create interesting reed-wet grassland interfaces and 'blue-zone' habitat. Commercial cutting of reed may be used as a means to create this structure.

- **Sustainability.** Serious consideration should be given to the use of the cut material. Simply burning or stacking the arisings will be neither seen as acceptable practice nor sustainable. Uses of reed may include thatch, compost or fuel (or a combination), and it is likely that local uses will need to be developed. Commercial reed cutting should not be seen as incompatible with conservation; a correct balance just needs to be achieved and it should be possible to remove up to 30% of a standing reed crop without damage as long as cutting patterns are considered. Such end-uses need to be taken into account when designing and establishing a new reedbed.

- Finally, it should be remembered that reedbeds are transitional habitats, and there will come a time to stop 'flogging a dead horse' and to look to replacing the habitat elsewhere. Wet woodlands are nice as well.

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