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THE SIGNIFICANCE OF REEDBEDS AS HABITAT ISLANDS AND BIOLOGICAL CORRIDORS FOR BIRDS IN MODERN LANDSCAPES: CONSERVATION STRATEGIES AND MEASURES AT THE LANDSCAPE SCALE

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Man is a reed, the weakiest to be found in nature but it is a thinking reed.

Blaise PASCAL, French philosopher (1623-1662 AD)

INTRODUCTION: THE VALUE OF REEDBEDS FOR ANIMALS

Many animal and plants rely on reed for some or all of their life cycle. As a natural habitat reedbeds are nationally scarce, and so the animal species and communities that rely on them must therefore be equally scarce.

Reedbeds support characteristic communities of national, and more and more international, uncommon species, mainly birds and invertebrates.

Invertebrates

At least 700 species of Invertebrates have been found to be associated with reedbeds in United Kingdom. Some 64 insect species are known to be dependent on reed to some extent and 40 entirely dependent (Fojt and Foster, 1992).

All stages in the succession of a reedbed support important invertebrate communities, although pure stands of wet reed will have lower value in terms of diversity than reedbeds with a drier litter layer (Kirby, 1992). Our knowledge however is limited largely to those species that are pests of commercial reedbeds, the effects of which have been studied by van der Toorn and Mook (1982). A common and widespread example in UK is the Large Wainscot, the larvae of which feed inside both the stems and rhizomes of reed, causing considerable damage to commercial thatching reedbeds. In the UK the internationally rare Fenn's Wainscot is found only in two natural areas, the larvae feeding at first in the stems of reed and later on the leaves.

The ecotone zones between reedbeds and terrestrial ecosystems and between reedbeds and water are particularly important for Insects, notably for dragonflies - (Odonata).

Fish

The species found in ditches and open water associated with reedbeds are those common to lowland eutrophic rivers in Europe.

These include Pike (*Esox lucius*), Tench (*Tinca tinca*), Roach (*Rutilus rutilus*), Rudd (*Scardinius erythrophtalmus*), Bream (*Abramis brama*) and Eel (*Anguilla anguilla*). Shoals of fry

and some smaller species like Stickleback (*Gasterosteus aculeatus*) and Minnow (*Phoxinus phoxinus*) occur amongst reed stems and in the shallow margins of open water. The eggs, larvae and fry are a food source for many creatures, from dragonfly larvae to Kingfisher (*Alcedo atthis*).

Some species may be absent from reedbeds which have become more or less isolated from a river supply and this may have important implications for recruitment.

Amphibians

Reedbeds growing along ditches and around small pools can support large populations of frogs, newts and toads. On larger wetlands (eg lakes), fish are very often present ; in turn, amphibians will be scarce or even absent. The presence of large reedbeds can, sometimes, help local populations of amphibians to occupy waterbodies also inhabited by fish.

Frogs can be an important food source for larger waterbirds like the grey heron (*Ardea cinerea*) and the bittern (*Botaurus stellaris*), but most animals find common toads distasteful. The larvae of amphibians are a food source for many animals, including the predatory larvae of the great diving beetle (*Ditiscus marginalis*) and of the dragonflies (Odonata).

Reptiles

The grass snake (*Natrix natrix*) is a common inhabitant of many reedbeds where it hunts primarily for frogs. It may lay its eggs in piles of cut reeds and other vegetation. The rotting vegetation generates heat, which incubates the eggs (Langton, 1989).

Mammals

Most mammals found in reedbeds are associated with a range of other aquatic habitats. The main species are Water Vole (*Arvicola sapidus*), the Water Shrew (*Neomys fodiens*), the Otter (*Lutra lutra*) and the two following North American exotics, the Muskrat (*Ondatra zibethicus*) and the Coypu (*Myocastor coypu*). The Harvest Mouse (*Micromys minutus*) was found to be the most dominant mammal species in a study carried out in the Broads (U.K.). Because it is not strictly a ground-dwelling mammal, it is able to thrive well in wet reedbeds which may support quite high densities. Its success in this wetland habitat was attributed to its ability to exploit the aerial habitat offered by reed and sedge and the abundant supply of insects in summer and seeds (including reed seeds) in winter (Jowitt and Perrow, 1993).

