The bittern in Europe:
a guide to species and habitat management

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The bittern in Europe:

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Foreword

The secretive bittern is one of the most fascinating birds in Europe – although it is more often heard than seen. Most people never forget the moment they hear the booming male for the first time – the deep eerie voice is very evocative of its wetland home. Despite its almost mythical status, little was known about the ecology of this elusive bird, as little research was carried out until the beginning 1990s. At the same time, this mysterious bird has become highly threatened in the European Union after a severe decline of the population during 1970–1990. Consequently, the European Bittern Action plan set up a framework for its conservation, including further research, in 1999.

In recent years, the bittern has benefited from numerous conservation actions in many European countries, mostly financed within the LIFE Nature Programme. These included scientific programmes to fill the gap between the conservationist's knowledge and the bittern's ecological requirements. Indeed, the bittern is the most-often targeted species in LIFE Nature projects. The positive results of these actions are now unfolding with the population stable or increasing in most countries. This success story is not only good news for the bittern; the bittern plays a key role in safeguarding the wetlands within the Natura 2000 Network of the European Union.

In 2004 a LIFE Co-op project was launched to collect, interpret, prepare and to disseminate the experiences, results and know how of Bittern EU-LIFE Projects. It is the first time that the wealth of experience from across Europe has been brought together and made easily accessible to a European audience. The three partners of the LIFE Co-op project, the Brandenburg State Office for Environment as a regional German authority, the Royal Society for Protecting of Birds and the Ligue pour la protection des Oiseaux, BirdLife International representatives in the United Kingdom and in France, are very grateful for the contributions of colleagues from all European countries. They have very generously given their time, knowledge, experience of bittern conservation and some amazing photographs.

This Handbook *The bittern in Europe*, therefore, offers guidelines for actions to promote bittern protection, enriched by many vivid practical examples from all over Europe. The Handbook has a very practical focus and is aimed at land managers, advisors and interested groups in wetland conservation. However, the support and understanding of many other organisations are necessary for successful action on the ground. Therefore, the Handbook is also aimed at Government departments and agencies, water suppliers and Local Authorities. Future bittern conservation projects will be able to draw upon the results and experiences of the recent LIFE projects in the United Kingdom, France Germany and other countries. All these projects are proving that it is possible to reverse the decline of bittern populations.

Future actions to protect the bittern need to stabilise a healthy network of Natura 2000 sites within the enlarged EU. They have to meet new challenges of wetland conservation, such as global climate change and land use changes in the new member states. This Handbook provides useful guidelines, not only to benefit the bittern but also to present the bittern as a charismatic ambassador for wetland conservation.

Philip Owen
Head of LIFE Unit

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- The Royal Society for the Protecting of Birds (RSPB) – UK – Sarah Alsbury and Graham White
- Ligue pour la protection des Oiseaux (LPO) – France – Estelle Kerbiriou and Christophe Jolivet

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INTRODUCTION

History of the handbook

The great bittern *Botaurus stellaris* ('bittern') is a prominent flagship species of wetland conservation. The bittern has benefited from numerous conservation actions in many European countries, which were mostly financed by the LIFE Nature Programme. Indeed it is the species most often targeted by LIFE Nature projects (see below). The bittern therefore plays a key role in the implementation of the European Union's (EU) Natura 2000 Network. Although bittern protection has been a very important issue for individual projects, there has been relatively little attention given to networking between different sites and countries. At the LIFE project events that have provided an opportunity to exchange ideas and experience, the great value of this exchange has been obvious.

And so, the idea of this handbook was born. It collects together the experience, results and know-how developed as a result of LIFE projects in order to improve the understanding of bittern ecology and habitat requirements throughout the EU and particularly in the new member states.

The main partners in this LIFE Co-op project are the Brandenburg State Office for Environment (Germany), the Royal Society for the Protection of Birds (UK) and the Ligue pour la Protection des Oiseaux (France). The Handbook has been greatly enriched by contributions from many other beneficiaries and bittern experts. This spirit of international cooperation was much in evidence at the LIFE Co-op workshop held in the UK in December 2005.

This handbook is primarily a practical manual, having been written by ecologists and practitioners with conservationists in mind. It presents the latest research results, as well as guidelines, techniques and methods of bittern protection and habitat management from across Europe. It also vividly demonstrates the importance for the bittern of the Natura 2000 Network – a key message for those responsible for its implementation on a political or technical level. Above all, it is hoped, that this handbook can inspire and guide people towards a strategic approach to the conservation of our wetlands and the bittern in particular.

Milestones in the protection of the bittern in the European Union

The milestones in the protection of the bittern in the EU include the following:

In 1996, the International Bittern Workshop in Hilpoltstein (Germany) to assess the conservation status of the bittern in Europe, resulted in the adoption of the EU Bittern Action Plan (BAP) in 1999. This workshop was the starting point for numerous activities on bittern protection at national and international level. The BAP has provided a framework for conservation strategies and action. Some of the key priority actions in the BAP are:

- To ensure the protection and integrity of existing natural or semi-natural large (over 50 ha) reedbeds and associated wetlands (particularly existing breeding bittern sites).
- To ensure the protection and appropriate management of existing 'artificial' bittern breeding sites and other large reedbeds to fulfil their potential for bitterns.
- To encourage the creation of substantial new areas of suitable reedbed and associated wetland habitats for bitterns in countries with small, fragmented populations.
- Set up research projects in contrasting core areas for bitterns to study their ecology, behaviour, breeding biology etc.

The latter priority action was necessary because of the rather peculiar situation of the bittern. It is a key flagship species in Europe, yet at the same time very little was known about its ecology. A research and monitoring programme was therefore set up in the UK in 1998 and a research programme in France started in 2001, as part of the French LIFE project. During the 1990s, considerable research was also carried out in Italy and Germany and in a

few other countries. The results of these efforts are presented in Chapters 2 and 3 of this handbook.

In accordance with the BAP, the bittern was included on the list of priority species for funding under the LIFE programme. This list, a sub-set of the species included in Annex I of the Birds Directive, was initially drafted by the European Commission. It was finalised in 1996 and 1997 and approved by the Ornis Committee (the official body established under the Birds Directive and composed of representatives of the competent authorities in each member state). Since then, 62 LIFE projects have carried out various measures, which benefit the bittern. About 20 projects have really targeted specific measures for the bittern (see Chapter 1).

Relationship with the EU Biodiversity Action Plan

This LIFE Co-op project has not had the capacity to fully update the Bittern Action Plan. However, it does go a long way in terms of updating the baseline information. At the December conference, a start was made on identifying the issues affecting bittern conservation and possible further actions.

Structure of the handbook

The development of the handbook has been guided by the Project steering group, which comprises representatives of the three main partners. The steering group identified the key authors and the many other people who were known to have important contributions to make. Drafts of the chapters have been widely circulated amongst those with a particular expertise in reedbed management or bittern ecology. Finally, everyone was invited to participate in a workshop, held in the UK in December 2005, at which the authors presented an outline of the main chapters.

The handbook has been laid out in eight chapters. In the first part, our current knowledge of the status of the bittern and its ecology is set out in **Chapters 1 and 2.**

Chapter 3 summarises some of the techniques for monitoring bittern populations. A thorough understanding of its local status and ecological requirements then guides successful habitat protection and management work. Natura 2000 clearly plays a critical role in the former.

Chapters 4 and 5 summarise the threats facing the bittern and provide a guide to a range of management techniques.

Chapter 6 looks at some of the successful techniques that have been used to involve people in the conservation of the bittern.

A comprehensive series of case studies, from throughout the EU, is then given in **Chapter 7.**

Finally, **Chapter 8** draws conclusions and gives recommendations for further priority actions.

1 THE BITTERN IN EUROPE

1.1 Introduction

This chapter introduces the bittern and provides data on its status and conservation. The summary of its status and population trend uses the most recent data set compiled by BirdLife International (2004), from the second review of the conservation status of birds in Europe. The geographical scale of this survey, documenting the population trend during the period 1990–2000, is pan-European and not limited to the EU.

Next, the network of protected sites of relevance to the bittern in the EU is presented. The final part of this chapter gives a brief report on actions to promote bittern conservation. It provides examples of the different approaches taken in several EU countries. Finally, an assessment of the contribution of LIFE funding and projects to bittern conservation is made.

Further reading

BirdLife International (2004) *Birds in Europe: population estimates, trends and conservation status*. BirdLife International, Cambridge, UK: (BirdLife Conservation Series No. 12).

Heath M F and Evans M I (2000) *Important Bird Areas in Europe: priority sites for conservation*. BirdLife International, Cambridge, UK: (BirdLife Conservation Series No. 8).

Tucker G M and Heath M F (1994) *Birds in Europe – their conservation status.* BirdLife International, Cambridge, UK: (BirdLife Conservation Series No. 3).

Hagemeijer W J M and Blair M J (1997) *The EBCC atlas of European breeding birds: their distribution and abundance.* T and A D Poyser, London.

1.2 Portrait of the bittern

The bittern is a medium-sized, brown heron, weighing between 700 and 2,060 grammes, 64–80 cm tall and with a wingspan of 125–135 cm. It is a shy and secretive bird, which is more often heard than seen. It is generally associated with reedbeds and its plumage is the perfect camouflage for its reedy home (Plate 1.1).

When alarmed, bitterns stop and stretch their neck and beak upwards; the markings along the underside of their neck imitate dry reedbed stems perfectly and the bittern will even sway in the wind. The males 'boom' in the spring to establish their territory and attract females. This eerie call – like a foghorn – can carry up to 5 km.

Chris Knights/rspb-images.com

Plate 1.1
The great bittern ***Botaurus stellaris*.**

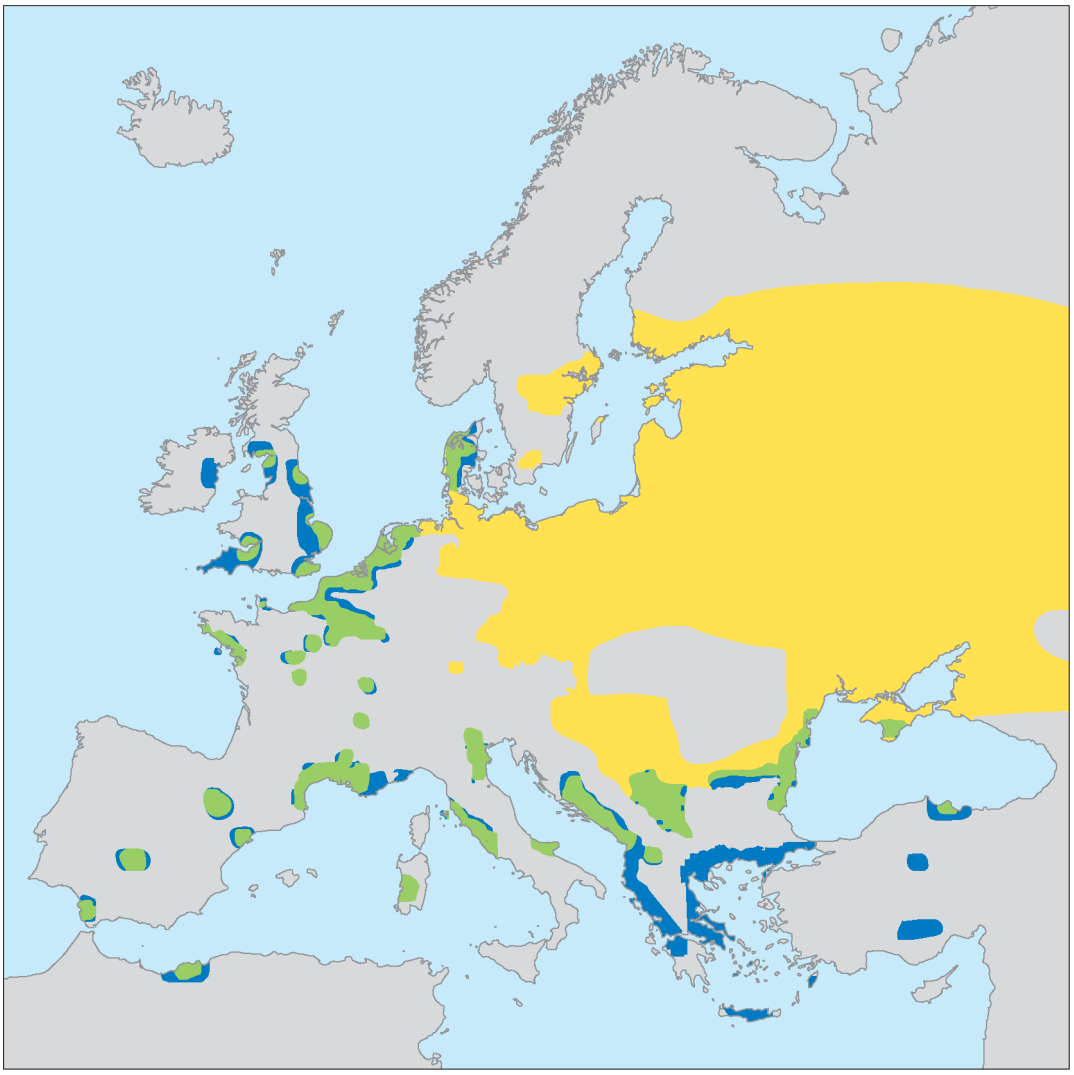


Figure 1.1
The distribution of breeding bitterns based on the EBCC breeding bird atlas (European Communities, 1995–2006).

Names of the bittern in Europe

Scientific name:	*Botaurus stellaris*
English:	Bittern
Czech:	Bukač velký
Spanish:	Avetoro Común
Finnish:	Kaulushaikara
Polish:	Bąk
French:	Butor étoilé
Russian:	ВЫПЬ
Greek:	Ηταυρος
Hungarian:	Bölömbika
Italian:	Tarabuso
Dutch:	Roerdomp
Portuguese:	Abetouro-comum
German:	Rohrdommel
Danish:	Rørdrum
Irish:	Bonnān
Welsh:	Aderyn y bwn
Estonian:	Hüüp
Latvian:	Lielas dumpis
Lithuanian:	Didysis baublys
Slovenian:	Velika bobnarica

Colloquial names of the bittern

British names
Bitter bum, Bog blutter, Bog-bull, Bog bumper, Bog drum, Boom bird, Bottle-bump, Bull of the bog, Bumpy cors, Butterbump, Heather blutter, Mire drum

'Bittern seems to come via Middle English from Old French butor, itself derived from Latin *butio* and *taurus*, bittern and bull. (ref John Pearson, www.birdsofbritain.co.uk)'

German names
Naumann (1901) enumerates 47 German names: Rohrdommel, Rohrdommelreiher, Gemeine Rohrdommel, Rohrtrummel, Rohrdump, Ruhrdump, Rohrpumpe, Rohrbombe, Rohrbrüller, Rohrbrummer, Moorochse, Wasserochse, Erdbull, Moor-, Moos-, Us-, und Lohr-Rind, Mooskuh, Moosreiher, Moosreigel, Mooskrähe, Rohrreiher, dickhälsiger Reiher, Iprump, Hortyhel, Faule, Rind- und Moosochse, Moosgais, Rind- und Kuhreiher, Hortikel, Mooskuh, Sterngucker, Fluder, Ridump, Reitrumper, Freesmarker Bull, Eerpump, Bullpump.

French names
Butor etoilé, Grand butor, Bos Taurus; Le butor also translates as 'grumpy old man'

1.3 Current status of the bittern in Europe

The bittern is distributed throughout the entire palearctic in the warmer boreal and temperate zones from western Europe through Central Russia to the Pacific. Discrete, small populations of a subspecies (*Botaurus stellaris capensis* Schlegel 1863) exist in southern Africa. In Europe the bittern is a widespread but patchily distributed breeder and this accounts for less than half its global breeding range (Figure 1.1). Its European breeding population is relatively small (<54,000 pairs). It is distributed densely and continuously in the east, becoming more sparse and fragmented towards the west, where it has suffered major declines. The 'borderline' between eastern and central Europe and the more sparsely populated western Europe, runs approximately along the former inner-German border, the south western border of the Czech Republic and the western border of Hungary to the Balkans, and thus alongside the eastern border of the 'old' European union before the reunification of Germany (Hagemeijer and Blair 1997, Flade and Koerner 2003). The present distribution is a result of a long decline since the 19th century. Once common in western and central Europe, the bittern has suffered from human persecution and the loss of semi-natural habitat, mainly the drainage of wetlands (Tucker and Heath 1994). Since the area and quality of pristine habitats have been reduced, man-made habitats such as fishponds, polders and rice-fields play an important role for the population (see Chapter 2).

According to the most recent data on the European bittern breeding population (BirdLife International 2004 – Table 1.1), the population has not yet recovered to the pre-decline level. Consequently, the European threat status has been evaluated in 2004 as a Species of European Conservation Concern (SPEC) Category 3 'depleted'. Previously, the status had been classified as SPEC Category 3 'vulnerable', due to the continuing decline well documented for the period 1970–1990 (Tucker and Heath 1994). The SPEC 3 status indicates that the bittern is a species whose global populations are not concentrated in Europe but does have an unfavourable conservation status in Europe.

In recent years (1990–2000), the population has had a more positive status, with stable or increasing trends across much of Europe (Ukraine being a notable exception). In particular, population increases in

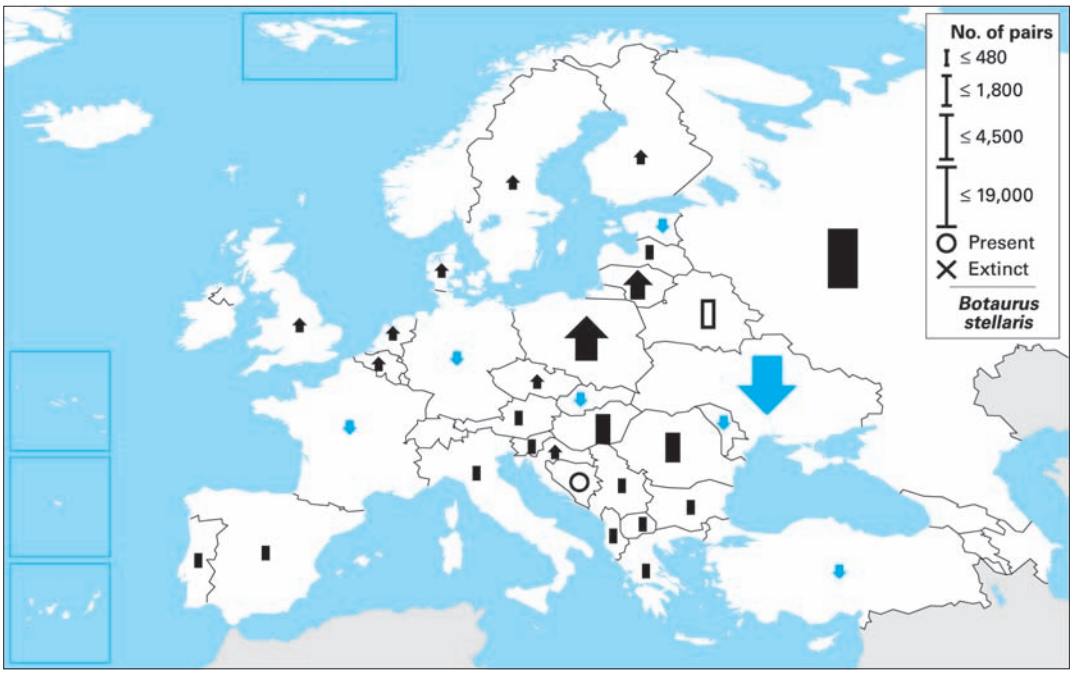


Figure 1.2 National breeding population trends of bittern (BirdLife International 2004).

Scandinavia and the Baltic States, and in Poland, are encouraging. However, in western and southern Europe the bittern populations still remain at very low levels (the Netherlands being an exception) and are highly fragmented and endangered at a national level. Compared to the previous review of the status (Tucker and Heath 1994), data quality has improved both for population sizes and population trends.

In contrast, the knowledge of the wintering status is still poor. Considering the high mortality during hard winters, better data on wintering populations and movements would be useful. The bittern is a partial migrant in Europe (see Chapter 2), whose migration is driven by winter conditions resulting in generally south westerly movements. Counts of wintering birds have been undertaken in the UK (Gilbert 2004) and France (Rufray and Kerbiriou 2004). In the Netherlands, a proportion of the population will migrate for the winter (Foppen pers. comm.). A similar situation is found in central Europe, eg in Poland. In Estonia, wintering birds were only recorded on six occasions up to 2005 (M Kose pers. comm.)

The bittern breeding population in EU countries (EU 25) totals 7,900–10,000 'pairs', which is 19–23 % of the pan-

Table 1.1 Bittern breeding populations and trends in Europe (BirdLife International 2004).

Country	Breeding population size ('pairs')	Year(s)	Trend	Mag. [%]
Albania	5 – 15	96–02	0	0–19
Austria	100 – 130	98–02	0	0–19
Belarus	**950 – 1,200**	97–02	?	–
Belgium	**12 – 20**	95–02	**+**	**0–19**
Bosnia and Herzegovina	Present	85–89	?	–
Bulgaria	20 – 70	95–02	(0)	(0–19)
Croatia	60 – 100	02	(+)	(>80)
Czech Rep.	**30 – 40**	00	**+**	**30–49**
Denmark	200 – 300	99–00	+	10–19
Estonia	100 – 150	98	–	20–29
Finland	200 – 300	99–01	**+**	**100**
France	**270 – 317**	00	–	0–9
Germany	360 – 620	95–99	–	20–29
Greece	**10 – 15**	02	0	0–19
Hungary	**700 – 1,000**	98–01	0	0–19
Italy	50 – 70	03	F	30–49
Latvia	300 – 500	00–03	(0)	(0–19)
Lithuania	**800 – 1,000**	99–01	+	0–19
Macedonia	(1 – 10)	99–00	(0)	(0–19)
Moldova	30 – 40	90–00	–	20–29
Netherlands	**200 – 250**	98–00	+	**34**
Poland	**4,100 – 4,800**	02–03	(+)	(0–19)
Portugal	0 – 3	02	(F)	(–)
Romania	(1,500 – 2,000)	99–02	(0)	(0–19)
Russia	(13,000 – 25,000)	90–00	0	0–19
Serbia and Montenegro	200 – 300	95–02	0	0–19
Slovakia	50 – 100	80–99	–	30–49
Slovenia	**0 – 2**	90–00	**F**	**>80**
Spain	0 – 50	98–02	(F)	(–)
Sweden	**360 – 400**	99–00	**+**	**10–19**
Turkey	(300 – 600)	01	(–)	(0–19)
Ukraine	10,000 – 15,000	90–00	–	5–9
United Kingdom	**21 – 21**	97–01	+	16

Breeding population size
The minimum and maximum figures are given (NB: Although the totals are described as 'pairs', the figures will in most cases refer to booming males.) Where the figures are the same, they should be interpreted as a maximum rather than a minimum. 'Present' indicates that a species occurs but that no other information is available.

Year(s)
The year(s) to which the population size estimate refers.

Trend
The overall direction of the population trend during 1990–2000, (for details, see BirdLife International 2004):
+ increasing,
0 stable (overall change less than 20 %),
– decreasing,
F fluctuating (annual changes of at least 20 %, but no clear trend overall),
? unknown (no trend data).

Mag.[%]
The overall magnitude of the population trend during 1990–2000, as a percentage. If the magnitude of the trend is unknown, it is denoted with the symbol'–'. for details see BirdLife International 2004.

Data quality
Bold– reliable quantitative data (eg atlas, survey or monitoring data) available for the whole period and country
Normal – generally well known, but only poor or incomplete quantitative data available
(Bracketed) – poorly known, with no quantitative data available

Legal status

The bittern is listed in Annex I of the Council Directive 79/409/EEC on the Conservation of Wild Birds (the Birds Directive), Annex II of the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), in the Convention on Migratory Species of Wild Animals (CMS), in Appendix II of the Bonn Convention, as well as in the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA). It is also listed as one of the waterfowl species used to identify wetlands of international importance under the Ramsar Convention.

European population (34,000–54,000 'pairs'). Among the 21 EU countries with breeding bitterns, 13 countries (Poland, Lithuania, Hungary, Germany, Latvia, Sweden, France, Finland, Denmark, Netherlands, Estonia, Austria and Slovakia) hold 98% of the population. Bitterns do not breed in only four countries: these are Ireland, Luxembourg, Malta and Cyprus. Appendix 1 gives more information country by country.

1.4 The European network of Natura 2000 sites

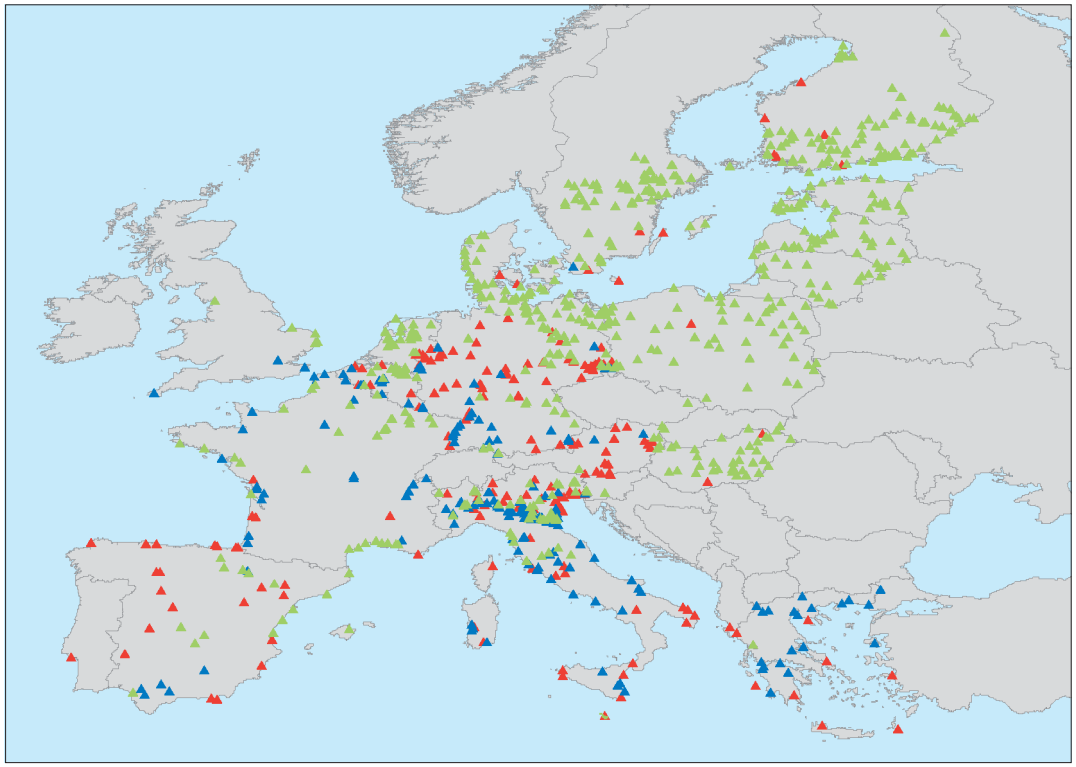


Figure 1.3 SPA's of importance for the bittern.

Key
- breeding
- wintering
- staging

The Natura 2000 network of protected sites, although still under construction, includes many sites for bittern, designated either under the Bird Directive or the Habitat Directive. Figure 1.3 presents all the sites of importance for the bittern derived from the EUNIS database (reference date: March 2006). The following categories have been distinguished:

- sites designated for breeding bittern
- sites designated for wintering bitterns
- sites not designated for bittern but supporting breeding or wintering birds

On the 25th anniversary of the EU Birds Directive, an analysis was undertaken of the occurrence of the bittern within designated SPAs (Romao 2004). SPA breeding population data in 1999 and 2004, as reported by Member States in the Natura 2000 SPA database were used and national breeding population figures were taken from *European Bird Populations: estimates and trends*, published in 2000. Data was only available for the 15 EU countries before expansion.

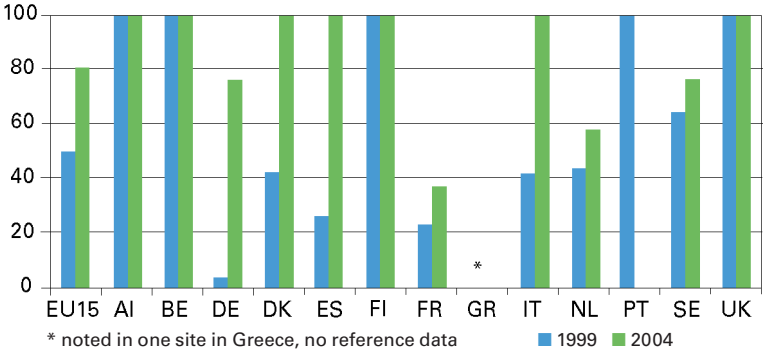


Figure 1.4 Percentage of breeding population in SPA's for *Botaurus stellaris* in EU15 (Romao 2004).

Nearly 80% of the EU breeding population of the bittern is included in the SPA network (Figure 1.4). Notable exceptions are France and the Netherlands, where less than 40% and 60% respectively of the national breeding population occurs in SPAs. In most EU countries, the entire regular breeding population is covered by the SPA network. There has been significant progress in the last five years regarding the notification of SPAs for this species. The bittern occurs in 639 SPAs, covering a surface area of 3,555,302 ha in the 15 countries of the EU before extension in 2004.

1.5 Approaches to bittern conservation in Europe, including LIFE projects

Conservation strategies

The bittern has been the focus of conservation action as its decline in most western European countries has become evident in recent years. These actions can be grouped as:

- legal protection of the species and key sites (see above)
- conservation or biodiversity action plans
- research
- monitoring of population
- habitat management and creation.

Countries have differing approaches, depending upon the legal and governmental framework and the 'conservation culture'. In the UK and the Netherlands (see Box 1.1), for example, national plans have been drawn up under the aegis of the relevant government department. These identified the importance of further research into bittern ecology and habitat requirements, as well as identifying action on the ground to deliver more and better quality habitat. In many countries action has been taken on a site-by-site basis. In France, whilst there is no national government plan, Ligue pour la Protection des Oiseaux (LPO) set up a national programme for the restoration and management of bittern habitats. This programme addresses issues that can only be tackled at a national level (such as the design of agri-environment schemes), as well as initiating action at a site level. The importance of national monitoring is being increasingly recognised and many countries now carry out regular counts, giving a much better understanding of the status of the bittern in these countries, (the UK, Sweden, Finland, the Netherlands, etc). Boxes 1.1 and 1.2 provide details on two approaches from the Netherlands and Germany.

Box 1.1 National conservation planning for the bittern in the Netherlands.

Bittern has been one of thirteen target species in the 'Conservation Plan for Marshland Birds 2000–2004', issued by the Ministry of Agriculture, Nature and Fisheries. The plan was written by Vogelbescherming Nederland, the Dutch BirdLife partner, which also co-ordinated and carried out actions within the plan. These include research, awareness-raising, lobbying and restoration projects for marshland birds. The following research projects, carried out under the direction of Vogelbescherming Nederland, guided the work on the ground:

- For each province, targets were set for sustainable populations of the thirteen target species. This exercise translated the national goals set in the conservation plan to a regional level. *Winden J.van der, R Foppen and RMG van der Hut, 2001. Provinciale streefwaarden voor moerasvogels. Bureau Waardenburg and SOVON.*
- Habitat requirements of bittern were quantified by an analysis of habitat characteristics and bittern territories, yielding a model that could predict or explain the presence or absence of bittern in a certain area, as well as identify which measures should be taken to improve an area for bittern. *Hut RMG van der, 2001. Terreinkeus van de roerdomp in Nederlandse moerasgebieden. Bureau Waardenburg.*
- Intensive assessment of the population in 2003, analysis of call series, as part of the campaign 'Year of the Bittern 2003'. *Turnhout C, AJ van Dijk, M van der Weide 2003. Jaar van de Roerdomp 2003, SOVON-onderzoeksrapport 2003/07. SOVON Vogelonderzoek Nederland, Beek-Ubbergen.*
- Bittern was one of the target species in research to assess the effects of commercial reed cutting on marshland bird populations, propose improvements for reed management and quantify the effect of different reed cutting scenarios. *Winden J van der, RMG van der Hut, PW van Horssen, LSA Anema, 2003. Huidige omvang rietoogst in Nederlandse moerassen en verbetering van rietbeheer voor moerasvogels. Bureau Waardenburg.*
- For the Ooijpolder area (part of Gelderse Poort) a research project was carried out to develop habitat restoration and management guidelines for bittern, great reed warbler and black tern. *Hut RMG van der, J van der Winden, KL Krijgsveld, 2005. Moerasontwikkeling in de Ooijpolder. Bureau Waardenburg.*

Contributed by Bernd de Bruin

Box 1.2 Feasibility study for north of Bavaria, Germany.

Following on from the LIFE project 'Measures for supporting and increasing populations of *Botaurus stellaris* in Bavarian fishponds' (see Appendix 1), a feasibility study was carried out looking at other areas in northern Bavaria. It was funded by the Bavarian Foundation for Nature Conservation and carried out by the Landesbund für Vogelschutz in Bayern (LBV). The aim was to identify suitable or potential bittern habitats, using the experience and knowledge gained through the LIFE project.

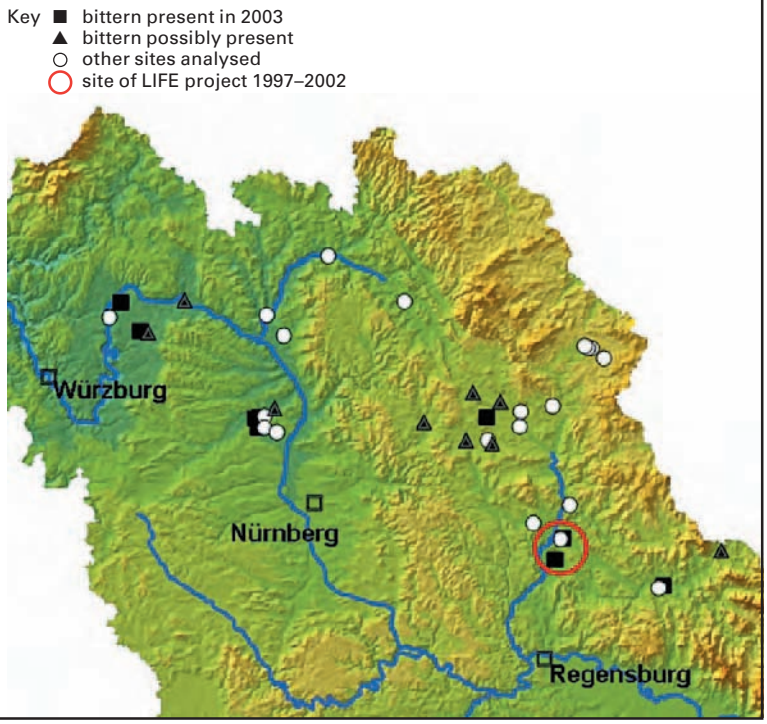
Sites were assessed for their quality as bittern habitat, focusing on existing reedbeds and using the following criteria:
- area of at least 2 ha (in combination with feeding areas nearby)
- the percentage of reed *Phragmites australis* within the reedbeds (as high as possible)
- the structure of reedbeds (different ages of reeds, presence of ditches, open waters etc)
- the water level especially in winter (a high water level results in better food availability), disturbance (as low as possible)
- the supply of open water in winter (availability of food when lakes are ice covered).

Thirty-six sites were identified as suitable or potential habitat, scattered across the area. The current site management was assessed together with required measures and the likelihood that the latter would be done. Each site was evaluated for its contribution to a network of sites by six different parameters of population biology, eg the effect on genetic flow, function as a stepping-stone etc. From this evaluation, a priority list was drawn up based on a site's potential contribution to the bittern population, the site's current state and the likelihood of remedial management works happening.

The outcome of the feasibility study is an action plan to connect the scattered and isolated remnants of breeding habitat with this network of 36 potential stepping-stones. This would reduce the average distance between bittern habitats from the current 55 km to 11 km. The feasibility study offers an effective plan for a future conservation programme in Bavaria. It has been distributed to NGOs and state authorities for nature conservation, development, etc. The first measures were carried out in 2004. Negotiations with landowners have started and the LBV is raising funds for the realisation of the project.

Contributed by Alf Pille

Figure 1.5
Sites analysed in the feasibility study.



The role of LIFE projects in bittern conservation

Funding from LIFE has played a major role in the implementation of the strategies for bittern conservation on the ground. It is very probable that the bittern's status would be much worse in many countries, if LIFE funding had not been available. The LIFE fund is unique in funding a wide range of work – ecological research, monitoring and management actions – and a wide range of measures – awareness raising, land purchase, etc. The bittern has been subject of 62 LIFE projects since the species is mentioned in the description in official project database at the Commission's website. In France and the UK, LIFE projects were set up to run national recovery programmes for the bittern. In many other countries, LIFE projects have restored and created wetland sites.

The greatest number of LIFE projects has been in countries where, according to the Bittern Action Plan, populations decreased significantly, such as the UK, the Netherlands, Belgium, France, Spain, Germany and Italy. LIFE projects have directly benefited the bittern by improving habitat conditions at the project sites and increasing the (local) population. Moreover, most of the recent research

programmes on the bittern (France, Italy, the Netherlands, Poland, Sweden, Germany) were either directly funded by LIFE or connected with LIFE projects.

LIFE 'Bittern' projects have often been the starting point for follow–up projects, funded either by a second phase of LIFE or by other programmes. Prominent examples are the first bittern project in the UK, the Siikalahti LIFE project in Finland, or the LIFE projects in Bavaria and Mecklenburg-Western-Pomerania.

Appendix 1 lists all the LIFE projects that have contributed to the conservation of the bittern by country. These were identified from the LIFE Projects database and then the Project Co-ordinator sent a short questionnaire to all beneficiaries in February 2005 to gain more detailed information. In particular, the questionnaire enabled projects, which directly targeted the bittern to be distinguished from those, where the bittern just 'occurs'. In most of the projects, the bittern has been one target species among others. Further, practical examples for key aspects, such as the different methods of population survey, the assessment of threats and the planning and implementation of suitable management actions were selected as case studies or boxes within the chapters.

2 ECOLOGICAL REQUIREMENTS – THE CURRENT KNOWLEDGE OF BITTERN ECOLOGY

2.1 Introduction

The bittern *Botaurus stellaris* is a secretive species of wet, tall marshy habitats, mostly stands of common reed *Phragmites australis*, but also vegetation of similar structure such as reedmace *Typha* spp., bulrush *Schoenoplectus lacustris*, saw-sedge *Cladium* or sedge *Carex* spp. (Plates 2.1–2.4). They take a wide variety of prey, predominantly fish but with amphibians, mammals, crayfish or aquatic invertebrates locally significant.

Information on bittern ecology was, until recently, patchy. However, following a significant population decline in Europe the bittern has become a conservation priority, and much research has been undertaken. This chapter summarises some of that recent knowledge that is most relevant to its conservation, notably habitat requirements, breeding biology and diet. It is by no means an exhaustive summary, nor meant to be, and more detail can be obtained by following up the further reading and references.

Further reading

Ligue pour la Protection des Oiseaux (LPO) (2006) *Handbook of the LIFE Bittern project: biology and management of bittern habitats*. Ligue pour la Protection des Oiseaux.

Graham White

Graham White

Marcin Polak

Graham White

Plate 2.1–2.4 Bitterns inhabit a range of tall wet vegetation.

2.1 (top left) Extensive stands of common reed are the main habitat of the bittern.

2.2 (top right) Bittern habitat in mixed stands of bulrush and reedmace.

2.3 (bottom left) A bittern nesting site in reedmace on a Polish fishpond.

2.4 (bottom right) Investigating a bittern nest site in a stand of bulrush.

2.2 Habitat requirements during the breeding season

Breeding habitat requirements of males

The results from several studies of the habitat composition of booming males' home ranges are described below. During the breeding season, the males feed within these home ranges and their selection seems to be driven by the availability of food. The common elements to the results are the presence of tall emergent vegetation and standing water, and in many cases, open water (Plate 2.5). The relative composition of these elements, the depth of water, the density of vegetation, varies according to the needs of the most available prey species. When fish are the main component of the diet, open water and flooded reed edge are generally important (UK, northern France, Poland, Belarus). In Italy, Spain and France (particularly the Camargue) where amphibians and crayfish are important components of the diet, more continuous vegetation with patchy flooded areas are selected.

In the UK, habitat preferences were initially established using comparisons between reedbeds that had lost their bitterns and those that retained them (Tyler 1994, Tyler *et al*. 1998). Recommendations for bittern conservation essentially involved keeping or returning reedbeds to an early stage of seral succession (RSPB 1996, Hawke and Jose 1996). In order to refine this management, fine scale, quantified habitat prescriptions were still required; in particular to identify preferred feeding habitat. To this end, eight territorial male bitterns were radio tracked and followed closely during the breeding season at two sites in the UK. These males were found to be most often active in reed with at least 20 cm water depth within the 30 m-reed edge next to open water. Areas of reedbed near scrub or further from the water's edge were avoided. Reed edge adjacent to open pools was preferred over that adjacent to channels and ditches (Gilbert *et al*. 2005). The home ranges of the males were, on average, composed of 30% open water (excluding ditches), 48% reed edge (30 m width adjacent to open water and ditches) and 16% reed that was 30 m or more from any water edge. Reed edge is typically very complex and convoluted, so the areas

Andy Hay/rspb-images.com

Plate 2.5 Bittern habitat at Strumpshaw Fen, UK.

Roberto Tinarelli

Plate 2.6
A bittern breeding site in Italy.

of reed edge (based on 30 m width) within home ranges, when converted to linear measures, vastly underestimated any real measures of the actual length of the complex reed/water interface. The average measured (from aerial photos) lengths of reed edge next to open water (60%) and open ditches (40%) inside home ranges were 400 m per ha. Overall, home range size seemed to be driven by the available areas of reed fringed open water (Gilbert *et al*. 2005). By contrast, radio-tracking of males in the Baie de Seine, northern France, identified the theoretical home range of a booming male as including 3.93 ha of wet reedbed, 1.96 ha of cut reeds, 0.78 ha of open water, 0.82 ha of meadow and 0.03 ha of dry reedbed (Provost *et al.* 2004).

This information on which to base habitat management advice for existing and newly created reedbeds has been crucial for bittern conservation in UK. It has however, been based on habitat from sites primarily occupied by booming males and on the behaviour of territorial males. On average only 57% (N=33, 1997–2001) of sites occupied by booming male bitterns showed any evidence of nesting females (Gilbert *et al.* in press).

In Schorfheide Chorin, Germany, bitterns are booming in reedbeds with considerable scrub encroachment which at first seems contradictory to the UK results (Rathgeber 2004). However, previous low water levels allowing scrub to colonise, have been raised. This emphasises the primary importance of water levels and reed/water edge, and that in this case, scrub is not an indicator of drying conditions, whereas it was for the UK sites.

In Italy, habitat preferences were studied at two sites holding the largest Italian populations. At Massaciuccoli (central Italy), analysis of the habitat composition around booming male locations revealed that they avoid open water-vegetation edges and select uninterrupted stands of 1–3 years old vegetation (Puglisi *et al*. 2005). Indeed, at this site vegetation is mostly dominated by saw-sedge, whose density increases from year to year after a fire or a cut. At Colfiorito (central Italy) vegetation is dominated by pure stands of common reed and bulrush, growing in 60–160 cm deep water. At this site, booming males occupied seasonally flooded areas with shallower water (<1 m; Adamo *et al*. 2004). At both sites, male preferences appear to be driven by factors which are likely to favour prey density and their accessibility by bitterns.

In the rice-fields of Italy, booming males were found in areas with a significantly higher proportion of paddy fields, natural wet areas, and higher rice plants than randomly selected control areas (Longoni *et al*. 2005). In Emilia Romagna (north-western Italy) newly created marshes in former agricultural fields are rapidly occupied by booming males as soon as vegetation (mainly reed and reedmace)

spread over the flooded ground (R Tinarelli pers. comm.).

Extensive studies in the Camargue, France have further added to our knowledge. In order to evaluate the factors involved in the selection of habitat, various parameters were measured at 40 booming sites and 33 non-booming sites in 2,500 ha of reedbed (Poulin *et al*. 2005). Analysis showed that booming positions were characterised by a homogenous cover of sparse green and dry common reed, occasionally mixed with other species, in shallow, clear water (10–15 cm). Open waters were not favoured. The interpretation of these results suggest that bitterns in the Camargue feed by walking on the ground between the reed stems. This behaviour is facilitated by the local reed cutting management (see Case study 7.12). Perhaps a key point though is that crayfish and invertebrates form a significant part of the diet in these areas (see food and feeding, below).

Requirements of nesting females

The female builds the nest (Cramp and Simmons 1977), the male taking no part in nesting activity, the care of the young or the female (Percy 1951, Gilbert *et al*. in press). As the division of labour between males and females is so stark, it is necessary to consider also the habitat needs of nesting females. The habitat within which females choose to nest is driven perhaps most by the need for concealment of the nest, although proximity to feeding areas also seems to be important. Common to the results of most of the following studies are the importance of water depth and density of habitat. Although presence of standing water seems to be important, depths range from a few centimetres to almost a metre. Vegetation density may be commonly important, but nests can be built within different vegetation types (common reed, saw-sedge, reedmace or bulrush).

In the UK, 71 of 74 nests studied were made (>90% of the material in the nest) from common reed, which was the dominant vegetation in the immediate vicinity (average 94.6% quadrat coverage). Three nests were constructed from reed, saw-sedge and rush *Juncus* spp., reflecting the vegetation in the surrounding mixed fen (average quadrat coverage: common reed 36.7%, saw-sedge 51.7% and *Juncus* 5%). It would appear that female bitterns avoid nesting in areas where the water level fluctuates dramatically, but that they can cope with some change. In the UK, total nest height varied positively with the height of water on the estimated first egg date, but there was no relationship between total nest height and water level fluctuation (Gilbert *et al*. 2005). However, the fluctuation was limited on UK sites, as water levels were closely controlled.

In the UK nests were situated in continuous blocks of reed that were on average 2.8 ha in size and 100 m at their narrowest width. These were blocks of reed uninterrupted by ditches or other features, but set within a larger wetland/reedbed site. The nests were on average within 70 m of open water, within 30 m of a ditch and surrounded by water 22 cm deep at the time the first egg was laid (Gilbert *et al*. 2005). Some habitat features at the nests were significantly different from those at random locations. Nests were further away from trees and had significantly less scrub and greater length of reedbed/open waters edge within 100 m, than random locations. The habitat immediately surrounding nests had a greater water depth at the driest point of the year, reeds with thicker stems, fewer non-*Phragmites* species and a smaller percentage coverage of non-*Phragmites* species than random locations. Of most importance, female bitterns nested at points where deeper water was maintained into the driest part of the season, perhaps using the presence of water tolerant plant species as an indication of this (Gilbert *et al*. 2005). It has also been found that in the UK, relative fish biomass was lower at sites with booming males and no evidence of nesting females compared with sites with females and nests (Gilbert and Jose 2003).

In eastern Poland, previous year's nests were not used by females, with new nests built each year. Three plant species

(common reed, lesser reedmace and bulrush) were used for nest-building. Thirty-three nests were built from reed material, 13 nests from pure reedmace, 13 from mixed reed/reedmace and one nest from bulrush (Polak in prep.). Nests were found in pure common reedbeds, pure stands of lesser reedmace, mixed stands of reedmace/reed, mixed stands of reed/sedge *Carex* spp. and mixed stands of bulrush/reedmace. In four cases, females built additional platforms during the nestling period on average 2.1 ± 1.3 m from the main nests. Bitterns selected the reedbed edge and most of the nests were located in the 30 m width of vegetation adjacent to open water. The maximum water depth at an active nest was 97 cm.

In a summary of nest locations in Italy and France, Puglisi and Bretagnolle (2005) found 4% of nests in saw-sedge, 15% in reedmace, 30% in bulrush and 52% in common reed in water 15–79 cm deep. At the Baie de Seine, France, females selected areas with dense common reed (average of 272 stems m^2 around nests compared with 188 m^2 in control zones) as well as tall reed (average 164.8 cm around nests compared with 132.3 for the control). A more in-depth analysis showed that females choose areas close to open water, in wet areas, away from reed cutting (Provost *et al.* 2004). However, where reed cutting is extensive, such as the Camargue, females do occasionally nest in totally cut reedbeds. Six nests of different females found in a single year at Colfiorito, Italy, were in pure stands of bulrush. Compared with random locations within the same stands, nests were built in denser vegetation thickets within apparently less dense patches (Adamo *et al*. 2004).

Gerhard Aescher

Plate 2.7 Although most nests are in larger reedbeds, where the surrounding wetland habitat is extensive and stands of suitable vegetation are limited, eg parts of the Pripyat floodplain in Belarus, bittern may breed in very small patches.

2.3 Mating system and territoriality

Understanding breeding behaviour is obviously crucial to piecing together the demographic jigsaw for any species. If breeding success is limiting the population then clear data on the influences are required. Those influences may be habitat change, food availability, predation or weather. With very secretive species like the bittern, our understanding of the mating system was confined originally to information gleaned from their most obvious behaviours, such as booming and glimpses of calling birds flying above the reedbed. A lot of useful information has resulted from this type of general observation, but more recent studies of the survival of chicks in the nest have been very instructive

Timing of booming

The date that the first male on a site starts booming is important, as this signifies the start of the breeding season. It is potentially the first opportunity for female and male bitterns to seek each other out. In European studies, the maximum booming season has been shown to extend from January to June, with only sporadic activity outside this period. However, the timing and quality of booming exhibits great variation and may be an important indication of environmental quality (see below).

Plate 2.8 Male bittern in threat posture.

Laurent Demongin

In the UK, since intensive monitoring of the bittern population began in 1990, the earliest confirmed date that males have started to establish a booming territory, has been 27 January, and the latest, 20 June, with an average of 13 March. In Italy, the booming season can start as early as mid January and extend until late June. By contrast, in northerly locations booming may commence as much as two months later. In southern Sweden, where some birds overwinter, booming may start in February. However, in the more northerly location of Sorfjarden, booming usually begins in late March or even early April, after the ice has gone (Broberg pers. comm.).

Various studies (Gilbert *et al.* 1994, Poulin and Lefebvre 2003a) have found that booming is particularly intense in the 2 hours before sunrise and around sunset, generally with more vocalisations at dawn than at dusk. A study in the Camargue, France, found that booming frequency was highest in April and May (Poulin and Lefebvre 2003a). The proportion of males booming peaked 0–30 minutes after sunset (68%) and 30–60 minutes before sunrise (78%).

French studies also analysed 5,299 boom 'trains' (the sequence of successive booms from an individual) from bitterns at ten sites in the Camargue in 2000 (Poulin and Lefebvre 2003b). Boom train length peaked in May, averaging 3.6 and 4.7 booms per sequence at sites with single and multiple bitterns respectively. Overall, 21.6% of booms were classified as incomplete, poor booms, and occurred mainly at the start of the season, in March. The results suggested that male bitterns try to produce the longest possible boom train without poor booms. Boom train length is likely to reflect body condition and therefore, habitat quality.

Within each site, each year, there may be a wide range of dates when different males will start and finish booming and therefore establishing their territories. For example, at Minsmere UK, the earliest and latest booming territories for each of the following years was: 1997 15 March–

7 April, (two boomers); 1998 14 February–9 March, (two boomers); 1999 24 February–26 May, (five boomers); 2000 4 February–3 June, (six boomers); and 2001 13 February–24 March, (six boomers). At the same site, the booming season can even show little overlap in subsequent years. At Massaciuccoli, booming lasted from 15 February to 5 May in 2003 and from 10 April to 12 June in 2004.

The onset of the booming activity appears not to be under strict hormonal control but strongly influenced by external factors, which may include:

- *Water depths and food availability*. Gilbert *et al.* (in press) found that the factors that determine the first boom date of a bittern on a particular site are water levels and fish density. Only when water depths and the density of appropriate fish species are sufficiently high will males start to boom. In the rice-field area of north-western Italy boom season shifts according to the flooding cycles of the fields from mid April to mid July.

- *Local population trends*. In Italy, a shortening of the yearly boom period has been noted in relation to decreasing booming male numbers (Fontanelli *et al*. 1995, Puglisi *et al*. 2003). At Massaciuccoli, it lasted about 150 days (mid January–mid June) in 1997 when there were 22–25 booming males, but only 75 days (mid March–late May) in 2000 (7–8 booming males). In studies in the Camargue, booming activity was also found to be less intense on sites with only one bittern (Poulin and Lefebvre 2003a).

- *Female activity*. In Poland, the booming rate was highest during the pre-laying phase and then dropped markedly after egg-laying. The peak of calling activity was synchronised with the female fertility period (Polak 2006). Similar results were found in Italy and the UK.

- *Weather*. The Polish studies showed that weather also has an effect. The long winter of 2002/2003 delayed the start of booming in 2003 and shortened the calling period (58 days from 15 April to 11 June in 2003, 92 days from 19 March to 18 June in 2004 and 91 days from 28 March to 27 June in 2005). In the Camargue, booming activity significantly decreased in cloudy and rainy conditions (Poulin and Lefebvre 2003a).

Gull calls and 'display' flights

Once males start booming on a site, it is often the case that 'gull calling' flights are seen. However, such behaviour is still poorly understood, and its function is largely speculative. In the UK, (1990–2001) such flights were noted between 15 February and 25 April, on average the 12 March. The 'gull call' can be given by both male and female bitterns and has been mainly associated with pre-migration behaviour when birds fly in a circle above the reedbeds in the autumn and the spring (Gaukler and Kraus 1965). In the spring, these flight calls can stimulate males to start or increase their booming rate (Whitherby *et al*. 1958, Gilbert 1994).

Broberg, studying booming bitterns overnight in Sweden in 1953, noted that a particular male increased its booming rate from once every 2–4 minutes to a remarkable 28 booms in one minute after another bird flew over.

Two general types of pursuit flights have also been recorded: a female chased by a male (ie a smaller individual chased by a larger one), or a male chased by another

Plate 2.9
Bittern in flight.

Andy Hay/rspb-images.com

male, as observed in Italy (L Puglisi pers. obs.). In the first case, the birds can:
a) display by raising their crown feathers, lowering their legs while flying slowly and land close to each other, or
b) fly one behind the other for a while and then land in different parts of the marsh. In the second case, they can either interact aggressively or just follow each other for a while before landing. In all these situations, bitterns produce a contact call very similar to that which they use during migration (Puglisi and Baldaccini 2000). Only during aggressive interactions do they use a somewhat harsher call.

These flights may relate to several distinct aspects of mating and social bonds. The flights could be females announcing their presence, attempts to obtain a copulation by unmated males, or male-male interactions. These types of behaviour would fit with the polygamous nature of bitterns. Also, see section below on interactions.

Other interactions

Adjacent male bittern booming ranges can overlap and males may initiate aggressive encounters with any intruders. Researchers have exploited this behaviour, and used playback of booming songs as a method of capturing territorial males (Gilbert *et al*. 2005). However, the response of the males to playback can be extremely variable, from a quick approach and increase in calling rate to no apparent reaction (Puglisi *et al*. 2003). These differences were seemingly related to the overall booming activity at the site with the strongest reactions observed in the years with the longest booming season (Puglisi *et al*. 2003). Close observations of two radio tagged male bitterns, during the breeding season at Minsmere, UK in 1999, showed that as they approached each other, they initially boomed. Then, as they got closer, gave soft single boom 'whump' noises followed by bill clicking, before one of the two males flew off. Males have been reported to fight fiercely at times (Percy 1951).

When females are nesting, they may fly from the vicinity of the nest to find food for the young, which exposes them to potential attack from other species. In the UK, these attacks are notably from marsh harrier and carrion crow. It also brings these females to the attention of male bitterns that may apparently lay in wait in order to chase the females. These chases can last for more than 15 minutes, the female seemingly reluctant to land first. On some occasions, the male physically drives the female to land in the reedbed. Axell (1967) witnessed similar flights ending in copulation, as have Yeates (1940) and Percy (1951).

Male home range distribution

As discussed above, booming home ranges are likely to be occupied in relation to the quality of the available habitat and the distribution of other males. The following information has mainly been gained from radio-tagged males in the UK and Italy.

The pattern of occupation. During the season, the relative order that different territories are occupied within a site can follow a similar pattern between years. Of two sites in the UK that have had at least five booming males during one season, those territories occupied first included the largest bodies of open water and are likely to be of better quality. In an 800 ha marsh in central Italy (Massaciuccoli) the general pattern of booming males distribution varied from one year to the next according to the availability of saw-sedge-dominated beds of less-dense young vegetation (Puglisi *et al*. 2005). However, four individuals, radio-tagged in different years, occupied the same or nearby areas during successive reproductive periods (Puglisi *et al*. 2003). When conditions are constant from year to year, those males which start to boom later tend to have home ranges on the periphery of the traditionally occupied areas.

Fidelity. The territories defended by male bitterns, are often similar in area and position between years (Gilbert *et al*. 2005), even when different males are involved. For example, a booming male at the RSPB reserve Leighton Moss (Lancashire, UK) identifiable by a unique ring was known to

have died during the winter. In the following year, his replacement occupied 85% of the same relatively small area (30 ha) within this larger site (140 ha) (Gilbert *et al*. 2002).

Fragmented or continuous habitat. On larger, continuous sites, booming territories usually form single units of area. Whereas on more fragmented sites, such as those in the Norfolk Broads in the UK, one male can boom from and defend several distinct units of habitat, perhaps separated by a road, path, woodland or river. This is also the case in Italy where the male home ranges proved to be multi-centric, that is made up of 1–4 small nuclei within a larger area. These nuclei could be scattered in various marshy sectors divided by large water bodies, even though each nucleus was surrounded by apparently suitable and available vegetation stands (Puglisi *et al*. 2003).

Male home range size

The size of the male home range is likely to be determined by the quality of the habitat (particularly water depth), the time of the year and the presence of other males. In the UK, male home range size estimated from the booming location of males, ranges from only a few hectares to more than 100 ha. The only quantitative radio-tracking information on home range size in the UK came from eight radio-tagged males. The average home range size was about 20 ha; the median boom period home range was 14.6 ha, compared to 19.27 ha moult period range and 33.08 ha during winter. The winter home ranges were significantly larger than the booming and moult ranges (Gilbert *et al*. 2005) (see Figure 2.1). In the UK, home range size was driven by the area of open water. Home ranges were smaller on sites with more males, but this could be due to better habitat quality.

At a 2,000 ha mixed wetland habitat in central Italy (Massaciuccoli), the home range of single individuals was typically multi-centric. It was made up of 1–4 nuclei totalling 2–16 ha within a 5–120 ha area during the reproductive period and of 1–5 nuclei totalling 5–35 ha within a 70–270 ha area during the post-reproductive period.

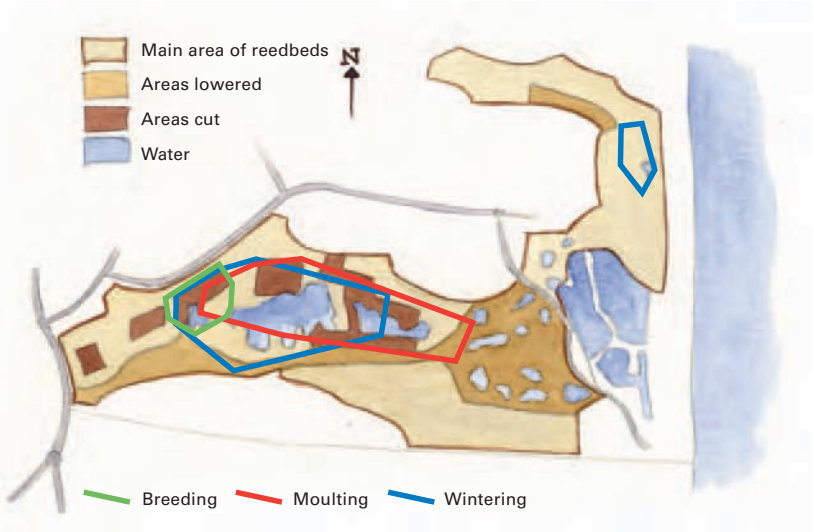


Figure 2.1
Breeding, moulting and wintering ranges of one male bittern at Minsmere, UK (Gilbert *et al*. 2005).

Different nuclei were visited successively. Individual home ranges overlapped in some cases, but different males simultaneously present in the same spot were never observed (Puglisi *et al*. 2003).

Nest distribution

From experiences in the Netherlands, it appears that bitterns can follow different strategies for selecting nesting and feeding locations. In a number of cases it was evident that nests were close to the booming location, and feeding of both male and female took place in the immediate surrounding area. This seems to be common in large-scale reedbeds, interspersed with many ditches and pools. In other cases the female nested a considerable distance (in one case c350 m) away from a booming location, in more or less dense, closed reedbeds. These females undertook foraging flights to open reed stands with ditches and pools. This seems to be common where foraging sites are separated from suitable nesting locations, especially in peat bog pastures with fragmented small-scale reedbeds. In a bog area with one reed parcel (Groote Peel), bitterns have nested close to each other, feeding in the wider area which provided good feeding conditions. In summary, it appears that bitterns are quite flexible, selecting nesting and feeding grounds according to the distribution of suitable areas on the site (van der Hut pers. comm.).

In Poland, three different types of booming sites were distinguished: without a nest, with a single nest and with clusters of nests of between two and four. The main evidence for polygamy in bitterns come from observers finding clusters of between two and five nests where there was only one booming male present (Zimmerman 1931, Gaukler and Kraus 1965). These nests were often 15–20 m apart and less than 50 m from a favoured male booming position.

In the UK, a clustering effect of nests has also occasionally been seen, and the smallest distance between two nests active at the same time was 19 m. Between 1997 and 2001 seven nests were attributable to a single female identifiable between years. She nested at Minsmere each year, nesting twice in 1998 and 1999, moving long distances (1,252 m in 1998 and 1,501 m in 1999) between re-nesting attempts (Mallord *et al.* 2000). But from year to year, the first nest was in a similar position, with the smallest distance being 4.5 m. In Poland, 2003–2005, the mean number of nests in the male territories in the study population was 1.4 ± 1.1 (range 0–4, N=39). The smallest distance between two active nests was 5 m (Polak in prep.). At Colfiorito (central Italy), the smallest distance between two active nests was 39 m (Puglisi and Bretagnolle 2005).

Timing of nesting

The dominant factor determining the date of first nesting on a site is the first boom date. There is a relative delay between booming and nesting, with a clear relationship between them (Polak 2006, Gilbert *et al*. in press). In patches of natural vegetation within rice-fields in north-western Italy, nesting is at least 40 days later than in the natural marshes of central Italy and France (Puglisi and Bretagnolle 2005). Furthermore, within the ricefields, clutches are laid about one month earlier in natural vegetation than among rice plants, presumably related to the vegetation reaching a sufficient height (Longoni *et al*. 2005).

First egg dates. Known clutches in the UK (1997–2001; 10 sites) were initiated between 25 March and 20 June. The earliest and latest dates of first egg laying in the Lublin region (Polak, M unpublished data) were 14 April and 31 May, while in Belarus the corresponding dates were 22 April and 31 May.

Re-nesting. In the UK, females can successfully raise two broods of young in one year (Mallord *et al*. 2000). Renesting is likely to be common following nest failure at least up to the middle of May (Gilbert *et al.* in press). Earlier clutches are bigger in the UK, and in France, there is evidence that breeding success decreased as the season progressed.

However, at higher latitudes successful double broods are unlikely. In Poland, the majority of bitterns arrive from their wintering quarters in mid March and leave the breeding sites from August to October (Tomiałojć and Stawarczyk 2003). The duration of one breeding cycle (from egg laying to independence of fledglings) is around 80 days (Cramp and Simmons 1977, Mallord *et al*. 2000) and therefore, in Poland, the potential end of the nesting season with two broods would be late September. Likewise, two broods are rare in Sweden.

Breeding success – chick survival

Data from the UK, Italy and some French sites implicates starvation as the main cause of chick mortality. At other French sites, and in Belarus, it is predation, although these two factors can be related.

In France, there were detailed studies into the breeding ecology of the bittern as part of the LIFE project (Demongin and Bretagnolle 2004). The size of the clutch and the volume of the eggs were very consistent from year to year and site to site. In Vigueirat, these measurements were slightly above average, which may imply better conditions for healthy chicks at birth. This was confirmed for very young chicks but not those above ten days old. Beyond this age, the Baie de Seine showed the best chick growth rate and

those at La Matte showed the poorest. Productivity (the number of 15 day old chicks per nest) was highest at La Matte, average at Baie de Seine and poorest in the Camargue. Summarising Italian and French data, Puglisi and Bretagnolle (2005) concluded that starvation was the main cause of chick mortality but that predation also played a part.

In the UK, the survival of 178 chicks from 64 nests was studied (see Figure 2.2). Of these chicks, 78 were followed until fledging (see below), while 84 died and 16 had an unknown fate. Of the 84 that died, the causes of death were starvation/exposure (61), predation (17–8 by mink, three by stoat and three unknown mammal), deformity/illness (two) and unknown causes (four). A total of 99 chicks were fitted with radio tags, with 78 fledging (as above). The average fledging age was 52.94 days (44–62 range). The chicks lost were due to starvation/exposure (76.25%) and predation (21.25%) (Gilbert *et al*. in press).

In summary, the factors most strongly influencing reproductive success are food availability and predation. These are generally closely linked with the water levels which drop during the course of the spring. It is suggested that this reduction in water levels leads to less plentiful food supplies, forcing the female to leave the nest for longer periods, thus exposing the chicks to more predators, which may also have easier access.

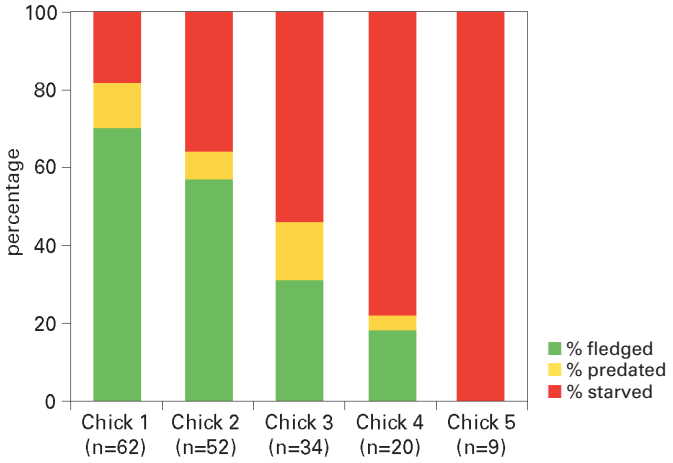


Figure 2.2
Chick survival within a brood in the UK. A higher proportion of chicks that hatched early fledged (Gilbert *et al.* in press).

Plate 2.10
Ringing a chick.

Marcin Polak

2.4 Food and feeding

Analysis of diet

Recent studies have shown that across all countries, bitterns take a wide variety of prey but predominantly fish. The fish species taken will vary with local abundance and availability. Other taxa that can dominate the diet are amphibians, crayfish, mammals and aquatic invertebrates. These will feature in importance relative to site specific situations.

There is little quantitative diet information published about bitterns. This is mainly because of the difficulties of gathering such data, as adults are very rarely seen feeding. Small cameras have been used to film female bitterns at the nest, but food is regurgitated directly to chicks and is not easily identified in this way. Bitterns do not excrete material that provides good dietary information. They do regurgitate a hard bolus of indigested material. However, these may be biased against easily digested prey and can underestimate the fish biomass (Amat and Herrera 1977).

The only way so far of accurately quantifying diet has been to examine the stomach contents of dead birds or to sample regurgitates of chicks (Gilbert *et al.* 2003) as has been done for similar piscivorous bird species (Moser 1986, Fasola *et al*. 1993, Barbraud *et al*. 2001). Of six published studies, four describe the stomach contents of dead adult birds, (Madon, 1935 – nine adult stomachs in France; Moltoni 1948 – 17 adult stomachs in Italy; Vasvári 1929 – 51 adult stomachs in Hungary; Gonzalez *et al.* 1984 – six adult stomachs in Spain) and two describe nestling diet (Gaukler and Kraus 1965 – diet of nestlings in 13 German nests; Pchelintzev 1990 – diet of nestlings from three Russian nests). Of these studies of nestlings, four ranked fish first by frequency, two ranked amphibians first by frequency. Five ranked fish first by weight, one ranked amphibians first by weight. In these studies that attempted to quantify the diet, a variety of fish species was most important, amphibians commonly occurred, invertebrates made up a small percentage, and birds, mammals and reptiles occurred regularly in small numbers.

A qualitative list of items found in the bittern diet from Cramp and Simmons (1977), also states that fish, amphibians and insects are most important. For example: fish (pike, carp, roach, dace, eel, tench and perch), amphibians (*Rana*, *Triton*, *Bombina*, *Pelobates*) and insects (Hemiptera: *Notonecta* and *Naucoris*; Coleoptera: Dytiscidae and Hydrophilidae; Orthoptera; Odonata). However, worms, leeches, molluscs crustaceans, spiders, lizards, small birds (wren, bearded tit) are also eaten.

An assessment of both nestling diet composition and selection of fish prey by bitterns was carried out in the UK. This involved 60 regurgitate samples from 44 broods that were examined during visits to bittern nests made at nine sites in England from 1996 to 2001 (Gilbert *et al.* 2003). The fish component of the diet was compared with species found to be generally available within each site from electro-fishing data. Eel and rudd made up the greatest proportion of biomass of the diet (see Table 2.1) and this proportion did not significantly change with the age of the chicks. The amount of eel in the diet changed during the season and the amount of rudd between years. From those fish species available, female bitterns preferred to feed chicks on nine-spined sticklebacks, eels (0–40 g), three-spined sticklebacks and rudd (0–20 g).

As part of the French LIFE programme, more than 2,200 prey items were identified from the analysis of 129 pellets and 51 regurgitate samples collected at five sites around France (Poulin *et al.* 2004). These samples contained 1,342 red swamp crayfish, 428 aquatic invertebrates, 294 terrestrial invertebrates, 84 fish, 38 amphibians, 10 snakes, 2 birds and 2 rats. Significant differences were observed between the sites, seemingly due to food availability. Thus amongst the main prey items at Charnier-Scamandre were terrestrial invertebrates (73%), while

Table 2.1 Main groups of prey in bittern nestling diet in the UK – note the prevalence of rudd, eels and sticklebacks.

	Proportion of biomass		% occurrence
Diet group	**Overall (n=574)**	**Brood mean (n=42)**	**Brood (n=42)**
Rudd	0.356	0.296	48.8
Eel	0.298	0.245	36.6
Amphibians	0.068	0.124	21.9
9-spined stickleback	0.072	0.123	36.6
3-spined stickleback	0.019	0.078	19.5
Invertebrates	0.027	0.065	43.9
Mammals	0.111	0.028	4.9
Tench	0.042	0.023	2.4
Shrimp	0.003	0.017	4.9
Birds	0.004	0.001	2.4

crayfish dominated at the Viguerirat marshes (69%), fish at the Tour du Valet (73%) and aquatic invertebrates in the Seine Estuary (55%) (Plate 2.11). Large inter-annual differences were also noted; for example crayfish represented 50% of all prey consumed at Charnier-Scamandre in 2003 compared with 79% in 2004. With a contribution of 66.7% of prey consumed, the non-native red swamp crayfish has become the main food source of the bittern in the Camargue. The studies also reveal a close relationship between the density of male boomers (and thus habitat selection) and the abundance of crayfish.

The diet of bitterns at carp fishponds in eastern Poland was quantified by the analysis of regurgitates from nestlings (Polak in prep.). The presence of cultured fish affected food composition, with common carp dominating the diet, followed by brown bullhead and perch. Amphibians (common frog) and mammals (rodents) played a less significant role. Among invertebrates, there were beetles (*Donacia*, *Dytyscidae*), dragonflies, annelids and snails.

Data from Italy, from young and adult regurgitates, films at nest, and direct observation reveal a great variety of prey. In the rice-field area a video-recorded nesting female fed her young with

Brigitte Paulin

Plate 2.11 Remains of crayfish taken from bittern pellets and regurgitate samples in the Camargue, France.

partially digested material including frogs *Rana* sp. and possibly invertebrates. At Colfiorito, based on both regurgitates and video-recordings from four nests, out of 33 recognisable prey items, 32 were fish and one edible frog. Among fish, 13 items were identified: three tench, one crucian carp, five perch, three rudd, and one *Leuciscus* sp. For 27 prey items whose dimension was estimated in comparison with the female bill length, nine were less than 6 cm long while 18 were longer; four fish of the first category and nine of the second were not ingested by the young and were eaten by the female (Adamo 2002). At Massaciuccoli, all the eight prey items

regurgitated by captured adult males and by nestling were red swamp crayfish. At Diaccia Botrona, 103 observed prey items caught by wintering bitterns were small fish, probably Mediterranean killifish less than 1 g in weight and 4 cm in length as revealed by sampling the available potential prey in the area (Puglisi 1998).

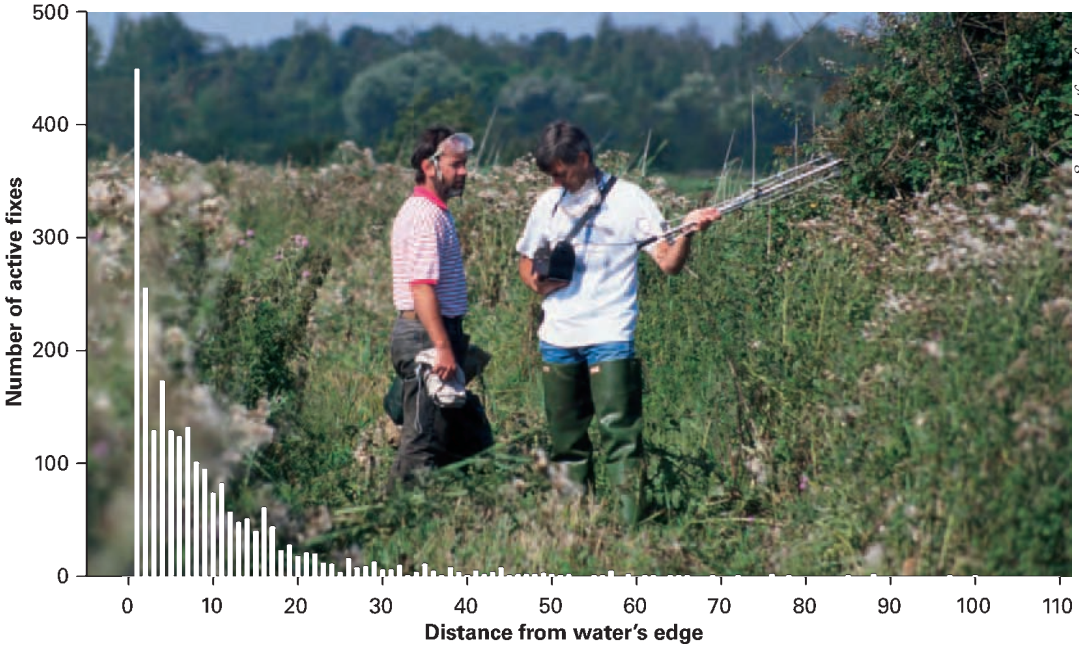
Feeding behaviour

Feeding habitat selection and feeding behaviour will depend on the available prey and may therefore vary between countries.

Bitterns are active during the day when they normally feed; this has been established through observations of captive birds (Lundevall 1939), wild birds (Percy 1951) and radio tag activity of wild birds (Puglisi *et al.* 2003, Gilbert *et al*. 2005). In Italy, 11 radio-tagged males and one female were usually inactive at night, although movements between different distant parts of their home range may occur (Puglisi *et al.* 2003). Video-recorded nesting females foraged by day but often left the nest shortly before dawn. The radio tagged males in the UK did exhibit some night-time movements. During the night, birds were mostly inactive (80% of locations recorded no activity, 20% recorded some activity) (Gilbert *et al*. 2005).

Adult bitterns are difficult to observe and any feeding observations are likely to be biased towards those made in unusually open habitats. From direct observations of radio tagged adult male bitterns in the UK, birds were inactive whilst preening and 'loafing', but were usually active whilst feeding. Bitterns may use 'stand and wait' as a fishing technique, but they are most often seen moving; feeding by searching, whilst creeping or wading in water (Zimmermann 1931, Percy 1951, Lundevall 1953, Gentz 1965, Pchelintzev 1990, Voisin 1991). Stand-and-wait fishing methods (Meyerrieks 1960) involve the body and neck held above the water, head slightly tilted, the eye at water level and bill partly in the water. They will also use their feet to stir up water and mud to attract small fish and eels.

A single radio-tagged female fed mostly within 50 m from the nest (Puglisi *et al.* 2003), while video-recording showed that they can fish even directly from the nest (Adamo *et al.* 2004). Nesting females probably forage on foot if profitable areas are nearby, since foraging flights are not the rule. At Colfiorito, the number of



Andy Hay/rspb-images.com

Figure 2.3
Frequency distribution of active bittern radio-tracking locations, 88% of 2,310 radio-tracking fixes were in the reedbed, within 30 m of the water's edge.

Andy Hay/rspb-images.com

Plate 2.12 Electro-fishing has increased knowledge of fish ecology and also the development of fish communities in newly created wetlands.

feeding flights by females are particularly variable among years (from 0–7 females, years 1996–2001) and individuals (a few flights in a season, up to seven during 13 hours of continuous observation in a single day). The distances travelled were usually less than 300 m (Adamo 2002, Adamo *et al.* 2004). Foraging areas (ie female landing zones) at Colfiorito coincided with male booming areas, eg seasonally flooded parts of the marsh or were wet meadows marginal to the marsh (Adamo *et al.* 2004). It seems likely that feeding flights are due to low prey density close to the nest: for example, the high number of females flying to foraging grounds at Colfiorito in 2001 (Adamo *et al.* 2004) coincided with a particular low reproductive success probably due to young starvation (Puglisi and Bretagnolle 2005). Young start to leave the nest when about 15 days old moving increasing distances with age, possibly following their mother on feeding areas (Puglisi and Bretagnolle 2005). Female bitterns in the UK have been found to fly from the nest to find food for the young (Gilbert *et al*. 2003) and starvation of chicks is the main cause of mortality (Gilbert *et al*. in prep.). It is likely that female bitterns feeding young have a limited prey choice in the UK.

Radio tagged male bitterns were found to feed almost exclusively in the reedbed, within 30 m of the water's edge. Their mean distance to the nearest water edge was 13.5 m (from 2,310 active radio-tag fix locations) (see Figure 2.3). There was evidence from radio-tagged males that they were choosing to feed in areas with greater water depth. In each year, at each site, during the driest part of the year, males used areas with significantly greater water depth than the average available across the site (Gilbert *et al*. 2005).

Electro-fishing studies of the behaviour of rudd (see Plate 2.12), one of the favoured fish prey of bitterns in the UK, point to the optimal wet reedbed edge profile (see Figure 5.3). Rudd use the littoral margin of open pools. The probability of occurrence of rudd in a flooded reed edge increased with the depth of water in the reed edge and the open water. Rudd were more likely to be present in open water depths of >70 cm and increased with increasing water depth in the reedbed, especially depths of >60 cm. The probability of occurrence of rudd increased with greater reed stem thickness, less litter (dead reed material) and less reed stem density (with stem density of 50–100 stems/m^2 being optimal) (Noble *et al*. 2003).

2.5 Migration and movements

Movements and site fidelity

Radio-tracking and ringing studies in the UK, Italy, Poland and Belarus have increased knowledge of movements and site fidelity (Figure 2.4). Males appear to be mainly site faithful between years, but may move to other sites during the winter. There is less information on females, but one nesting bird in Poland relocated 40 km away in a subsequent year (see below). Young bitterns disperse in their first winter. In the UK 10% of radio-tagged fledglings returned to breed at the natal site, 15% were found elsewhere and the remainder were not relocated.

Italian radio-tagged bitterns from Massaciuccoli significantly expanded their movements after the breeding period. Their favoured areas did not change in size between the two periods. However, they were located in different parts of the marsh. Four males were recaptured within 150–400 m from the first capture site while a single male spent a summer (June–September) in a second much smaller site 15 km north. Three re-tagged birds occupied almost the same areas during the two reproductive seasons studied, while the only male that was also tracked during the post-breeding periods in both years showed a very similar displacement pattern, with only slight timing differences after the end of the booming season. Within a multi-centric home range (see also Home range size), the same nucleus was not occupied continuously over the entire study period, but visited several times (Puglisi *et al.* 2003).

Six males in the UK were tracked closely both during their booming or moulting periods and into the winter. Of these, four were present on site through the winter. Of the two others, one left Minsmere from 2 October 1996, was relocated at a site 12.5 km NNE, returning to Minsmere on 13 November 1996. The other bird was absent from Minsmere from 6 October 1997, found at a site c53 km NNW on 22 October 1997 where it stayed until it returned to Minsmere in February 1998. There were two cases at Minsmere, where known individual bitterns had booming-period home ranges estimated in two

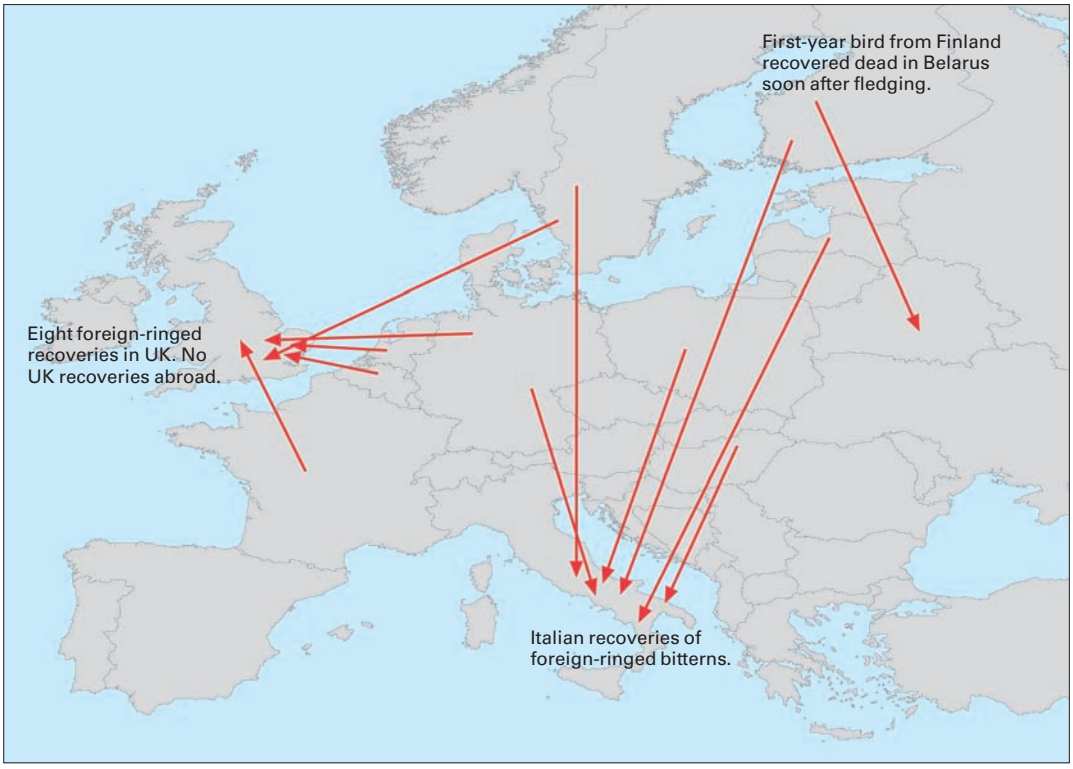


Figure 2.4 Ringing recoveries of biitterns found in the UK and Italy from abroad.

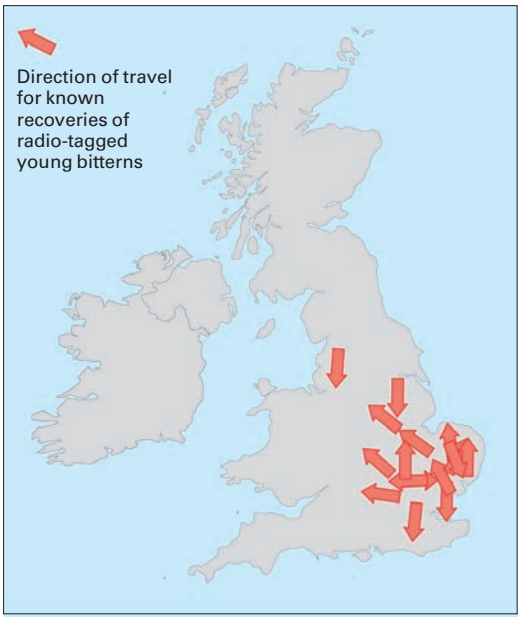


Figure 2.5
Dispersal of young bitterns in the UK.

separate years, the greater part of these ranges were used in the subsequent year (63.7% and 74.5%). At Leighton Moss between 1990 and 1999, there was only one instance of a bittern changing territory between years (Gilbert *et al.* 2002). Identification of bitterns between years based on acoustic matches revealed no movement of males between different regions of the UK.

A female ringed as a nestling in 2003 on Samoklêski fishponds (eastern Poland) was controlled at a nest in the same pond complex in 2005. By contrast, a laying female caught at a nest at Samoklêski in May 2004, moved and built a nest 40.7 km away at Niedrzwica fishponds in 2005.

Annual migration and dispersal

In European terms, the bittern is a partial migrant, with migration driven by winter conditions. Analysis of European-wide recoveries reveals a generally south-westerly movement during the winter. Countries such as Italy and Belarus also record high numbers of birds on passage in the spring.

The UK breeding population of bitterns seems to remain resident through the winter. Territorial males mainly remaining on site, youngsters dispersing from their natal sites and female movements being relatively unknown, but probably some stay on site and some disperse. In winter, numbers of bitterns in the UK are boosted by the arrival of birds from the Continent. Sightings of birds away from known breeding sites increase to an average of 120 individuals, (a range of 55–250 from UK winter sightings between 1980 and 1997). Radio tracking studies of young bitterns in the UK have shown that they do disperse from natal sites, travelling as far 200 km to seek out new sites in their first winter (Figure 2.5). A small late autumn peak in sightings of bitterns away from known breeding areas may be of dispersing youngsters, most of which are likely to be of British origin. This would explain the low level of sightings throughout August–October before the first heavy frosts of the winter (Bibby 1981).

Italian breeding bitterns also appear to be resident, males remaining all year around their reproductive site, females probably doing the same; juveniles disperse from their natal sites but their movements are not known (there are no recoveries of ringed birds outside breeding sites). In Italy, numbers increase remarkably in winter and during migrations. Ringing indicates that this is because of bitterns coming from central and northern Europe (recoveries of birds ringed in Germany, Poland, Hungary, Sweden, Finland, Latvia). Observations carried out at two coastal sites in central Italy revealed an intense spring passage from the end of February through into early May, but with a clear peak during March and early April. In this period, up to 20 bitterns in a single day can be observed at dusk flying up individually, grouping together and leaving the marsh, mostly in a north-easterly direction. In a single year, a passage of more than 300 individuals at each site is estimated (Puglisi and Baldaccini 2000). These numbers can be significantly higher (up to more than 30 individuals per day) after particularly severe winters. High numbers of migrating bitterns are also reported from south-eastern Italy where the spring passage is possibly even more intense although no estimates are available.

There have been 15 recoveries from the 98 bitterns ringed in the UK since 1909, and eight foreign-ringed individuals have been recovered here (Toms and Clark 1998). No British or Irish ringed bitterns have been recovered overseas. In the UK, most ring recoveries during winter have been from bitterns fledged from East Anglia, with the pattern of recoveries not demonstrating any one direction of movement. An analysis of European-wide recoveries by Zink (1958) demonstrated a generally south-westerly movement of birds during the winter period. Sightings of bitterns away from known breeding sites in UK are relatively consistent from September through into November. However, numbers increase sharply in December and reach a peak in January (Bibby 1981). This seems to point to an influx of birds (suggested by ring-recoveries from north-west Europe: the Netherlands, Belgium, Sweden and Germany) following hard weather on the continent (Toms 2002). Bitterns are susceptible to severe winter weather (Day and Wilson 1978, Bibby 1981, Day 1981). However, a study of annual local survival rates of adult male breeding bitterns in the UK, carried out between 1990 and 2000, showed that low spring rainfall had the greatest negative effect on adult overwintering survival (Gilbert *et al.* 2002).

Recoveries of bitterns ringed in Poland (data from Institute for Ornithology Polish Academy of Sciences) showed that the birds migrate in a south-westerly direction. The main wintering grounds were in Western Europe. These birds were recorded in the following countries: Belgium (1), France (3), Holland (1), Germany (3) and Italy (3). There are six records of bitterns ringed abroad and recovered in Poland. These birds originated from Belgium (1), Finland (1), Holland (2) and Germany (2). However, the results should be used with caution. The number and distribution of recoveries depends on hunting pressure and a level of local awareness, with the detectability of rings low in eastern and south-eastern Europe.