THE VALUE OF REEDBEDS FOR BIRDS

THE EUROPEAN SPECIES USING REEDBEDS AS BREEDING HABITAT

In Europe there are 32 breeding bird species that are dependent on reedbeds for their survival, from which 17 species mostly or entirely rely on reedbeds as breeding sites.

1. the Great-crested Grebe (*Podiceps cristatus*)
2. the Little Grebe (*Tachybaptus ruficollis*)
3. the Bittern (*Botaurus stellaris*)
4. the Little Bittern (*Ixobrychus minutus*)
5. The Purple Heron (*Ardea purpurea*)
6. the Hen Harrier (*Circus cyaneus*)
7. the Marsh Harrier (*Circus aeruginosus*)
8. the Montagu's Harrier (*Circus pygargus*)

9. the Water Rail (*Rallus aquaticus*)
10. the Spotted Crake (*Porzana porzana*)
11. the Little Crake (*Porzana parva*)
12. the Baillon's Crake (*Porzana pusilla*)
13. the Purple Crake (*Porphyrio porphyrio*)
14. the Mediterranean Gull (*Larus melanocephalus*)
15. the Black-headed Gull (*Larus ridibundus*)
16. the Bluethroat (*Luscinia svecica*)
17. the Cetti's Warbler (*Cettia cetti*)
18. the Fan-tailed Warbler (*Cisticola juncidis*)
19. the Lanceolated Warbler (*Locustella lanceolata*)
20. the Grasshopper Warbler (*Locustella naevia*)
21. the River Warbler (*Locustella fluviatilis*)
22. the Savi's Warbler (*Locustella luscinioides*)
23. the Moustached Warbler (*Acrocephalus melanopogon*)
24. the Sedge Warbler (*Acrocephalus schoenobaenus*)
25. the Paddyfield Warbler (*Acrocephalus agricola*)
26. the Blyth's Reed Warbler (*Acrocephalus dumetorum*).
27. the Marsh Warbler (*Acrocephalus palustris*)
28. the Reed Warbler (*Acrocephalus scirpaceus*)
29. the Great Reed Warbler (*Acrocephalus arundinaceus*)
30. the Bearded Tit (*Panurus biarmicus*)
31. the Penduline Tit (*Remiz pendulinus*)
32. the Reed Bunting (*Emberiza schoeniclus*)

Facing the reduction in reedbed area and the overall wetland habitat deterioration, some of the above mentioned species have switched to other substitute habitats during the breeding season, mainly crops. This is the case for the Marsh Harrier (crops, mainly wheat fields), the Montagu's Harrier, the Reed Bunting (crops, grassland, vegetation of ditches, ...) from which large populations are now found in new habitats.

Beside the above mentioned species, many other families and species use the reedbeds as a resting area and, mainly, as a feeding area. We can mention the warblers, mainly the Whitethroat (*Sylvia communis*), the Garden Warbler (*Sylvia borin*), the Lesser Whitethroat (*Sylvia curruca*), the leaf-warblers, mainly the Chiffchaff (*Phylloscopus collybita*) and the Willow Warbler (*Phylloscopus trochilus*), the Dunnock (*Prunella modularis*), the redstarts (*Phoenicurus* sp.) (see table). A species of international concern is the Aquatic Warbler which occurs in significant numbers during autumn in reedbeds in NW Europe.

Outside the breeding season, the reedbeds are used as a staging area during migration by a large amount of birds, mainly Passerines.

In summer and autumn, the reedbeds are also often used by Swallows (*Hirundo rustica*) and Sand Martins (*Riparia riparia*), sometimes in huge numbers (150,000 are recorded in the Inner Tay UK in some years). Grey Wagtails (*Motacilla alba*), Yellow Wagtails (*Motacilla flava*), Corn Buntings (*Miliaria calandra*) and Wrens (*Troglodytes troglodytes*) are other bird species which use reedbeds as a roosting place outside the breeding season. As reedbeds disappeared from our landscapes, this function is partly replaced by corn fields, which display the same vegetation structure.

In winter, the bird community is poorer than in spring and summer. This is mainly due to the

disappearance of most of the food resources (invertebrates). In winter, the reedbeds are, however, a common roosting place for the Starling (*Sturnus vulgaris*), the Marsh Harrier (*Circus aeruginosus*), the Hen Harrier (*Circus cyaneus*) and the Merlin (*Falco columbarius*).