2.6 Habitat requirements during winter

Wintering bitterns have been less well researched, but some studies have been undertaken in Italy, the UK and France. Wintering bitterns favour a much wider variety of sites and habitat than breeding birds. They occur in all manner of rank waterside vegetation at gravel pits, fish farms, reservoirs, ditches, riversides, sewerage farms and any other small wetlands. The only criteria seemingly necessary for wintering sites is a source of food with enough emergent vegetation to allow the birds access to that food. Through necessity, bitterns are more likely to be seen in open habitats in winter. It is worth noting, however, that their presence at less suitable sites may be heavily overestimated since birds are easily visible at the vegetation edge. For example, in Italy, each winter a number of bitterns are recorded during wildfowl counts at small sites with sparse vegetation cover, while just a few are noted at Massacciucoli. However, at this site, during organised surveys up to 12 individuals could be flushed from vegetation stands as small as 5 ha.

Richard Brooks/rspb-images.com

Plate 2.13 A wintering bittern in northern Greece in alarm posture.

Roosting behaviour

Bitterns flying into roost at dusk or out again at dawn can provide almost predictable, if fleeting views of these birds in the winter. Roosting flights to and from the foraging area are regular where the habitat is fragmented and the vegetation cover is uneven, and prey density higher where the vegetation is thin and discontinuous. In continuous good quality habitat, birds will walk to the roosting site. Bitterns can roost communally, 6–8 m apart, with up to eight recorded in small areas less than 1 ha.

At Diaccia Botrona marsh (central Italy), bitterns had clearly separate foraging and roosting areas. They foraged in areas covered by sparse and thin vegetation, flying at dusk (on average about 20 minutes after sunset) to the roosting areas located in denser and wider *Phragmites* and *Juncus* beds located up to 2 km apart. Although several individuals could share the same roosting area, they usually reached it separately (Puglisi *et al.* 1995, Puglisi 1998). Bitterns spent the night on a platform, built using the neck and feet to concentrically fold two bunches of stems.

In observations of the roosting behaviour of bitterns wintering in the Lee Valley (UK), the main roost sites were characterised by *Phragmites* reedbeds, irregular in shape (not linear) and of a minimum size of at least 630 m² (Harris in prep.). Two of these reedbeds were in water depths of over 1 m and normally totally undisturbed and inaccessible to predators. Four of the reedbed roost sites

were in gravel pits growing into open water, where bittern chose to roost in the outer edge, usually within 4 m of open water. In the 2001–2002 winter in the Lee Valley when the water at the aforementioned roost sites was frozen, birds were seen to roost in scrub, presumably they realised that predators might reach them in the reedbed over the ice.

Feeding behaviour

Observations carried out at Diaccia Botrona (central Italy) on foraging bitterns, revealed that they intensively searched a small spot, walking slowly among the vegetation in loose circles, stopping frequently and searching for food (mostly small fish, see Food). In most cases they spent the whole day within 100 m. Several individuals could share the same foraging ground (up to nine bitterns in less than 15 ha) but without forming any kind of group. Often a bittern attacked another one if too close (usually less than 10 m). Foraging grounds were changed according to water level variations (Puglisi *et al.* 1995, Puglisi 1998): at this site most bitterns were found in 10–20 cm water depth.

In observations of the feeding behaviour of bitterns wintering in the Lee Valley, UK, bitterns were observed feeding from dawn to dusk in bouts of activity followed by periods of inactivity (Harris in prep.). By preference, bitterns fed as deep within the reed as they could whilst still within striking distance of fish. Where better fishing was available outside the main reedbed, the bittern would sometimes hunt in very sparse cover, even completely exposed. When water was frozen on their usual feeding sites, bitterns would also feed in exposed positions. Of fish taken by bitterns during timed watches in the Lee Valley, 50% were identified, and of those 96% were perch. Other prey species identified were bream, roach, tench and pike.

Plate 2.14 Typical feeding technique of the bittern.

Andy Hay/rspb-images.com

3 SURVEY AND MONITORING

3.1 Introduction

It can be incredibly exciting and enjoyable to be out listening for bitterns. Whilst most people are asleep, the observer has privileged views and sounds of many seldom seen species and the odd spectacular sunrise.

However, surveying and monitoring are essential activities too, as they provide the basis for judging conservation decisions and the effectiveness of resulting actions. Having a believable baseline count or estimate for such an elusive species as the bittern can provide the justification necessary to prioritise valuable resources, attract funding and set targets. The habitat management necessary to rehabilitate sites or even create sites for bittern can be very expensive. It is therefore necessary to be able to measure how the population reacts to such expenditure.

There is not one single technique for monitoring the bittern; it will depend on the level of information required and the resources available. Common methods include absolute counts and estimated indices of booming males to provide a breeding population figure. Greater understanding of the population and its requirements can be achieved from monitoring nesting females, prey availability and habitat, but this can be very time consuming and expensive. If you have yet to adopt a monitoring strategy for bittern then in some respects you are in a fortunate position, as it can be more difficult to change an ongoing system than it can be to start from scratch.

Tall emergent vegetation in standing water, and an available food supply, are fundamental requirements for the bittern. Therefore, when setting up a monitoring protocol to assess a population, there are benefits to monitoring their prey (fish mainly, but also amphibians), the quality of the water relative to the requirements of the main prey species, the structure of the vegetation, the water levels and the presence of predators (such as American mink) (Wilson *et al*. 1998). There are some excellent texts on ecological monitoring (eg Sutherland 1996) that go into more detail than is possible here; about invertebrates, fish (Cowx 1996, 2002), amphibians, plants, water quality (Ward *et al*. 1996, Bartram *et al*. 2003) and water levels. As an example, a description of the monitoring of ecological factors carried out as part of the second UK LIFE bittern project is given at the end of this chapter.

Further reading

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Cowx I G (1996) *Stock assessment in inland fisheries.* Blackwell Science, Oxford.

Gilbert G, Gibbons D W and Evans J E (1998) *Bird monitoring methods*. Sandy: The RSPB.

Poulin B and Lefebvre G (2003a) Optimal sampling of booming Bitterns *Botaurus stellaris. Ornis Fennica* 80:11–20.

Poulin B and Lefebvre G (2003b) Variation in booming among Great Bitterns *Botaurus stellaris* in the Camargue, France. *Ardea* 91(2):177–182.

3.2 Population monitoring objectives

The term 'monitoring' is used quite loosely in every day conversation and can appear to have a broad definition, but it is important to be clear about what is meant by it from the outset. It is useful, even when determining the objectives of a single-species count, to distinguish between monitoring, surveillance and survey. A survey is a method of collecting data (like mapping), which provides a framework for the systematic measurement of variables. Surveillance is the systematic measurement of variables over time, with the aim of establishing a series of time-related data. Monitoring refers to the measurement of variables over time in a systematic way with specific objectives in mind (Gilbert *et al*. 1998, Spellerberg 1990).

The distinction between a survey, surveillance and monitoring is that monitoring assumes a specific reason for the collection of data, such as ensuring targets are being met. For bitterns, the target will be to maintain or enhance the numbers and distribution of the population.

The monitoring objectives even just for bitterns may be different from site to site, or from country to country. They will depend on what level of information is necessary and above this there will be unavoidable constraints imposed by logistics. One of the most fundamental decisions to make before undertaking a survey is to decide whether you need to obtain an absolute estimate of the numbers of bitterns as done in the UK (Gilbert *et al*. 2002), or whether a relative index will suffice, as in the Camargue (Poulin and Lefebvre 2003). Both can be used to measure between-year changes (which may be all that is required), but only an absolute estimate will tell you how many birds are on the site. A common mistake is to aim for an absolute estimate without enough resources or effort to achieve this objective; a reliable index is always preferable to a poor count.

There are different costs associated with monitoring related to the amount of effort required. Techniques designed to provide an absolute estimate, such as sound recording booming males to discriminate individuals (Gilbert *et al*. 1994, Gilbert *et al*. 2002), or triangulation to map booming positions (Lefebvre and Poulin 2003), require considerable investment of time. This is also true for long watches or searches for nesting females or any attempted assessment of wintering numbers. It will be difficult to provide an absolute population estimate for very large inaccessible reedbeds or remote wetlands and in this situation, it may be more effective to survey samples of the population and to extrapolate the results to obtain an estimate of the entire population.

Sampling is commonly used where the area to be surveyed is particularly large, or where counting all individuals is impractical as there are simply too many of them. Greenwood (1996) gives a lengthy treatise of sampling procedure. It is a whole subject in itself and can only be touched on here. Important points of sampling are that the sample areas must be representative of the whole and they must be selected by non-subjective means. Stratified random sampling should be used where possible, for bitterns this would be particularly relevant for a national survey that entailed surveying different types of wetland some of which would be more accessible than others, eg natural floodplains, reservoirs, rivers and fish ponds. In this case, an estimate would be produced for each habitat type and extrapolated accordingly.

Regardless of whether an absolute population assessment or a relative estimate are sought, it is important that the method used is repeatable and carried out in a standardised way. This necessitates recording the details of the method used so that others can repeat it, whether annually or every 10 years. It is also important when reporting the results of your bittern survey that you are honest about what the figures mean. This can be achieved by providing minimum and maximum figures for absolute population estimates and confidence intervals for any population estimates derived by a sampling procedure.

3.3 Monitoring booming male bitterns

The most obvious indication that bitterns are breeding on a site is the booming vocalisation of the males, and this is used as the census unit for the species. There are inherent problems when counting a species from vocalisation alone. This is particularly true with a species like bittern which is rarely seen, often in a large expanse of wet marshland, has a low frequency song that is difficult to locate, sings at an unsociable hour and varies in the likelihood that it will boom at all! Diurnal booming behaviour is well understood, with surveys concentrating their efforts before dawn and at dusk, the peak periods of singing activity (Okada *et al*. 1986, Gilbert *et al*. 1994, Puglisi *et al*. 1997, Poulin and Lefebvre 2003a,b).

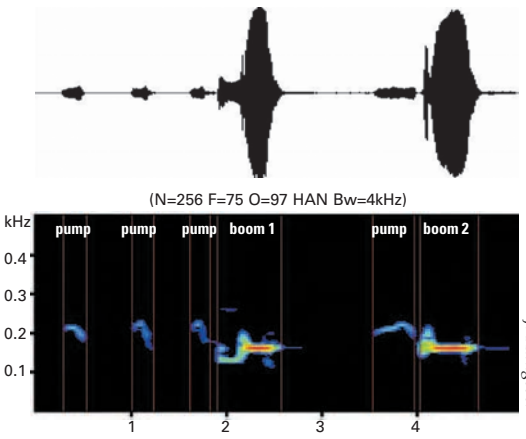
In the UK, since 1990 there has been an absolute count of booming male bitterns every year. The main method involves visiting all known sites as regularly as possible and mapping the booming positions of males using triangulation. Lefebvre and Poulin (2003) provide a useful description of this technique in direct association with bittern monitoring. This builds up a picture during the season of the number of booming males and where their home ranges are.

On sites with several booming males there can be difficulties with deciding on the identity of birds between visits, purely by their location. As an aid to identification in the UK from 1990 until 2004 the population of booming males were sound recorded (Gilbert *et al*. 1998, Gilbert *et al*. 2002). On a site-by-site basis, the individuality expressed within the booms recorded was used to help to discriminate between birds. This was only used within each season for specific cases when the identity of a male was uncertain. This technique combined with mapping the positions of booming males for many years, has built up knowledge of their home range behaviour that has subsequently made monitoring easier.

Now, monitoring of booming males in the UK is based purely on mapping the locations of males and noting descriptions of their booming characteristics. The time saved by not sound recording the males allows personnel to visit a larger area during a visit or to visit more sites. However, without having reference to sound recordings, there can be uncertainty as to whether or not two males are the same or different in some situations. Decisions are always made from the cautionary viewpoint that two booming males are assumed to be the same, unless there is contrary evidence from their booming characteristics or territorial behaviour.

A well documented example of how to apply these techniques in a national survey of booming bitterns exists for the Netherlands (Turnhout *et al*. 2003), co-ordinated by SOVON, the Dutch Centre for Field Ornithology. The survey was undertaken by working on two levels: a network of volunteer birdwatchers recorded booming birds across the country, and on the second level, more detailed investigations, including boom analysis, were carried out in key areas to verify the accuracy of counts.

When personnel, time or resources are limited, there are potentially large numbers of booming males or the terrain is very difficult to cover, then a relative index of numbers would be a more realistic monitoring objective. Poulin and Lefebvre (2003) provide an in-depth description of standardised protocols for the optimal sampling of booming bitterns that provides reliable estimates of numbers across years.



J. Ratcliffe

Figure 3.1
Example of a spectrogram.

3.4 Monitoring nesting female bitterns

In the UK, it is estimated that only about 50% of sites with booming males show any evidence of nesting females (Gilbert *et al*. in press). For this reason, part of the annual monitoring of bitterns in the UK provides an estimate of the numbers of nesting females. This estimate is achieved through very time-consuming watches over sites with booming males. These watches are continuous for about 5 hours, and take place at least once every 10 days. Any sign of female nesting behaviour is noted and criteria are used to decide on the probability and stage of nesting. The figures are reported in terms of a minimum number that included definite nests and a maximum number including probable and possible nests. The figures are considered estimates, as they will be biased towards females that have reached the chick – feeding stage, and are unlikely to include nests that fail during incubation. This technique is possible in the UK, because females tend to make flights from their nests in order to find food for their young (Gilbert *et al*. in press). In other countries, notably those Mediterranean countries where bitterns have a different diet and perhaps a more plentiful food supply, females are not seen to fly to find food (*in Italy* Adamo *et al*. 2004; *the Camargue* Poulin pers. comm.; *and in Spain* Romero and Streich pers. comm.). In these situations, researchers have used cold – searching techniques to locate nests to establish breeding success, but not for general population monitoring. The level of disruption caused to the habitat, and possibly to other species as well as bittern would probably not be justifiable for any reason other than a specific research study on breeding success.

Jan van der Geld

Plate 3.1 Locating bittern nests is likely to result in disturbance and is therefore strictly limited to research programmes. Watching for feeding flights is the usual method of monitoring nesting females in the UK.

3.5 Monitoring wintering and passage bitterns

There are no reliable methods of counting wintering bitterns that are generally applicable to all situations. This is because of the unpredictability of bittern behaviour in winter. In the winter, bitterns can be less elusive, coming out of their preferred dense habitat to feed in a more visible way. This uncharacteristic behaviour is usually related to the difficulty birds have in finding food due to harsh weather. As such, national estimates of wintering bitterns are biased due to the weather. If more birds are seen during spells of colder weather, it is difficult to tell if this is because more birds are being driven to migrate, or because birds are easier to see, or both. In winter, bitterns can be seen to fly to roost at dusk and fly out again at dawn. This is a predictable winter behaviour that has been used at some UK sites to coordinate counts of bitterns. However, it has only proven reliable at more fragmented sites that are likely to have separate areas suitable for feeding or roosting and therefore require bitterns to fly in and out.

Most European bitterns, notably those breeding in the central and eastern European strongholds, move to wintering areas in the western and Mediterranean countries, and in Africa. During their journeys, they have to cross large areas with limited suitable habitat. Thus the scarcity of suitable stop-over sites for passage birds may constitute a threat for these migrant populations.

Because of the elusive behaviour of the bittern, the only way to identify a stop-over site is to observe birds leaving (Puglisi and Baldaccini 2000). Although feeding solitarily by day, at dusk bitterns may form flocks of up to about 10 birds which fly for some minutes in circles before leaving the site. The flock is formed by an individual that rises in flight and calls continuously. Others join it, calling in turn. This conspicuous behaviour makes it possible to detect the presence of passage birds and to roughly evaluate their numbers. This is made easier by the tendency of most bitterns to leave sites by similar routes.

Gunter Bachmeier

Plate 3.2
Bittern in winter.

3.6 Monitoring other ecological factors

A wide range of ecological factors can affect bittern populations. In the UK, as well as natural succession, preliminary investigations by the RSPB identified high nutrient loadings, poor macrophyte growth and heavy sedimentation of dykes and pools in several of the wetland reserves with declining bittern populations. Such conditions are inimical to healthy fish populations and this could be one of the underlying causes of the decline. An important part of the second UK LIFE bittern project (see Appendix 1) is, therefore, a monitoring programme. As well as bittern monitoring, this includes other biological parameters:

- fish species and biomass
- chemical water quality, water level and turbidity
- reed cover.

Through this monitoring, the RSPB has identified ecosystem problems that probably affect whether or not bitterns are present and breeding successfully. Action can then be taken to address these problems. In addition, the RSPB will be able to evaluate the impact of the management work, particularly the development of wetland creation sites.

To complement the LIFE project monitoring programme, the RSPB has set up a 'Wetland Health' project, looking at the ecological conditions at a range of wetland sites. The objectives of this project are:

- to ascertain whether water bodies achieve the target 'good' quality conditions, using the ECOFRAME classification assessment (Moss 2002)
- to highlight where current knowledge is insufficient and therefore further data collection is necessary
- to identify future actions to improve poor conditions.

Additional data on macrophytes abundance and diversity, macroinvertebrates and cladocera have been collected in 2003, 2004 and 2005.

Fish species and biomass

At each site, a series of transects is selected, aiming for a representative selection of locations and water bodies around the site. The start and end points of each transect are recorded using a Garmin GPS, so that the same transect can be used from year to year. Electro-fishing is carried out in winter, as this is when fish tend to gather in shoals. Where possible, transects including whole water bodies, such as ditches and pools, are worked towards blind ends and narrowings.

A Millstream single-anode electro-fishing system is used, powered by a portable generator, which is set to produce 1.8–3.0 Amps of 240v pulsed DC electricity, the pulse rate set at 50 per second. A 2.4 m boat is used with no keel and an almost flat bottom for easy access in shallow water. One person propels the boat and a second operates the anode, gently

Table 3.1 Results of electro-fishing, winter 2003/04, the RSPB Reserve Dungeness.

Species	Number of individuals/ha	Total weight (g)	Mean weight (g)	Standard error	Weight/unit area (kg/ha)
3-spined stickleback	78.30	52.00	1.00	7.21	0.31
Bream	1.50	4.00	4.00	1.00	0.02
Eel	159.60	81,174.00	765.80	10.30	489.00
Perch	87.30	927.00	15.98	7.62	5.58
Pike	52.70	2,629.00	75.11	5.92	15.84
Roach	3.00	103.00	51.50	1.41	0.62
Rudd	81.30	5,519.00	102.20	7.35	33.25
Tench	1.50	37.00	37.00	1.00	0.22

sweeping it and pushing it into marginal vegetation. Fish are netted and transferred to a holding bucket until the end of the transect. Eels are kept in a separate bucket.

At the end of each transect, all fish are measured (head apex to caudal fin fork) and weighed. Once data have been collected and analysed, the fish population is classified at each site in terms of biomass (g m^{-2}) and community structure. An example of the results for the RSPB Reserve Dungeness (south-east England) is given in Table 3.1.

The water bodies at Dungeness were formed by the extraction of gravel and are fed by groundwater. About 10 years ago, the connection to the sea via a ditch was cut off by the installation of an outfall with tidal flaps. The eels already in the water bodies were therefore unable to leave and no immature eels could enter. This has resulted in the large number of huge eels and not many bittern snack-sized fish. Rudd are present in one lake and appear to be able to co-exist with the eels. The RSPB has therefore introduced rudd to some of the other water bodies with the aim of establishing a self-sustaining population and providing more food for the bittern. The Environment Agency and the RSPB are currently looking at whether the connection to the sea can be re-established for eels.

Water quality monitoring

Reserve staff collect water samples four times a year. The choice of sampling points is important to find a 'representative' point or to examine a particular issue e.g. quality of water entering a site. The water samples are collected in a plastic bottle from just under the water surface. During the first two months of sampling, an extra sample is taken to determine chlorophyll a concentrations (a measure of the algal content of the water). The samples are sent to a laboratory within 24 hours for the following analysis:

- total Nitrogen (as N)
- total Phosphorus (as P)
- conductivity (at 25°C)
- pH
- chlorophyll a

All sites sent in samples for 2002/3 and 2005/6 to establish a baseline and to look at changes. Where the first set of samples showed up a problem, additional sampling was done in 2003/4 and 2004/5.

Water level and turbidity

Water level monitoring is carried out by site staff on a regular basis, using a gauge board (see Case study 7.4).

Turbidity was initially measured using a secchi disk. However, many of the water bodies were too shallow to get a result with the disk and a turbidity tube is now used instead. The units used are Nephelometric Turbidity Units (NTU), which measure the amount of light that is scattered from the particulate matter in the water. The higher the NTU score (usually on a scale of 0–250) the greater the particulate matter present and therefore the amount of light being scattered.

Measuring reed cover

To establish the impact of the UK LIFE project's management work, aerial photographs were taken at the start of the project (2002) and again in 2006. The area of reed can then be digitised in order to calculate the area and the percentage change. On newly created sites, an increase should be evident, whilst on existing reedbed sites there should be a decrease in reed area as open water has been created.

Cladoceran sampling

Rotifers and crustaceans are the major groups of freshwater zooplankton, other than protozoa. The crustacean zooplankters include cladocerans. Cladoceran samples are collected from locations around the water quality sampling point. A total of 10 litres is collected using a hand-held water pump and filtered through a 50 µm mesh sieve. All samples are stored and analysed in-house. Cladocerans are identified to genus level and the ratio of large to small bodied individuals is calculated.

Table 3.2. Baseline monitoring results for RSPB Reserve Minsmere, North Marsh, 2002/3.

	Nitrogen total oxidised – as N	Conductivity at 25C	pH	Phosphorus total – as P	Secchi depth	Lake depth	Chlorophyll (a+b)
	mg/l	µS/cm	pH	mg/l	m	m	µg/l
19/11/02	0.324	285	6.91	0.161	0.43	–	–
16/01/03	0.278	263	6.96	0.146	0.39	–	–
23/04/03	0.19	267	6.98	0.125	0.47	–	16.2
04/08/03	0.2	314	7.1	0.174	0.39	–	41.8
Chemical Total Oxidised Nitrogen (TON) was **High**, total Phosphorous was **Bad**, Chlorophyll A and B was **Poor**, and pH was **High**.							
Biological The macrophyte community type (EIPo), diversity and abundance were all classed as **Moderate**, the cladoceran community was **High**. Overall, using the ECOFRAME scoring system North Marsh was given a classification of **Moderate** ecological quality.							

Macrophyte survey

Macrophyte surveys are undertaken during the summer using a double-headed rake to plumb the water column (two rake heads back to back to act as a grapel). The species are identified and listed to give a calculation for species richness and to determine the dominant plant community type. Abundance is recorded by the use of an arbitrary scale (0–4), depending on the Percentage Volume Infestation.

Macro-invertebrate survey

Where possible, stems of the characteristic emergent macrophytes species are removed at sediment level in each water body. Any invertebrates present were scraped free and stored. Using the hand-held pump from the cladoceran sampling, a second sample is taken around the soft sediment of the littoral zone. This is then stored and sieved through a 240 m mesh. The total number of oligochaetes and the total number of chironmids are counted.

Outcomes

The data collected over the last three years has enabled the RSPB to identify particular problems at individual sites. These often need further investigation or a programme of remedial action. Where water quality problems have been found, the solutions are often outside of the RSPB's direct control, because they relate to changes in the management of the wider catchment. Overall, sites have been classified as of 'bad', 'poor', 'moderate', 'good' and 'high' ecological status, following the ECOFRAME classification system of 75% compliance (see Table 3.2). In 2005, one sample site (water body) was classified as having 'high' ecological status, four were classified as having 'good' ecological quality, ten as 'moderate', seven as 'poor' and eleven as 'bad'. The monitoring of wider ecological parameters is therefore pointing to some worrying conclusions about the health of many UK wetlands. As the 2005/6 data have only just been collected, there has not been time to do a detailed analysis across the sites to identify any significant correlations with bittern breeding success. However, a quick look down the list of sites would seem to show that bittern does not require 'high' or even 'good' status, as several long-established breeding sites are in the 'moderate' category.

4 THREATS AND LIMITING FACTORS

4.1 Introduction

Bitterns face a wide range of threats, from indirect effects on their habitat through to direct persecution. Some threats, such as major loss of wetlands are hopefully mainly historical (at least in western Europe), while the effect of others, such as climate change are likely to be significant problems for the future.

Current significant issues include the lack of large reedbeds, problems with food availability, pollution and human recreational activities, but it is perhaps seral succession and the inappropriate management of reedbed habitats that form the greatest overall threat to the bittern. However, it is important to underline differences in the relative importance of each threat across Europe.

In Western Europe a history of wetland loss has resulted in smaller, fragmented reedbeds that either require restoration or increasing in size through habitat creation. The low numbers of bitterns inhabiting these smaller reedbeds are more vulnerable to local extinction due to poor food availability, predation or unpredictable events. By contrast, in Eastern Europe, large reedbeds and good bittern populations remain, and it is critical that these are maintained. Here, the over-exploitation of commercial reedbeds and the inappropriate or changing management of fishponds are key issues. Countering these threats must be a priority conservation action.

Differences in the level of threat are also found elsewhere. In Scandinavia for

Table 4.1 Importance of limiting factors in each EU country (where information available).

	Habitat loss and degradation			Species dynamics			Climatic effects		Other human effects	
	Seral succession and inappropriate management	Lack of large reedbeds	Water abstraction/drainage	Food availability	Predation	Pollution	Hard weather	Sea level rise	Recreation	Persecution
Austria	+	0	0	0	–	0	–	0	0	0
Belgium	+	+	–	–	–	–	–	–	+	–
Denmark	++	+	0	0	–	+	+	+	0	0
Finland	+	0	0	0	+	+	0	+	+	0
France	++	+	+	+	++	+	+	+	+	+
Germany	++	++	+	0	–	+	+	0	+	0
Greece	–	0	–	0	–	–	–	0	–	–
Italy	++	+	+	+	–	–	0	0	+	+
Netherlands	++	+	++	–	–	+	+	0	+	0
Poland	++	0	+	0	++	0	–	0	+	+
Portugal	+	+	0	0	–	0	0	0	0	+
Spain	++	++	++	0	–	+	0	0	++	+
Sweden	–	++	–	0	–	0	0	++	0	–
UK	++	++	+	++	+	+	0	++	++	+

– no information; 0 not important; + of some importance; ++ very important

example, the overgrowth of important meadow habitats by reed seems to point to alternative conservation priorities. However, the key cause – lack of management – is at the same time affecting the reedbeds. Finally, the spread of tourism and the resultant demands on water continues to put reedbeds at risk in some countries.

Further reading

Tucker G M and Evans M I (1997) *Habitats for birds in Europe: a conservation strategy for the wider environment.* Cambridge, UK: BirdLife International.

4.2 Habitat loss and degradation

Seral succession and inappropriate management

Reedbeds represent an early stage in the **seral succession** of lowland freshwater vegetation communities from open water through to woodland. In some areas, reedbeds appear to be relatively long-lived, with natural processes such as deep and regular floods, preventing succession. However, in other areas, without careful management or changes to the water levels, reedbeds will naturally dry out as leaf litter accumulates and thus, with time, the surface of the reedbed rises. Succession will also reduce habitat diversity within the reedbed, as pools and ditches grow over. This in turn will lead to the invasion of various willows, alder or other woody species and the development of carr woodland (Plates 4.1 and 4.2). These changes may also be initiated by human activities such as drainage, water abstraction or isolation from water courses (see below). A lack of management may also cause adjacent habitats, such as wet grasslands, to be lost to reed encroachment while the reedbed itself declines in quality.

In the UK, a study of 22 sites that were occupied by bitterns in 1979 showed that only 11 held birds by 1991. Habitat degradation, through seral succession, leading to a lack of food and suitable places for foraging were believed to be of primary importance in the abandonment of many of these sites (Tyler *et al.* 1998). Electro-fishing studies have shown that the bitterns' food sources diminish away from the edge of the reedbed as conditions get drier and access to aquatic species is more difficult. The French national plan for bittern also identifies drying of reedbeds and natural succession as one of the most important threats, with examples in the Seine Estuary and fishponds in Brenne.

The general problem is that natural dynamics have been lost in many European landscapes, with early successional reedbeds now scarce. The impact of controlled water levels (see below) is to progress succession. The challenge for restoration projects is not only to raise water levels but to maintain a dynamic hydrology.

The **commercial management of reedbeds** is not necessarily incompatible with use by bitterns (see Case study 7.12). Management by regular winter cutting favours a monoculture of reed, and the retention of high water levels in spring and summer to promote rapid growth slows the build-up of reed litter and provides foraging sites for bitterns. The threat arises

Plates 4.1 and 4.2 Reedbed succeeding to scrub.

Sarah Alsbury

David Tipling/rspb-images.com

as management intensifies and too large an area is cut in any one year. This can be highly detrimental and result in inadequate cover in winter and a lack of suitable nesting habitat in spring. Commercial beds may also become less diverse and lack sufficient ditches or areas of edge for feeding bitterns. Commercial beds are often burnt after cutting in winter, which also helps to remove reed litter. However, burning can be detrimental if carried out excessively or over too large an area. Where the water levels in cut beds are held artificially low in spring, bitterns may be deprived of favoured wet feeding areas and may in consequence delay breeding.

In many parts of Europe, bitterns occupy reedbeds around the edges of commercially managed **fishponds** (Plate 4.3). This is especially true of parts of eastern Europe (Hungary, Poland and Russia for example), where there are very large complexes of ponds. The intensification of fish farming has lead to poor water quality due to the application of artificial foodstuffs, fertilisers and pesticides. Over-stocking can also potentially cause problems of eutrophication, but at least ensures wet conditions and a good supply of food for bitterns. Habitat degradation can occur where pond edges are made steeper and reed fringes are removed to allow access to the water and prevent encroachment of invading reed into the open water. Such problems are common, with examples in pond complexes in Central Limburg in Belgium, Saxony in Germany and the Dombes in France (see Case studies 7.15 and 7.16). Privatisation of fish-farming in former communist states may in future have a large adverse effect on wetland birds, including the bittern. This may come about through intensification of the enterprise or conversion to other uses (see Case study 7.17).

Water level management, undertaken in many rivers and lakes in Europe in order to reduce flood risk or regulate water supplies, is a significant threat. Abnormal or sudden increases or decreases in water levels may present a threat to bitterns. This may affect food availability or increase the risk of nest predation or flooding. At Lake Bourget, France, fringing reedbeds have declined following water level regulation (Miquet 2003). This has come about through an abnormal water regime of less water in spring, more in winter and a reduced overall fluctuation. This has resulted in greater erosive effects on the reed and a reduced vigour in its growth.

The control of river water regimes has resulted in the loss of extensive floodplain marshlands over many years as rivers have become more regulated. Floodplain

Marcin Polak

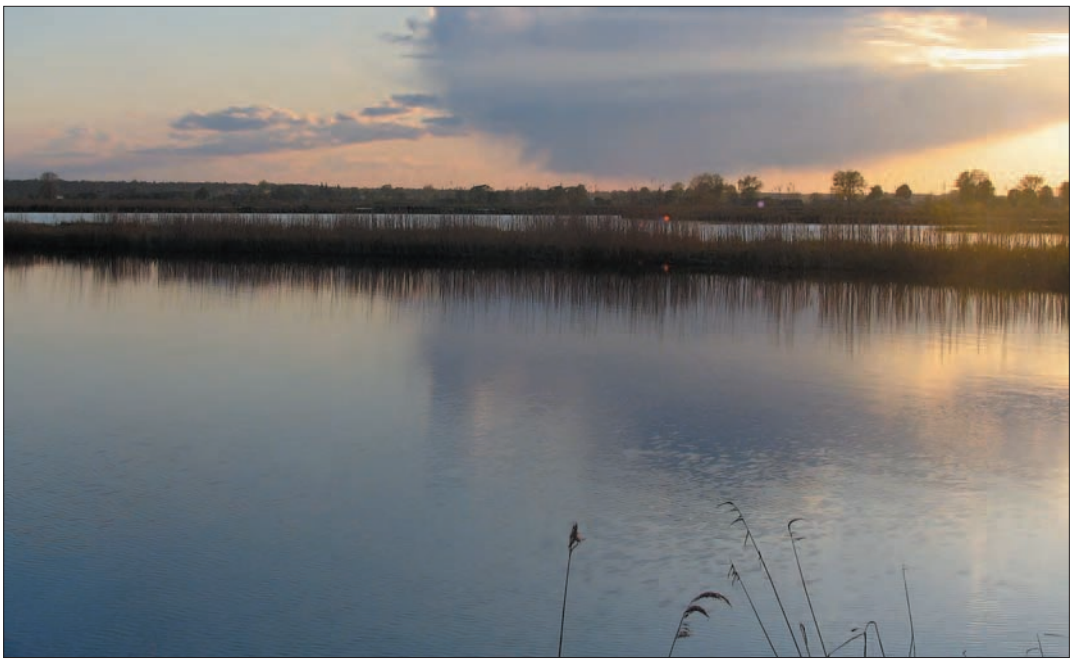


Plate 4.3
A Polish fishpond with breeding bitterns.

habitats such as oxbows, secondary channels, riparian woodlands and marshes, have become dryer or been lost altogether. In many cases the loss of riparian wetland has been due to the drive to create more agricultural land especially arable farming, for example in the floodplains of the Tisza in Hungary and the Skjern river in Denmark (see Case study 7.5), and has gone hand in hand with drainage (see below).

In the Hortobágy National Park, Hungary, the natural hydrology was disrupted during the communist period by the construction of a vast network of ditches and irrigation channels to create rice fields and grassland irrigation systems (see Case study 7.9).

Chris Gomersall/rspb-images.com

Plate 4.4 A deeply cut drainage ditch, Norfolk, UK.

Lack of large wetlands

It is clear that in countries with little remaining reedbed habitat, some bittern populations have been limited by the **lack of large, wet reedbeds** with adequate feeding conditions. Recent work has confirmed that site size is of major importance for bitterns in these areas (Tyler *et al.* 1998). In addition, studies in the Netherlands have shown a clear effect of reedbed fragmentation and lack of connectivity on bittern distribution (Foppen 2001). However, it is also clear that bitterns are not entirely confined to large reedbeds and may actually breed in very small areas of reed. In these cases, it is probably the presence of extensive wetland complexes that is crucial, with birds known to utilise reed-fringed dykes and pools over a large area in adjacent habitat, particularly if food is abundant. The lack of large reedbeds is not a limiting factor in all EU countries, but bittern populations may be very prone to local extinctions when they occur in small, isolated sites.

Drainage and water abstraction

The **drainage of wetlands** for agriculture has been responsible for the loss of many European reedbeds (Plate 4.4). Such drainage has been underway for centuries right up to the present day. The Dümmer Fen in north-west Germany, with its extensive marshes, flooded in winter, was a key area for breeding and passage wetland birds (see Case study 7.10). However, in 1953 the Dümmer was dyked and flooding ceased. The land was farmed and became dry in summer. Only recently has restoration work been undertaken. In the UK, the loss of reedbeds in the fens of East Anglia and in the Somerset Levels, ultimately led to the extinction of the bittern as a breeding species at the end of the 19th century.

The rate of wetland loss may now be slowing and this is no longer an active threat in western EU countries, where most wetlands with potentially productive soils have already been drained. Some reversal of this loss will be necessary to achieve the long-term targets for bitterns. Nevertheless, further losses remain likely, particularly in eastern Europe, and therefore drainage for agriculture remains a significant threat in some areas.

Abstraction of groundwater or surface water is undertaken for use in agriculture, industry, domestic water supplies or tourism. Total abstraction in Europe is increasing, most markedly in southern countries, and such trends are expected to continue (Tucker and Evans 1997).

Excessive water abstraction occurs where abstraction exceeds the re-charge rate of the aquifer. In the catchments of key reedbed sites, this could either lead directly to drying of the reedbed or cause indirect

damage through difficulties in water level control, drying of springs, reduced river flows, saltwater intrusion into aquifers or by affecting food supplies, such as elver runs. Such problems are most likely to occur in drier areas where demand for water may outstrip supplies. This problem can also apply to newly-created sites, and it may not be possible to secure a water supply to some specific locations. Spring-fed wintering sites have been lost in some areas, probably increasing bittern winter mortality. Inter-catchment water transfers have also caused wetland loss, especially in the drier southern areas.

In the Cheimaditita-Zazari wetlands in Greece, a number of drainage projects were undertaken in the 1970s for agricultural purposes. This reduced the surface area of lake Cheimaditita and agricultural activities continue to threaten the site through pollution and excessive water abstraction.

The alteration of natural hydrological cycles to regulate water provision for agriculture is a related threat, and frequent in the Mediterranean where wetlands are surrounded by re-claimed land. This leads to artificially high water levels in the wetland during rainy months and, conversely, lower levels during the summer. This can cause rapid water level variations, nest loss, reduction or loss of feeding grounds and effects on the prey populations. Although these effects have never been directly proved for the bittern, they have for the little bittern (Rezzo and Benocci 2001).

4.3 Changes in species dynamics

Food availability

Bitterns feed on a variety of primarily aquatic animals – fish, amphibians, invertebrates and some birds. In the UK, fish that penetrate the wet reedbed margin are important prey items and only a few native fish species will do this. As a result, there is a problem with food availability at some sites and enhancement of fish populations may be an important consideration. To help maintain fish populations, their freshwater habitats must be of suitable quality. An area of 1 m water depth provides maximum growth of aquatic plants and deeper water 1.5–2.0 m provides refuge during cold and warm weather. With considerable evidence of a large scale decline in European eel numbers, it is important to ensure where possible an unimpeded elver run into suitable freshwater sites (see Plates 4.5 and 4.6). Impassable structures within river courses provide a major problem in some areas.

It is important not just that food is present at a site but also that it is available to the birds. For example, deep, steep-sided dykes, or fish ponds, may contain good fish populations but these may be inaccessible to bitterns. A gradual profile that brings the reedbed gently into deeper water will naturally provide a wide margin with deeper water and sparser reed. Pollution can also affect food availability.

Matt Self

Plate 4.5
A glass eel. Eels are a major prey item for bitterns and therefore recruitment of young eels is important.

Giovanna Pisano

Plate 4.6
Monitoring an eel pass on a new water control structure at Lodmoor, UK.

Predation

Both mammalian and bird predators are known to take bittern eggs and chicks (see Plate 4.7). This may be related to the dryness of the reedbed, particularly for foxes. Aquatic species, notably introduced species such as racoon dogs or American mink are also a problem. Control of non-native species is being undertaken in some

Graham White

Tero Tapponen

Plate 4.7 (left) Bittern predation by eagle owl.

Plate 4.8 (right) A raccoon dog with a whooper swan cygnet. Small predators such as American mink and raccoon dog can destroy nests, eggs and broods.

Box 4.1 Trapping of small predators in the Gulf of Finland.

The main threats to bitterns and other wetland birds in most Finnish wetlands are seral succession and predation. American mink and raccoon dog (see Plate 4.8) are not indigenous species in Finland and they have few natural enemies, allowing their numbers to increase enormously. Thus in addition to habitat management (dredging, mowing and grazing), the reduction of predators is regarded as one of the basic wetland management measures.

In the Lintulahdet LIFE-Project, which aims at managing 12 wetland areas located along the Gulf of Finland, predator control is implemented in each area. Planning and implementation of trapping is carried out in cooperation with local hunters and game districts. The game districts are responsible for drafting the trapping plan, which defines the placement of traps and the methods used. The traps and snares are checked by local hunters, who have made an agreement with Regional Environment Centres and receive compensation for their work.

The trapping seasons last from September to November and from February to April. The traps are checked daily. Trapping of mink and raccoon dog which have settled down in nesting territories in the spring is especially effective and it significantly decreases the rate of bird predation during the whole breeding season. Small predators especially disturb the breeding of bittern, marsh harrier, common crane and colonies of black-headed gull and common tern.

Intensive trapping decreases the numbers of raccoon dogs very effectively. For example, in the Viikki-Vanhankaupunginlahti nature area (approximately 300 ha), 89 raccoon dogs were killed with 20 traps in 2003 (the first project year), with 30 in 2004 and about 20 in 2005. The number of trapped mink (using 15 traps) has been approximately 20 animals each project year. The monitoring data already shows that active trapping has increased brood productivity of waterfowl species such as mallard and common coot. Due to intensive trapping, bitterns have started to breed regularly in the Bay of Viikki Vanhankaupunginlahti and marsh harrier has succeeded in breeding for a first time in a considerable period.

Trapping will continue on a voluntary basis after the LIFE-Project and the traps are given to the local hunters' organisations. The hunters involvement in the project has increased their knowledge of wetland ecology, and the management and use of Natura 2000 areas. They still don't want to give up their hunting rights, but discussion and exchanging of views is easier as the management work and effort of the both parties (conservationists and hunters) benefits the common interest – the biodiversity of wetlands.

Contributed by Marjo Priha

areas, for example the wetlands of the Gulf of Finland (see Box 4.1).

The French bittern research programme found that at all sites, predation is the factor that affects productivity the most, with 70% of 84 nests lost within 15 days. The research concluded that two main limiting factors, predation and food resources, were interlinked, and directly related to habitat quality (Bretagnolle and Demongin in prep.). Following a reduction in water levels during the spring, food resources became scarcer at a critical time for the chicks. The female is therefore forced to leave the nest for longer, increasing the risk of predation. Experiments in the Camargue with fake nests suggested that birds (mostly corvids and marsh harriers) were responsible for 50% of predation, and that bird predation occurs mainly early in the season before the reed gets tall. The Polish studies (Polak in prep.) showed that in the Lublin region 20 nests out of 60 (30%) were predated during incubation. Recently, the impact of avian and mammal predators (especially non-native species such as the American mink) on bird populations has increased markedly in Poland.

As the population expands away from managed core sites, predation may become an important limiting factor. It may already be so in some areas.

Low population size and restricted range

Where bittern populations reach critically low numbers within a given area, they become highly vulnerable to unpredictable events that may lead to local extinction. Their favoured large, wet reedbeds are a scarce and naturally short-lived habitat. Such a restricted distribution exposes the bittern population to the threat of significant decline if key sites become unsuitable or are affected by adverse conditions. For example, adverse factors acting at two key sites in Tuscany, Italy lead to the decrease and even the extinction of breeding bitterns. Bitterns were also reduced at secondary sites (occupied by 1–3 males) not far from the main sites (L Puglisi pers. obs.).

The impact of other species

Certain other species may have an impact on the bittern through habitat change or disturbance. The introduction of the non-native coypu has had a serious limiting effect on reedbed growth in some areas, for example France. Even native species may also present a problem at times; wild boar in reedbeds can cause disturbance and nest losses. However, the same activities may also create some structure within the reedbed.

4.4 Pollution

Degradation of habitat through pollution

Water quality is also important in maintaining breeding habitat, since poor quality water cannot support the aquatic ecosystem that bitterns require. Run-off of nutrients from agricultural land and the loss of natural filtering wetlands have gone hand-in-hand to cause eutrophication in much of Europe. The excessive eutrophication at Massaciuccoli Lake in Italy, resulting from the inflow of nutrients is but one example of this.

The intensification and overstocking of commercial fishponds can also cause eutrophication of the bittern's feeding areas. Algal blooms resulting from eutrophication could also decrease bittern feeding efficiency because of turbidity and direct fish kills: these have increased markedly (see Plate 4.9). Botulism is also becoming a severe problem in France. Heavy silt loads can exacerbate the drying out of the reedbeds and increase the turbidity of the water.

In addition, the eutrophication of water supplies can adversely affect reed quality and is believed to have resulted in **reed die-back** and problems of reed rehabilitation in some areas. Examples of this come from Schorfheide-Chorin, Germany (Koerner and Graumann 2003)

David Kjaer/rspb-images.com

Plate 4.9 Pollution may result in fish kills.

W. Schoenberg

Plate 4.10 Reed die-back on a German lake is the subject of a research project.

and the Norfolk Broads, UK. In the latter example, inputs of nitrates and phosphates from agricultural run-off and sewage have increased markedly and bottom sediments have been churned up by passing tourist boats. This has led to the die-back of marginal vegetation and, significantly, the break up and degeneration of floating mats of reed. This results in the development of anoxic sediments, which will not support reed re-colonisation. At Diacca Botrona, Italy, reedbed progressively died back because of the input of salt water from the adjacent fish farm rearing marine life. This resulted in the rapid decrease and then extinction of the local breeding bitterns (Puglisi *et al*. 1995, pers. obs.).

Research on the importance of genetic diversity of reed has underpinned its role in the adaptability of reedbeds to changing site conditions such as increasing nutrients (Koppitz and Kuhl 2000, Gusewell and Klotzli 2000). Reedbeds with low genetic diversity can suffer severe and unsustainable die-back if affected by pollution (see Plate 4.10).

An assessment of river quality in Europe (based on nutrient status of the water) found that about a quarter of all river reaches are of bad or poor quality. Although there is an improving trend in western countries, this is not the case in eastern Europe.

Contamination of birds

Bitterns, like other herons, are potentially at risk from heavy metal and pesticide pollution, being at the top of the food chain. Pesticide levels were known to be high in grey herons in the 1950s and 1960s. Contamination has declined since then and the heron population is increasing, though in some countries cessation of hunting may have been at least partially responsible for this. Heavy metal (eg mercury) pollution is a potential problem in some areas.

During 1963–93, the corpses of 18 bitterns were analysed for organochlorine and mercury residues in the UK (not all of these birds were necessarily of British origin, as some may have been immigrants from mainland Europe). The death of one bird in 1963 was attributed to HEOD, but in general residues of DDE and PCBs were relatively low. Levels of mercury in some of the livers examined were high, although all the birds appeared to have died from other causes. A further 12 adult and young bitterns from 1997–2001 were analysed (Shore *et al.* 2002) and showed that the levels of DDE, HEOD and PCBs were unlikely to be of toxicological significance. Liver mercury concentrations were mostly low, but one recent liver sample and one of those from the early 1990s, had liver mercury readings of a magnitude close or greater than that associated with the toxic effects in some other species.

4.5 Weather and climatic effects

Sea-level rise and climate change

Sea level rise and a breakdown in sea defences would be very damaging to bittern habitats because of the resultant tidal fluctuations in water levels and possibly because of reduced food availability. There are occasional saline intrusions at a number of sites in north west Europe, and around 25 IBAs supporting breeding bitterns appear to be a some risk from future sea level rise.

Plate 4.11 Seawater inundation of coastal reedbed at Minsmere, UK in December 2003.

Geoff and Hilary Welch

In the UK, a number of important reedbeds for bitterns are found in coastal areas of East Anglia, where the impact of sea level rise is likely to be greatest. The over-topping of sea defences along this coastline in December 2003 (see Plate 4.11), showed that saltwater inundation is a significant threat to several key bittern sites. Plans are also being drawn up for more sustainable coastal management, which may involve greater saltwater incursion into some of the major coastal reedbeds. With a current lack of alternative habitat, any loss of breeding sites may halt the recovery of the bittern population in the short-term. There are similar problems in Italy, where for example at Maremma Park, coastal erosion is resulting in the loss of freshwater reedbeds to brackish habitats. In the Mediterranean region of France, there are many examples of increased salinity of coastal wetlands due to a combination of a lack of freshwater input on one hand, and incursions of seawater via dykes and poorly maintained water control structures on the other. For example, reedbeds at Vendres (900 ha) have decreased by 80% in the past 20 years.

Climate change may also result in reduced water availability in certain areas

Box 4.2 Climate change and its impact on the bittern in Brandenburg, Germany.

In 2003, a study on climate change up to the year 2055 was carried out by the Potsdam Institute for Climate Impact Research (PIK) (Gerstengarbe *et al.* 2003). Its effect on water balance, forestry and agriculture within 15 different land-use types in Berlin and Brandenburg was examined. The federal state of Brandenburg encompasses the German capital Berlin and covers 29,472 km^2. It lies within the transition zone between sub-Atlantic and continental climate in middle Europe (average temperature in summer: 14.7°C, average temperature in winter: 2.7°C, average precipitation 1951–2000: 604 mm). The climate change scenario on which the study is based upon is assessed as relatively 'conservative' by the authors, which means that the changes in the hydrologic regime could be even worse.

Brandenburg holds a population of 100–150 booming bitterns. The results of the study show that the effects of climate change could become increasingly critical for bittern habitats over the study period.

Against the background of an already sensitive hydrological situation with declining ground water tables, the results of this study show that some of the key parameters influencing landscape water balance will significantly worsen. Even the relatively small changes in temperature and precipitation chosen in the climate scenario, can have significant influence on evaporation, groundwater recharge and run-off. A further decline in summer precipitation, in combination with a rising evaporation rate will lead to severe consequences in Brandenburg. Increased loss through evaporation over open water bodies and in wetlands will lead to a halving of groundwater recharge by the year 2055. This development could be aggravated by an increasing tendency towards extreme droughts and floods. An overall lowering of groundwater recharge and an increase in winter run-off will cause a decline in groundwater tables, water levels in lakes and rivers, and a steep decline in water quality, especially in the summer months. Rivers and wetlands may fall dry during summer and semi-natural boggy areas may be lost. These natural areas are extremely sensitive to climatic changes because of high evaporation and low ground water recharge rates.

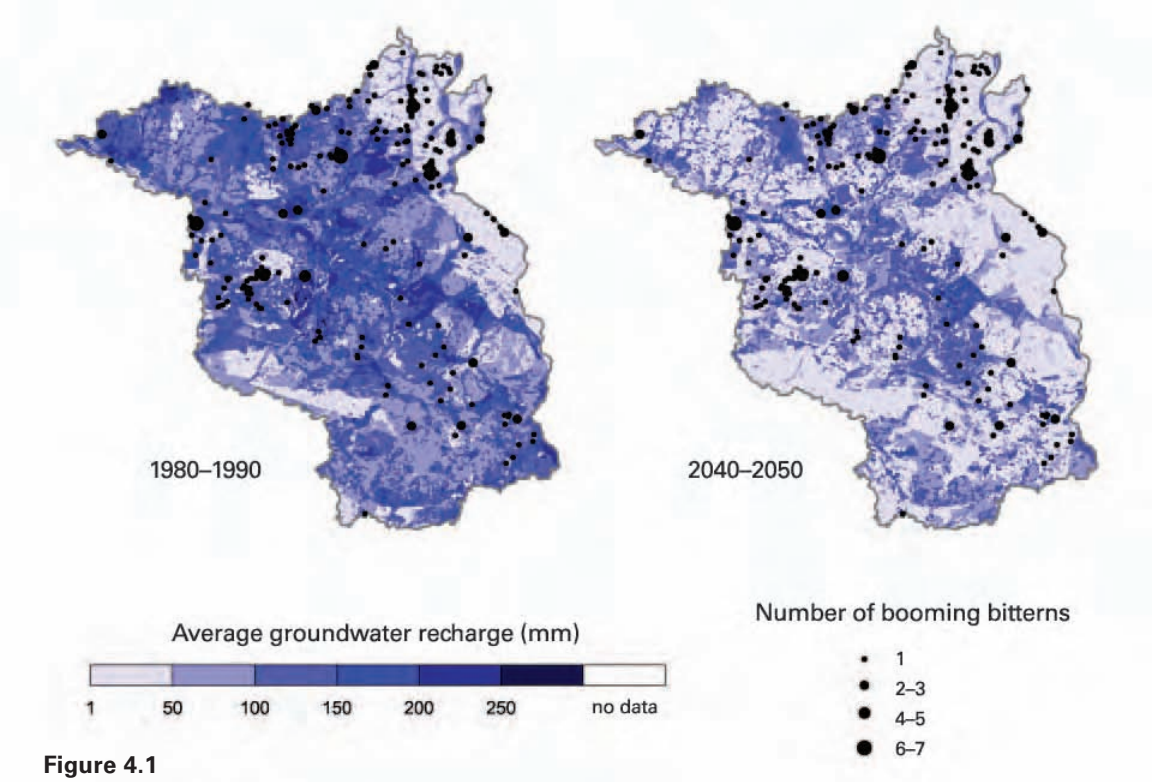


Figure 4.1
Changes in groundwater recharge in Brandenburg in relation to bittern distribution.

if we experience changing rainfall patterns or prolonged droughts. A study by Potsdam Institute for Climate Impact Research (2003), forecasts a severe decline in water levels and lakes due to climate change by 2055 if current conditions continue (see Box 4.2)

Hard weather

The impact of hard winters is best monitored by assessing the decline of breeding populations in the following summer. Hard weather fluctuations will always have been a natural process, but there is now some concern because recovery appears to be slow (indicating poor breeding success) and suitable wintering sites in the south and west of Europe may not be available. The impact of hard winters on populations is not clear-cut because the number of birds moving south and west is probably increased by severe weather. For example, after some hard winters the population breeding in England has not been significantly affected, despite apparently high mortality. In this way, hard weather may play an important role in the dispersal of the species. It is known that young birds tend to disperse away from the natal reedbed and this underlines the importance of protection of reedbeds outside the current breeding range. Conversely, the severe winter of 1978–79 resulted in a 30–40% decline in parts of Europe the following summer. Provided bitterns are able to breed well and have reached a self-sustaining population level, they will be able to recover naturally from the effects of hard winters. However, in the short-term, this recovery may be slow if local extinctions occur in the more outlying sites.

Overall, our knowledge of winter movements in response to hard weather is poor and would suggest further study is required.

4.6 Other human effects

Recreation and disturbance

Wetlands are coming under increasing pressure from many forms of recreation. In recent years, more people are visiting the countryside. They can cause damage both by trampling growing reed and by disturbing wildlife at critical times. In the past, quiet pursuits such as angling and boating were most widespread. More recently noisy aquatic sports (water-skiing, speedboat racing and so on) have become much more popular. They are having an adverse effect on wildlife, both through noise disturbance and physical damage from the wake of fast boats, particularly to reed fringes. A related threat is the loss of habitat due to development associated with the tourism industry. Wetlands in the Mediterranean basin are particularly at risk due to the concentration of international tourism in this area (Tucker and Evans 1997). Examples of this are found in the marshes of the Ebro, Llobregat Delta and the Aiguamolls de L'Emporda in Catalonia, Spain. However, such problems are not exclusively in the south and are an issue in northern areas such as the Gulf of Finland.

Collision

Collision with power lines is an issue in some areas such as Aragon in Spain, the Po Delta in Italy and Dungeness in the UK. Road traffic may cause problems in certain areas; for example, eight bitterns were killed in four years on the main road crossing the Seine Estuary reserve in France.

Persecution

The bittern is fully protected throughout the EU and is not a quarry species. In general, it does not suffer from illegal persecution, although in particular areas (such as France and other Mediterranean countries) individual bitterns may be shot by wildfowlers. This can occur either through ignorance of the species, poor visibility (especially shooting at night) or irresponsibility. For example, two bitterns were shot in Rochefort Marshes, France during winter 2003. Shot birds may well be wintering individuals from other countries; so shooting may have an impact far from where it takes place. A resident radio-tagged female was shot at Massacioccoli, Italy in autumn 2003 (Puglisi *et al*. 2003).

5 HABITAT MANAGEMENT FOR BITTERNS

5.1 Introduction

The management of reedbeds and other wetland habitats is an extensive topic that this short chapter cannot cover in its entirety. The texts listed under 'Further reading' below cover a broad range of basic information. This chapter aims to summarise recent work that has been undertaken, primarily through EU LIFE projects, to try to reverse the declines in bittern populations and maintain reedbeds in an early successional stage. It aims to highlight best practice and link to case studies.

As this handbook focuses on management that will benefit bitterns, it is important to stress that any proposed management should only be undertaken when sufficient knowledge of the ecology of the site has been gained. In particular, the likely impact of the work on other species (see Case study 7.1) should have been evaluated.

Further reading

Hawke, C J and José, P V (1996) *Reedbed management for commercial and wildlife interests*. The RSPB, Sandy.

White, G J and Gilbert, J C (2003) *Habitat creation handbook for the minerals industry*. The RSPB, Sandy.

Jochen Purps

Plate 5.1
There are many different methods and solutions to managing bittern habitats; reedbed ditches at Minsmere, UK.

5.2 Planning for management

Whatever the ultimate goal for a project, making the most of any opportunity requires careful consideration and planning. Planning may be at various levels, from strategic down to site. Regarding the bittern, where the population may be highly fragmented, several countries have produced strategic Species Action Plans at the national or regional level, in order to coordinate more specific site management plans. Such an approach has generally been very successful. (See Chapter 1.)

At the site level, it is useful if the background and reasons for any management work are put in writing. This can be a short project proposal or where there are longer-term implications, as a management plan. The main functions of a site management plan are to:

- Describe the site by collating all available physical and biological information.
- Identify relationships between the site, user groups and other stakeholders. This allows stakeholders to be involved in the management planning process, and is vital in large complex sites with multiple uses.
- Identify clear management objectives. This ensures that all work is linked to objectives and allows the efficacy of management to be assessed during the review process. Part of the process of producing management objectives involves identifying constraints to ideal management and conflict resolution.
- Identify and describe the management necessary to achieve the objectives.
- Identify the monitoring effort and methodology required. Ensures that objectives are being met by the chosen management approach and provides a feedback mechanism whereby management can be altered according to results.
- Ensure that project results are systematically recorded.
- Organise resources and funding. Producing a management plan for a five-year period allows necessary work to be agreed with a funding agency.
- Ensure continuity of management in the event of staff changes.

A useful Management Planning Toolkit can be downloaded from the Eurosite website (www.eurosite.org).

The points to investigate and evaluate when assessing the potential value of a reedbed will include the following:

- existing site interest, including status and ownership, geographical location, proximity to other reedbeds, wildlife value, quality of the reed and depth of the litter
- physical and chemical characteristics, including hydrology, soils and water quality
- legal constraints
- management constraints and opportunities such as accessibility, labour and financial resources.

Where the management, restoration or creation of reedbeds for the benefit of bitterns is being considered, the site *hydrology* is one of the essential factors to consider at the outset (see Case studies 7.6 and 7.8). The nature of hydrological investigations will depend on the scale of a project and the resources available. The opportunity to restore a small area of existing reedbed may simply require a brief field visit to discover if an existing sluice is derelict. In contrast, a major creation scheme will require detailed investigation (see Table 5.1, p.71).

At the outset of any project a description of the site, including location of low-lying areas, patterns of water flow and soil type will give invaluable information. A detailed levelling survey (Plate 5.2) to determine site topography is often required, but may be unnecessary if you are able to observe the area in flood and make a photographic record.

Determining the availability of water at a site is particularly important when creating a new reedbed. Assessment of a site's water balance (inputs, eg rainfall and river flows, and losses, eg evapotranspiration

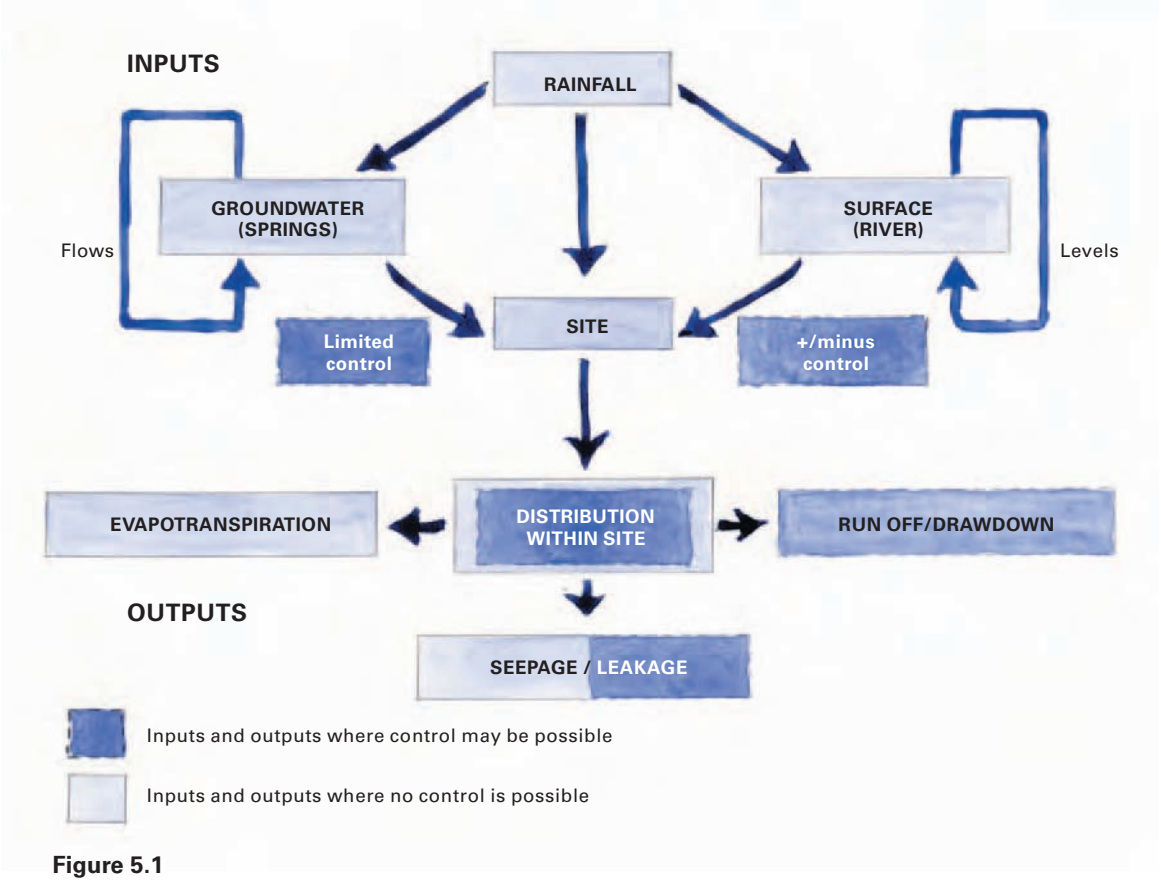


Figure 5.1
Supply, distribution and control of water on reedbeds (adapted from Hawke and Jose 1996).

and seepage) should be considered essential for major schemes (see Figure 5.1). The ability to hold and manipulate water levels on a site is also important.

Manipulation of water levels may have effects beyond the immediate site and large re-wetting projects take time and care in the preparation. In Germany, there are a number of interesting projects that have dealt with re-wetting reedbeds and associated issues (see Case studies 7.8–7.10). At Schorfheide-Chorin, the negotiation of the local water rights issues provide useful guidance for all such projects (see Case study 7.6). A related issue is the consolidation of land parcels to enable effective hydrological control; a problem that may be overcome by land purchase or agreement (see Case study 7.2).

Norman Sills/rspb-images.com

Plate 5.2
Levelling survey, Lakenheath Fen RSPB Reserve, UK.

5.3 Reedbed management

Why manage reedbeds?

Without action to hold or reverse succession, either traditionally through management or in some cases, natural dynamics, a reedbed will tend to dry out and turn to woodland. This will result in the loss of characteristic reedbed animals and plants, with those species typical of the wetter, early stages of reedbed succession, such as the bittern, amongst the first to be lost. This natural process can be accelerated by drainage, water abstraction or isolation from watercourses.

Full details of reedbed management are published elsewhere (eg, see Hawke and Jose 1996), but in summary, reedbed management is primarily concerned with two issues: the water regime and the vegetation. These are considered in the following sections.

Water regime and quality

The wildlife interest of a reedbed is influenced by the physical and chemical characteristics of the water environment. Poor water quality and the over-exploitation of water as a resource, by increased abstraction or drainage, has had a serious deleterious effect on European reedbeds. In particular, two aspects of water management are important; that of water regime (levels, duration and timing) and of water quality.

Water regime describes the combination of water level (eg surface water depth), the length of time that level is maintained and at what time of year. The control of water levels can be used to:

- encourage reed at the expense of other plants
- increase the rate of litter break-down (after draw-down)

Chris Gomersall/rspb-images.com

Plate 5.3 Cutting and gathering reed using a reciprocating mower.

Table 5.1 Hydrological assessment of reedbed sites (adapted from Hawke and Jose 1996).

	What to assess	How to assess	Importance/value
1. Location and description	Catchment area	Maps. Aerial photographs.	Indicates sources/flow of water and low-lying areas suitable for reedbed
	Soil types	Soil survey maps. Auger on site.	Soil type will determine the hydrological regime which can be sustained on site. Low permeability clay soils hold water on the surface. Surface flooding is essential to maintain wetness. Water levels in highly permeable peat soils need to be maintained by keeping high ditch and ground water levels.
	Topography	Levelling survey or observe area in flood conditions. Pre-flood site before undertaking work.	Indicates low-lying areas and provides information for siting of water level management structures.
	Flow patterns	Observe directly and mark on map.	Provides indication of where to site sluices etc.
2. Overall water availability	Climatic conditions	Water budget calculations and field measurements.	To give an indication that there is sufficient water. To determine the viable size of the reedbed. To indicate if winter water storage is required to supplement summer shortages.
	River/ditch levels and seasonal fluctuations	Gauge boards. Check site for: • existing embankments and bunds • depth of stream or water table below field surface.	Where water level below ground level indicates requirement for sluice construction, bed lowering or pumping. These together with topography will affect distribution of water around the site.
	Requirements of other water users in the catchment.	Water management agencies.	Need to achieve a balance with other user groups, particularly in low rainfall or highly populated areas.
	Groundwater	Determine seasonal nature of seepage/spring flows. Water table heights can be measured using dipwells.	Often a source of high quality water. Will indicate seasonal problem periods of low water levels.
3. Ability to hold and manipulate water levels	Water levels/ topography (as above)	Gauge boards/dipwells.	Water level fluctuations should be appropriate to objectives.
	Determine nature of existing drainage.	Examine condition of existing water control structures, • check for leakage in bunds • check sluices etc • determine nature of sub-surface drainage. Liaise with water management agencies.	May provide potential to sub-irrigate a site.
4. Other factors Influence of proposals on adjacent land.	Impact of flooding/ raising water levels.	Liaise at earliest opportunity with water management agencies.	May require bunding of site to protect adjacent land.

- facilitate management practices
- provide open water habitats.

The water regime of a reedbed may be influenced by natural processes and by management, the amount of water available and the means of distributing it around the site. These include:

- water supply – evaporation, rainfall, surface flows and groundwater (see Figure 5.1)
- water distribution – sluices (including weirs and pipes), dams, bunds and pumps (see Box 5.1, p.80).

Bitterns require wet reedbeds that provide not only adequate feeding opportunities but also a safe nesting site (see Chapter 2). The drying out of reedbeds and the loss of a suitable water regime loss is perhaps the most likely reason for the decline or loss of bitterns as a breeding bird (eg UK research – Tyler *et al.* 1998).

Issues relating to high water levels. Where water can be controlled in a managed reedbed, it may seem logical to keep levels relatively high and stable with the assumption that this not only benefits bitterns but also slows natural succession. However, there is considerable debate about the wisdom of such an approach and the effect it may have on the quality of the reed – and, ultimately, on the bittern itself if it leads to reedbed degeneration.

Reed-cutters have long argued that stagnation of water is detrimental to reed and may result in the firm bed of a reedbed breaking up. 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 tables may be a key factor in die-back by both promoting litter production and anaerobic conditions. These may be more favourable for other competitive emergent helophytes, such as reedmace. 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.

The drying out of reedbeds in early autumn may be beneficial in promoting oxidation of reed litter. In addition, increased winter water levels and throughput of water assist with the flushing of organic material. In summary, in sites where the water regime can be controlled, a regime cycle that mimics natural conditions, with drawdown in autumn, as is typical in Mediterranean countries, may be better for reeds than those with constantly deep water, which increases the exposure of reeds to the negative effects of litter accumulation. A throughput of water would also be beneficial. Drawdown of water to ground level or below is also required for reed management, such as cutting (either for conservation or commercial reasons), to enable access.

Water quality. Reed grows well in eutrophic water, although high nutrient levels have been implicated in some cases of reedswamp decline. However, many of the associated plants and animals can suffer greatly from highly eutrophic water, which encourages fast growing, dominant species such as algae. Algal blooms, resulting in turbid waters, may mean that fish-eating specialists, such as the bittern, cannot see their prey. The decline of aquatic plants in eutrophic conditions may result in changes in a finely-balanced food chain.

Dealing with poor water quality can be a problem. Measures that have been used include:

- isolating a site from eutrophic water, although this has severe disadvantages in loss of connectivity of water, fish movement etc
- removing nutrients from a site by phosphate stripping or suction dredging
- maintaining flows and throughput of water to carry away litter and accumulated nutrients
- designing part of the reedbed receiving the water inflow as a water treatment system to remove excessive nutrients, such as at Potteric Carr, UK (see Plate 5.4)
- in Schorfheide-Chorin, Germany, the eutrophication of lakes by inflowing nutrients from surrounding agricultural land was tackled by using agri-

WWF (UK)

Plate 5.4
The five cells around the semicircular lake in the bottom half of the picture make up a reedbed filtration system, Potteric Carr, Yorkshire, UK.

environmental subsidies to create buffer zones in the appropriate areas (see Case study 7.14)
- wider floodplain restoration (see Case study 7.5).

Management by cutting

The cutting of reedbeds may be undertaken for conservation or commercial purposes, or both. 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 create structure within the reedbed, in the form of open, wet habitat, pools, glades, reed edge etc
- to supply reed for commercial purposes.

Commercial reed cutting may provide for large areas of reed management, but it can also represent a threat to reedbed wildlife. The threat arises as management intensifies, with a higher proportion of the reedbed being cut and water levels being affected (see Chapter 4 Threats). The reedbeds producing the most reed are in eastern Europe, whereas the reedcutting industries in the UK and France are small, and compete with imported reed from further afield (Plate 5.5).

In considering reed cutting, the key variables are:
- the time of year
- the frequency
- the extent.

Timing. Winter cutting of reed, combined with spring flooding, will maintain its dominance and may provide thatching-quality reed. Summer cutting reduces its competitive ability, allows a more diverse mix of vegetation and ultimately eliminates it (Gryseels 1989). No management will allow natural succession to continue, the speed of which is largely dependant on the water regime. Conservation cutting to maintain reed dominance may therefore be undertaken anytime during the non-growing season.

An issue that may arise with commercial cutting of reed is the timing of the water drawdown. Commercial cutting is generally undertaken when the reed leaves have fallen. In the milder western countries, this may not occur until the turn of the year and so commercial cutting may be undertaken from January onwards. Bitterns establish territories from February, and a conflict may arise where low water is being maintained for cutting. This can result in delayed breeding or displacement of birds from potentially suitable sites (see Case study 7.11).

Frequency. Reed may be cut annually (single wale) or biennally (double wale) to produce a commercial crop, or on longer

Plate 5.5
Commercial reed cutting in the UK.

Andy Hay/rspb-images.com

rotations of maybe 7–15 years for conservation objectives. Cutting of reed will maintain its vigour, reduce litter and scrub, and increase stem density and flowering. It will also remove the standing reed used by birds such as bittern, and invertebrates, and frequent cutting may reduce plant diversity.

Extent. The extent of cutting will vary greatly depending on whether it is a commercial crop, the available resources and the site objectives. The extent of cutting, and the potential conflicts between conservation and commercial objectives, is a key issue of debate and the subject of continuing study.

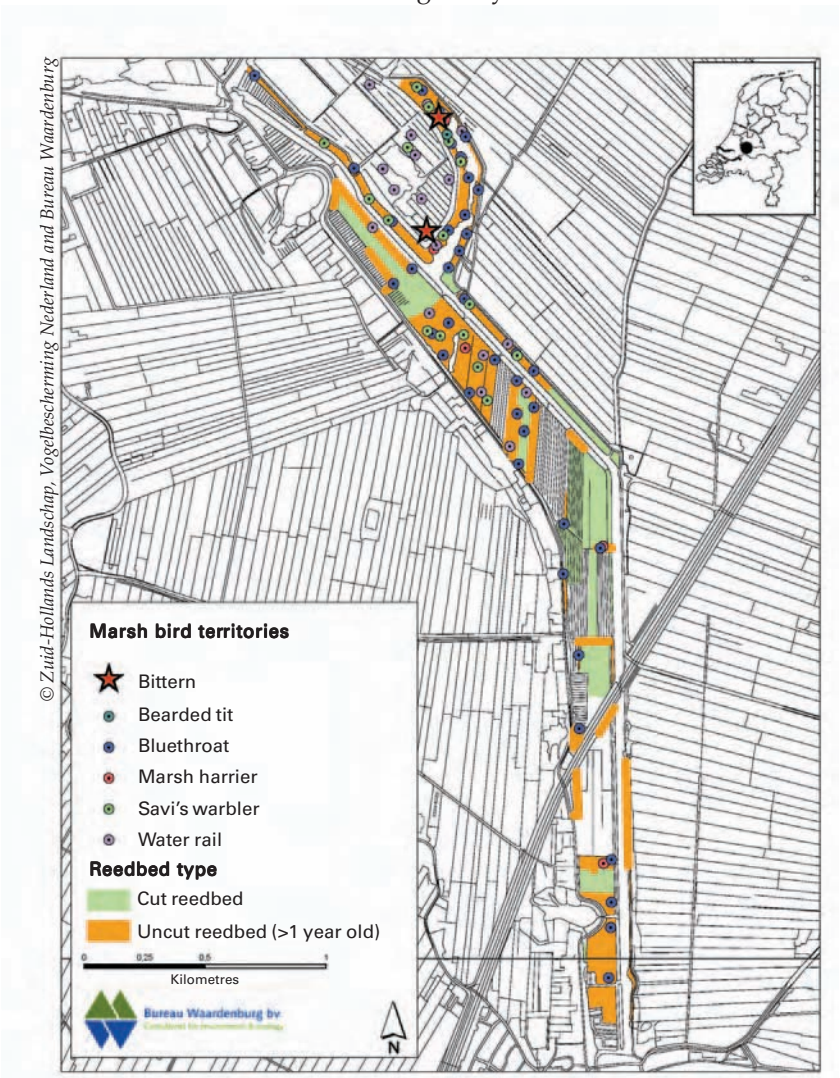


Figure 5.2
Breeding distribution of several marsh birds in relation to the occurrence of uncut (>1 year old) reedbeds in the SPA Zouweboezem, Province Zuid-Holland, The Netherlands in 2003. Agricultural grasslands surround the area. Highest densities are present in old uncut reed beds and remaining reed bed strips.

In the Netherlands, 31% of all available reedbeds are cut commercially. Locally in some of the larger wetlands, such as Weerribben and Nieuwkoopse Plassen, this figure rises to at least 75%. In many wetlands, areas are cut completely with only small fragments (1% of area) along ditches or bordering woodlands remaining. Locally, nature management policies restrict the amount of cutting. In general, about 10% of the area is protected in this way and managed on rotation.

To determine the most appropriate reedbed management policy in commercially cut sites, a study was undertaken (van der Winden *et al.* 2003) into the extent and location of reed cutting in the key marshland areas. The densities of breeding birds were compared in cut and uncut reedbeds over a number of years according to four management scenarios; with 1%, 15%, 50% and 100% of retained uncut reed area (see Figure 5.2). The results showed that where 50 to 100% of the reed remains, it does not significantly contribute to higher populations of most bird species, including bittern. The reason for this outcome is concluded to be that most species prefer edges of reedbeds, where they forage along borders, and cut areas are used for foraging as well. The important exceptions are colonial breeders (spoonbill and purple heron) and Savi's warbler, which require larger areas of reed. The study therefore advises to retain at least 20% of the standing reed in intensively exploited areas, in 10 m wide strips along waters or pools and also including some larger patches for colonial breeders.

Baldi and Kisbenedek (1999 and 2000) found that certain reedbed passerines bred at greater densities close to reedbed edges, notably great reed, reed and sedge warblers 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, colonial species such as purple heron, spoonbill and great white egret, favoured large areas of reed and may be considered 'interior' reedbed birds rather than the 'exterior' edge specialists. French studies (eg

Barbraud *et al.* 2002) have also shown that purple herons prefer large, wet unharvested reedbeds. The reason for edge preference by certain species may 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 ducks.

In the Seine Estuary, France (see Case study 7.11), around 700 ha were traditionally harvested annually. Since 2000, trial guidelines restricting both the timing and extent of cutting were introduced. Key areas for bittern were left unmown, representing 20% of the exploitable area. Similar experiments in the Petite Camargue, France (see Case study 7.12) demonstrated an increase in booming bitterns where uncut reed was retained in an area previously entirely cut.

In summary, there is a complex relationship between birds and reedcutting. Many species, including bitterns, prefer edge habitats, often wet with good habitat structure. Cutting of a large dryish reedbed may not significantly reduce bird populations if reed is retained in appropriate edge habitats. However, a threshold will be reached on any site where further removal of reed will depress populations. General good-practice guidelines may suggest that, in intensive reed harvesting areas, 20% of reed should be left uncut. However, this will not be the case on nature reserves, where a greater proportion of habitat features will support more birds. Here, the figure of at least 50% of retained reed as suggested by Hawke and Jose (1996) may be more appropriate.

Cutting economics and equipment

The traditional hand-scythe is now rarely used and the commonest means of cutting is with a reciprocating mower. These are machines with cutting bars one, two or three metres long. The smaller walk-behind machines, such as Bucher, BCS or

Graham White

Plate 5.6
A Seiga harvester operating on the Tay reedbeds, Scotland.

Olympia, are commonly used on nature reserves. They may also bundle and tie the reed in some cases.

Most reedbed management on UK nature reserves, where sites are small is non-commercial and currently undertaken with hand-held machines, either brushcutters or walk-behind mowers (Plate 5.3). Traditionally, the arisings are raked, stacked and/or burnt. The cutting is usually achieved with one paid land-manager working with volunteers. Cutting takes around 15% of the time, gathering and/or burning 85%. Using these methods, costs have been calculated as £1,200–1,600/ha (Leighton Moss), £2,200–5,600/ha (Minsmere) or £3,000–7,000/ha (Ham Wall), or varying from 10–60 m^2/'man' hour. These variations are accounted for by site wetness, length of rotation, amount of litter and degree of clearance. Overall, the operation can only realistically cope with small areas of reedbed, and on average, reserves will only manage 3 ha of this type of work each winter. Such reedbed management practices are labour intensive, weather dependent and contribute only in a minor way, if at all, to slowing succession.

The larger Seiga Harvester (Plate 5.6), commonly used in the larger European reedbeds, is a specialised and efficient reed cutter, working best on flatish, firm

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Plate 5.7 The Aquaclear 'Truxor'; a versatile amphibious reedcutter.

ground in large single/double wale reedbeds. The Seiga is a self-propelled amphibious machine with a 3 m long reciprocating blade mounted on a cargo rig with a deck area of 4 m × 3 m and a capacity of 1–2.5 tons. Two to three people are required to operate the machine. It is capable of cutting and tying 2,000 bundles of reed daily (1–1.5 ha). A new machine will cost c£100K and annual maintenance may be around £9K.

The Aquaclear 'Truxor' (Plate 5.7) is essentially a floating cutter, using a broad cutter bar and rake that can be raised or lowered and may be a particularly useful machine in very wet reedbeds. It is operated by two people and works most efficiently in a water depth of 30–50 cm. The Truxor costs c £90K. In trials in the UK estimates suggested that the Truxor could cut a hectare of reed in about 40 hours for a price of £2–3K/ha. However, time and costs need to be carefully evaluated, not only against the condition of the area to be cleared (notably the amount of litter), but also the end result.

Management by burning

Burning is a traditional management technique undertaken in late winter when the reed is dead and dry (Plate 5.8). 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). 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 to an increased diversity of plants

David Kjaer/rspb-images.com

Plate 5.8
Cutting and burning reed in winter, Ham Wall RSPB Reserve, UK.

Amy Hay/rspb-images.com

Plate 5.9 Ponies grazing in reedbed, Minsmere RSPB Reserve, UK.

and greater flowering and seed production of the reed itself. Burning reed has also been shown to increase early shoot emergence and density (Haslam 1969) and assist the dominance of reed (van der Toorn and Mook 1982). The precise effect may depend on timing, frequency and water regime.

Studies on the burning of sedge beds (*Cladium*) in the Rhône delta, France showed that bitterns favoured burnt areas in the year after the fire (Poulin pers. comm.). The openness created by burning may provide better feeding conditions, whilst unburnt areas were still required for nesting. It was suggested that a patchwork of burnt and unburnt parcels may represent an optimal management regime.

Management by grazing

Grazing of wetlands, including reedbeds, is a widely used method of management in many parts of Europe. Grazing of reedbeds, ideally combined with water level control, is a valuable tool for the maintenance of early succession and diverse habitat mosaics (Plate 5.9). For wetland managers, the knowledge of the grazing capacity of reedbeds and proper stocking densities are essential information. However, it cannot always be found in the relevant literature, as they vary greatly between sites and countries (see Gordon *et al.* 1990, Mesléard and Perennou 1996, Kazoglou and Papanastasis in press).

A distinction may be made between more extensive grazing (social or natural grazing) and seasonal grazing, but both may have a role to play. Natural or social grazing is based on the principal of year-round grazing. The carrying capacity is determined by times of food scarcity, generally late winter. The animals develop and retain a social structure, with a 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. This practice is well illustrated in many Dutch wetlands. 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. Where these conditions are not met, a 'boom and bust' cycle is likely to develop as the number of herbivores overwhelms the resource and the population then crashes.

By contrast, in seasonal grazing, the number of animals relates to the maximum amount of food to be removed, usually in a restricted area. The grazing density is generally much higher than natural grazing and habitat mosaics do not generally develop. Summer seasonal grazing by cattle will convert a dry reedbed to grass pasture in 3–4 years at relatively low grazing densities (c0.5/ha). However, with natural grazing over larger areas, reedbed may be grazed seasonally, mostly in winter/spring but also in relation to water levels. Exceptions to these general views may be seen with specialised grazers, such as water buffaloes. They may graze in reedbeds throughout the year (perhaps less in winter at sites with harsh winters when the water temperatures are low and food quality decreases). They create habitat mosaics with seasonal grazing (buffalo wallows, 'corridors in reedbeds', pools and patches of heavily, lightly, and non-grazed reedbeds).

The 'blue-zone' of Scandinavian wetlands also relies on grazing with a fluctuating water regime. The annual drawdown allows summer grazing into the reedbed margins. Winter flooding then re-establishes open water between the reed and grassland. A transitional habitat from grassland or marsh through open water to reedbed is created. This can provide a dynamic reedbed edge that is good for fish, amphibians and bitterns. Similar patterns are observed at Lake Mikri Prespa (north-western Greece) where the 'blue-zones' are covered by low-growing herbaceous plant species typical of wet meadows (see Plate 5.10). The latter are created and maintained by water buffalo and cattle with rotational seasonal grazing at medium–high densities around several littoral sites. A preliminary comparison of sites treated by (1) grazing by buffaloes, (2) summer reedcutting and grazing the aftermath and (3) summer and autumn reedcutting, showed that after three years, the first method was the most effective in controlling reeds and creating open habitats. Previously these sites were dominated by dense and high reedbeds. Additionally, the site grazed by buffaloes had higher concentrations of feeding birds, such as pygmy cormorants and heron species than sites managed by other means. The ongoing actions (LIFE project – see Appendix 1) aim at the restoration and maintenance of wet meadows at Lake Mikri Prespa. They are of major importance for the conservation of key-species (eg Dalmatian pelican, pygmy cormorants), while the re-breeding of glossy ibises in 2005 (after 35 years) may well be related to them (Society for the Protection of Prespa 2005).

Yannis Kazoglou, Society for the Protection of Prespa

Plate 5.10 Grazing by cattle and water buffalo creates a diverse reedbed-wet grassland zone at Lake Mikri Prespa, Greece.

In summary, grazing can be an effective management tool, either for successional renewal or for creating diverse habitat mosaics. The value of edge habitat in reedbeds is established (see above) and the use of grazing animals to create diverse 'edges' is clearly cost-effective and beneficial.

Scrub management

Invasion by scrub is probably the single biggest management problem in reedbeds. Neglect, or under management, allows the development of scrub on drier

Vincent Swinnen, Reserves Naturelles RNOB

Plate 5.11 Scrub removal in Prés de Grand Rieu wetland.

margins and disturbed areas. Willow and alder in particular flourish on wetlands, although others such as birch and bog myrtle can be a problem on some sites. They support important wildlife themselves, but progressive scrub development is generally disastrous for a reedbed and requires management by way of control (Plate 5.11). The most widely used methods of control are:

- raising water levels
- cutting and burning
- grubbing.

For further details, see Hawke and Jose (1996).

5.4 Restoration of reedbeds

Where reedbeds have become dryer , one of the simplest ways of rehabilitating such a site is to alter the hydrology by raising water levels. However, where raising water levels is not possible or has reached its limits, bed regeneration by removing the accumulated reed litter may be possible. This bed 'lowering' effectively returns the habitat to an earlier stage of the succession. This work may involve lowering extensive areas or creating features such as pools and ditches, or a combination of both.

Rehabilitation by raising water levels

A key first step is an assessment of the site hydrology. This will identify control structures that can be installed or changed

Box 5.1 Water control structures.

Bunds
Bunds, or low earth banks, keyed into an impermeable substrate can be used to retain water. Using bunds it is possible to create tiered wetlands that have a constant flow as water moves from a higher input source, through compartments, to the outflow. Bunding also permits the retention of winter floodwater, thus reducing the flood risk in other areas and offsetting to a degree the summer moisture deficit. Construction follows the same general principles as dam construction, but is less complicated and relatively cheap. Bunds should be set well back from the edges of drainage channels to prevent slumping and reduce seepage.

Dams
Dams are often constructed in drainage channels to retain water within isolated hydrological units. Creating compartments with independent water level control allows greater flexibility in managing sites. Dam construction is easier using clays and loams. Clay and loam dams can be used effectively across channels up to five metres wide. Peat will only make satisfactory dams if well compacted and the maximum width is less. In general, the basal width of a dam should be five times its height. The top of the dam should be level and at least 500 mm above the normal water level.

Sluices
Sluices can perform the same function as dams, but are designed to permit controlled through-flow so that the water levels can be regulated. There are four main types:

- Pipe sluices – cheap (£50–200/€70–280) easy to install and an effective method of precise water level control, but capable of moving only low volumes of water. They consist of ribbed, plastic pipe, with an adjustable right-angled bend unit, incorporated into an earth bund or dam. (Plate 5.12 and Figure 5.3)
- Dropboard sluices – simple structures comprising a series of boards that drop into a grooved spillway. Water levels are adjusted by inserting or removing boards. Medium priced (up to £1,000/€1,400). (Plate 5.13)
- Lifting gate sluices – characteristic of older water control systems, they are unpopular as precise control is impossible. They work on an 'all or nothing' principle.
- Tilting weir sluices – very effective at precision water level control but are expensive.

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Plates 5.12–5.13
Pipe sluice (top)
Dropboard sluice (bottom)

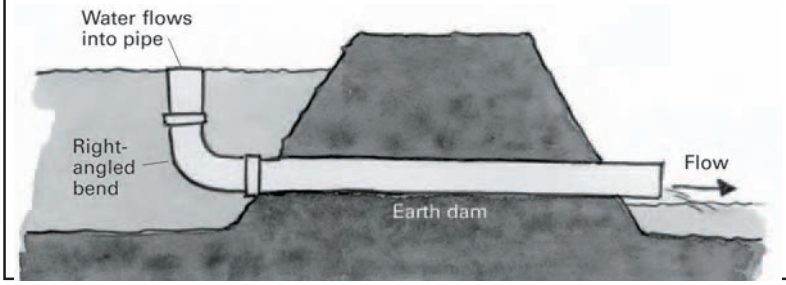

Figure 5.3
Diagram of a pipe sluice.

to facilitate higher water levels. Levels may have dropped because of abandoned sluices, diversion of supply or water abstraction. Reinstating the supply and holding water to a level above the reedbed surface will extend the life of the reedbed (but see earlier section on water regime). Plants that have invaded the dry reedbed will die off and further colonisation by scrub will be prevented, although well established willow and alder may tolerate the flooding. Reed should flourish, although initially sudden changes in water regime may inhibit reed (Haslam 1970). However, it should recover and quickly re-establish.

Although raising water levels may benefit the reed and associated wet reedbed species, careful consideration must be given to the potentially damaging effects on other taxa. Raising water levels in a long-established reedbed may be extremely damaging to invertebrates that inhabit older reedbeds with abundant litter, and to the botanical communities of reedfen. It is therefore crucial to

Box 5.2 Raising water levels at Vejlerne, Denmark.

Vejlerne is situated in northern Jutland, Denmark and at 5,500 hectares is one of the largest nature reserves in northern Europe. It consists of approximately one-third shallow wetlands, one-third brackish water meadows and one-third reedbeds. The wetlands of Vejlerne are bunded; floodgates allow water to drain from the shallow wetlands, primarily to further local agricultural interests. However, at the reedbed areas at Tømmerby Fjord and Bygholm Vejle bunds (dykes) have been mended and floodgates secured over the years in order to maintain high water levels. Contrary to this, the reedbeds at Selbjerg Vejle and Glombak are often exposed to low water levels, providing Vejlerne with two contrasting areas to study how the bittern population is affected by water levels.

Bitterns are counted by mapping all the booming males in a specific area in a count, with counts repeated several times during the breeding season. Over the years, it can be seen that males are very faithful to their respective territories. Only with changes in water level or unstable weather conditions are movements of territories seen.