DETAILED ACCOUNT ON THE THREE MOST THREATENED EUROPEAN SPECIES BREEDING IN REEDBEDS

The Bittern (*Botaurus stellaris*)

Habitat

The Bittern is most often found in marshes with extensive stands of *Phragmites* reeds. It can also breed in marshes dominated by reedmace *Typha* and bulrush *Scirpus lacustris* (Hancock and Elliot, 1978). It is also known in Central Europe to breed in dense growths of willow (*Salix*) (Dementev & Gladkov, 1951). Males are polygynous and generally take no part in the rearing of the young. The nest is a platform of reed stems within the reedbed, normally at water-level. Occasionally, several nests can be found close to each other within the territory of one calling male.

Status

The Bittern is known to have declined considerably in Europe in both population size and range during the early 1900s. This trend has continued and half of the European countries with breeding populations experienced a decline between 1970 and 1990. Approximately three-quarters of the European population are found in Russia and the Ukraine. In North-West Europe, only The Netherlands and France hold substantial numbers.

Threats

The recent decline has been caused by a reduction in availability and quality of large Phragmites-dominated marshes. Much of this land has been lost to drainage, but the abandonment of traditional management and the use of reed areas have also caused degradation of suitable sites. Elsewhere, conversely, the intensification of reed harvesting has also reduced habitat suitability.

Water pollution, especially eutrophication caused by runoff from domestic and agricultural sources, has also reduced reedbed viability and has disturbed ecological balances in fish populations within reedbed sites. Consequently, this has reduced the availability of habitat through the loss of reedbeds as well as the quality and abundance of food within them. In addition Bittern have suffered from various sources of pollution in the recent decades. Other threats include shooting of autumn migrant and wintering birds in central and eastern Europe and disturbance by anglers, water-sports and other human activities.

Conservation measures

Bitterns require extensive areas of reeds and swamps to maintain good populations. Retaining traditional but environmentally sensitive management of reedbeds is therefore important for this species, but the restoration and the creation of suitable habitat is also necessary where this has become scarce, fragmented or degraded.

Effective protection of breeding sites must include conservation and, where necessary, treatment of water supplies.

Some wetlands occupied by Bitterns may require the creation of no-disturbance zones as protection from recreational activities.

The Little Bittern (*Ixobrychus minutus*)

Habitat

The Little Bittern occurs mainly in freshwater habitats in lowland areas, including reedbeds and other dense vegetation along rivers, fringes of lakes, marshes and small ponds, preferably with trees such as willows Salix.

Status

A major decline in the population size and range of the species is thought to have occurred over the 1970-1990 period in nearly all countries, affecting up to 90% of the total European population. Decreases have been particularly common in north-west and central Europe. In several countries, populations have declined by more than 50%. This includes France, where censuses indicate declines exceeding 80%. A decrease in range size is also evident in most countries where breeding occurs.

Threats

The decline of the European population seems largely to have occurred since 1970 and cannot be attributed to habitat destruction or pollution in the breeding areas alone. It is therefore thought that the substantial overall fall in European numbers is due to high mortality of birds during migration or when wintering in Africa. Local declines have been explained by pollution, drainage and marsh destroyed by building constructions.

Conservation measures

Given the likely causes of the Little Bittern's decline, no conservation action on the European breeding grounds seems able to reverse it. Nevertheless, wider-scale habitat conservation measures in Europe (such as the maintenance of reedy fringes to rivers and ditches) should be taken to ensure that sufficient habitat exists for the species should conditions in Africa again become more favourable for it.

The Purple Heron (*Ardea purpurea*)

Habitat

The Purple Heron is confined to freshwater marshes, particularly reeds *Phragmites*. Nests are usually built in stands of mature reed which must be inundated throughout the breeding season, since drying out causes nest desertion.

Status

A decline was noted in the major part of the Purple Heron's European breeding population between 1970 and 1990. The Dutch population, for example, declined from between 500 and 600 pairs in 1981 to 210 pairs in 1991. The declines registered in Russia and Turkey are also of particular significance.

Threats

Permanent freshwater marshes are rapidly declining in extent and their destruction and deterioration are probably the major cause of the decline of the Purple Heron in some European countries. Purple Herons are extremely sensitive to disturbance and consequently some otherwise suitable sites may be rendered unacceptable for breeding. Reed-cutting or burning removes nest

material (dead reeds of the previous season) and therefore prevents nesting. At least in western Europe, the species' decline may be related to drought conditions on the wintering grounds in tropical Africa.