The results have shown that bitterns are dependent on a high and relatively stable water level in the reedbeds. The advantage is two-fold. It enables foraging close to the nest site and provides security for the nest against mammal predators, especially foxes, which breed on the bunds. On the other hand, falling water levels in spring are critical. In Selbjerg Vejle, where March water levels are often high, there are frequently high numbers of booming males early in the season. However, if the water levels fall considerably, many birds leave the area. For example, in 2000, the water level fell by about 40 cm from the middle to the end of March, bringing the number of booming bitterns down to seven from the initial 21, with the remaining birds located in the outer margins of the reedbeds, close to the open water. In the areas of high water level, the males boomed throughout the whole width of the reedbeds and the population stayed stable throughout the breeding season.

The results have also shown that new birds appear to arrive in the beginning of April, but that many of these seem to be 'bad boomers'. They are also located in the inner margins of the reedbeds close to the bunds, which are poor territories owing to the greater risk of predation. It is suggested that these 'bad boomers' are immature birds.

At Bygholm Vejle, the main bund (Krapdike) was mended in 1994, thus securing a high water level in the reedbeds. In addition, all commercial harvesting of reeds was stopped in the reserve. The population of bitterns has grown markedly since then, from around 50 to around 200 boomers. Increased breeding success in the growing population at Bygholm Vejle has allowed young birds to populate other sites in Vejlerne, giving the site a key role within the area. It is concluded that the breeding potential of bitterns has been fully utilised at Vejlerne.

Contributed by Henrik Haaning Nielsen

Plate 5.14
The reedbed and wet grassland habitats at Vejlerne, Denmark support up to 200 booming bitterns.

understand the wildlife value of a site before implementing water regime changes. In addition, there is a limit to which levels may be raised before undesired flooding occurs eg of neighbouring land. Periodic exposure of the litter layer to air also facilitates decay (see above), reducing the bulk of the detritus.

Water levels are controlled by the rate at which water enters and leaves the site. The principal techniques are as follows:

- controlling water with structures such as pipe, drop-board or lifting gate sluices
- bunding or damming an area to raise levels (see Box 5.1).

A number of German LIFE projects have involved rehabilitation by raising water levels. At Rambower Moor and Lake Dümmer in Lower Saxony (see Case studies 7.8 and 7.10), adjustable weirs have been used to control water levels. In the UK at Leighton Moss and Minsmere, water levels were raised to reduce the effects of many years of litter build-up and silting, increasing the area of wet reed (see Case study 7.3). In the Hortobágy National Park, Hungary, an ambitious LIFE project aimed to restore the natural water regime to an area of 10,000 ha (see Case study 7.9). Raising of water levels at Vejlerne, Denmark (see Box 5.2) has successfully increased bittern populations.

Management by bed lowering

Bed lowering by excavation is relatively quick, not labour intensive and the result can create a varied open water/reed mix. Bed lowering involves the removal of accumulated surface litter above the rhizome layer, generally around 20–30 cm. This lowers the surface of the ground, increases wetness and promotes a strong growth of reed from the rhizomes. With deeper excavation, removing rhizome, open water can be created. If a strong re-growth is required, care must be taken to avoid frosting, crushing or flooding of the rhizome. However, a patchy re-growth of reed can form an interesting reed/water mosaic. Additional pools and channels can be incorporated into lowered areas while the machines are on site.

The average cost for bed lowering is around £10K/€14K 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.

Bed lowering has been particularly successful at Minsmere, UK (see Case study 7.3) in increasing the bittern population. Bed lowering was also undertaken in the Bassin de la Haine, Belgium (see Case study 7.2) and at the Ilperveld, the Netherlands (see Box 5.4, p.92). At Leighton Moss, UK, the very soft nature of the substrate and likely damage to rhizomes, prevented repeated tracking over the bed by machines. The litter layer was dug and put into piles by an excavator, then macerated and put into a concrete pump on an adjacent machine and pumped off the reedbed to a deposition site (see Plate 5.15).

One of the questions that is often raised is the impact on other organisms of these drastic management measures. There is no doubt that as reedbeds move along the successional gradient to fen, carr and wet woodland they become richer in plant and animal species (Friday 1997, Friday and Colston 1999) but this will be at the expense of the specialist early succession species. It is important that the work is

Plate 5.15 Bed lowering at Leighton Moss, UK.

Graham White

undertaken on a proportion of the site only and that later successional stages are still represented around the edges of the reedbed. It is the early successional stages that require positive management intervention if they are to be retained in this condition.

Bed lowering is probably a good imitation of the natural processes that would normally maintain or create early successional reedbeds. In natural floodplains reedbeds would develop as vegetation encroached on oxbow lakes, meanders and backwaters and in ungrazed fields. Some reedbeds would continue to develop to carr and wet woodland but in others catastrophic floods and ice flows would periodically set the succession back; a process perhaps rather similar to the intervention of machines in highly managed systems.

Creation of open water

The creation of pools and ditch networks within a reedbed can be highly beneficial for bitterns, where such features are lacking. In addition, the re-profiling of existing steep banks can enhance the reed/open water interface, creating wetter margins and allowing fish into the reedbed. Such work has been undertaken at the Catalonian Marshes, Spain and in the UK. It is also applicable to fishpond habitats (see below). Typical designs and profiles are shown in Figure 5.4.

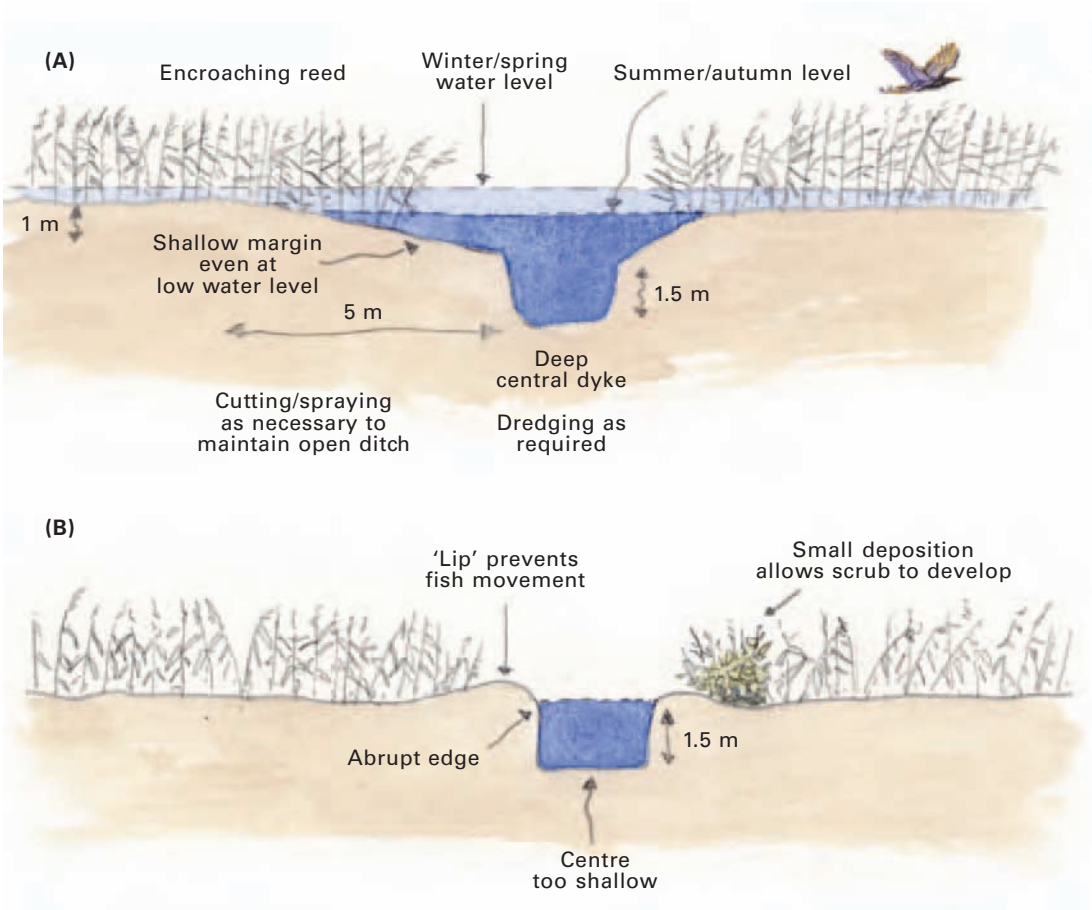

Figure 5.4 Typical ditch design and profile. (A) Suggested ditch profile with required management (B) Poor ditch profile

5.5 Creation of new reedbeds

The creation of new reedbeds for wildlife has been a priority for conservation action in the UK in recent years. By 2005 at least 1,000 ha of new reedbed had been created, or was in the process of creation. Much information has been generated on reedbed design and establishment. Work on the ground combined with continuing research into particular aspects of reedbed or species ecology, has continued to add to our knowledge and experience.

New reedbeds may be created in a number of situations. Where water levels can be restored, reedbeds may be created on previously drained agricultural land (see Case study 7.4). In some areas, where the land topography is ideal, simply raising water will allow reedbeds to develop. In others, structures such as dams and bunds, and reedbed features such as pools may need constructing. Mineral extraction provides a major opportunity for wetland, and therefore reedbed, creation. New sites may be designed with reedbed in mind, or older sites may be re-worked to create suitable habitat. Wider floodplain restoration also provides opportunities, often in combination with mineral extraction.

The ideal design for new reedbeds

Research in the UK, where fish is the main food, has shown that a new reedbed designed primarily for bitterns should aim to provide:

- open water 25–30%
- wet reed 40–50%
- dryer reed 15–25%
- scrub 5%.

Wet reed should be within 30 m of a pool, or ditch connected to a pool, and have a water depth of up to 1 m but a minimum spring water depth of 20–40 cm. Some wet reed further away from pools and ditches is ideal as bittern females look for habitat that is not going to dry out when choosing nesting areas. Where the reedbed is distant from similar habitat, at least 20 ha should be created. Smaller areas may be considered within wider wetland landscapes.

The design should aim to provide extensive areas of water around 1 m deep in spring, with fewer deeper areas to 2.0 m. Open water pools are better for fish than ditches and channels. Although edge is a very important feature, it is better to increase the length of reed/water edge by creating a more complex pool edge, with channels coming from a pool; rather than creating lots of linear channels.

Landform gradients between 'zones' eg open water to wet reed, should be gentle (around 1 in 40). However, variability is valuable and all stated depths should be treated as averages. Any given

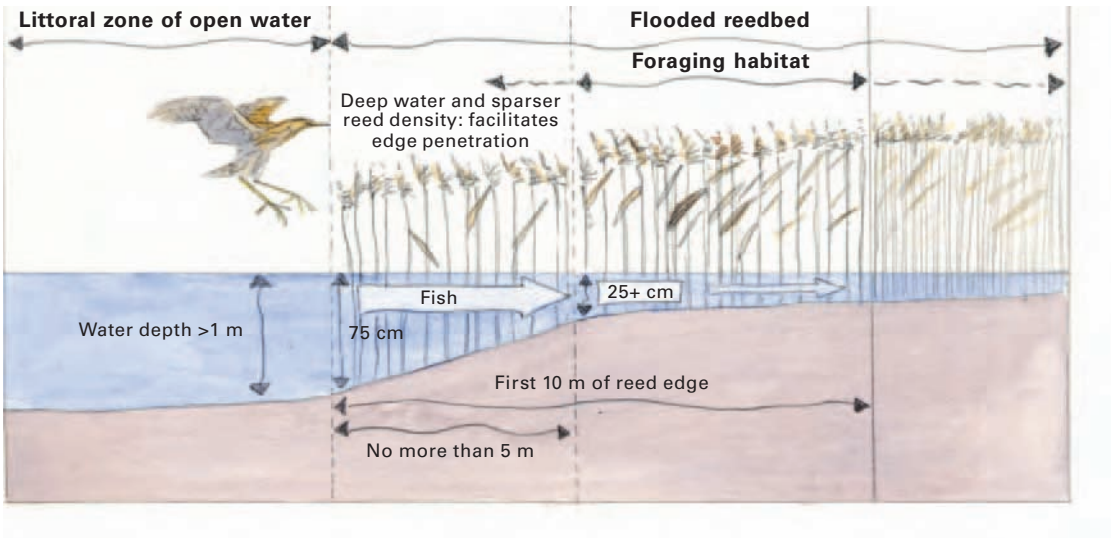

Figure 5.5 Suggested reed edge profile to facilitate the penetration of fish into flooded reed edge and the foraging habitat of bitterns.

zone should contain 'roughness'. For example, the open water will on average be 1 m deep but in practice have shallower bars and deeper gullies. Connectivity of water bodies is crucial to allow flow and fish movements (see Figure 5.5).

Where future management requires access for cutting, reed areas will need to incorporate access connections, with some loss of random variability. This may be compensated for by the creation of a regular 'ridge and furrow' landform, with peaks of the ridges at c10 m spacing. This will create variability in water levels across the reedbed. Designs need to take account of future needs to show people birds through considering edge design and visibility of waterbodies.

Nutrient levels in the resultant reedbed pools should ideally be low. When landforming new reedbeds sub-soils should be used rather than nutrient-rich topsoils. It may be necessary to 'flush through' newly created sites in order to remove elements released because of the earthmoving. In addition, consideration should be given to the water source and the possibility of removing excessive nutrients prior to input.

Reedbed establishment

Several techniques are available for establishing reed; all have advantages and disadvantages. Each site needs to be assessed and the techniques chosen on a site-by-site basis, with water level and degree of control (as well as the time of year) often determining the technique used. The techniques include:

- natural regeneration
- sowing seed
- planting seedlings
- planting cuttings
- spreading rhizomes
- turf transplants.

Whichever technique is employed, it is not necessary to 'plant up' the whole site. Planting a nucleus of reeds in an area with good water level control creates a source of reed that can spread out into appropriately managed areas. Expansion rates vary greatly from 1–10 m/year. The rate of expansion is likely to be affected by temperature, water depth and competition. Where reed is present in adjacent ditches natural colonisation can be rapid, especially if aided by turf transplant.

When establishing reed, consider the source of the material – seeds, rhizomes and shoots. Ideally, material should come from the site itself. If this is not possible then from some other similar local site. Planting reed taken from local sites with similar conditions will be more successful. Shallow flooding allows the site's lowest areas to be identified. These can be marked out using canes and planted following drawdown. It may also be appropriate to use the techniques in combination.

Where there are existing stands of reed, in ditches for example, natural regeneration is the easiest and cheapest method. Creating the appropriate conditions and allowing reed to colonise will often produce the most 'natural' looking result. However, it may take longer and the final effect is less predictable.

Natural regeneration of reed is also an issue in many Baltic states. Changes in agricultural economics are leading to reduced or no grazing of meadows. This allows reed to regenerate. Although this may contribute to an increase in bitterns, it is at the expense of the rich diversity associated with the meadows, and is therefore undesirable (see accounts for fenland in Lithuania in Appendix 1).

Seed sowing. Hand sowing of prepared reed panicles (generally cut into 1–2 cm pieces) is currently the only available practical option. It requires careful ground preparation to ensure good soil/seed contact and to reduce weed problems, good water level management and the collection of large numbers of panicles. Where these conditions are met, sowing can be a very cheap and successful method of establishing reed. The following factors need to be considered:

- Seed viability within the panicles should be tested before sowing.
- Sowing should take place in still wind conditions.

- Soil should be saturated but not flooded, long pre-flooding may be advantageous. This saturation needs to be maintained as seedlings are very prone to drying in the early stages.
- Bed should be flat and free of vegetation.
- Sowing should take place in May/June, ensuring the daytime temperatures range from 10–25°C and nights are frost free. Pre-germinating on a heated mat may give more flexibility with timing.
- Panicle fragments should be pressed gently into the seedbed to ensure good contact. Rollers are rarely suitable, instead compression boards or trampling should be used.
- Mixing the panicle fragments in a carrier such as silver sand can be beneficial when sowing.

Planting seedlings. Planting out pot-grown seedlings of known origin is the most widely used method of establishing reedbed, though it may also be costly and labour intensive. Planted out seedlings are more able to compete and survive adverse weather conditions. If the bed conditions are suitable, success rates are close to 100%. Buying nursery-grown material is expensive, although costs are reduced if buying in bulk for large-scale projects. For large-scale planting it may be more cost-effective to grow your own (Plate 5.16).

Pot-grown material can be planted out by hand using a dibber to create a hole of sufficient size. Individual seedlings are usually planted at densities of 1–4 m^{-2}. At the higher density, planting time is approximately 540 person hours ha^{-1} (Mills *et al.* 1999). Mechanical planting is currently at an experimental stage. It is best to plant in June, as early as possible after the frosts have ceased. Planting any later leaves plants vulnerable to competition. Water levels should be at or just above the soil surface. An alternative option may be to plant big seedlings late in the season after competition has been controlled.

The RSPB

Plate 5.16
Growing reed seedlings in a polytunnel, Langford Lowfields, UK.

Andy Hay/rspb-images.com

Plate 5.17
Reed planting at Lakenheath, UK.

Where good water level control exists, bed preparation is less important, as water levels can be used to discourage most weed species (although an initial topping of existing vegetation is beneficial). Seedlings less than a year old can tolerate water levels up to 200 mm above the topmost shoots, but only for short periods. Under ideal conditions, reed is likely to out-compete other species but some areas of mixed vegetation should be seen as beneficial.

Planting cuttings. Stem cuttings are easily cut and planted but have widely differing success rates, often very low. This approach is limited to a short period of the year. A donor area of 100 m2 will yield around 100,000 stems. Stems should be cut cleanly with scissors or a grass-hook in May and June with as many nodes as possible retained. Cut stems can be stored in water but should be planted on the

Andy Hay/rspb-images.com

Plate 5.18
Volunteers reed planting at Lakenheath, UK.

same day if possible. The bases should be planted into water. A hole can be pushed into the soil with a metal rod with a diameter slightly less that the stem and at least two nodes pushed in.

Transplanting rhizomes, either by spreading rhizome-rich soil or using turves, can be a quick and successful method of establishing reed. It has the added advantage that litter and soil invertebrates are introduced to the site together with plants that may be of conservation value. It is most useful on project sites where donor material is located close by.

Spreading soil containing rhizomes involves the transfer of the top 300–500 mm of an existing reedbed to a prepared recipient site. Rhizome-rich soil is often excavated during the maintenance of drainage channels and can be used for this purpose. The following points should be considered when using this technique:

- The soil should be spread at least 250 mm deep.
- The soil must be moist and must not dry out, but equally should not be saturated as bare rhizome fragments need to have some contact with air.
- Soil manipulation should be minimised to avoid damaging rhizomes and the material should not be stored for long periods.
- Excavation and spreading should ideally be carried out in the winter, but avoid frost on exposed rhizomes. Excavation should be to just below the rhizome level; the depth varies according to the site.
- It may be necessary to pre-excavate the recipient site to achieve desired water levels and easier future management.

Spreading rhizome-rich soil in this way is only really practical over small areas as 2,500 m^3 of material is required per hectare. Transportation costs over long distances are also prohibitive. Alternatively, loads of excavated rhizomes can be dumped at 10 m intervals, ie 100 ha^{-1} across the proposed reedbed area.

Cutting turves as complete rhizome mats decreases damage and reduces the volume of material to transport. This technique can be very successful. On a small-scale, turves can be cut by hand with a spade, but for large-scale projects diggers with buckets capable of digging 1 m × 1 m turves are required. The same equipment is used to cut the recipient hole. The spacing of planting depends on the size of the turves and the desired rate of spread. The following points are important:

- Larger turves contain more undamaged material and will establish a reedbed more quickly.
- Water levels may be from just below the surface to up to 500 mm deep providing turves have long, intact reed stems attached.
- Bed preparation is less critical, providing flooding is immediate to suppress competition.
- Where large machinery is already on site for landforming, the positioning of rhizome turves at the end of the process can be a cost-effective and efficient method of starting reed establishment.

Reedbed protection. The first season after sowing/planting is the most critical for reed survival with drought, weed control and wildfowl grazing all being important factors. Problems can be very costly to resolve in terms of money and delays to reed establishment.

Lee Valley Regional Park Authority

Plate 5.19 Protecting reed seedlings from grazing by waterbirds is usually required, Lee Valley, UK.

It is necessary to protect the establishing reedbed from competition with other plants and from grazing animals in the first year. Newly-sprouted reed is eaten by a variety of grazing animals, eg geese, coots, deer, rabbits and livestock, and this can seriously inhibit reed growth/ expansion. Some form of fencing is essential (Plate 5.19). Plastic netting with tape stretched across the enclosure has been successful at some sites to protect new plantings from grazing, but needs to be combined with regular human disturbance of the site. At other sites, complete cover with netting has been required to keep birds such as coot out of the enclosures. Other possible solutions include minimising the area of open water in the early stages to reduce attractiveness to water birds, as well as bird scaring devices such as rook scarers, plastic bags on tall sticks etc.

5.6 Wider habitat issues

Fishponds

Fishpond complexes are an important habitat for bitterns and other wetland birds, especially in eastern Europe. Problems of intensification of use, resulting in loss of marginal vegetation, poor edge profiles and the input of chemicals has lead to degradation of many sites. The issues involved in resolving the problems are essentially the same as for reedbeds in general; the need to maintain ideal water regimes (particularly during the breeding season), good reed management and maintaining diverse open water/reedbed habitat (sse Case studies 7.15 and 7.16).

A number of projects have focused on fishpond complexes and have looked at reaching agreement with fishpond operators on good environmental management. In Bavaria, Germany, purchase or lease of fishponds has been used to develop contracts with the operators. The contracts require maintenance of an agreed percentage cover of reed on the pond, the water regime, limit inputs such as fertilisers and artificial feeds. In addition, one-off measures to re-profile steep edges and encourage the regeneration of reed, perhaps through planting have been undertaken. Schemes for managing fishponds in a sustainable manner have also been developed in Upper Waldviertel, Austria. Overall, the development of an environmental code of practice for fishponds would be beneficial (see Case study 7.17).

Floodplain restoration

Wider floodplain restoration may bring multi-functional benefits, from flood defence to recreation and nature conservation. It also has a role in conserving reedbeds and bitterns.

The Skjern river valley in Denmark has a history of river canalisation and land reclamation. In 1999, a LIFE project commenced to restore 2,200 ha of the river valley with construction completed by 2002 (see Case study 7.5). The old river course was re-excavated and the canalised ditches infilled. The resulting habitat is largely meadows but includes around 75 ha of reed and extensive areas of shallow wetland. In other areas in Europe, the connection of floodplain gravel pits to the river has been undertaken (eg Tisza, Austria, Gelderse Poort, the Netherlands/ Germany) (Plate 5.20). This has created some excellent wetland habitat but not always ideal for bittern due to fluctuating water levels and a poor retention of water in reedbeds during the summer.

Graham White

Plate 5.20 Birders viewing seasonally flooded grasslands in the Gelderse Poort, the Netherlands.

Box 5.3 Bitterns in the Gelderse Poort.

The Gelderse Poort is situated in the Lower Rhine Valley at the start of the Rhine Delta, where the river splits into several tributaries. The area covers some 214 km^2 along the German-Dutch border. Nearly one third of the area consists of river-forelands, the remaining two-third being protected from flooding by bunds (dykes). The area has been declared a SPA, partly because of the marsh habitats and its bird populations, including bittern. Although most of the area is in agricultural use, some 1,750 ha of open water and semi-natural marsh vegetations is present. Most of the marshes are found in former river branches, isolated as a result of river works to shorten and deepen the river for navigation. Shallow clay pits form another major element, mainly excavated in the period 1900–1960 and often managed as nature reserves since. Currently, marshland is increasing because of ground level lowering works in the river forelands, aiming at reducing the risks of extreme high water levels as well as restoring natural riverine habitats. However, the Gelderse Poort demonstrates that maintaining reedbed quality in an area where different demands are made of the water environment is not easy.

Some decades ago, the Gelderse Poort was among the most important areas for marsh birds in both the Netherlands and Germany. The Rijnstrangen and Ooijpolder sites, both in the Dutch sector, held large populations of many typical species. During the first large-scale breeding bird surveys in the 1970s, some 50 pairs of bittern (10% of the Dutch population) were recorded. Other nationally important numbers included 20 pairs of little bittern and 80 pairs of great reed warbler. Since then, the populations of most marsh birds including bittern have almost vanished. The causes for this are various. The first areas to deteriorate, were the river forelands. Due to modifications of the river and intensified drainage in the wider catchment, spring water levels have become more irregular and summer water levels have declined by around one metre during the last century. As a result, willow carr, or grasslands (depending on grazing intensity) largely replace the reedbeds. Similar processes have caused bittern to disappear from nearly all river forelands in the Netherlands. Newly created marshes in nature restoration sites have shown to rapidly develop a great importance for many waterbirds. However, in general, the water regimes are too dynamic to maintain a long-term interest for reedbed species.

The marshes in the Ooijpolder are found in clay pits as well as former river branches. Water levels partly follow river levels via ground water flow, but are more constant then in the forelands. Drainage of the surrounding agricultural areas has resulted in average water levels being lowered by a metre since 1965. Although some attempt is made to maintain high water levels in the marshes, water seeps via underground sand layers to the surrounding drained land. This has increased natural succession rates and reed has largely been replaced by willow. Frequent clearing of clay pits, aimed at restoring reedbeds, has only slowed down the decline. Up until 1978, the Ooijpolder held about 25 pairs of bittern. The severe winter of 1978/79 caused a dramatic decline to 5 pairs, from which the species did not recover. Since 1990, the population has declined further to 0–3 pairs in recent years.

The Rijnstrangen are a complex of former river branches. Up until 1970, these branches were connected to the river and thus followed natural water levels. Since 1970, the area is isolated from the river and a pumping keeps the water levels artificially low for agriculture. Reduced dynamics resulted in increased reed vegetation at the start and an increase in the bittern population during the 1970s. However, continued lowering of water levels resulted in a rapid build-up of reed litter and succession to willows and other vegetation. Nowadays, most of the area is covered with dry reedbed. The bittern population was stable at 25–30 pairs until 1990, but decreased sharply since.

In 2004, no bitterns boomed at either Ooijpolder or Rijnstrangen. Strong protests from several organisations ('Aktie Roerdomp', Dutch for 'Bittern Campaign') pushed the water-board to increase water levels in the Rijnstrangen by 25 cm during spring. This increased the area of wet reedbeds to 20 ha. This has resulted in higher breeding numbers of several species in 2005, including three breeding pairs of bittern.

However, in both Rijnstrangen and Ooijpolder, further measures are needed in order to get bitterns and other marsh species back to a sustainable population size. In both the Ooijpolder and Rijnstrangen, patches of agricultural land within nature reserves are taken out of production, which will allow higher water levels and the restoration of natural dynamics. Some of this land will revert to marsh. However, a more drastic improvement in water levels is required for a further recovery. The water-board and other responsible authorities have the task of improving water management, better balancing the interests of nature conservation and agricultural interests.

Contributed by Frank Willems, SOVON Dutch Centre for Field Ornithology

5.7 Manipulation of food supplies

Food supplies are clearly essential to maintaining bittern populations within an area. The variety of prey is wide and depends considerably on site and location (see Chapter 2).

Fish

The reed/water interface is crucial for feeding bitterns. The reedy fringes must allow access and provide shelter for fish whilst at the same time provide foraging habitat for the birds. Cyprinid fish typically exhibit seasonal variations in distribution and habitat use. Adult fish generally gather in deeper, more enclosed waters during the winter months. In the spring, more open, warm, vegetation-filled shallows less than 1.5 m deep are important for spawning and sheltering fry. Fish may also exhibit diurnal variations in distribution, using the littoral zone more by day and open waters more by night.

Fish biomass and abundance is generally greater in shallow open waters and lakes than in reedbed/ditch systems. Therefore, reedbeds will ideally contain or be adjacent to plenty of open water with abundant aquatic plants. Pools within reedbeds are preferred to ditches, although deep ditches may be useful winter habitat. Connectivity is vital to allow movement between seasonal habitat preferences and to ensure recruitment. Overall, diversity in underwater structure, with variations in bed depth and deeper refuge areas, are important to ensure microhabitat preferences between fish species, and seasonally within species, are met. Where new reedbeds are being created, artificial underwater habitat in the form of rock piles or log-jams may be created.

The introduction of fish into newly created sites requires careful consideration, not only of the range of species typical of the location but also the ease and availability of natural colonisation (Plate 5.21). Stocking is not a sustainable solution, but where the wetland design has provided all the habitat types required for the life cycle, the seeding of locally appropriate species to establish a breeding population could be considered.

Amphibians are also a major prey item in many areas (Plate 5.22). In continental Europe, floodplains may support a diverse amphibian fauna. The principal limiting factors for most species are probably the flooding or drying of breeding pools, and predation by fish. Ideal situations would include a number of separate fish-free pools, with good water quality, within wider wetland habitats. Where pools may be flooded, introducing fish, late summer drying to remove them may be beneficial. The 'blue-zone' management of Scandinavian countries, where grazing of reedbed margins can create pools inaccessible to fish, provides excellent amphibian breeding habitat. Where bitterns are feeding mainly on amphibians, large areas of open deep water are not necessary.

The RSPB

Graham White

Plate 5.21 (left) Releasing fish at Rye Meads.

Plate 5.22 (right) Marsh frog.

Box 5.4 Improving habitat structure and food availability for the bittern in the Netherlands.

The Wormer – and Jisperveld is a nature reserve situated 15 km to the north of Amsterdam, the Netherlands. Formerly a raised bog in a brackish environment, it was drained in the Middle Ages and was surrounded by a dyke enabling drainage to change the vegetation to grassland. The reserve supports grassland (1,400 ha), reedbeds (100 ha) and water (500 ha). The drainage and subsequent erosion of the ditches has led to a mosaic of isolated parcels of land, surrounded by broad ditches. Due to high water levels and poor access, only low-intensity farming was possible, but was very beneficial for grassland breeding waders and duck. However, around 25 years ago, the numbers of breeding waders dropped, notably species like ruff, snipe and black-tailed godwit. For this reason, Natuurmonumenten, a Dutch non-governmental nature protection organisation, started buying land in the polder in order to be able to manage the area. The intensification of agricultural use, especially intensified drainage of the island-like grassland parcels, was suggested as a reason for the decline. Therefore, the internal drainage over 50 ha was completely stopped. This resulted in increased inundation of the grassland in winter and spring. The number of breeding waders stabilised and some species even increased.

An unexpected side-effect was a positive response by the bittern, as the wet grasslands became a favourite feeding ground. It appears that the abundant frogs are an important food source. To improve the food situation even more, it was decided to mow dry reedbeds in an irregular pattern to leave patches of high vegetation. Voles and mice prefer situations like this and bittern prey on these small mammals, especially in autumn and winter. There was also a severe lack of breeding locations for bitterns, with only 2 ha of the 100 ha of reedbed in the polder judged as suitable for nesting sites. The rest were already in an advanced stage of succession and had become too dry or were already changing into woodland. It was decided to increase the number of potential breeding sites by digging out dry reedbeds (bed lowering). The successful management has led to a spectacular increase in bitterns, from one pair breeding irregularly in the 1990s, to 15 booming males in 2003. Remarkably, these bitterns are thriving in small wet reedbeds amongst a wider wet grassland habitat.

Nearby, in the Ilperveld, a nature reserve managed by the Foundation for the North Holland Landscape, there were similar problems, notably a shortage of young reedbeds. The existing reed vegetation was old and hypertrophic. Bed lowering was undertaken to create the right conditions for the development of young reed. Material was removed from above the reed rhizomes, with shallow water levels of up to 20 cm resulting. After 3–5 years, there is a considerable re-growth, these young reedbeds acting as a foraging and breeding ground for the bittern. Water quality was also an issue. Aquatic vegetation is essential as a foraging ground for the bittern because of the fish, insects and other fauna that it attracts. Yet the high levels of nutrients in the water had resulted in excessive growth of algae and very turbid waters. Typical prey species, such as first-year individuals of roach and Rudd become less abundant in these unfavourable conditions. Removing the surplus eutrophic material by dredging and incorporating it into a fertiliser, and isolating the small waters from hypertrophic water through specially designed tilting weirs that do not restrict the passage of small boats and skaters are the key actions within the restoration plan.

Contributed by Cees de Vries and Jan van der Geld (Wormer and Jisperveld) and Ron van 't Veer (Ilperveld).

Jan van der Geld

Plate 5.23 Small pockets of reedbeds can provide bittern nesting sites within extensive wetland habitat, Wormer and Jisperveld, the Netherlands.

5.8 Wintering habitats

Wintering sites are crucial to the survival of individual birds. Wintering requirements are less exacting than during the breeding season. Small sites that have a good food supply and at least some cover in the form of wetland vegetation may be occupied. Management of small sites for wintering birds should therefore be seen as important even if breeding is unlikely.

Many of the same management issues will be involved: appropriate water levels and a good vegetation cover giving access to prey species. Lakes may be improved as wintering habitat by creating shallows to allow reed to develop. In many cases, existing reed on shorelines becomes overshadowed by trees, management to allow more light to the reeds is beneficial.

6 PARTICIPATION AND COMMUNICATION

6.1 Introduction

Communicating and awareness raising is an important component of a project. The success of nearly all projects depends upon the support of local decision-makers and residents. It is important to be clear about why, when and how you approach which organisations and people; also to be honest about what you want people to do and what you can offer. One useful way of thinking about these issues is to use Sherry Arnstein's ladder of participation (see below). She was writing in 1969 about citizen involvement in planning processes in the United States. This is a simplified version of the model to make it more applicable to conservation projects. *It is not that any one step is necessarily better than another – each is appropriate in different circumstances.*

To illustrate the ladder…

Projects provide an excellent opportunity to raise awareness about Natura 2000 and the value of biodiversity. There may even be a specific education component eg developing materials for use in schools. Opposition to a project from local people can seriously delay its implementation or even stop it going ahead. It is therefore very important to inform local agencies and find out what consents are needed at the very start of the planning stage. At the same time, local people may need to be informed of the project's objectives and results in order to allay any concerns. This will highlight any potential stumbling blocks – such as fears about increasing flood risk – and allow the project design to take these into account (see Case study 7.6). Consultation/information can also bring positive results. Local people have an invaluable knowledge of the area and may be interested in volunteering or fund-raising. Local agencies can contribute expertise and funding and are more likely to do so as members of a partnership. Where land is owned by private landowners or by a commune, a project can only really succeed with the active participation of the landowners. In general, it is thought that the higher up the ladder people are, the more committed to and personally involved they will be.

The EC has recently published a report (*LIFE-Nature: Communicating with Stakeholders and the General Public – best practice examples for Natura 2000*) which focuses specifically on the wealth of experience of communicating with different stakeholder groups and the general public, gained through LIFE-Nature Projects. Its key message is:

'People need to be fully informed about the aims of Natura 2000 and actively involved in decisions over the future management of the sites. Not only will this help to dispel unfounded fears and mis-perceptions but it should also help to incite interest and active collaboration from different sectors of society.'

The aim of this chapter is not to cover the philosophy, principles and techniques of involvement and communication in any detail. There are many books and articles

Citizen control	Local people come up with and implement their own ideas
Partnership	Local people/organisations *participate* in decisions
Involvement	Local people/organisations have a direct 'advisory' role throughout the process but no control
Consultation	Local people/organisations are asked for their views, generally as a 'one-off'
Informing	Local people/organisations are told what is proposed
Education/ awareness raising	'Advertising' on general issues

devoted to this huge topic. Instead, this chapter will highlight some examples from LIFE projects, which specifically target the bittern. The bittern presents a particular challenge, as it is shy, extremely well camouflaged and spends most of its time in tall vegetation in inaccessible wetlands. It is quite easy to see why most people have never heard of bitterns, let alone seen one. So why should they care about its conservation?

Yet the experience of many LIFE bittern projects is that it is possible to increase support for bittern conservation, even amongst people who have never heard of them before. Below are illustrations of some of the processes and materials that have been used to do this.

Further reading

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6.2 Focus on Butorstar – French LIFE project

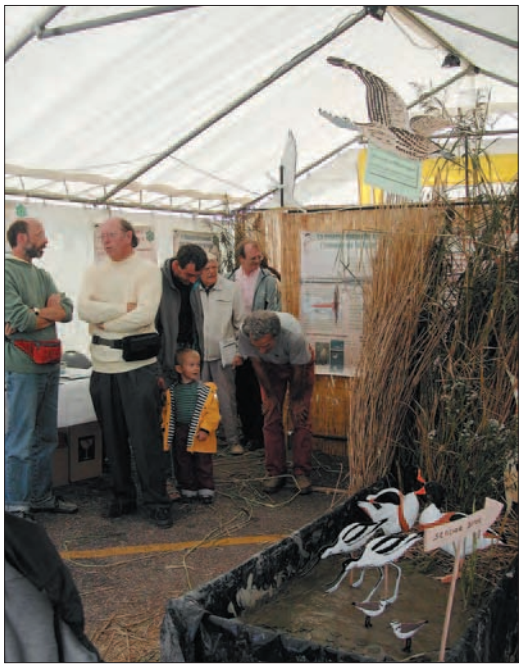
Reedbeds are multi-use wetlands. Grazing, reed harvesting, fishing, water fowl hunting and management for nature conservation are each associated with specific management practices that can interact at different levels. Wetlands are often owned, managed or used by many different people. These interactions – sometimes complementary, sometimes conflicting – can have long-term consequences for human exploitation of the wetland and its conservation value. In France, six wetland sites have been involved in a LIFE project (2001–2005) to improve reedbed management for the bittern (Plates 6.1 and 6.2).

It was realised that low awareness of the bittern and its ecological needs, amongst the general public, landowners and managers, is one of the barriers to the bittern's conservation in France. Several educational tools are being developed to address this issue, such as a pack for schools and a computer-based role-playing game called *Butorstar* (Plate 6.3).

This role playing game was designed to promote awareness about:

- the biological and hydrological interdependencies within a site and the interplay between them, which affects an area over time.
- the technical and socio-economic factors involved in the different reedbed uses
- the usefulness and limits of the negotiation process in reaching agreement on collective rules for reedbed management.

Using CORMAS software, the game allows people to simulate the mid and long-term impacts on reedbed management, which result from the decisions made by the players as farmers, reed harvesters, hunters and naturalists. The game takes place in a virtual landscape, representing an archetypal wetland. The wetland is divided into two estates – one privately owned and one publicly owned – which are hydrologically interdependent. So the decisions on each estate will affect the other. Each estate is divided into eight units. These units can be embanked by the players, if they wish to secure hydrological independence. Different water regimes are then proposed, each one being required for a particular wetland use. Land-use and



Maison De L'estuaire

Plate 6.1 (left) Public event in the Seine estuary.

Plate 6.2 (below) Raising public awareness.

Maison De L'estuaire

E. Kerbiriou

Plate 6.3 Butorstar roleplay in action.

water management decisions are made by the players at the level of both the estate and the hydrological unit. These decisions are inputted to the model for each year, recording the results of the negotiation process between the players. The impact of these decisions on wetland health and biodiversity (for example, presence of reed, reed density and diversity of birds) is simulated for different periods of time to assess the compatibility and sustainability of various practices over time.

This role-playing game has an educational objective, targeting:

a) secondary school pupils
b) agricultural and environmental engineering students.

However, it is also intended to use it in real situations to encourage dialogue between the different parties and to aid collective decision-making.

A participant's verdict on Butorstar

Jenny Parker, (Assistant Warden, the RSPB), attended a course on conflict resolution, which used Butorstar, at the Duchy College, Cornwall in October 2005.

'I attended the course with Andrew McDouall, English Nature (the national government agency for nature conservation). We were both very pleased with the outcome of the day. We were split into two groups; the first had interests on privately owned land and the second had interests on publicly owned land. We took on different roles – reedbed harvester (two players), a hunting group, graziers (two players) and a conservation NGO group (two players). Each year, each group would decide how to manage the habitat and the whole community had to come to some consensus about water levels. At the end of the game it was clear to us all that in order to manage the habitat so that all groups would have some level of success then there had to be a lot of information sharing, negotiation etc.

The course was really good fun and had a very interesting outcome. It was also very interesting to play the role of a group other than conservation. I would suggest that other staff involved in land management negotiations should attend this or similar courses. Andrew McDouall was so impressed that he hopes to ask the college to run the course for EN staff and other NGOs.'

6.3 The Bog-ox – German LIFE projects in Brandenburg

There is a German saying (and also British): 'ochsenstark', which means 'as strong as an ox' – that is to say 'very strong'. One of the local German names for bittern is 'Moorochse' or Bog-Ox. It was therefore a short leap of imagination to create the Bittern LIFE Project's motto: 'Moorochsenstark! Für unsere Seen!' – 'Strong like a Bog-Ox! For our Lakes!' To bring this motto to life, a friendly-looking, comical cartoon bittern, showing his human-like biceps muscle, was designed as the mascot of the LIFE Project Schorfheide-Chorin, (see below and p.98).

A folder of general information on the project was produced. This included a sticker with the motto and the mascot printed on it and a poster of a painting of the friendly Bog-Bull as a 'WANTED' poster, with facts on the bittern ecology and needs. Another Bog-Bull figure indicates the project sites with a pointer on a map, wearing a hat with the EC's flag on it. In addition, each of the main problems affecting the project wetlands, such as falling water levels, water pollution and disturbance by leisure activities, was illustrated by the friendly Bog-Bull obviously suffering. (See pictures.)

The cartoon Bog-Bull was also used in a Power-point presentation of the Project, which was shown at public information events. Here the biceps-flexing Bog-Bull illustrated the summary of the project results, highlighting the message that the project had not only been good for bitterns but had also brought benefits for people, such as:

- an improved water management regime
- cleaner lake water
- more attractive landscapes
- national and international publicity for the area
- improved nature tourism infrastructure.

The information material with the cartoon Bog-Bull received a lot of positive feedback from people to whom it was given and public relations and environmental education experts. An owner of a camping site in the area wanted to use it for his site's logo. In summary, the cartoon Bog-Bull was an easily recognisable and endearing mascot that improved the effectiveness of the LIFE project's awareness raising actions. It helped to win acceptance of many of the management measures.

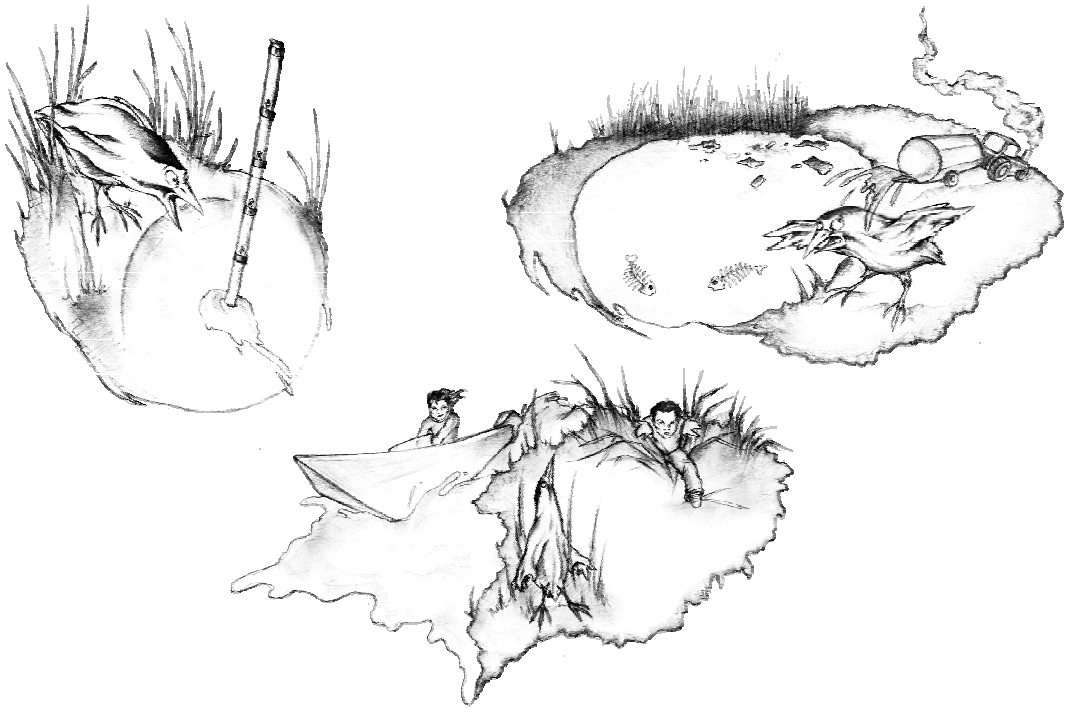


Figure 6.1 Cartoons of the Bog-ox, Germany.