Conservation measures

Extensive areas of reedbeds and feeding areas are required if a population of Purple Herons is to be supported. In the Camargue (South France), Moser (1984) showed that in reedbeds of less than 30-40 hectares, population size was limited by the surface area of available reedbeds. In addition, an analysis of the feeding habitat requirements of breeding Ardeidae in the Mediterranean region reveals a threshold of 8 km^2 of freshwater feeding area, below which only very small breeding heron populations can exist.

The maintenance throughout Europe of extensive freshwater marshes and reedbeds, rich in fish and amphibians, is essential for the conservation of the breeding populations of Purple Heron. These habitats have become extremely vulnerable in Europe, and in many areas reedbeds are over-exploited. Throughout the Mediterranean basin the Purple Heron's distribution is now extremely patchy as a result of the small number of suitable reedbeds which remain in the region.

At local scale, conservation organisations could take action by acquiring and managing reedbeds.

At a more local scale, during management works by cutting or burning the reeds, undamaged areas should remain in order to let the Purple Heron breed.

SOME LANDSCAPE ECOLOGY PRINCIPLES IN CONSERVATION

The wetlands, including reedbeds, are some of the most threatened ecosystems on earth. In Northern France, for instance the area covered by wetlands has been reduced from nearly 30% of the region covered by wetlands 300 hundred years ago to less than 1% by now.

Some of the main threats identified as being responsible for the substantial decline of bird Species of European Concern (named SPECs, Heath & Tucker, 1994) find their origins in the degradation and destruction of the wetlands.

The conservation of the wetlands and the reedbeds are, therefore, of particular concern for some birds species, both the breeders and the migrants.

Most of the modern transformed landscapes can be described as land mosaics. The patch-corridor-matrix model coalesced when it was realised that a land mosaic is composed of these three types of spatial elements only.

Thus, every point of a landscape is either within a patch, a corridor or a matrix. The reedbeds must most often be considered as patches or corridors in most of our European landscapes. Sometimes, however, they can act as a matrix or if we change our scale, the local reedbed can become a matrix, the small clearings (e.g. open water), patches and the ditches and its fringes, corridors.

The reedbeds, which in comparison with the surrounding landscape are homogeneous and clearly delimited, can be considered as either biotope islands or biological corridors. The reedbeds act as habitat islands when they are isolated and as ecological corridors when their shape are more or less linear ; a mixing of these functions is, of course, sometimes possible.

The reedbeds, like other ecosystems, have five fundamental functions :

- habitat
- conduit
- filter

• source
• sink

The habitat function is well understood and this is the most comprehensive one. This is often the only one which is well documented and studied in most of the ecological researches.

The reedbeds act as a conduit when animals move along them. Contrary to that, they can act as an ecological barrier when species or individuals are inhibited from crossing between patches on opposite sides. Conduit fluxes can be either inside or outside the element (corridor or patch). The source and sink functions are understood conceptually, but as yet the diverse empirical evidence of flows are little known. As a source (a reedbed can be seen as a reservoir that gives off surplus individuals) of effects on neighbouring patches, reedbeds produce many offspring's of reed passerines which, in turn can colonize adjacent less suitable habitats. As a sink (an area or reservoir that absorb individuals or species) for fluxes from neighbouring areas, reedbeds may, for instance, accumulate animals from the matrix (migrants or wintering birds).

These functions operate whether the reedbed acts as a corridor, a matrix or as a patch. Of course, the general role played at the landscape level, generates major differences at the local scale for each of the five above mentioned functions.

The LOS (large or small) and SLOSS (single large or several small) theories have generated lively debate. Some say a single large patch is better to protect more species. Others claim several patches are better. One experiment with flies in bottles supported the single-large-patch hypothesis and one with plants in a disturbed grassland supported the several-small-patch hypothesis.

Several major ecological values of large patches are known. Some advantages are known for small patches, but few if any are known for mid-sized patches.

Disadvantages are mainly described for small patches. Interestingly, the values of the box transcend the LOS and SLOSS questions. The bottom line of this box should be <large patches, large benefits ; small patches, small supplemental benefits>.

The advantages hold no matter how many small patches are present, one, ten or a million.

As a regard to the reedbed breeding bird community, some species use only the largest reedbeds : these are the Bittern, the Bearded Tit, the Great Reed Warbler... As these habitats, they become rarer and rarer and are threatened or vulnerable to extinction.

On the other hand, some species can use the smallest fragment of reedbeds, such as the margins of ponds and reed-filled ditches. This is the case for the Reed Warbler and the Reed Bunting. These species show by no mean signs of decline at global scale.

The ecotones between the reedbed and the surrounding matrix play a major role in the richness and density of the breeding bird community. As a matter of fact we can define some strategic points in a mosaic landscape. The phenomenon of interspersion, adjacencies and convergency points are somehow important for the overall richness and density of a breeding bird community in a defined reedbed.

The grain size of a landscape can also, at various scales, influence the available ecological niches and, therefore, the richness and distribution of breeding birds. A coarse-grained landscape provides large patches for interior species, natural disturbance regimes and other ecological benefits. Such a landscape has a high 'landscape diversity' but a low 'site diversity'. That is, the whole landscape tends to contain interior and edge conditions of each patch type present, but moving locally from spot to spot is monotonous. Each adjacent spot appears the same, except when crossing an occasional boundary between large patches. Thus a coarse-grained landscape is ideal for interior species and large territory species. However, it is inefficient and costly for

multihabitat species. Except for locations near occasional boundaries, such species must move long distances among habitats to satisfy their requirements. Finally, the habitat for edge species is minimal.

A fine-grained landscape with small patches has a low landscape diversity but a high site diversity. That is, the landscape as a whole is monotonous, with different portions having the same fine-scale heterogeneity repeated throughout. But in moving locally, each spot or adjacent small patch is different. Thus, little movement is required to satisfy the needs of multihabitat species. Boundaries and edge species are everywhere. The problem with a fine-grained landscape is that the range of ecological conditions is limited, due to the absence of large areas with interior species. Essentially, only generalist species are present.

The shape of the reedbed can influence, mainly, the presence of core habitat and, therefore, the presence and abundance of interior species.

Sometimes the orientation angle of the reedbed patch should be also important as it has been demonstrated in woods (Gutzwiller & Anderson, 1987, 1992).

The influence of 25 ecological parameters on reedbed avifaunistical breeding communities was studied by means of stepwise multiple regression in N. France.

The studied parameters of the breeding bird communities were as follow : species richness (S), diversity (H'), pair value sum (a rather simple index in which the species are more or less heavily weighted in accordance to their local, regional or global rarity) and breeding density.

The main parameters which are responsible of the structure of the breeding bird communities are the reedbed overall area and its degree of isolation.

Area proved to be the major single independent variable. Most of the pair counts, the total pair count and the pair value sum are closely correlated with their absolute values, the number of species (richness S) showing the closest correlation with the root function of the reedbed total area and the diversity indices with the logarithm of the total area.

The curve of the logarithm of number of breeding species against the logarithm of the total area shows a gradient of 0.380 (0.274 when the influence of other independent factors is eliminated).

In contrast, the degree of isolation plays a subordinate role. Apart from area, five other factors are more significantly correlated with the independent variables than one of the 3 isolation characteristics. Number of species and diversity, however, are negatively proportional to the distance from the nearest big reedbed. Due to the prevailing spatial dimensions and their mobility, the bird populations of the reedbeds cannot be so clearly separated as the fauna of tropical archipelagos are, studies on which promoted the elaboration of the island theory (MacArthur and Wilson, 1963, 1967).

Eight of the ecological factors scrutinised (besides area and isolation) provide a significant explanation of the dependent variables, the major ones being habitat diversity within the reedbeds, occurrence of litter meadows on hinterland, soil cover by peat due to the decomposition of the reeds and width of the shallow water zone (all positively correlated).

Precise measurements of reedbed area allowed computation of the minimum area for each of the commoner species. Equally, the proportion of reedbeds occupied by a particular species to the total number of reedbeds of similar size can be determined (called incidence curve by Diamond, 1975a) and the area (F50) around which 50% of the reedbeds are occupied by a particular species estimated.

Three groups of valuable reedbeds can be distinguished. Each displays characteristic features and up to a certain point accommodates its own typical bird fauna.

The farther we get away from an individual caring for his own garden, the less effective planning and management decisions are (Richard Forman, 1995).