Four Villages by the Moor and One Theatre

Rambower Moor is located half way between Berlin and Hamburg, in the federal state of Brandenburg. Between 1999 and 2003, the LIFE project implemented a number of actions to improve the ecology of the Moor. (see Appendix 1 and Case study 7.8) When the project started, local people knew little about the bittern and its ecological requirements. Therefore, much effort was devoted to building up relationships with the local community to gain their support for the proposed conservation measures and Natura 2000.

A communication strategy was devised which included several elements:

- Two working groups were established: A technical group, with academics, planners, hydrologists, ecologists and local people with relevant training, which came up with solutions to difficult technical problems and drew up the management plan; a second group of 'local interests', which included local mayors, land owners, farmers, reed cutters and anglers and addressed socio-economic concerns. Joint meetings were also held to ensure mutual understanding and both groups approved the final management plan.
- Information panels: five panels, each with colourful drawings on a particular theme (eg large copper, otter, etc) were designed to attract visitors as well as local people. The bittern's silhouette was cut in the frame of each panel. The location of the panels was carefully chosen so that they also became a form of 'landscape' art (Plate 6.4).

Jochen Purps

Plate 6.4
Information board at Rambower Moor.

Jochen Purps

Plate 6.5
The wooden bittern hidden in the reeds, Rambower Moor.

- Wood-carving of a bittern: A life-like carving was placed in the reeds near an observation tower. Clues as to its presence and whereabouts were given on a small panel in the tower. The tower has become very popular and the panel is now sponsored by a local pub (Plate 6.5).
- External 'ambassadors': local people and working group members were always involved in visits by ministers and foreign guests. Several students lived in the village, Boberow, whilst carrying out fieldwork, and therefore were also able to engender greater local appreciation of the Moor.
- Open-air theatre: Boberow holds a summer festival every year and this was used as an opportunity to promote the work to a wider audience by presenting a play on an open air stage, overlooking the Moor. This performance was put together by students from the Academy of Music and Theatre, Rostock, who saw it as an opportunity to practice in front of a live audience. In addition, members of the project team dressed up as 'the Moor-Witch' and the 'Sad Princess of the Moor' and offered 'dragonfly' cocktails, 'peat' dishes and other bizarre culinary treats! The performance was a success and it was repeated in the following summers and continued after the LIFE project ended.

6.4 The Bittern Bytes – UK LIFE project

The problem

In the UK, awareness of the bittern is thought to be quite low outside of bird-watching and conservation circles. As part of the LIFE Project Awareness Raising Strategy, a pilot 'education' project was set up in 2004. It aimed to find out if children and young people, who were unlikely to have any prior knowledge or interest, could be enthused by bitterns. Bitterns and other endangered species are not generally seen as relevant to young people and they are less likely to become involved in conservation.

The approach

A series of activities around the bittern were designed by Wayne Talbot, who specialises in environmental education work. Schools and youth groups in the Lee Valley area (from north London to Luton) were contacted and asked if they would like to participate. Ages ranged from five to 17 years old. This area was chosen because there is already an existing education programme and public awareness project, which can provide a follow up to schools that want to do more.

Wayne offered 2–3 sessions with each group. The first was an introduction to the bittern and conservation. The young people were asked to write down three reasons why we should conserve the bittern and three reasons why not. They were asked for ideas of what they could do and what the RSPB could do to save the bittern. For the second session they were asked to draw up a more detailed action plan of what they could do and publicity ideas for the RSPB to follow up.

Schools were interested because the project offered:

1. *The active participation of young people* in a real conservation issue. Participating schools and youth groups had the opportunity to research and develop action plans to be presented and discussed with professional conservationists.
2. *Curriculum-related ideas to stimulate projects* which discuss, record and measure ways to encourage people to help save rare species.
3. *A free activity service* with a project worker to run the sessions.
4. *Input into the RSPB*: ideas generated and submitted in written form will be used by the RSPB.

The results

- *Involving those normally not interested*: the initial finding is that people became engaged in the project because of the opportunity to tell adults what to do, and that their ideas might actually be used. (No promises were made!) Once they were interested, the young people came up with a host of excellent ideas. One of the key messages, particularly from the older ones, is that conservation messages are generally too serious and should be more 'fun'.
- *The RSPB is not known by these groups* but all of them were willing to raise money to help the bittern in terms of habitat and food.
- *Only a few people had heard of the bittern*: this was very obvious and illustrated by the suggestion that several groups came up with, of feeding bitterns at a bird table, as with garden birds.

These are just a few of the ideas:

- give them injections to make them breed
- stop people getting rid of all the wetland
- make posters and put them up around town explaining why we should save the bittern
- leave some land for the bittern and some for us
- surveys of what people think about birds and they think we should do
- fund-raising bazaars
- football tournaments
- fishing matches (to raise money)
- wildlife and sponsored walks
- bittern bake sale (of biscuits and cakes)
- don't shoot the bittern
- we should agree to save the bittern.

Cardinal Newman RC School

Plate 6.6 "Does my bum look big in this?"

Aren't birds brilliant – The Lee Valley

Each year up to ten bitterns winter in the Lee Valley, an area of flooded sand and gravel pits along the river course. Small amounts of reed fringe these lakes. At 70 Acres Lake there is a hide overlooking a patch of reedbed, smaller than a tennis court. The bitterns often fish on the inside edge of this reedbed, that is in front of the hide. It is probably one of the best places to see bitterns in Europe.

For the last few years, The Lee Valley Park Authority and the RSPB have run a joint project to encourage people to see and appreciate the bittern, under the slogan 'Aren't birds brilliant'. This is a slogan that the RSPB uses around the country, where it sets up viewing points for people to see particular bird species up close (eg peregrine in London). A project officer is employed on a short-term contract to be at the hide and to talk to people who visit the hide. The project officer also visits groups that would not normally visit, such as adults with mental health problems, local schools and clubs, to encourage them to come. It is estimated that 8,000 people come each year between November and February to see the bitterns (Plate 6.7).

Lee Valley Regional Park Authority

Plate 6.7 Bill Oddie opening Lee Valley Bittern Watchpoint.

Wigan Flashes – raising awareness and community involvement from nothing!

Wigan Flashes Nature Reserve, in north-west England, is made up of eight large lakes – the flashes being their local name. They formed 100 years ago when land subsided following mining. The site is important for its mix of habitats – wet woodland, mossland, fen and reedbed – and regularly attracts bitterns in winter. The LIFE work has created more than 20 ha of additional reedbed areas by digging out edges and islands to create areas just below water level. It is hoped that this will be sufficient to support breeding bittern and one was heard booming in February 2006.

Wigan itself is an area of high unemployment and deprivation, following the loss of mining and manufacturing industry. The town itself is very built-up and the Flashes provide an area of green space within easy reach of the centre and residential areas. Other lakes are used for recreation and angling.

Lancashire Wildlife Trust has been managing the Flashes on behalf of the local council for the last six years. Before this, the wildlife potential of the area went largely unrecognised and unvalued. The Trust has done a huge amount of work to enhance the habitats and raise awareness of their value with local people. The bittern has been the focus of both strands of this work. Some of the main awareness-raising and community involvement activities are detailed below.

The site manager has built up a good relationship with the local papers. They now regularly report bittern stories. Maintaining this high profile for bittern and reedbed means that many people now recognise their importance and there is some local pride and a feeling that the bittern is 'their bird'. Around 97,000 visits per year are made to the Flashes, mostly by local people. The number of visits has gone up as paths have improved.

The 'birding' market has been specifically targeted. A display about the Reserve was taken to the North West Bird Fair (an annual event celebrating birds and all things to do with birds eg optics, art, wildlife organisations etc). Birdline, a website which posts news about rare birds, is contacted when an unusual bird appears eg long-tailed duck. In addition, the site manager writes articles for various bird-watching magazines.

There was no history of conservation volunteering in Wigan before the Trust started. The site manager has developed a team of local volunteers, which includes at least four people who regularly work at least three days a week. All are being trained to achieve a National Vocational Qualification (NVQ 1 or 2). They are trained in management work, including chainsaw courses, and are now able to take on some responsibility on their own. A weekend group has just been started and local groups also come for occasional work parties.

All of the volunteers are from the Wigan area and from diverse backgrounds. Amongst the current group, three have either mental health or learning disabilities, one has a degree and two are older citizens. This diversity shows that people come for different reasons and that the Trust is able to offer a wide range of training and experience to suit varying needs. In the last 12 months, 12 volunteers have gone on to get jobs, two of which were in the environmental field.

The Trust works with the local College of Higher Education, which has sent three New Deal trainees (a government scheme for young unemployed people) to the Flashes for work experience. The college also has a scheme through which their own staff and volunteers can work at the Flashes for their personal development. On average, four people come every week.

Mark Champion

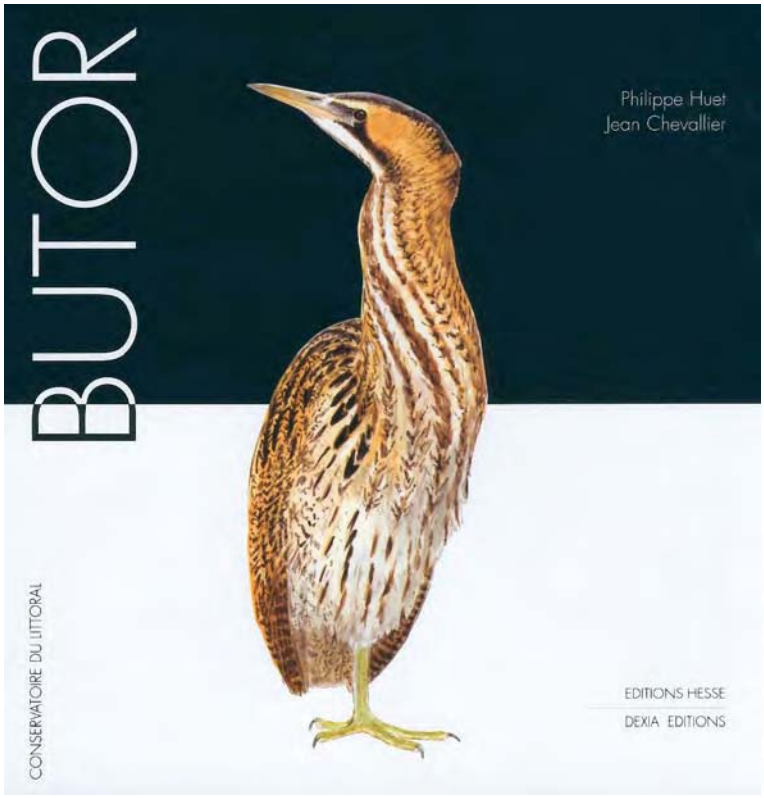
Plate 6.9 Volunteers at Wigan Flashes making a coracle.

Tasks carried out by volunteers include, surveys and monitoring, tree planting, path construction, woodland thinning, reed-cutting, etc. In total, around 1,000 volunteer days are spent at the Flashes each year.

Wigan has areas of housing that are in the top 10% of the most deprived areas in the country. It therefore receives Government money to tackle social and economic problems. The Trust has also been able to access this money, in recognition of the contribution of the Flashes to local people's quality of life and the excellent training that the Trust provides. The Trust has therefore appointed a Community Liaison Officer to work with people in the target areas. She has supported various projects, such as improving green space, and is developing a package of events and community support. Part of this work involves working with local schools and artists. Bittern willow sculptures have been created and one local school now has a gate which celebrates the reedbed wildlife of the Flashes.

It is possible to raise awareness of a site and its wildlife amongst local people, even when starting from a very low level of interest. When a range of activities and opportunities are on offer, people can be involved in actively looking after a reserve. In this way, local people see that the reserve has direct benefits for their community, as well as appreciating it for itself.

6.5 Bittern images and branding



Dave Hutton

Plate 6.10 Clockwise from top left:

Picture book *Butor* by Philippe Huet and Jean Chevallier, Conservatoire du Littoral, Editions Hesse (2004)

The Bittern Trainline (Norfolk, UK) beer mats

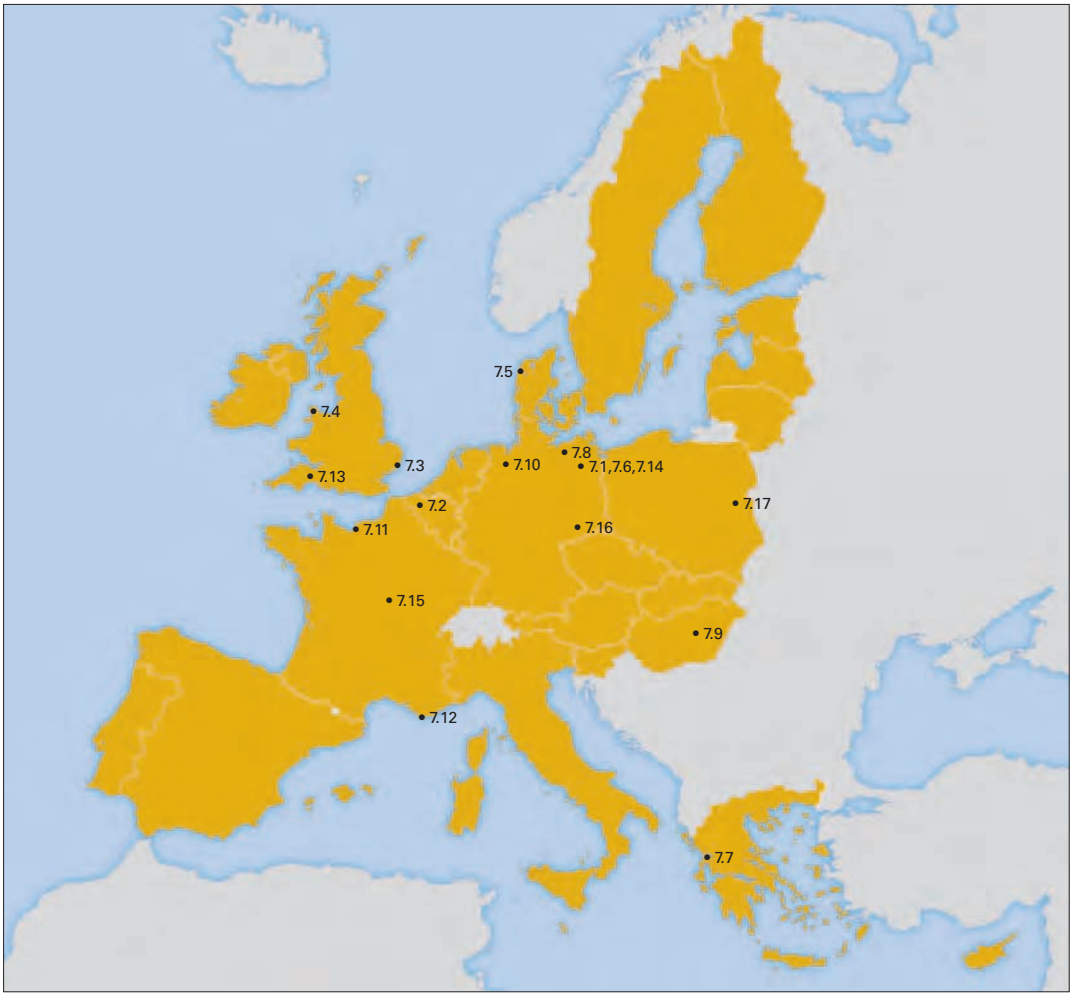
The rudder of the Bittern, Suffolk, UK

Bittern badges – Siikalahti, Finland and RSPB, UK

Bittern beer, Reephaven Brewery, Norfolk, UK

7 CASE STUDIES

Case studies



Case study 7.1
How does management for bittern affect other bird species? Lake Parstein, Germany

Featured technique: Managing for reedbed bird communities
Location: Lake Parstein, Germany
Contact: Dr Martin Flade, Landesumweltamt Brandenburg, Abt. Großachutzgebiete, Raumentwicklung, Referatsleiter GR 3, Tramper Chaussee 2, D - 16225 Eberswalde, Germany
E-mail: martin.flade@lua.brandenburg.de
Local status of the bittern: Up to 20 booming males
Designation: SPA, UNESCO-Biosphere Reserve
Date of featured work: 1997–2004
Management objective: To understand the implications for wider avifauna of reedbed management for bitterns

The avifauna of bittern habitats

How does bittern protection affect the whole reedbed avifauna? Which other species benefit and which do not?

The bittern is not the only rare or threatened bird species occurring regularly in reedbeds. Quite a number of more or less specialised reedbed birds share its habitat. For central and northern Germany, Flade (1994) identified 15 indicator species that represent the avifauna of reedbeds (Table 7.1). In addition to these typical species, many waterbirds, such as grebes, swans, geese, ducks and coot, as well as gull and tern colonies may use reedbeds (especially the water fringe) as a nesting habitat. In western and southern Europe bigger heron colonies (grey heron, purple heron, great white egret, spoonbill) occur in reedbeds.

Among the typical reedbed species there are those that prefer the high and thick reed stands in deep water adjacent to open water bodies, such as bittern, little bittern, moorhen, little crake and great reed warbler. Other species such as water rail, reed warbler, and reed bunting prefer the more dense, homogeneous inner reedbeds with shallow water or even only moist ground. The transition zone between reed and sedge marshes (with mixed sedge and reed stands) is preferred by spotted crake, common snipe, Savi's warbler and sedge warbler. The bluethroat prefers the more bushy parts with muddy places in late spring. Richly-structured reed stands with a higher density of reed litter are preferred by little crake, Savi's warbler and bearded tit, whereas reed warbler and great reed warbler can cope with simple-structured, monotonous stands.

With respect to the bittern, three species groups can roughly be separated:

- species with more or less similar habitat needs that normally should benefit from conservation management for the bittern. These are the species which prefer high and strong reed stands with open water or small water bodies and channels within the reedbed (little bittern, moorhen, little crake, Savi's warbler, great reed warbler)
- species with more variable habitat needs that may be supported by bittern conservation management, but can cope well also without such measures (water rail, harriers, reed warbler, bearded tit, reed bunting)
- reedbed species, which may have contradictory habitat needs, eg preferring big water level fluctuations and/or ground patches with open mud in spring (spotted crake, common snipe and especially bluethroat).

As the following case study demonstrates, bittern habitat management may support bittern and many other species, but may also be disadvantageous for species of the third group. In such situations, a strict priority setting or a multiple-target optimisation is necessary.

Table 7.1 Characteristic breeding birds of reedbeds in central and northern Germany (according to Flade 1994); the frequency for reedbeds ≥10 ha, and, for sites with three or more breeding pairs (bp), the median (and 95% confidence interval) and maximum density is indicated (n = 23 study sites). The characteristic species are ranked by frequency.

Species	Frequency (%)	Density (bp/10 ha)		
		Median	95% confidence interval	Maximum
Reed warbler *Acrocephalus scirpaceus*	100	9.6	7.4–14.3	54.0
Sedge warbler *Acrocephalus schoenobaenus*	96	4.5	2.0–13.5	37.5
Water rail *Rallus aquaticus*	83	2.1	0.7–6.0	13.4
Moorhen *Gallinula chloropus*	74	2.2	0.7–4.0	4.5
Marsh harrier *Circus aeruginosus*	74	0.9	0.3–1.8	2.1
Great reed warbler *Acrocephalus arundinaceus*	69	1.4	0.7–6.3	9.1
Savi's warbler *Locustella luscinioides*	65	2.6	0.9–8.8	14.4
Bittern *Botaurus stellaris*	48	0.4		0.9
Spotted crake *Porzana porzana*	43	1.0		5.7
Little bittern *Ixobrychus minutus*	35	0.2		
Bluethroat *Luscinia svecica cyanecula*	30	2.2		3.2
Bearded tit *Panurus biarmicus*	26	2.8		4.5
Little crake *Porzana parva*	22	2.4		4.0
Montagu's harrier *Circus pygargus*	13	1.0		
Short-eared owl *Asio flammeus*	9	1.4		2.5
Further species with high density Reed bunting *Emberiza schoeniclus*	100	11.6	5.5–23.2	29.2

The Lake Parstein case study

At Lake Parstein, one of the best breeding sites of bittern in Germany, a detailed inventory of reedbed birds and the habitat factors determining their population dynamics was compiled, using territory mapping, mapping of single species and captures with mist nets and cage traps.

Background – characteristics of the study area

The study area is located in the Schorfheide-Chorin Biosphere Reserve, Germany and comprises 8,000 ha, including Lake Parstein (1,150 ha) and 12 surrounding smaller lakes. The area share of wetland habitat types is as follows: open water: 1,453 ha, reedbeds: 118 ha and reed mires: 147 ha.

This area is part of a young glacial landscape which was formed 12,000–15,000 years ago. The various types of lakes are situated in the hinterland of the Chorin terminal moraine, a hilly range covered by beech forests. Lake Parstein itself is a deep, calcareous, mesotrophic,

Martin Flade

Plate 7.1
Typical reedbed shoreline at Lake Brodowin, Lake Parstein basin; breeding site of eg bittern, water rail, great reed warbler, reed warbler, Savi's warbler, great crested grebe, greylag goose, pochard, tufted duck.

Biosphere Reserve administration

Plate 7.2 Shallow northern part of Lake Parstein, the reed islands and peninsulas are preferred breeding sites of bittern, little crake, great reed warbler, Savi's warbler and bearded tit.

clear water lake, that has large shallow bays with wide belts of marginal aquatic vegetation in the north (Plate 7.2) and the south-east. Other surrounding lakes are mesotrophic to eutrophic clear water lakes (Lake Brodowin, Lake Rosinsee) as well as shallow eutrophic to polytrophic lakes with more or less wide reedbeds (Lake Serwest, Lake Weißensee, Lake Wesensee). A characteristic feature of all lakes is that they are situated in inner catchments and have no natural outflow. This causes long-term and short-term water table fluctuations, depending on weather (precipitation, climatic water balance), soils, and surrounding land use.

Some of the lakes were artificially connected by channels in the late middle ages (eg Lake Parstein, Lake Weißensee), which led to lower water tables and smaller water level fluctuations on average. Other lakes are still extremely variable and show long-term changes in the water table of more than 2 m (eg Lake Pehlitz, Lake Wesensee).

The normal annual water regime of Lake Parstein is an increase from midwinter to April, then a decline, with a minimum water level in October/November (Figure 7.1). This cycle may be considerably different in some years (eg 1997 and 2000). The water table amplitude within one year is between 18 and 54 cm, the difference in maximum water levels between years is up to 44 cm, and the full amplitude of the last 8 years was 70 cm (Figures 7.1 and 7.2). Due to high precipitation, 2002 showed an extremely high water level and, after thick snow cover in spring 2003, the water table was still very high. After an extended drought in spring/summer 2003 the water level dropped down dramatically again but did not reach the minimum level of the previous years (see Figure 7.2). So, in 2002 and 2003 there were two years with high water table in spring, thus being optimal for bittern.

Bittern conservation management at Lake Parstein

The main problem for bittern conservation is the artificial lowering of the water table. As a result, in most years only a relatively narrow reed belt occurs as wet reed, whereas large areas consist of dry to moist 'reed mires' ('Röhrichtmoore'). Another problem

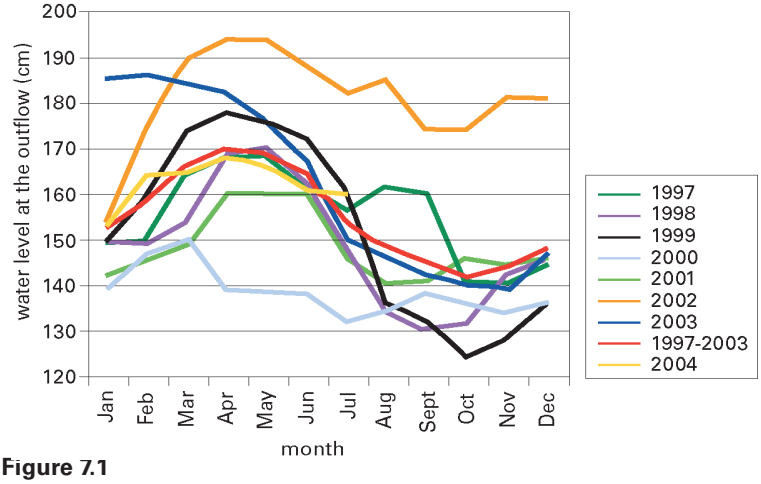


Figure 7.1
Amplitude of seasonal water level fluctuations of Lake Parstein 1997–2004, measured at the outflow (data of the Biosphere Reserve administration, from Schleicher 2005).

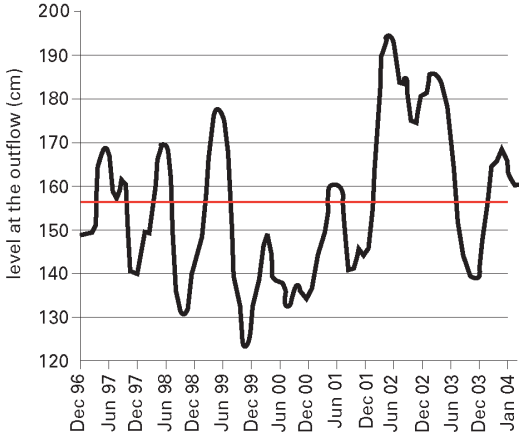


Figure 7.2
Total water table fluctuation of Lake Parstein 1997–2004 (data of the Biosphere Reserve administration, from Schleicher in press).

caused by low water tables is the vegetation succession of the inner reedbeds, especially the development of shrubs and trees (willows, birch, alder). As reed cutting has not occurred for several decades, this vegetation succession has accelerated.

In early 2004, the outflow of Lake Parstein was rebuilt and established at a higher level (part of the LIFE Bittern project). The main target of this management measure was to raise the average water table and to avoid the minimum extremes; the total water table amplitude should not exceed 50 cm. This was mainly done in order to slow down the vegetation succession and to favour bitterns (see Case study 7.6). A further measure was the experimental cutting of reed in patches of 1 ha size.

Reedbed birds of the Lake Parstein basin and responses to water table changes

In the period 1997–2004, selected reedbed birds were mapped in the whole study area (eg bittern, little crake) or in section areas (eg great reed warbler, bluethroat). In 2003, a detailed inventory of the breeding occurrence of bluethroat and its habitat features was performed (Schleicher in press). Additionally, six areas were studied in more detail. At Lake Weißensee, a reedbed of 6 ha was investigated in July 1999 by mist-netting and with cage traps (capture-recapture method). In the northern part of Lake Parstein, where 70 ha of water/reedbeds occur, four sites were also investigated by mist-netting and cage traps in July 2001. At Lake Brodowin, all water fringe reedbeds and an adjacent reed mire of 10 ha were mapped (by territory mapping) from 1997 to 2000, and the 10 ha reed mire was studied annually (July–September) by mist-netting and cage-trapping from 1997–2003. These inventories allowed the extrapolation of the population sizes of all reedbed birds and the detection of population changes of the scarce and rare species.

Nearly the full set of characteristic reedbed species of central and northern Germany was found (13 out of 15). The most numerous reedbed bird of the study area is the Reed Warbler with roughly 1,000 breeding pairs and densities up to 65 pairs on 6 ha of reeds (Lake Weißensee), followed by reed bunting and water rail (Table 7.2). The rarest species are little

Table 7.2 Populations of reedbed bird species in the Lake Parstein area, north-east Brandenburg, Germany (8,000 ha), ranked by importance for Brandenburg (percentage of the total Brandenburg population, ABBO 2001; geometric mean).

Species	2003	Population estimate 1997–2003	% of total Brandenburg population
1 Bluethroat *Luscinia svecica*	17	17–35	24
2 Bittern *Botaurus stellaris**	20	11–20	15
3 Bearded tit *Panurus biarmicus**	no data	40–70	9
4 Little bittern *Ixobrychus minutus**	[1]	0–3	8
Spotted crake *Porzana porzana**	[3]	5–10	8
Little crake *Porzana parva**	[2]	2–5	8
5 Water rail *Rallus aquaticus**	no data	120–200	7
6 Savi's warbler *Locustella luscinioides**	[25]	50–70	4
7 Reed warbler *Acrocephalus scirpaceus*	no data	800–1,000	3
Great reed warbler *Acrocephalus arundinaceus**	[58]	60–80	3
8 Marsh harrier *Circus aeruginosus**	no data	15–20	1
9 Common snipe *Gallinago gallinago**	4	4–10	<1
Sedge warbler *Acrocephalus schoenobaebus*	no data	5–10	<1
Moorhen *Gallinula chloropus**	no data	10–30	<1
Reed bunting *Emberiza schoeniclus*	no data	200–400	<1

Figures in brackets [ ]: counts in section areas; species marked with asterisk (*) benefit from high water level during the breeding season.

Konrad Schleicher

Konrad Schleicher

Plates 7.3 and 7.4
Typical bluethroat territories of Lake Parstein in late spring/early summer: after the water table has dropped, open muddy patches occur within the reedbeds or under adjacent willow thickets.

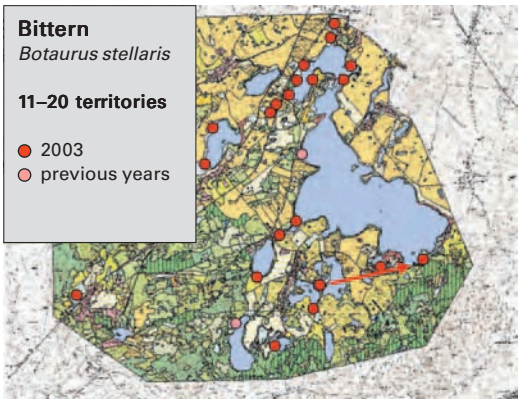


Figure 7.3
Distribution map of bittern in the Lake Parstein basin; in 2003 (maximum water level), nearly all territories of booming males of the previous years were occupied.

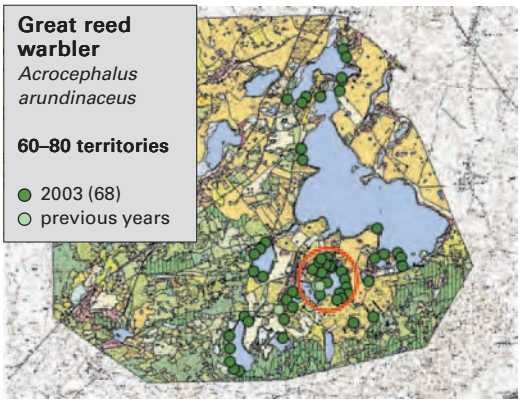


Figure 7.4
Distribution map of great reed warbler in the Lake Parstein basin (incomplete! total population estimated at 80 bp). Note the big concentration at Lake Wesensee in the south-east (marked with a red circle; 18 males), caused by a sudden rise of the water table after having declined for more than 12 years.

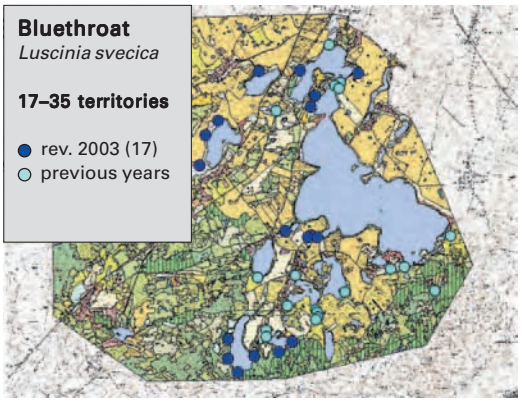


Figure 7.5
Distribution map of bluethroat in the Lake Parstein basin; in 2003 with maximum water level and maximum populations of bittern and great reed warbler, many bluethroat territories of the previous years remained unoccupied.

bittern, little crake, spotted crake and common snipe. Additionally, water birds such as great crested grebe, red-necked grebe, black-necked grebe, little grebe, mute swan, greylag goose, mallard, gadwall, pochard, tufted duck, black-headed gull, common tern and black tern occur as breeding birds of the wet reed (and adjacent water-lily fields).

If the Lake Parstein populations are ranked according to their share of the total populations of the Federal State of Brandenburg, the result is quite different (Table 7.2). With around 24% of the Brandenburg population, the importance of the bluethroat is the highest, followed by bittern with 15%. This means that the habitat needs of both species have to be considered.

Investigation into the local habitat needs of the bluethroat revealed that the species inhabits reedbeds with large proportions of willow thickets and/or peatland succession forests of birch and alder, and avoids pure reedbeds. An essential part of all bluethroat territories are extensive bare, muddy areas, either within reedbeds or under young alder or willow thickets (Plates 7.3 and 7.4). Optimal habitat conditions occur in years with low spring water table following a period of high water level, because this combination leads to the occurrence of mud banks. That means that in contrast to the bittern, the bluethroat benefits from vegetation succession (intrusion of shrubs) and low water table during the breeding season as well as from water table fluctuations. Good bittern years are always bad bluethroat years and vice versa (Figures 7.3 and 7.5). But good bittern years are also mostly good years for great reed warbler (Figure 7.4), Savi's warbler, water rail, crakes and common snipe. Spotted crake and snipe benefit from more water in the reed and sedge mires further away from open water bodies.

Conclusions

Due to its priority EU conservation status, the bittern should, in theory, take priority in relation to habitat management. Additionally, out of 15 reedbed bird species of the Lake Parstein basin at least 11 species benefit from a high water table during the breeding season (see Table 7.2, marked with *). So there was no doubt that overall the management measures taken point in the right direction. However, because of its regional importance, the habitat needs of the bluethroat should not be neglected. Notably, the amplitude of water table fluctuations should not substantially be reduced, and the development of willow thickets and peatland succession forests should not be totally avoided. The next years will show, whether the management measures at Lake Parstein will be successful: increasing the average population size of bittern (and other reedbed species) without a complete deterioration of the breeding habitats of the bluethroat.

Case study contributed by Martin Flade

Case study 7.2
Action for reedbed birds in the River Haine basin, Belgium

Featured technique: Wetland restoration through hydrological studies, scrub removal and land purchase
Location: River Haine Basin, western Belgium. 50°27'N, 03°44'E
Contacts: Réserves Naturelles – Natagora
Rue du Winsconsin, 3
B-5000 Namur, Belgium
Tel: 081/830.570 Fax: 081/830.571
E-mail: info@rnob.be
Local status of the bittern: A rare and sporadic breeder, regular in winter
Designation: SPA and Ramsar site
Date of the featured work: 2001–2005
Management objectives: The conservation of reedbed bird populations in the River Haine basin

Background

Wetlands in the Haine valley were mainly created in the beginning of the 20th century, following ground subsidence due to mining activity. This large valley has very gentle slopes, with groundwater close to the surface. The area is very densely populated, with extensive urban and industrial areas.

The project area is about 6,500 ha, of which more than 700 ha are protected by some kind of designation. The most prominent sites in the area are the Harchies-Hensies-Pommeroeul Wetlands (500 ha), the Prés de Grand Rieu (80 ha) and the Marionville-Douvrain Wetlands (150 ha). These sites are composed of large ponds surrounded by marsh (*Phragmites* and *Typha* beds, sedge-dominated fens, tall herb communities, etc), wet meadows or pastures, farmland, wet woodlands, as well as schist spoil heaps, which were created as a result of the mining.

The LIFE project is a partnership between a charity – Réserves Naturelles – Natagora (RN-N) – and the regional government authority, the Ministry of the Walloon region, which between them own or lease, and manage, most wetlands in the Haine valley. They were already working together through the Management Committee of the 'Harchies-Hensies-Pommeroeul Wetlands' nature reserve. As part of the LIFE project, another committee was set up, which included volunteers for RN-N, representatives of the regional authority, as well as local naturalists. This committee regularly met to discuss project progress and results.

This LIFE project is aimed at the conservation of all reedbed birds, such as marsh harrier, bluethroat, little bittern, warblers, as well as the bittern. In the project area, the bittern is a rare and sporadic breeder, (with numbers ranging from zero to two singing males in any one year), but it is a regular winter visitor (between 10 and 20 individuals.). The river Haine valley is the only regular breeding site for this species in Wallonia.

Before the project started, the reedbeds were deteriorating, mainly due to drying out and scrub invasion. Many of the actions carried out during the project aimed to restore an earlier stage in the succession. Other habitats, which are used by reedbed birds for feeding, were also targeted through various management measures (for example, management of fish stocks or agricultural measures).

Approach

Sixty hectares of unprotected land were acquired in the project area to:
- increase the size of existing sites (by acquiring surrounding or adjacent land)
- establish small wetlands as 'stepping stones' between existing sites
- to create a new 20 ha nature reserve (Préelles in Hensies).

These larger sites allow management to be carried out in a more efficient manner.

Much of the management work involved the removal of willow scrub and trees, over more than 80 ha of reedbed. The work was all done by hand, with the cut shrubs and trees removed from the site. This work was mainly contracted to specialist companies, although volunteers did some of the work. Re-growth was prevented by:

- stump-uprooting and soil stripping with heavy machinery; and
- chemical treatment (Trichlopyr) of stumps that were in less accessible areas.

In addition, hydrological studies recommended a number of changes to water management. At the Harchies wetland, for example, the following work was recommended:

- channel creation within a large reedbed
- introduction of a 'natural', dynamic water table, with slight changes in the mean value of the annual water table throughout the year, to counter natural succession (this was made possible because land purchase gave the partners control of the water levels, which could then be managed for nature conservation)
- a system of ponds, which can be managed independently following the channel creation.

Vincent Swinnen, Reserves Naturelles RNOB

Plate 7.5
Extensive grazing with Galloway cattle in Harchies-Hensies-Pommeroeul wetlands.

Extensive grazing, using Galloway cattle, has also been put in place at the edge of several reedbeds in order to diversify and enhance habitat conditions within and near reedbeds (Plate 7.5). A remarkable partnership is being developed here between the charity, RN-N, which owns the animals, the regional government authority, which owns part of the land and local farmers, who are responsible for the animals.

Results

It is too early to draw long-term conclusions about the effects of the project on reedbed bird populations or, more particularly, on the bittern. Nevertheless, since 2002, an important increase in sedge warblers has been observed and little bittern bred in 2005 at a site where it was previously unrecorded. In the same year, there were at least two successful breeding attempts by the locally rare marsh harrier.

On the various sites, the project actions will be followed up either by the Ministry of the Walloon region, or by volunteers from 'Réserves naturelles – Natagora', or by a collaboration between both partners. This work will include, among other things, control of willow re-growth. In the long term, reedbed dynamics will be managed through water level control and by limiting willow re-colonisation.

Lessons learned

In some sites, water level could not be sufficiently elevated, allowing willow to re-grow rather quickly. In these locations, it would probably have been better to attempt to lower ground surface through bed-lowering. The costs involved in such work are unfortunately very high, especially when the excavated material needs to be taken a long way away from the site.

Case study contributed by Vincent Swinnen

Case study 7.3
Restoring reedbed by bed lowering, Minsmere, UK

Featured technique: Reedbed lowering and raising of water levels
Location: RSPB Minsmere Reserve, UK
Contacts: Ian Hawkins, RSPB Minsmere Reserve, Westleton, Saxmundham, Suffolk, IP17 3BY, UK. www.rspb.org.uk E-mail: ian.hawkins@rspb.org.uk
Local status of the bittern: Recently increasing to around 10 boomers
Designation: SSSI, SPA
Date of featured work: 1994–2000
Management objectives: Restoration of an old, drying reedbed

Background

Minsmere, one of the RSPB's premier nature reserves, is located on the Suffolk coast, UK. Reedbeds became established when the coastal grazing marshes were flooded for defensive purposes in 1940. The development of reed cover must have been very rapid as there were already extensive reedbeds when the site became an RSPB reserve in 1947. Since then the reedbeds have been managed by a combination of reed cutting, scrub clearance, water level manipulation and small scale spraying with the herbicide Dalapon to maintain open pools. In 1990, there was a total of 157 ha of reedswamp.

The earliest record of breeding bitterns at Minsmere was of four to six booming males in 1946, only six years after the site was allowed to flood. Numbers gradually increased to ten males in 1949, 12–14 in 1971–73 and 13 in 1976 making Minsmere one of the key breeding sites in the UK at the time. However, from then on, there was a steady decline to the low point of a single booming bird in 1991.

Approach

One of the earliest results from the UK research programme was a clear link between bittern declines and seral succession of wet reedbeds (Tyler *et al*. 1998). Those reedbeds with high levels of

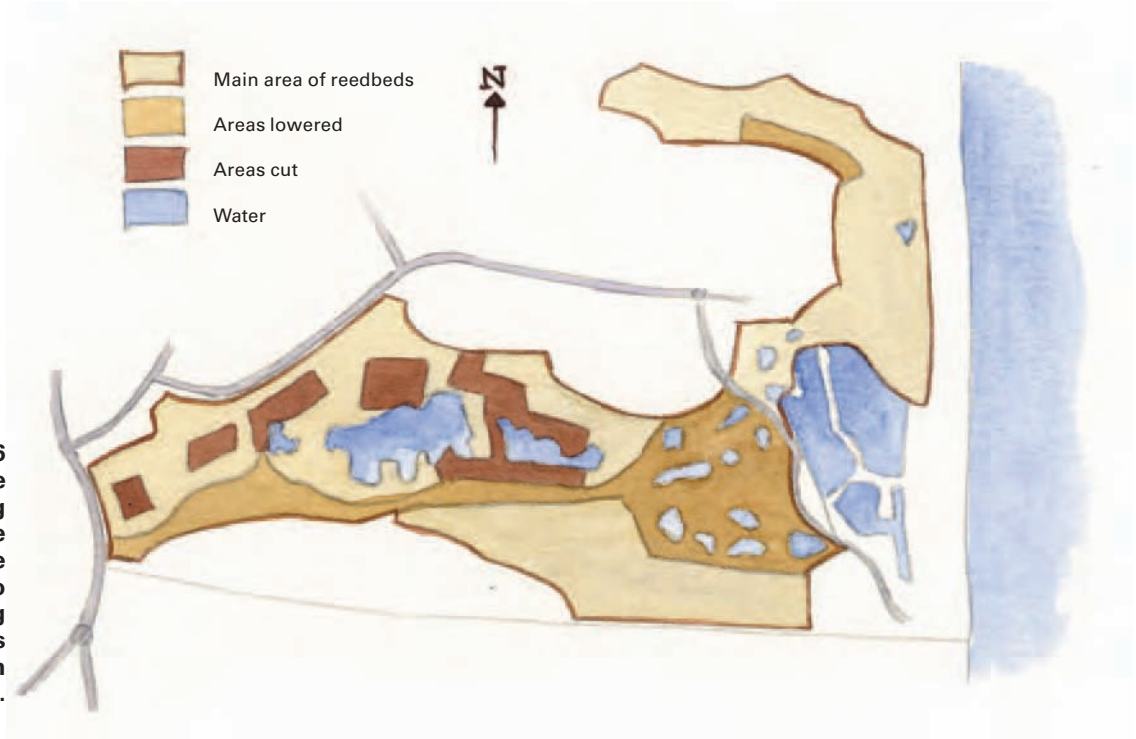


Figure 7.6 The Minsmere Reserve showing the extent of the main reedbeds, the zones subject to periodic cutting and the areas lowered between 1991 and 2000.

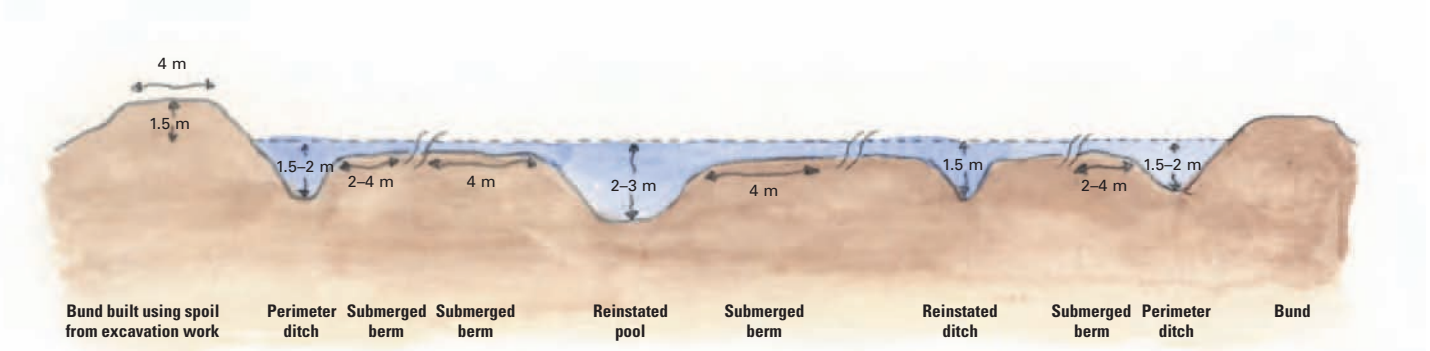


Figure 7.7
A schematic cross section of a typical lowered area showing the profiles of the meres and dykes.

encroachment by carr and scrub and those with a high coverage of species other than reed were the ones that lost their bitterns between 1980 and 1990. Work at Minsmere was therefore designed to reverse this process and to restore areas of the reedbeds to an early successional state. The management works were partly funded by a LIFE project ('Urgent Conservation Action for the bittern *Botaurus stellaris* in the United Kingdom').

In the winter of 1990/91, sluice and bank works were carried out to allow the water levels to be raised in the reedbeds, and a programme of reed cutting and scrub coppicing on a seven year rotation was established in part of the area. However, it was soon realised that more drastic action was needed if suitably wet conditions were to be restored in a significant area of the site. After much consultation and planning, a major programme of reedbed lowering (Figure 7.6) was initiated in the winter of 1994/95. Over the course of five winters, the bed levels of 48.75 ha of reedbed were lowered, and embankments and water level control structures installed (Table 7.3). In each section 0.2–0.5 m of reed rhizome and peat were scraped back and the material used to form low bunds. Within each cell, ditches were re-profiled and pools created, so that in total 10.8 km of ditches were re-profiled and 8.1 ha of pools created. Where possible, ditches were dug to follow historic channels. A schematic of the profile of each cell is shown in Figure 7.7.

Reed re-establishment from the rhizomes left in each section was rapid with reasonable cover present in most cases after two and certainly by four years.

Table 7.3 The areas of reedbed managed and pools and ditches created at Minsmere from 1991–2000. In addition, in each year 0.5–1.8 ha of scrub were coppiced.

Winter period	Area of reed cut and cleared (ha)	Area of reedbed lowered (ha)	Area of new pools created (ha)	Length of new ditch created (m)
1991/92	1.36	0	–	–
1992/93	1.41	0	–	–
1993/94	2.30	0	–	–
1994/95	3.38	11.0	1.50	1,350
1995/96	2.66	15.0	1.55	1,650
1996/97	1.58	7.25	1.15	625
1997/98	1.90	4.50	0	650
1998/99	1.88	0	1.90	1,050
1999/2000	3.55	11.0	2.00	5,450
Total	–	48.75	8.10	10,775

Andy Hay/rspb-images.com

Plate 7.6
Bed lowering at Minsmere.

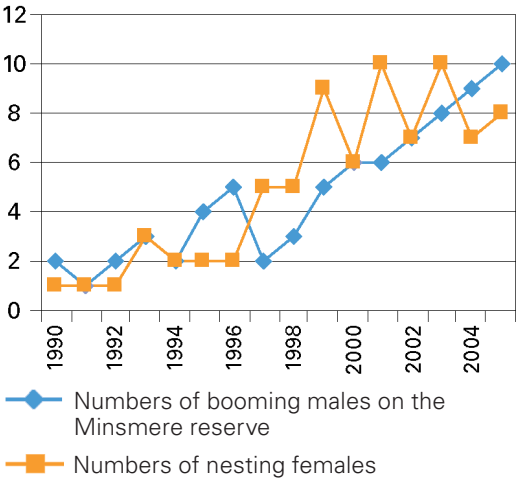


Figure 7.8
The response of breeding bitterns to the management works from 1990 to 2000.

Results

At Minsmere, the monitoring of bitterns is particularly intensive, with the first and last dates of booming recorded, together with an assessment of the quality of the booms as well as the numbers of booming birds. In addition, an assessment of the numbers of females with nests and young is made, although, particularly in the early years, not all nests may have been located. Females whose nests failed early during incubation were also likely to be missed.

The overall figures from 1990 to 2004 are summarised in Figure 7.8. The numbers of males have increased from one or two in 1990 to 10 in 2005. A pronounced shift to earlier first booming from around 15 March in 1990 to 4 February in 2000 has accompanied this. The number of females with nests and young has also increased greatly to six in 2000 and eight in 2004 and 2005. The lowered areas have also been utilised by booming, feeding and nesting birds – usually from three to four years after the management works.

Lessons learned

The evidence is clear that the management works have been responsible for the increase in bittern numbers. Over the same decade, numbers have remained stable or declined at other Suffolk coastal sites and there has been no trend in the dates of first booming. The results are also direct evidence to support the results of the studies that seral succession has been the key problem in many bittern breeding sites. The management works have returned the reedbeds to an early successional stage and the bitterns have responded rapidly. Evidence from radio tagged young birds shows that the increase in males at least has been fuelled by local productivity and recruitment. The situation is less clear for females but it is possible that new birds have been attracted to Minsmere by the highly suitable habitat conditions and the increased booming activity of the males.

The traditional long-term management of reedbeds is by cutting and this, together with the high summer water levels required to grow good quality reed, serves to reduce the rate of litter build-up and scrub encroachment. Cutting is not possible on all sites, so bed lowering is a viable option for setting back the succession at degraded sites and, as it is probably only needed every few decades, is potentially a far more realistic proposition in many situations.

It is probable that the management works have improved the conditions for bitterns in at least two ways. Firstly, the creation of wet reedbed and the increased length of reed-open water interface will have provided increased areas in which to forage. Secondly, by creating pools and dykes there are improved conditions for the main prey of bitterns at Minsmere – eels, rudd and nine-spined stickleback. Although there is no quantitative data to compare fish populations before and after the works, the lowered areas have been rapidly colonised by good numbers of rudd and sticklebacks. Eels too are present in the areas but their life cycle means they are unlikely to have responded in numbers so rapidly as the other fish species.

The lowered areas provided wet reedbed earlier in the year and the water level management in the older parts of the reedbed was changed from 1998 by raising water levels from the end of December, again to ensure plenty of wet reedbed was available as early in the year as possible.

The provision of wet reed from January may also have contributed to earlier booming and bringing the females into breeding condition earlier. This gives the females more chance to relay if a nest fails, and has also enabled some birds to rear two broods in a season.

It is tempting to associate the earlier dates of first booming observed at the end of the decade with improved habitat and better feeding conditions allowing the males to attain the breeding condition earlier in the season. It is known that males develop specialised musculature around the neck during the booming season and this may be an energetically demanding process (Gilbert 1993). However we cannot rule out the possibility that the higher numbers of males mean they are simply stimulating one another to boom earlier in the season.

This case study was modified from an article originally published in British Wildlife Vol 12, 2000, by Ken Smith, Geoff Welch, Glen Tyler, Gillian Gilbert, Ian Hawkins and Graham Hirons.

Case study 7.4
The creation of reedbeds at Malltraeth Marsh, Wales, UK

Featured technique: Reedbed creation on former grassland, including hydrological study and controls, and reed establishment
Location: Malltraeth Marsh, Anglesey, UK
Contacts: Malltraeth RSPB reserve, c/o Maes y Ffynnon, Penrhosgarnedd, Bangor, Gwynedd, LL57 2DW, Wales www.rspb.org.uk
Local status of the bittern: In process of colonisation; 1 boomer in 2004
Designation: SSSI
Date of featured work:1994–2005
Management objectives: Creation of new reedbed suitable for bitterns in a former stronghold

Background

Anglesey was formerly a key area for breeding bitterns, with booming males recorded from at least ten sites in the 1970s. Unfortunately, in line with the rest of the UK, a decline followed and the last proven record of breeding came in 1984. Malltraeth Marsh lies in the valley of the river Cefni in the south-eastern corner of Anglesey. The valley was once an estuary but the construction of a sea wall in the early 19th century reclaimed some 1,500 ha for farmland.

The Malltraeth Marsh reserve was acquired by the RSPB with the aim of creating a reedbed site capable of supporting breeding bitterns. The original purchase of 139 ha in 1994 was acquired with the intention of creating 100 ha of reedbed, the remainder being managed as wet grassland. The land chiefly comprised semi-improved grassland (much of it suffering from heavy infestation of soft rush) but also included a small reedbed and Llyn Gwaith Glo, a lake with an associated reed fringe and willow scrub. Subsequent acquisitions have increased the reserve area to 272 ha. The reserve was included in the LIFE project: 'Urgent Conservation Action for the bittern in the UK'.

Figure 7.9 Malltraeth Marsh showing areas of reedbed, wet grassland and water.

Approach

Hydrological issues
Prior to purchase, a full topographical survey of the land to 25 cm intervals was undertaken. This showed that roughly 60% of the area lay below the 2 m AOD contour. By raising water levels to this height, a large area with varying water depths suitable for establishing reed would be created. Areas at 1.5 m or below would be likely to stay as open water. The 2 m level would also avoid flooding the numerous public footpaths that cross the site. Initial sampling suggested that the soils were of a clay/silt type and would be capable of holding water. A hydrological study was also undertaken. This study showed that there was a shortfall in the calculated water budget but that

abstraction pumping could be used to supplement rainfall.

A long-standing association with Bangor University has provided information on how groundwater levels react on the reserve, as well as calculating a water budget and a possible way of providing a more sustainable source of water in the future. Students have looked at the presence of palaeo-channels and found that water loss through these channels is negligible and can be ignored.

Works
Ditches that drain adjacent farmland surround the reserve. Controlling these ditches was not possible as it could affect neighbouring land. Therefore, water control on the reserve depends on preventing drainage into these ditches. The first work carried out, in the summer of 1994, was to construct a water retaining bund. The topsoil was stripped from the line of the bund and a borrow ditch dug on the inside. The ditch spoil was used to form the bund, 'keying' into the underlying clayey soils to create a watertight seal. The topsoil was then used to cap the bund. At strategic points, pipe sluices were installed in the bund in order to allow water to run off if so desired. This bund controls water levels over approximately 45 ha. In the autumn of 1994, the rush was cut and the whole area allowed to flood simply by storing the winter rainfall.

In 1999, further land acquisition and the purchase of an agricultural tenancy secured another 33 ha of land where water levels could be raised. Once again, a water retaining bund was built to prevent run-off into the drainage ditches, with pipe sluices to provide water control. There was little open water in this section, so a series of new ditches were dug. These followed the line of old estuarine features that could still be seen in the field. At two locations, where solid clay was found, large pools at least 2 m deep were excavated. Careful thought was given to spoil disposal. It has been used to raise access tracks and repair the adjacent river flood bank. Winter rainfall was again used to flood this area.

Dave Rees

Plate 7.7 Completed trench sheet sluice.

Over the winter of 2005/06, the next phase of controlling water levels was carried out, this time covering 50 ha. Pipe sluices are no longer used; instead, more substantial drop-board sluices made from pile driven trenching sheets are installed (Plate 7.7).

Water management now consists of storing rainfall on the reserve by bringing levels to 2.1 m by the end of the winter. Water is then maintained as close as possible to this level by using abstraction pumping from one of the main drainage ditches. However, summer rainfall rarely supplies enough water in the ditch to keep up with evapo-transpiration from the reserve, so water levels generally fall by 30–35 cm over the summer, which is felt to be acceptable.

Fish introduction
Successive electro-fishing surveys have shown that the reserve supports low numbers of fish (principally sticklebacks and eels) insufficient to support breeding bitterns. To rectify this, 500 rudd were introduced in spring 2005, with further introductions planned, in order to establish a self-sustaining population. To supplement this work, eel passes were installed on the major outlet sluices to allow eels that are moving up the main drainage ditches to access the reserve.

Reed establishment

Three methods of reed establishment have been used at Malltraeth: rhizome transfer, planting seedlings and natural

Dave Rees

Plate 7.8 Reed seedlings with protective netting.

regeneration. Natural regeneration was found to be the easiest and cheapest method. Simply raising water levels and removing livestock allowed the rhizomes present in the soil to grow. Areas of dense rush adjacent to expanding reed areas are cut to reduce competition.

Where existing reed rhizome material is absent, reed seedlings have been planted. Where the seedlings are planted in water that is at least 10 cm deep, it unfortunately provides access for coot and geese to graze on the seedlings, both preferring to swim into areas to graze. Complete netting of the seedlings is then needed to prevent grazing (Plate 7.8). This adds considerably to the cost and it is not feasible to net large areas. Strips roughly 4 m wide and 100 to 150 m long were planted and netted. The maintenance of the netting is time consuming and it takes three growing seasons for the plants to reach a size and density that can withstand grazing. To avoid this, reed planting is now carried out along ditches prior to water levels being raised. This allows the reed time to establish so that when water is raised, it can spread into the surrounding area.

Results

The constructed bunds and five major sluices now control the water level over 82 ha, with a further 50 ha coming under control in the winter of 2005/06. Reed establishment has principally used natural regeneration or planted seedlings to provide small core areas that will in time expand to create a bigger reed area. To date nearly 275,000 seedlings have been planted and reed cover is extensive. Over 3 km of new ditches have been formed, 3.7 km of existing ditch have been re-profiled and 2.2 km of old meander (former estuarine features) have been cleaned out.

Bitterns now regularly winter on the site with some indication that they are staying longer into the spring. No breeding has yet occurred but a booming male was present in the spring of 2004. A range of wildfowl breed, as well as a good number of reedbed passerines including reed bunting, reed, sedge and grasshopper warblers. Numbers of wintering shoveler have increased so that the site now holds a UK important wintering population. Malltraeth Reserve now forms part of the UK network of key sites for water vole (a UK priority species) and 12 monitoring transects have been established. Otter and brown hare occur on the site as does the rare plant, pillwort.

Case study contributed by Dave Rees

Case study 7.5 Restoration of the Skjern River floodplain, Denmark

Featured technique: Restoration of a river course, meadows, lakes and reedbeds
Location: Skjern River, Denmark
Contacts: Niels Dahlin Lisborg, Oxboel State Forest District, Danish Forest and Nature Agency, Aalholtvej 1, DK-6840 Oksboel, E-mail: ndl@sns.dk
Local status of the bittern: Returning to breed from 2003
Designation: SPA, SAC
Date of the featured work: 1999–2002
Management objectives: Restoration of the Skjern floodplain to benefit water quality, wildlife and people

Background

The canalisation of the Skjern River in the 1960s led to the loss of many species, including the bittern. Over hundreds of years, a delta of about 4,000 ha developed at the mouth of the Skjern River. It was formerly marshland with reed-swamps, meadows, meandering watercourses and shallow lakes. Older locals can remember booming bitterns and large flocks of wildfowl. However, in the 1960s, arable fields were more profitable than cattle farming and the marshland was reclaimed. Between 1962–68, the lower part of the Skjern River was straightened and dykes (bunds) were built to prevent the river flooding. Pumping stations and drainage channels lowered the groundwater level. This work soon had a massive, negative impact on the wildlife, as only a few, small natural wetlands were left. There were also severe effects on the water quality, and thereby on the fish and waterfowl populations, of Ringkoebing Fjord, at the mouth of the Skjern.

Almost 20 years later – in 1987 – the Danish Parliament decided to restore the lower part of the Skjern River and its floodplain. The main reasons for this were:

- to use the restored wetlands as a way of capturing nutrients and silt, thereby reducing the pollution of the fjord downstream
- to restore habitats of international importance
- to develop the area for 'nature' tourism and recreation.

A working group was established with representatives from local and national authorities and NGOs. They assessed the restoration possibilities and acted as an advisory body to the Danish Government. This stage was funded by a LIFE-Environment grant. A project proposal and an Environmental Impact Assessment were published in 1997. The ideas and proposals from a public hearing that followed went into the Parliament Act for the Restoration of the Skjern River, which was passed in 1998.

Approach

Before the restoration work could take place, the state had to buy the private land within the project area. During a difficult but amicable process, almost all landowners agreed to sell or exchange land with the Danish Forest and Nature Agency, which was acting for the

Plate 7.9 Flooded wetlands by the River Skjern.

Danish Forest and Nature Agency

Government. Some landowners chose to keep their land in the river valley. They received state compensation for the loss of earnings from arable cultivation and for accepting management conditions to benefit wildlife and public access.

The construction work started in June 1999 and was largely finished by December 2002. The restoration work covered about half of the reclaimed area (2,200 ha) at a total cost of €38 million. The main restoration activities were:

- the excavation of the river course, using one of the original riverbanks wherever possible
- the removal of dykes/bunds
- the filling in of the channels dug to straighten the river.
- the removal or disconnection of pumping stations
- the construction of bridges and paths.

In total, 2.7 million cubic metres of soil has been moved, enough to fill a line of dumper trucks from Denmark to Italy!

Ongoing management

The Danish Forest and Nature Agency is responsible for the management of the area. It has drawn up a management plan to guide the local Forest Authority, which carries out the day-to-day work programme. This involves grazing, reed cutting, haymaking and maintenance of fencing etc. All reed cutting takes place during the winter. Only a small proportion of the reedbed is harvested every year and a strip of at least 10–15 m is left along the edge of the open water to benefit the bittern. As few tracks as possible are made into the reedbeds, as these attract predators, such as foxes. The costs are expected to be covered by income from the lease of grazing rights, haymaking, hunting and fishing. The newly restored meadows are grazed by about 850 head of cattle.

Results

The river and its floodplain have been restored, creating valuable habitats for many species (Plate 7.11). (See Figure 7.10 for the main habitat types). In 2005, only 3% of the restored area was covered with reed – corresponding to about 75 ha. However, the area of reedbed is expected to increase considerably as the reed colonises shallow lakes.

The numbers of fish, amphibians and insects have increased considerably, providing food for many species, including spoonbills, avocets, black-necked grebes and white-tailed eagle (Plate 7.10), with the newly flooded grassland proving very important for ruffs on migration. Not least, bitterns have returned to breed, with four booming males in 2003 and 4–5 in 2005. The number is expected to increase in the years to come. Both the Skjern River and the Ringkoebing Fjord are designated as SAC under the Habitats Directive, and the

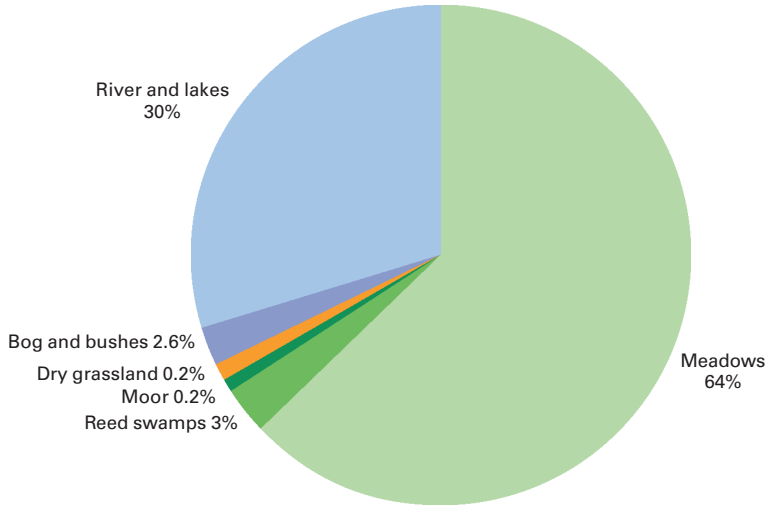


Figure 7.10
Habitat types created by the Skjern River Restoration Project, 2005.

Danish Forest and Nature Agency

Plate 7.10
White-tailed eagles have benefited from the restoration scheme.

Fjord, together with the Skjern River Delta area, is designated as a SPA under the Birds Directive.

Since 2004, monitoring of the project area has been part of the national environmental monitoring programme (NOVANA). At selected sites the monitoring includes:

- protected species and habitats
- vegetation in rivers and the riparian zone
- river water discharge and concentrations and transports of pollutants
- river invertebrates, otters, amphibians, salmon and birds

Many kilometres of surfaced trails provide visitors with great opportunities to explore the area. The location of the trails was carefully considered to limit the disturbance to wildlife. Already 100,000 people visit the area every year, and it has been found that they rarely leave the trails.

Lessons learned

The overall project assessment is unambiguous: it has been a tremendous success. The monitoring shows how quickly wildlife has responded to the changes. The only 'failure' is that 1,200 ha of grassland have been established rather than the 1,600 ha originally intended. This is because a greater area of lakes and wetlands has been created. These wetland areas will, however benefit important species like spotted crake, avocet and bittern, at the expense of waders, like ruff and black-tailed godwit.

Socio-economic effects

In the short term, the loss of agricultural production in the project area and EU subsidies, provides a negative overall economic assessment. It is not easy to give a monetary value to the restoration of habitats and wildlife. However, in the medium term, socio-economic effects are expected to be positive or at least neutral. This is due to the retention of nitrogen and phosphorus in the floodplain, as it contributes to better conditions in Ringkøbing Fjord, and the projected increase in tourism.

The future

The main concern for the Skjern River wetlands is in regard to waders and not the bittern, which seems to be doing well. The new agricultural measure, which came into force in Denmark in January 2005, has changed the subsidies for cattle, with the result that it may reduce the numbers available for grazing. If the meadows are under-grazed then they will become overgrown and unsuitable for waders. However, so far, the Danish Forest and Nature Agency has been able to get the necessary cattle and expects to maintain numbers in the next few years. The alternative to grazing cattle would be more intensive mechanical mowing.

Case study contributed by Niels Dahlin Lisborg

Graham White

Plate 7.11 Extensive shallow wetlands with wet grassland and some scrub and reeds are found on both sides of the restored channel.

Case study 7.6
Gaining the legal 'water rights' to enable wetland restoration, Schorfheide-Chorin, Germany

Featured technique: Obtaining legal 'water rights'
Location: Schorfheide-Chorin Biosphere Reserve, Germany
Contacts: Rüdiger Michels and Uwe Graumann, Biosphärenreservat Schorfheide-Chorin, Hoher Steinweg 5–6, 16278 Angermünde, Brandenburg, Germany, E-mail: ruediger.michels@lua.brandenburg.de
Sebastian Koerner, freelance wildlife biologist
E-mail: sebastiankoerner@online.de
Local status of the bittern: Up to 35 booming males
Designation: SPA, UNESCO-Biosphere Reserve
Date of featured work: 1999–2003
Management objective: To control and raise water levels in order to restore lakes and their associated wetlands

Background

The 42,700 ha Schorfheide-Chorin SPA is part of the larger (130,000 ha) UNESCO-Biosphere Reserve of the same name. It is situated about 80 km north-east of Berlin within the former socialist German Democratic Republic (GDR), close to the Polish border. The German bittern population falls in the transition zone between the dense populations of eastern countries such as Poland and the scattered populations of western European countries. With 200 lakes larger than one hectare, and more than 2,000 small wetlands, such as mires and kettle holes, it is likely that Schorfheide-Chorin supported at least 100 booming bitterns at the beginning of the last century. However, by 2000, only between 13–20 booming males remained.

Drainage, leading to the drying of reedbeds, is one of the most important reasons for the decline. Originally, each lake and its associated wetlands had their own water catchment basin. From the mid-18th century, considerable effort went into drainage schemes to gain agricultural land. Lakes were connected by ditches and then to a river to facilitate drainage. A final effort was undertaken during the 1980s. Each drainage channel had its own control weir, and its water level was regulated by GDR water legislation.

With the reunification of Germany in 1990, the GDR water legislation became invalid and the weirs were used without control or were abandoned. The drainage had resulted in not only a significant drying out of the wetlands but also highly dynamic water levels in existing lakes with long periods of low water followed by short and deep inundation. Against this background, the LIFE project 'Bittern Recovery Programme at the SPA Schorfheide-Chorin' was approved in 1999. It was undertaken by the Biosphere Reserve Schorfheide-Chorin, a sub-department of the 'Brandenburg State Agency for Environment' (LUA Brandenburg), together with governmental and non-governmental partners.

Approach

The project analysed habitat conditions at 10 sites, comprising 18 lakes and wetlands totalling 8,500 ha. It showed that the most urgent restoration actions were to secure better water retention in five lakes, to raise the water level of six lakes, and to restore two mire-lakes.

Following new water legislation in the reunified Germany, the use and management of each water body had to be approved by the responsible authority, in this case the federal state of Brandenburg. The procedure to obtain the

Rüdiger Michels

Plate 7.12
The flooding of the drained mire lake 'Large Meadow' at the village Altkünkendorf was one of the first water management measures, which was successfully carried out by the Schorfheide-Chorin Bittern LIFE Project.

'water rights' depends on the scale of change. It varies from simple permits, eg for the restoration of an existing weir in a ditch, up to a detailed assessment by the water authority for the restoration or creation of a lake (Plate 7.12). This would involve consultation with the lake users, such as fishermen and farmers, but also local government, nature conservation agencies and the public.

There have been two important decisions, without which the authorisations and approvals following the new water legislation would not have been achieved and implemented within the project life of four years. These were

- to set up a timetable for authorisation that took a holistic view of all requests rather than each single request; and
- to inform, advise and coordinate all relevant stakeholders, including the public, on each planned water management measure and its consequence for the environment and people (Plate 7.13).

Each approval needs a varying amount of time because of the different hydrological investigations and reports that need to be completed. Because a management plan had to be drawn up for each sub-site within the LIFE project, the approval procedure started relatively late. The SPA also covers four regional administration districts and it was difficult to convince the different water authorities to treat the approvals as a priority. The convincing argument was that the planned water management would not only promote bittern conservation but would also help implement the federal republic´s water laws across Brandenburg. Thus the authorities agreed to a joint timetable for water rights approvals and water management infrastructure, such as weirs and barriers, within the running time of the project.

In a region with a long history of drainage, it is not easy to convince landowners of the necessity for re-wetting projects, and it is difficult to carry them out against public opinion. So the project put a lot of effort into informing the public about the advantages of the measures for the local community and 'win-win' outcomes were sought with the farmers and fishermen. For example, project funding allowed the construction of fencing close to wetlands to prevent livestock entering, giving the farmer better control of the animals. A higher water level in the lakes leads to

Plate 7.13
Even after the implementation of a water management measure, it is important to inform the stakeholders of the results to keep their support.

Frank Neuschulz

greater fish productivity, so in most cases fishermen were in favour. The local drainage boards were important partners for all new consents, contributing their experience in hydrological planning and management and convincing many stakeholders of the positive effects of the planned measures. Where landowners and users did not agree voluntarily to the new water regime, they were given compensation. In some cases, the project had to purchase land, but even then any tenant farmers had to be compensated for any reduced productivity.

With the appropriate policy in place, the project achieved approval for changes to the water regime at 12 lakes. Through the construction (one), restoration (one) or removal (five) of weirs, and the modification of two pipes, the project achieved the recovery of 125 ha of former reedbed, re-wetting of 690 ha of drained fen mires and shallow water lakes, and the improvement of water levels in the 12 lakes.

Lessons learned

A water management project in an area with many land owners and users is a time-consuming challenge. First a management plan has to be prepared, followed by the water right approval procedure. The amount of time required is unpredictable. However, the key to success is careful planning and the involvement of all stakeholders. It is also important to persuade drainage board managers of the ecological responsibility of their work. They can be key partners for wetland conservation projects, if for example, they support improved water levels and supervise the technical work. Land acquisition makes it easier to gain control of the water but does not solve all the problems. It is more expensive than achieving agreements with landowners, unless compensation payments are required.

Case study contributed by Sebastian Koerner

Case study 7.7
Reedbed restoration at Amvrakikos, Greece

Featured technique: Providing infrastructure (sluices and canals) for re-wetting a floodplain reedbed
Location: Amvrakikos, Greece 38°59'–39°11'N, 20°44'–21°07'E.
Contacts: S. Zogaris, Hellenic Center for Marine Research, Institute of Inland Waters, 46.7 km Athens-Sounio, GR-19013, Anavissos, Attiki, Greece
E-mail: zogaris@ath.hcmr.gr
Y. Rigas and T. Arapis, OIKOS-Nature Management Ltd, Ermou 14, GR-14121, Iraklio Attiki, Greece
Local status of the bittern: Greece's breeding stronghold
Designation: Proposed National Park; SPA, Ramsar
Date of the featured work: 1999–2003
Management objectives: Re-establishing freshwater influence in degraded brackish reedbed

Background

The northern shores of the Amvrakikos Gulf comprise one of the largest wetlands in Greece, with freshwater wetland covering over 22,000 ha. This unique area, with its diverse habitats is an outstanding area for waterbirds, including Greece's only known breeding bittern population. One of the most significant sites in this extensive wetland complex is the Louros river floodplain and Rodia Swamp (covering 2,700 ha), the largest reed-dominated swamp in Greece (Plate 7.14). In former times, the swamp was an active part of the Louros floodplain but it has been deteriorating since the early 1960s when the entire lower stretch of the Louros river was embanked for flood control and agricultural development. The resultant hydromorphological changes brought an increasing influence of brackish water from the adjacent saline lagoons and the vegetation began to deteriorate. Since the 1970s, the varied reed and woody vegetation communities have died-back and water salinities increased, with declines in species diversity and biological productivity (Szijj 1981, Lawrie 2002).

A LIFE project, '*Conservation management of Amvrakikos Wetlands*', was awarded to the local development agency ETANAM S.A. from 1999–2003. This project included actions for wetland conservation, education, research and systematic monitoring. The project initiated research into restoration of the surface-water connection between the river Louros and Rodia Swamp.

The Amvrakikos has one of the most important and most southerly populations of bittern in the Balkans. Surveys discovered 8–12 breeding territories at two different areas: the Rodia Swamp and Fidocastro Wetland (a semi-artificial wetland of abandoned fish farms and flooded rice-fields). Between 70–90% of the Amvrakikos breeding population is concentrated at Fidocastro, which is about 25 km east of Rodia Swamp on the eastern shore of Logarou Lagoon. At Rodia Swamp, only 2–3 booming males were recorded. These booming males were observed during all three years of the

Plate 7.14 Rodia Swamp, Amvrakikos.

S. Zogaris

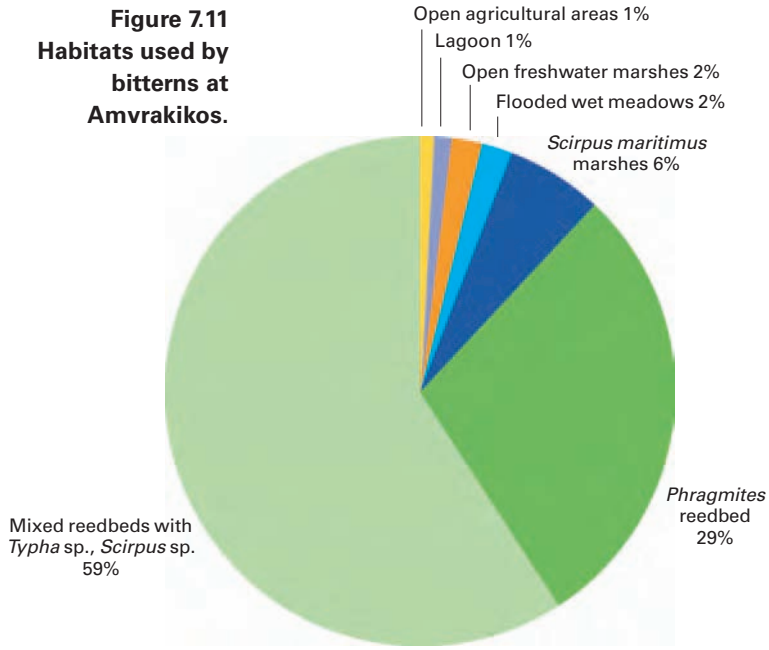


Figure 7.11 Habitats used by bitterns at Amvrakikos.

project, showing that breeding was probably regular. Although seemingly adequate large reedbeds exist elsewhere at Amvrakikos, exhaustive searches proved that only these two sites held booming males. The bitterns primarily use the freshwater habitats and large reedbeds, although outside the breeding season they are more dispersed and often also found in the brackish marshes (Figure 7.11). The wintering population is between 10–50 individuals, with a notable fluctuation of numbers from year to year. There is evidence of use by passage birds also.

Approach

The continuing degradation of the reedbeds at Rodia Swamp was having an impact on the bittern breeding population. Local people report that booming was more common and more widespread in the past. Rodia Swamp provided a unique opportunity for rehabilitation. However, there was a deficiency of hydrological data or knowledge of the reference conditions of this large wetland. Also, the local fishermen's cooperative did not want to see any disruption of the functioning of downstream lagoonal fish-traps. Although restoration should aim to create self-sufficient and naturally functioning systems, several human uses such as small-scale fisheries, adjacent agriculture and livestock grazing needed to be accommodated at Amvrakikos. A politically acceptable and environmentally benign re-wetting scheme was therefore devised. The construction of appropriate re-wetting infrastructure was envisaged as a first step towards a more holistic restoration in the future. The purpose of the infrastructure was three-fold:

1. To restore flood-pulses from the river to Rodia Swamp, without negative impacts to the river.
2. To enable freshwater flooding for the re-establishment of natural plant and animal communities, including the bittern.
3. To provide the potential for more holistic water resources management in the future.

Infrastructure development

The main infrastructure consists of two large sluices and two canals that function as distributaries through the swamp. Each canal is 1,000 m long, 6 m wide, 1.5 m deep, and can transport water directly from the river to the swamp without draining the river's embanked flood-zone. It was crucial not to drain this wildlife-rich relic of the former floodplain. The sluices were constructed 13 km upstream from the Louros' river mouth, the uppermost possible position in the swamp, to simulate the freshwater filtering effect that presumably took place through natural flood-pulse events. Dredged material (approximately 14,600 m^3) was piled into heaps next to the canals. These low long islands were created for waterbird use; this was more feasible than removing the material.

Work began in October 2002 and was completed by July 2003. The scheme was immediately effective; even during low summer flows water flows from the river to the canals in the swamp without pumping as the swamp is topographically lower that the embanked river. The water flow is controlled simply by manually operated sluice gates.

Monitoring

The following monitoring of bitterns was undertaken:

- spot mapping of booming males, wintering or transient birds, and

- recording habitat-use of birds, including specific habitat details, foraging and movements.

Viewing positions were established at the two breeding areas to confirm booming territories and to map flight paths. Baseline distributional, seasonal abundance and habitat-use knowledge were thus obtained and this helped the development of conservation proposals (Zogaris *et al*. 2003).

Results

An early assessment showed the value of the re-wetting and the potential of the infrastructure for the long-term restoration of the wetlands.

- The canals can transport approximately 134,000 m^3/day of water from the river to the swamp. This maximum amount represents about 13% of the river's discharge during its lowest summer flows and showed that it can effectively increase water levels in nearly all parts of the swamp.
- Regeneration with freshwater helophytes and aquatic plants was rapid, and certain freshwater plants have expanded into former seasonally brackish reed-swamp.
- Many waterbirds and other wildlife used the canals immediately after their construction. Storks and waterfowl fed in the canals and rested on the islands created from the dredged materials. At least nine species of fish were recorded, including rheophilic cyprinid fishes, presumably from the river's floodplain.

Lessons learned

This was an ambitious and wide-ranging project. For bittern conservation the project had several successes, notably the establishment of base-line information on its distribution. This helped extend the SPA boundaries to include Fidocastro wetland in early 2003. Unfortunately however, with the end of the LIFE project, there was a collapse of organised conservation effort. The infrastructure remains in place but its operation did not continue due to a lack of funds and the absence of a functioning management body within the proposed National Park. Fish-farming proposals also threaten parts of the Fidocastro wetland and the local hydrological regime. The area's breeding bittern population remains under pressure. It is clear that the long-term success of habitat rehabilitation cannot depend on providing infrastructure alone.

Case study contributed by Stamatis Zogaris, Niki Kardakari, Yannis Rigas and Thomas Arapis

Case Study 7.8
The re-wetting of Rambower Moor, Germany

Featured technique: Re-wetting of a wetland complex, including a large lake and mires
Location: Rambower Moor, Brandenburg, Germany
Contact: Biosphere Reserve Flusslandschaft Elbe, Neuhausstr 9, 19322 Rühstädt
Tel: +49-38791-980-0
E-mail: Heike.Garbe@lua.brandenburg.de
Local status of the bittern: Up to four booming males, regularly wintering birds
Designation: SPA and pSCI, Nature Reserve as part of MAB-Biosphere Reserve
Date of the featured work: 1999–2003 LIFE project 'Regeneration of the Rambower Moor' for protecting bittern
Management objectives: Restoration of water levels and enhancement of bittern habitat

Background

The Rambower Moor (Plate 7.15) is situated halfway between Berlin and Hamburg in the Flusslandschaft Elbe Biosphere Reserve, in the Federal State of Brandenburg. It is located on the western edge of the main bittern population in northern Germany. Thus, the area forms an important stepping-stone for the recovery of the species in the sparsely populated western Germany, although the numbers of booming males are low.

Plate 7.15 The Rambow Lake forms the central part of the project area.

Heide Filoda

The Biosphere Reserve comprises parts of the Elbe valley lowlands as well as parts of the northern Brandenburg hill country, where Rambower Moor is located in a large depression, 10 km in length and almost 1 km wide. Rambower Moor is a complex of natural and semi-natural wetlands covering an area of around 850 ha. Rambow Lake (Rambower See) lies at the centre of the area, a shallow eutrophic lake surrounded by a belt of littoral vegetation, mainly comprised of common reed and sedges. The boggy areas are fed by lime-rich springs and water from the valley slopes. Of special conservation value are the intact parts of a percolation mire, as well as the more common hydrogenetic type of a terrestrialisation mire. Due to minor but continuous drainage work during past decades, a negative water balance threatens the diverse plant and animal communities. The accelerated seral succession of Rambow Lake, now a fifth of its original size, has included a deterioration of the fringing reedbeds.

The aims of the project were to secure the water supply of the mire and Rambow Lake, and to maintain the area as a breeding and wintering site for the bittern. Restoration work had to consider the mosaic of natural and semi-natural biotopes. In particular, the water-level management had to meet the needs of grassland management, as well as mire restoration. Another objective of the mire re-wetting was the prevention of diffuse pollution downstream due to peat decomposition processes. A popular bathing lake, Rudower See, was suffering from phosphate eutrophication.

Frank Neuschulz

Plate 7.16
The theatre in action.

Approach

Communication and planning process
At the beginning of the project, nature conservationists and land-users were in opposition: the former wanting higher water levels and the latter requiring better drainage of pastures and meadows. Step by step, this unfavourable situation was turned around. Two working groups were initiated to promote communication. One group consisted of the local stakeholders and the other comprised authorities and scientists. Both groups also met together. This communication work used some quite innovative techniques (see Section 6.3 – Four Villages by the Moor and One Theatre (Plate 7.16)).

The planning process started with a thorough hydrological study. By combining older topographic data with measured land levels, a detailed digital elevation model was created. The model helped to identify the rate of peat decomposition and demonstrated how the topography had altered. Systematic measurements of the discharge rate at over 20 positions revealed the impact of the drainage system on water levels. The impact could be measured for 'sub-catchments' in the mire due to a comprehensive mapping of the ditch system. Moreover, the nutrient status of the run-off was investigated to identify possible local sources of pollution.

The results of the hydrological study were combined with the inventory of habitats, obtained through the management plan that was drafted in parallel. Thus, the complex hydrological system of the mire and its effects on both land-use and ecosystems could be interpreted and discussed in the working groups. Part of the management plan became a study of historic maps and former negotiations on water and fishing rights in the 19th and early 20th century. Consideration of the site's history enhanced the readiness of landowners and land-users to accept and support re-wetting actions, notably to enlarge the Rambow Lake again. As a consequence, the negotiations over land acquisition, long-term leases or changing of land uses were facilitated.

The project site was divided into 'management sectors', each of which had specific objectives and actions. The working groups assessed the actions on two scales: conservation priority (priority 1: achieves many conservation objectives, covers large part of pSCI to 3 – local effect only) and feasibility (letters A – high acceptance, no difficult

permit procedures, good cost-benefit ratio – to C – low acceptance, great efforts needed). So a 1A action should be implemented first as it is both easy to carry out and gives a high conservation return. This helped rank the actions within the LIFE project.

Water control measures
To gain the water right approval, the re-wetted area was partly acquired and partly long-term leased. The landowner (Rambower Seegemeinschaft) committed to accepting the water level rise after the end of the 25-year leasing period.

After the interests of all farmers were considered (land use is divided among three larger farming companies and seven part-time farmers), the mosaic of managed and non-managed wetlands were grouped by land parcels according to changes in the water regime. In the area where the existing land use was abandoned or carried out extensively eg by grazing with horses, 35 smaller weirs were installed, locally raising the ditch water level up by 20–50 cm. Some banks of the ditches were re-profiled in order to provide better bittern habitat.

The construction of a large, adjustable weir at the outlet of the Rambow Lake at the beginning of the Nausdorf Channel became a key action. This weir re-wets an area of 150 ha, including bittern breeding habitats. Moreover, the project undertook the construction of a second, larger weir across the Nausdorf Channel, co-funded by EAGGF-Guidance. This weir re-wets the whole central and lower part of the project area by setting a minimum water level throughout the year. This will also benefit the large copper butterfly, and several amphibian species. Because this will improve the development of wet grassland (Angelico-Cirsietum and Calthion meadows) by increasing the annual crop, this measure was appreciated by the local farmers. Agri-environmental schemes for wet grassland management have been strongly promoted among farmers by the project.

Results

A monitoring programme is being implemented by the Biosphere Reserve rangers and local universities. It includes biological, hydrological and nutrient monitoring. As the re-wetting of peatlands can be accompanied by the mobilisation of phosphorus and its transportation to adjoining aquatic ecosystems, accelerating eutrophication, the nutrient status of the mire's run-off is continuously monitored. In the first two years the re-wetting actions did not contribute to a higher phosphate concentration.

The project has benefited bitterns. In 2000, no bitterns were observed, but by 2002, four booming males were recorded and there was almost certainly one nest. In 2003 there were two nests. In 2005, visual observations of the birds showed that they were concentrated in places where the ditches and the reedbed fringing of the Rambower Lake had been improved by the project. The little bittern, which had not been recorded during the period 2000–2002, returned in 2003 and two singing male great reed warblers appeared for the first time in 2004. The marsh harrier (currently a small stable population) is expected to benefit in the medium term.

Lessons learned

Due to thorough planning and good communication, a well-balanced management system targeting Natura 2000 habitats and key species could be implemented, involving local farmers and water authorities. The implementation of this complex project required tenacity, pragmatism and a readiness to compromise. The project will serve as a demonstration for re-wetting of a percolation mire with phosphate eutrophication. It is expected that in the mid- to long term, the project will help to improve water quality in the Rudower See by halting peat mineralisation.

Case study contributed by Jochen Purps

Case study 7.9
Restoration of the steppe marshes at Hortobágy National Park, Hungary

Featured technique: Removal of drainage systems; grazing
Location: Hortobágy National Park, Hungary
Contacts: Dr Szilvia Gõri
Tel: +36 52 529-928
E-mail gori@www.hnp.hu
Local status of the bittern: Significant breeding population
Designation: National Park, SPA and proposed SCI, UNESCO Biosphere Reserve (52,000 ha), World Heritage Site, Ramsar Site (24,000 ha)
Date of the featured work: 2002–2005
Management objectives: To reverse past drainage activities and restore a more natural hydrological regime

Background

The Hortobágy region of eastern Hungary is situated in a shallow depression of the Great Hungarian Plain. The 82,108 ha National Park is dominated by vast, alkaline grasslands, interspersed by a range of wetland habitats, such as ephemeral waters, temporary alkaline marshes, permanent marshes, oxbow lakes and fishponds. Most of the steppes are located in the catchment area of the River Hortobágy, which is the hydrological axis of the region, crossing the Park from north to south over a length of 55 km. When it was a naturally functioning catchment, there was a high degree of connectivity with the floodplain, the river draining and flooding the surrounding area. These processes sustained an extremely rich diversity of dry and wet habitats and, together with natural soil erosion processes, created small depressions, 'benches' and areas of bare soil. The characteristic wetlands in the project area include:

- Ephemeral waters, seasonal and transient marshes with a hydrology connected to their micro-topography and the alkaline soils. They are highly susceptible to any alteration of the natural water regime, which cannot be simply replaced by an artificial water supply.
- Permanent marshes with a natural connection to the watercourses during floods. They were characterised by extreme water level fluctuations. In periods of drought, these marshes even dried out (about every 8–10 years).

The natural water regime and micro-topography of the Hortobágy wetlands have been greatly altered by a series of developments, which began with the canalisation of the river in the nineteenth century. During the 1950s and 1960s, many structures, such as ditches, dykes/banks and sluices, were constructed to create rice fields and irrigation channels. Many of these projects were so poorly designed that they proved unworkable. Later on, those within the National Park were abandoned. However, these structures continue to fragment the steppes and marshes and to block the natural movement of surface water. In addition, and only in the last ten years, the bed of the River Hortobágy was dredged. The average water level of the river is now lower than the base of the natural arms of the river, which previously carried flood water to the marshes. All these changes have led to a marked deterioration in habitat quality and biological diversity.

The status of the bittern

The number of booming males in the National Park is estimated to be 180–300, which is roughly 30% of the Hungarian population. The number depends on wetland conditions. For example, in 1999 and 2000, 100–110 booming males were counted in an 8,000 ha area, where 40–50 males are usual in an average year. Fishponds in the National Park extend to 6,000 ha and support 100–160 booming males. These are only rough estimates of

the breeding population. It is very difficult to give a precise number of boomers as sonogram identification has not been undertaken and the number of females is unknown. The bittern is present within the Park all year, but there is some movement within the region, with bitterns overwintering at unfrozen marshes and fishponds. It is difficult to give precise numbers, but perhaps 45% of breeding birds overwinter in the Park in a mild winter and 22% in an average winter.

Approach

The main principle, which guides the restoration of the Hortobágy wetlands, is to reinstate the natural hydrological regime. In the case of ephemeral waters, seasonal and intermittent alkaline marshes, this involves the restoration of the catchment area by reducing its fragmentation and thus reinstating the natural surface water movements. In the case of permanent marshes, the aim is to ensure an adequate water supply by simulating the natural flooding regime.

The funding from LIFE enabled the following to be implemented comprehensively and quickly.

- The elimination of almost 500 km of unused grassland irrigation and rice-field dyke (bank) and canal systems by levelling embankments and in-filling ditches. The depth of the minor ditches varied between 50–100 cm, with the main ditches as much as 2 m deep and 5 m wide (Plate 7.17).

Plate 7.17
An irrigation canal before infilling.

Hortobágy National Park

- Removal of water management structures – more than 800 m^3 of concrete were removed from the steppe.
- Building of some structures to keep water within the marshes and thus provide the optimal water level.
- Mechanical weed control on the backfilled canals and then seeding with native grass species in the first year after the earth works, to aid re-colonisation.
- Watercourses reinstated and reshaped to a more natural form. Before the project the dykes stopped the waters which therefore could not flow in the natural watercourses. The project eliminated these obstacles and now waters 'find their natural ways'.
- Expansion of extensive grazing.

The importance of extensive grazing
This region would once have been grazed by herds of wild ungulates. It long remained one large, common pasture for the animals (cattle, sheep and horses) of the surrounding settlements. However, the dykes and ditches of the rice-fields and irrigation systems hampered extensive grazing. Now that the channels and dykes have been removed, the whole area is suitable for grazing again to the benefit and delight of many local people. Grazing is also vital for wetland management and restoration. The marshes, as well as the seasonally wet alkaline meadows around them, are grazed. As they gradually dry out (natually in summer), the animals graze into the marshes, maintaining a mosaic-like habitat structure and preventing open water becoming overgrown with vegetation. Trampling also has important role in the development of the habitat structure.

Results

It is expected that:

- The fragmentation of the steppe will be reversed, the watercourses will take their natural surface forms and connections again. Overall the natural hydrological processes will be reactivated.
- Recovery of the flora and fauna of grasslands, meadows and seasonal and permanent marshes, and the

Hortobágy National Park

Plate 7.18
The flooded marsh after the completed works.

natural habitat structure of the steppes and marshes.

- The local watershed will function naturally and the natural pattern of surface water movements will be re-established, filling the natural depressions of wet meadows and marshes. The water level in the marshes will be higher (Plate 7.18).
- The natural surface erosion processes, which maintain the habitat diversity of the steppes, will return.
- Habitats suitable for breeding and foraging of the key species of the project area will be enhanced and increased.

Although it will take decades for the natural hydrology to be fully restored, early results have been favourable. The maintenance of higher water levels in the marshes has directly benefited bitterns by providing more breeding and foraging habitat. A definite increase in the number of booming males in the LIFE project area has been detected. The rehabilitation works carried out by the project has significantly contributed to the population increase of bitterns in that area. In 2002 the population of this species increased only in the project activity area, elsewhere it was stable, or slightly decreasing (due to periods of drought). During the period of the project activities (2002–2005) the population in areas directly targeted by the project increased from 19 to 28 booming males (53% increase).

One of the most valuable permanent marshes of the National Park had had a ditch and dyke system built across part of it. It completely altered the natural hydrological regime of the marsh and blocked the flow of surface water. This system was demolished in 2003. Once the earth works were finished, the marsh was re-flooded. At the same time, grazing of the marsh edge by cattle was started in order to suppress reed growth. In spring 2004, masses of waders on migration used the restored area of the marsh. The natural flow of surface waters started again. In 2004–2005, the greatest increase in the number of booming bitterns anywhere in the project area was noted. There was much more breeding habitat than before, with optimal hydrological conditions and a mosaic of open water, fringed by *Phragmites* and *Typha.* The marshes had enough water and therefore offered a food supply throughout the nesting period. The shallow, water-covered meadow zone of the marsh (which formerly was cut up by ditches) is now an excellent feeding area for herons, spoonbills, waders and terns. This area is also a key site for common cranes in the summer.

Case study contributed by Dr. Szilvia Gõri and colleagues from the Hortobágy National Park Directorate

Case study 7.10
The restoration of Lake Dümmer, Germany

Featured technique: Re-wetting of fen, wet grassland and reedbed
Location: Lake Dümmer Area, Lower Saxony, north-west Germany
Contact: Heinrich Belting, Naturschutzstation Dümmer, Am Ochsenmoor 52, D-49448 Hüde, Germany Tel: 0049 5443 1393 E-mail: heinrich.belting@nlwkn-ol.niedersachsen.de
Local status of the bittern: Regularly breeding until 1980s, still present in winter
Designation: SPA (4360 ha); pSCI; IBA; Ramsar site; Game reserve; Nature reserve; 'Europareservat'; Protected Landscape Area
Date of featured work: 1987–2006
Management objectives: Restoration of the Lake Dümmer marshlands

Background

The marshland of the Lake Dümmer area is of international importance for nature conservation. The varied semi-natural habitats shelter a great number of meadow, reed and water birds which either breed, rest or overwinter in this area. The 1,300 ha lake is surrounded by 300 ha of reedbed, with patches of alder and willow carr, and 5,000 ha of wet grassland/fen (Plate 7.19).

Plate 7.19 Mouth of river Hunte in Lake Dümmer with the dyke.

Naturschultstation Dümmer

Various developments in the past have put the area at risk. The building of embankments (dykes) around the lake in 1953 not only resulted in drainage and intensified farming in the lowland area but, together with peat cutting in adjacent raised bogs, led to nutrient enrichment of the river Hunte. The river Hunte flows through the Dümmer, with the poor water quality causing eutrophication of the lake. As a result of the embankments, the water level of the lake (and the reedbed) is regulated, without taking conservation into account. The area of the reedbed is decreasing year by year, willows are spreading, and several areas are already overgrown by scrub. Before embankment, the bittern population fluctuated between 10–20 booming males. After 1953, the population decreased steadily (1960s = 5–10; 1970s = 3–8; 1980s = 2–4). The last record of booming was of two males in 1985. Only in 1995, a year with high water levels in winter and spring, were there nine booming males again. Up to five wintering birds are still recorded, at which time the birds not only use the reedbeds, but also the ditch edges in the fens close to the lake.

All over Lower Saxony, between the rivers Ems and Elbe the population of the bittern has also declined. In 2004, there were only nine sites with 10 booming males over an area of 47,000 km², most of them east of the river Weser. In Lower Saxony, there are even only a few wintering sites left. The reed-habitats at Lake Dümmer seem to have potential as a breeding site, yet it is unclear why birds are not breeding (see below).

Approach

In 1987, the state of Lower Saxony decided to restore Lake Dümmer and its surrounding lowland with the project management undertaken by the Dümmer Nature Conservation Centre. Farming, water industry, nature conservation and tourism interests have to cooperate in a way that promotes conservation. Several projects have been undertaken, involving

the local districts, the Federal State of Lower Saxony, the Federal Republic of Germany and the EU. €40 million has been spent purchasing 2,500 ha of private land (Figure 7.12). The re-wetting has been carried out as part of two LIFE projects: 'Rewetting of the Ochsenmoor 1998–2000 (Budget: c€1 million)' and 'Rewetting of the western Dümmer fen area 2002–2006 (Budget: c€3 million)'.

The aims of the projects are:

- improving the water quality of Lake Dümmer by diversion of the 'Bornbach' brook (see Figure 7.12) – this measure will reduce the input of phosphates by about 50%
- extending a large wet grassland and reedbed area by purchasing privately owned productive land
- re-wetting the fens by installing adjustable weirs in ditches over an area of 2,500 ha
- maintenance of wet grassland in cooperation with 140 local farmers
- restoration of the reedbed by scrub removal, and increasing the area and the quality of reeds

The re-wetting has been undertaken with adjustable weirs (Plate 7.20). More than 70 km of ditches are controlled by 45 adjustable and 15 permanent weirs, making it possible to accurately manage water levels. This has reinstated the pre-embankment water regime (winter levels 80 cm higher on average than in summer).

Since the installation of the weirs, the meadows are flooded again in winter, and in summer the water is allowed to flow back slowly in order to facilitate extensive farming on the meadows and pastures.

Results

The two LIFE projects are targeted towards the protection and enhancement of wet grassland habitats and their associated birds. Already success is evident with improved wet grassland vegetation, as well as increasing numbers of several migratory birds (eg white-fronted goose, bean goose, shoveler, garganey and lapwing). After re-wetting, several species returned to breed (eg white stork, shoveler, garganey, redshank, spotted crake, corncrake and short-eared owl). The number of breeding pairs of several species, and their productivity, has increased (eg lapwing, common snipe, curlew and black-tailed godwit).

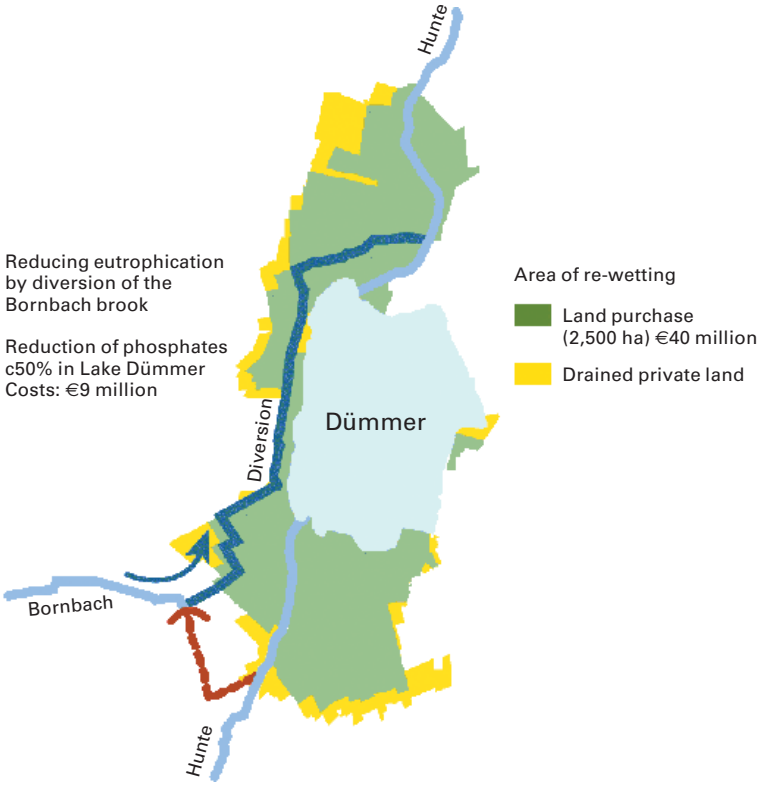


Figure 7.12
Re-wetting area at Lake Dümmer.

The bittern is not a target species of the LIFE project but it should benefit from re-wetting and the higher water levels. An improvement in habitat will hopefully see the return of breeding bitterns to this

Naturschutzstation Dümmer

Plate 7.20
Regulating of natural water levels by adjustable weirs in the fens at Lake Dümmer.

former stronghold in the coming years. The following actions to optimise the existing reedbeds are just starting:

- A new lake water regime is being implemented, with higher spring and summer levels (+20 cm) leading to a higher percentage of flooded reeds. This is a compromise between the competing interests of water industry, tourism, agriculture and nature conservation.
- Reduction of nutrient input will lead to a reduction in eutrophication of the lake, improved water clarity and more food for bitterns.
- Installation of wave breakers along the reed edge to facilitate the spread of reeds back into the lake.

The measures taken in the fens (beyond the dyke) have led to an improvement in bittern wintering habitat and may create new breeding habitat in the future. The restoration of the reedbed in front of the dyke is only small-scale so far but should increase as various actions take effect in the coming years. Recently, there has been a significant decrease of fish in the lake with greater than 80% decrease in biomass and 98% in individuals, and the dominance of algae in the water results in high turbidity. Consequently, a lack of food may be the limiting factor for the bittern.

Case study contributed by Heinrich Belting

Case study 7.11
Guidelines for the exploitation of reeds in the Seine estuary, France

Featured technique: Reed cutting – establishing cutting guidelines
Location: Seine Estuary, France
Contacts: Christophe Aulert (Maison de l'Estuaire), 20 rue Jean Caurret, 76600 Le Havre, France
E-mail: mde@maisondelestuaire.org
Local status of the bittern: 22–29 booming males annually
Designation: SPA
Date of the featured work: 2000–2005
Management objectives: To trial a reed cutting regime, which is more favourable for breeding bittern

Background

The Seine Estuary reserve covers 8,528 ha and is managed by La Maison de l'Estuaire, a local non-governmental organisation (NGO), which leads on the French LIFE project. It was created in 1997 as environmental compensation for further port development in the estuary.

The main activities on the reserve are reed cutting (six reed cutters), grazing (130 farmers) and hunting (2,500 members in the local hunting group). However, as they do not own the land or have any rights (it is public maritime land), La Maison de L'Estuaire has overall control.

Of the 1,250 ha of reedbed in the Seine Estuary Natural Reserve, 700 ha of mainly wet reedbed (the amount allotted in 2001–2005) are cut each year. This traditional practice of reed cutting slows down the process of habitat succession. This has been exacerbated by the various industrial and port-related developments, that have been built here since the beginning of the 20th century (the Seine embankments, the Normandy bridge, Port 2000, etc). Reed cutting is therefore important but at the same time brings the potential of conflict with bitterns, which begin to establish booming ranges from February and seem to prefer areas of uncut, wet reed.

Figure 7.13 Location of cut compartments in the reedbeds (season 2003–2004).

Approach

Starting in 2000, changes to the reed cutting regime, which were thought to better meet the needs of breeding bittern, were trialled. These were:

1. The cutting season was limited (from 15 November – after the first frosts – to 15 March).
2. Cutting was prohibited in certain areas, where breeding activity had been found the previous year (booming position and nests). This amounted to 20% of the total exploitable reedbed area each year.

Aerial photographs were taken at the end of each cutting season (April–May) to ensure that the guidelines were being followed and to digitally map areas of cut and uncut reedbed (Figure 7.13).

Results

Since 1997, the bittern population has increased in the Seine estuary. This increase can be attributed to several factors:

- a more accurate count of male boomers since 1999
- an increase in reed coverage
- the introduction of the bittern-friendly guidelines for reed cutting.

Overall, the guidelines were followed each year. Over 3 years (except for the cutting season 2002–2003, when the aerial photos were taken too late to be of use), 58% of male boomers (n=67) were located in or within immediate proximity of the areas of uncut reed, 24.4% were present where small patches had escaped cutting and only 17.5% were located in cut reedbeds. As far as nests were concerned, (n=15), the correlation was even stronger: 91.6% of nests were found in reeds still standing as opposed to only 8.4% (n=1) in cut reedbeds.

Consequently, this method of management has been shown to be especially favourable to females, which prefer to build their nests in patches of uncut reed. This management method also seems to benefit the marsh harrier and reedbed passerines, which nest in uncut reed (Provost and Aulert 2003).

Each year, although there were a few small exceptions (isolated or overly-small patches left uncut, very late cutting, etc), the surface of reeds left standing totalled over 20% of the total exploitable reedbed. (44.3% in 2001, 28.2% in 2002 and 22% in 2004). Thus, the decrease in population of the bittern between 2003 and 2004 (22 male boomers in 2004 as opposed to 29 in 2003) is possibly linked to the smaller proportion of reeds left standing (22%).

Pascal Provost

Plate 7.21 Commercial reed cutting in the Seine estuary.

There is also a potential conflict with the management of water levels for reed cutting. In order to cut the reed, water levels must be lowered in winter (to enable the land to be accessed by the machines), which leads to low water levels in spring. This is unfavourable for nesting in certain species, including bittern. It can increase predation of the broods, as in drier reedbeds, the female leaves the nest for longer periods to hunt prey to feed her young.

The reed cutting guidelines and the water level management regime have led to conflicts between the cutters and hunters. Hunters want more water in winter and cut the edges of their ponds to create zones to attract wildfowl. However, this practice reduces the area of reedbed available for the reed cutters, who are already constrained by the guidelines to leave 20% of the total area standing. Following many meetings to raise awareness of these issues, the hunters are now authorised to cut a 30 m strip around the ponds, with the agreement of the reed cutter who owns the plot where the pond is located.

These guidelines have also caused technical difficulties for the reed cutters, particularly where smaller reedbed areas have resulted. Smaller areas tend to take longer to cut and increase the number of passes that reed cutters have to make, risking damage to the reed rhizomes, and therefore the reed re-growth. To avoid damaging the reedbeds, it is preferable to use a system of rotation, even if only a few metres from one year to the next, and even if a male boomer was recorded in the area the year before.

Lessons learned

The current guidelines seem to better meet the ecological needs of the bittern during its breeding season and will therefore be continued with some adjustments:

- plans will be drawn up for suitable penalties in the event that the guidelines are not followed
- the method of attributing the reed patches to individual reed cutters will need to be adapted
- the management of water levels for reed cutting will need to be monitored in certain sectors
- monitoring by aerial photographs should be improved or replaced with another more accurate and less expensive method.

All these issues will be dealt with in the Natural Reserve Management Plan (Maison de l'Estuaire 2001).

Case study contributed by Christophe Aulert

Case study 7.12 Experimental management of reedbeds in the Petite Camargue, France

Featured technique: Reed cutting – adapting commercial cutting regimes
Location: Charnier-Scamandre, Camargue, France
Contacts: Brigitte Poulin (Station Biologique de la Tour du Valat), Le Sambuc 13200, Arles, France
E-mail: poulin@tourduvalat.org
and Raphael Mathevet, UMR 5175, Centre d'Ecologie Fonctionnelle et Evolutive – CNRS 1919, route de Mende 34293, Montpellier, France
E-mail: raphael.mathevet@cefe.cnrs.fr.
Local status of the bittern: Between 45 and 70 booming males each year
Designation: SPA
Date of the featured work: Experiment conducted between 2002 and 2005 as part of the LIFE project 'Restoration and management of the habitats used by the bittern in France'
Management objectives: To evaluate the impact of leaving reed uncut on booming male bitterns

Background

The Charnier-Scamandre is a large area of semi-natural habitats, including over 2,270 ha of reedbeds. Varying from year to year, between 25% to 45% of the reedbed area is mechanically cut. The reed is mainly used for thatching. Reed cut in southern France (including Charnier-Scamandre) amounts to about €2 million turnover annually and equates to about 70% of the French market for thatching reed. Other activities include wildfowl hunting (on public and private land) and angling. The conflicts between the differing water management regimes required for these activities has led to a local deterioration in the quality of the habitat.

Between 45 and 70 booming males use this habitat each year. The main factors which could influence the bittern population are water level management and reed cutting. Measurements of reed density show that the males search for places where a few reeds have been left standing amongst the cut areas. Yet, these are few and far between, because it is usual practice to either cut all standing reed or to not cut the reedbed at all.

A local authority, the Syndicat Mixte pour la protection et la Gestion de la Camargue Gardoise (SMPGCG), is responsible for drawing up the sites's Natura 2000 management plan. It is working in partnership with the Station Biologique de la Tour du Valat, which has done many scientific studies of the area and provides advice on nature conservation in the Camargue. The Station Biologique de la Tour du Valat is the lead partner of the Bittern LIFE programme (2001–2006) and SMPGCG is a partner.

Approach

Very little is known about the relationship between reed cutting and the use of reedbeds by bittern. An experiment was therefore set up to enable the evaluation of the attractiveness to bittern of reedbeds with equal proportions cut and uncut. Areas of reed of at least 5 ha, which are usually cut, were left uncut. They were adjacent to cut areas of a similar size.

It was first carried out within the Bouvau reedbeds, which cover about 69 ha, and have been completely cut every year for the past 15 years. These reedbeds were home to two booming males in April 2002, before the experiment started. The bitterns start booming in April, by which time the cut reed has already grown considerably higher than in more northern areas.

Results

In April 2003, there were seven booming males, of which six were using the uncut

areas. The experiment was repeated in 2004 – that is the same areas were cut again and the same uncut areas were left uncut. In these areas, the dry reed stem density doubled in comparison with 2003. In 2004, there was a slight drop in the numbers of booming males to five, all found in the uncut areas. However, in 2005, the numbers had increased again to seven (see Figure 7.14). This experiment was also carried out on a second area, the Listes reedbeds, which cover 31.5 ha, starting in 2003. Similar results were obtained.

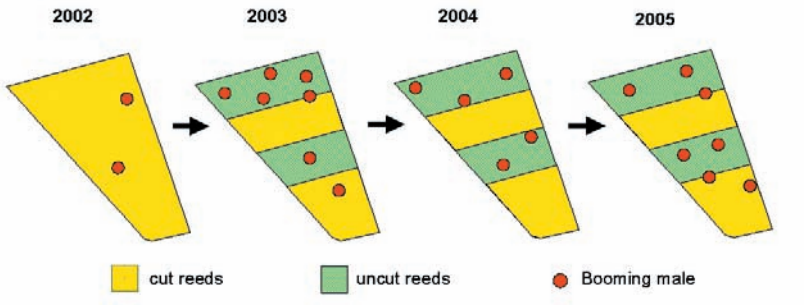


Figure 7.14
Impact of three years of experimental cutting on male boomers in the Bouvau reedbeds in the Petite Camargue Gardoise.

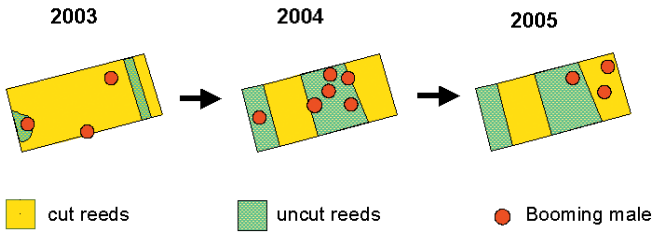


Figure 7.15
Impact of two years of experimental cutting on male boomers in the Listes reedbeds in the Petite Camargue Gardoise.

Lessons learned

The commercial exploitation of the Camargue reedbeds, which is economically important, can be compatible with the ecology of the bittern. These reedbeds appear to offer optimal conditions for the booming males one year after they are cut. The sustainable exploitation of these reedbeds would therefore involve leaving occasional patches of uncut reed within cut areas. These patches would be in different places from year to year.

It is important to note that the Mediterranean climate, in encouraging the early growth of reed in spring is on average three weeks ahead of the reed in the Seine estuary in northern France. Therefore, this probably helps to reduce the impact of cutting on reedbed fauna, such as bittern and passerines. This is suggested by a comparison of the bittern counts in April and May, which show a slight movement of booming males from uncut to cut areas, (whether these were experimental areas or not). Further studies will be necessary, therefore, to determine whether these findings are specific to the Mediterranean region or whether they are also characteristic of other European regions.

The medium-term objective of this experiment is to ensure that the ecological conditions, identified as favourable to the bittern, can be integrated into future agri-environmental contracts governing the commercial exploitation of the reedbeds (Natura 2000 specifications, CAD etc). Agri-environment measures were drawn up for the period 1996–2001, which altered cutting practices in order to manage the reedbeds for highly threatened bird species (purple heron, bittern, marshland passerines). The Natura 2000 contracts are intended to continue efforts to find a balance between this economic activity and the conservation of natural habitats.

These specifications, drawn up by all the partners, are already addressing some of the potentially negative effects of over-exploitation or intensification of cutting activity. However, this experiment has shown that it is still necessary to agree some additional ecological guidelines. One of these would be to leave reed uncut over 10% of the surface area of commercially cut reedbed, in return for a subsidy in the region of €35/ha, to compensate for the shortfall in earnings.

Case study contributed by Brigitte Poulin and Raphael Mathevet

Case study 7.13
Reed establishment at Ham Wall, UK

Featured technique: Techniques for reed establishment
Location: RSPB Ham Wall Reserve, UK
Contacts: Sally Mills, the RSPB, 2 Ashcott Road, Meare, Glastonbury, Somerset, BA6 9ST, UK
www.rspb.org.uk
E-mail: sally.mills @rspb.org.uk
Local status of the bittern: 1 boomer
Designation: National Nature Reserve (NNR) (part)
Date of featured work: 1994–2005
Management objectives: Reedbed creation

Background

The RSPB Ham Wall Nature Reserve is located in the River Brue Valley at the eastern end of the Avalon Marshes, Somerset, UK. The area has a long history of drainage for agriculture and then peat extraction for horticulture. During peat extraction groundwater levels are lower than in the surrounding land. This lower level means that worked areas gradually fill with water once peat extraction and its associated drainage ceases – producing a major opportunity for wetland creation. The site is now managed by the RSPB and was included in the LIFE project:

Developing a strategic network of SPA reedbeds for bittern.

The objective is to develop the site as a nationally important wetland, which will form an integral part of a larger area called the Avalon Marshes. The site design includes an extensive mosaic of reed-dominated swamp, open water and ditch systems to provide nesting habitat for reedbed species of high conservation priority. In particular, the aim is to restore breeding bitterns to the south-west of England.

Ham Wall is one of the foremost UK examples of a large reedbed creation scheme, and has proved very instructive in testing techniques for the establishment of reed. The reserve currently covers 225 ha (Plate 7.22).

Plate 7.22 An aerial view of the reedbeds at Ham Wall.

The RSPB

Approach

This former peat extraction site has been progressively restored back to reed-dominated wetland over the last 10 years, as each phase of extraction finished. Treatment of each area to achieve restoration has been determined by how the site has been left, particularly in relation to ground levels. All phases were bunded with clay excavated from an adjacent borrow dyke. Areas of deeper water and ditches were excavated and the ground re-profiled to obtain the required water levels. The design specified a proportion of open water, which has varied from 20% to 50%. This was also the case with the proportion of reed/open water interface per hectare, which has varied from 250 m up to 450 m. Additionally, sluices, pipes, and wind and electric pumps were installed to enable water levels to be manipulated accurately.

Reed establishment

Four different techniques were used to establish reed, enabling comparisons of effectiveness and costs to be made. Reed establishment is carried out in each

Table 7.4 Key breeding species (pairs/singing males) at Ham Wall 1997–2004.

	1997	1998	1999	2000	2001	2002	2003	2004
Bittern	0	0	0	0	0	0	0–1	1
Reed bunting	23	23	25	21	32	35	24	32
Gadwall	1	4	6	9	3	50	77	22
Garganey	1	3	2	1	2	3	3	2
Shoveler	1	0	3	2	3	12	15	14
Pochard	1	4	5	8	3	10	19	17
Water rail	2	4	5	6	6	28	n/c	n/c
Lapwing	2	2	7	6	10	9	14	9
Cetti's warbler	2	2	2	9	9	15	26	29
Bearded tit	0	0	0	0	0	0	0	2
Sedge warbler	38	44	36	57	75	31	70	79
Reed warbler	24	71	110	179	181	215	235	370
Tufted duck	1	4	6	11	8	22	43	40
Little grebe	11	9	18	11	38	49	20	14
Great crested grebe	0	3	4	4	12	14	15	19

phase after engineering work has been undertaken.

1. *Seeds*. Reed seeds were introduced as pre-germinated panicles or panicle fragments collected from the nearby Shapwick Heath. Seeds were surface-spread at a density of about 80 seeds m^{-2} in late May to early June. The original intention was to maintain the water level at or just below the surface after sowing, but a period of very dry weather prevented this. A rotary sprinkler was used to keep the soil surface damp.

2. *Seedlings*. Initially, seedlings were grown in plugs by a commercial nursery from panicles collected in December 1994. In total, 100,000 seedlings were grown in plugs of sizes 200 cm^3 and 50 cm^3. The first phase of the restoration received 18,000 seedlings, with the remainder being over-wintered and planted in the second phase in the following year. Seedlings were only planted in areas where the soil water table was no more than 14 cm below the surface. Subsequently, all seedlings were grown on site in plugs using a polytunnel, seeding in March and planting out in June/July. Weeds were controlled by raising water levels to cover the planting area, leaving a bare substrate for planting when water levels were lowered.

Table 7.5 Key wintering species at Ham Wall 1999–2004.

	1999/2000	2000/01	2001/02	2002/03	2003/04
Bittern	1	1	1	2	1
Little egret	11	11	11	18	11
Mute swan	70	70	70	55	30
Wigeon	273	273	273	505	578
Gadwall	299	299	299	372	246
Teal	535	535	535	720	500
Mallard	326	326	326	300	189
Shoveler	113	113	113	185	136
Pochard	68	68	68	185	111
Tufted duck	106	106	106	167	125
Coot	144	144	144	325	103
Lapwing	110	110	110	280	400
Snipe	71	71	71	66	18
Bearded tit	0	2	0	6	9

3. *Transplanted rhizomes.* Mechanical rhizome transplantation has been used extensively, mainly along the banks of the reedbed phases. An excavator was used to dig out clumps of reed approximately 2 m × 2 m × 0.5 m in size from a patch of nearby dry reedbed. These clumps were placed at 10 m intervals along the water's edge on the inside of the bunds. Individual rhizomes and spade-sized clumps have also been planted by hand, throughout the year, but making sure to leave erect dead stems above the surface

to accommodate rising water levels and prevent drowning.

4. *Stem planting*. Reed stems were cut well before flowering during June and July. Vegetation in the planting area was cut and removed, and stems were planted in May, June and July. Stems were planted at about 16 stems m^{-2} to a depth that ensured at least one, and preferably two nodes, were buried. Water levels were kept at or just below the soil surface during planting. Once the stems started to produce shoots, the water level was raised to discourage the growth of competitive vegetation.

Results

Two years after sowing seed, a mean density of 28.8 reed shoots m^{-2} with mean percentage cover of 26.8 was achieved. This compares to a mean density of 80.3 shoots m^{-2} with mean percentage cover of 28.0 achieved two years after planting of seedlings in the first phase of restoration. The second phase seedlings performed better; yielding a mean density of 146.5 shoots m^{-2} and percentage cover 60.5 one year after planting. Hydrology appeared to have a greater effect than planting density on the amount of reed cover produced, with best results produced in areas with less than 20 drought-stressed days per year. However, in these wetter areas, seedlings planted at 8 m^{-2} produced almost seven times the reed cover of seedlings planted at 4 m^{-2} after two years.

Rhizome transplantation was less successful than seedling planting after one year, but after two years, the mean density of stems had risen to 40.3 m^{-2}. Approximately 50% of planted reed stems survived, producing 8 stems m^{-2}, each giving rise to a mean of three shoots. This provides an initial mean density of 24 shoots m^{-2} one year after planting.

Lessons learned

- Planting seedlings grown on site is the most effective way to establish reed cover, and is one of the most cost-effective approaches. As long as the plants are part-flooded, a planting density as low as two plants m^{-2} produces results over two years equal to higher planting densities.
- At sites where a damp, weed-free seedbed can be prepared and a good local seed source is available, sowing may be the most effective approach. It may not be suitable on sites with clay soils and abundant competitor rhizomes or in cooler, northern areas.
- Rhizome transplantation is suitable for relatively small areas with a donor reedbed nearby and is a technique that can be used all year round.
- Reed establishes and achieves dominance more rapidly in areas with little or no competitive plant cover. Sites with marginal or emergent competitors such as soft rush and reedmace may require some weed control before reed is established.
- The rapid achievement of reed cover in the first season after planting is a successful method of promoting long-term dominance. Such cover is best achieved by establishing seedlings at a high density, ie eight plants m^{-2} or higher, particularly if there is no surface water.

Overall, the results at Ham Wall are highly encouraging. The most successful of the methods tested achieved stem densities and lengths comparable to those found in mature reedbeds after only one season. Planting of seedlings grown on site appears to be the most effective method of establishing reed. The control of water levels early in the establishment phase is critical and was probably the cause of some methods doing less well. Water level management in the early stages is also important in all of the methods for controlling competing vegetation. Over 200 ha of ex-peat workings have now been restored at Ham Wall, including over 60 ha of reed swamp, 55 ha open water, 30 ha of mixed swamp vegetation and 10 ha of wet scrub. All areas are developing well, with good establishment of wildlife populations and significantly, the arrival of the first booming bittern in 2003, nine years after the project started.

Case study contributed by Sally Mills

Case Study 7.14 Implementing wetland buffer zones through agri-environmental schemes, Schorfheide-Chorin, Germany

Featured technique: The use of GIS to define wetland buffer zones
Location: Schorfheide-Chorin Biosphere Reserve, Germany
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E-mail: Uwe.Grauman@LUA.Brandenburg.de
Sebastian Koerner, freelance wildlife consultant
E-mail: sebastiankoerner@online.de
Local status of the bittern: Up to 35 booming males
Designation: SPA, UNESCO-Biosphere Reserve
Dates of featured work: 1999–2003.
Management objectives: To use existing agri-environment funding to create buffer zones around 28 lakes in order to reduce nutrient levels

Background

The Schorfheide-Chorin SPA is situated about 80 km north-east of Berlin within the former socialistic German Democratic Republic (GDR) (see Case study 7.6 for further details).

The eutrophication of lakes by nutrients from the surrounding agricultural land is one of the main factors affecting the habitat quality of the reedbeds at Schorfheide-Chorin. With increased nutrients, the reed produces a lot of mass but the stems are weak and the litter layer builds quickly, increasing the rate of seral succession. Following the reunification of Germany in 1990, farmers can receive agri-environmental subsidies for less intensive production. However, a diversity of funding programmes exist and there has not always been a comprehensive strategy to determine the ecological objectives for the area.

In 2001, a management plan set up by the LIFE project (Bittern Recovery Programme at the SPA Schorfheide-Chorin) showed the necessity of effective agricultural buffer zones around 28 lakes and associated wetlands. Only a small part of these buffer zones could be established by land purchase and subsequent lease to farmers under appropriate restrictions. The majority of the buffer zones were achieved by using existing and new agri-environment funding (Plate 7.23).

Approach

In order to coordinate the agri-environmental subsidies as an effective tool for buffer-zone creation, it was necessary to know what had already been implemented and which parts of the landscape should be targeted for new contracts. Data on existing agri-environment funding had to be collected. To facilitate the analysis over an area of around 3,000 ha, land registry maps had to be digitised. Finally, the ecological data, land registry data and the agri-

Plate 7.23 Protecting hedge planted at a buffer zone.

Sebastian Koerner

environment subsidies data were merged within a GIS (Geograghical Information System) file map to make the final assessment as to where and how to create the buffer-zones. This would involve changing existing or negotiating new agri-environment contracts.

Working steps

1. Registration and digitisation of ecological and land use data
The LIFE project's Reedbed and Bittern Management Plan provided biotope-type and land use surveys for the 1,300 km^2 of the Biosphere Reserve. (Figure 7.16.)

2. Registration and digitisation of land registry data
The borders of all land ownership plots were digitised from existing maps. Ownership and tenancy data for each plot were collected.

3. Existing agri-environment funding
The agencies for agri-environment subsidies were consulted, to confirm which contracts already existed with which farmer.

4. GIS-map merging
Using the GIS programme ArcView 3.1, the data on topography, habitat type, land use, ownership and agri-environment subsidies were combined in one digital map.

5. Classifying buffer-zone land
Based on the merged GIS maps, the land plots were divided up into three different 'traffic light' classes;

- green – existing agri-environmental subsidy contributing to the buffer zone
- yellow – agricultural land which does not impact the wetland because it is too far away or is downstream of the bittern habitat; and
- red – agricultural land which impacts on the habitat and where action to create a buffer zone is urgent.

Based on the 'traffic light' maps, the administration of the Biosphere Reserve was able to offer subsidy contracts to farmers of red, high priority buffer zone plots. The administration also used the information to give advice to other

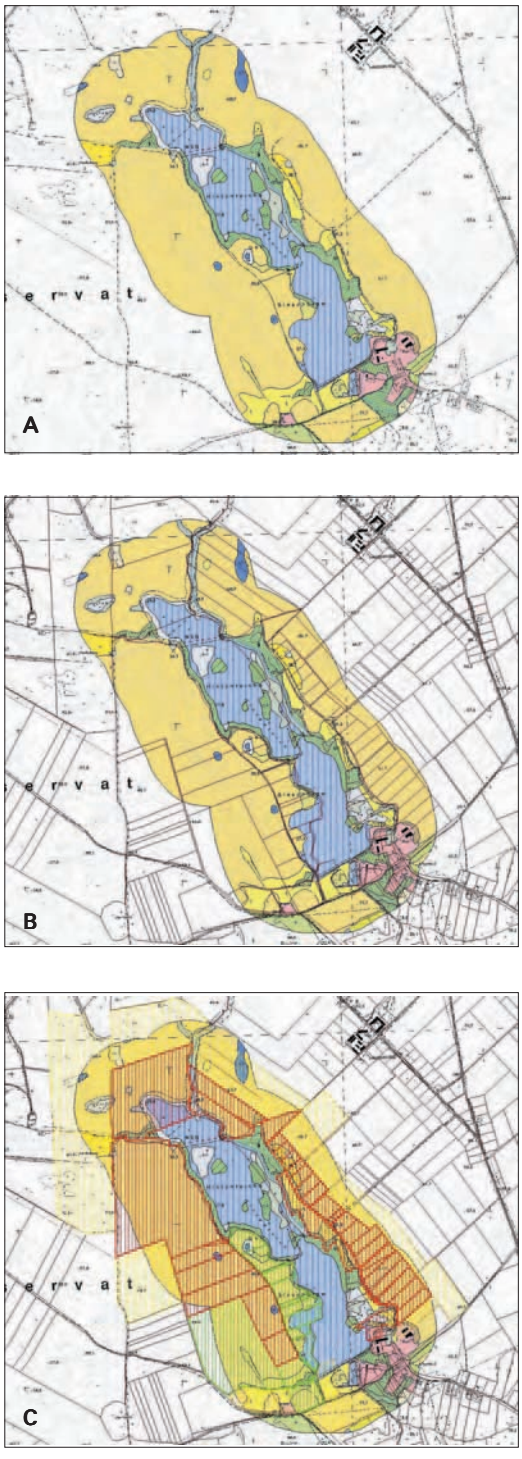

Figure 7.16
Example for the creation of a traffic light map: Schorfheide-Chorin Bittern LIFE Project subsite 'Hintenteiche Biesenbrow'.

A. Biotope type map with highlighted agricultural use (arable land and grassland)
B. Biotope type map with land plot borders
C. Biotope type map with land plot borders and green for existing agri-environmental funding, yellow for buffer zone not necessary and red for buffer zone necessary

organisations, such as regional agriculture authorities, as to where to concentrate subsidies to create effective buffer zones.

Results

Nearly 3,000 ha of agricultural land were evaluated, with 1,900 ha identified as having existing land management measures that would benefit wetland conservation. Conventional agriculture, using pesticides and fertilisers, could continue on 350 ha. The remaining 700 ha were the targeted areas for new agri-environment subsidies and new contracts for 400 ha were negotiated during 2003.

Lessons learned

GIS is an effective tool for coordinating and targeting agri-environment funding for nature conservation objectives over a large area. The visualisation of the land identified for less intensive agricultural use as a buffer zone was very helpful in negotiations with the farmers. Dedicated project officers, to provide advice and negotiate with farmers, are important in delivering such a project. Many farmers do not like to apply measures for nature conservation on their land. They are wary of not being able to return to intensive use when they agree to an agri-environment contract.

Another problem is that the soils close to wetlands are often of high quality and the farmers want to manage them intensively without any restrictions. As the Project was carried out before the CAP (EC Agriculture Policy) reform with its new subsidy regulations, the production subsidies offered more money per hectare than the environmental subsidies.

A further constraint, at least in Brandenburg, is that some local agri-environment programmes which are not funded by the EU, will decrease in monetary value or terminate. The local nature conservation contracts only run for one year, which is too short for both nature management objectives and for the farmer to make long term plans with sufficient security. Nevertheless, once created, the buffer zones will assist future negotiations between the farmers and authorities in maintaining appropriate mitigation for nutrient run-off.

Case study contributed by Sebastian Koerner

Case Study 7.15
Reedbed extension by drying out fishponds in the Brenne, France

Featured technique: Fishpond management: reedbed restoration by drying out lakes
Location: Brenne, France
Contacts: Jacques Trotignon and Eric Male-Malherbe, Association de gestion de la Réserve Naturelle de Chérine, Maison de la Nature, 36 290 Saint-Michel en-Brenne
Tel: +33 (0)2.54.28.11.02
Fax: +33 (0)2.54.38.03.71
E-mail: rncherine@wanadoo.fr
Local status of the bittern: 30 booming males each year (1–2 on the Chérine reserve)
Designation: SPA
Date of the featured work: 2001–2003 as part of the LIFE project 'Restoration and management of the habitats used by the bittern in France'
Management objectives: To provide suitable habitat for bitterns by setting up local management agreements with lake owners

Background

The Brenne area in central France covers 80,000 ha. Fishing, tourism and hunting are the main socio-economic activities. Of the 2,240 lakes in this area, a mere 85 (some 5%) have reedbed (the smallest between 0.25 and 0.5 ha and the largest several hectares), which is judged to be potential bittern breeding habitat. The Brenne's lakes are traditionally emptied and fished each winter. To remove accumulated organic matter on the lake bottom by the process of mineralisation, the lakes are usually left dry for a longer period – a few months – every ten years or so. However, because commercial fishing has intensified, this traditional management is no longer done very often. As a result, many of the reedbeds are aging.

There is an area of 145 ha, which is managed by a local non-governmental organisation (NGO), called the Association de gestion de la Réserve Naturelle de

Estelle Karbiriou

Plate 7.24 La Touche lake: a typical lake of the Brenne.

V. Delecour

Plate 7.25
Trapping coypu.

Chérine. It is responsible for the management of the reserve for conservation. This organisation has also initiated a programme to raise awareness of the biodiversity value of wetlands amongst other lake owners.

Approach

On the edge of the Chérine national nature reserve, *Barineau* lake had not been left to dry out for several years, resulting in the reedbed being 'suffocated' and progressively disappearing. The owner agreed to drain the lake and leave it to dry out for the whole of the 2001 season. It was partially re-filled with water the following year (2002). A 'dry' year means the loss of a fish harvest and therefore a financial loss. The lake owner was therefore paid compensation for this loss, calculated on an estimate of the value of fish (pike, roach and carp), which could have been expected.

In addition, once the lake was re-filled with water, the population of coypu and muskrat was kept in check by trapping (Plate 7.25). Coypu and muskrat have a negative impact on vegetation re-growth.

Results

The results were very encouraging. The aquatic vegetation very quickly re-grew across an extensive part of the lake. Trapping resulted in eliminating several coypu, which helped the vegetation to re-grow. This attracted many invertebrates and amphibians and thus increased the suitable feeding area for bittern, as well as other species, such as purple heron. A booming male occupied the site for a while in 2004, for the first time since 1994.

Lessons learned

A number of difficulties were encountered:

- The draining of the lake for a whole season, obviously meant that most of the aquatic fauna was destroyed and the site could not be used by aquatic birds during the operation. Different species re-colonised the site at different rates.
- Trapping was very effective for coypu but less so for muskrat, which are more wary. It is easier to kill muskrat by shooting, but this causes disturbance that may have a negative impact on wildlife (duck in the hunting season, for example). Trapping should be continued on the site, especially as surrounding estates do not control these animals at all, and they are therefore constantly moving in from neighbouring lakes.

Deliberately leaving reedbeds dry for a year, as with Barineau, should be encouraged. However, in the current context, it seems unlikely that it will happen at other lakes, as lake managers show no interest in doing so nor in the condition of the reedbeds in general. Furthermore, lakes used for fish-farming are still not officially eligible for grants, such as Natura 2000 contracts or agri-environment measures, which could cover the costs of this management action. It is therefore important that both lobbying of the national authorities and actions informing lake owners should be continued.

Case study contributed by Eric Male-Malherbe

Case study 7.16 Fishpond management at Doberschützer Wasser, Germany

Featured technique: Fishpond management
Location: Doberschützer Wasser, Federal State of Saxony, Germany
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Grüne Liga Sachsen e.V. 02625 Bautzen
Dr. Joachim Ulbricht,
Sächsische Vogelschutzwarte Neschwitz
E-mail: joachim.ulbricht@vogelschutzwarte-neschwitz.de
Local status of the bittern: breeding and wintering
Designation: (SPA, IBA, etc)
Date of the featured work: 1994–1997
Management objectives: to improve the breeding and wintering habitats of the bittern

Background

The project area is situated in the Oberlausitzer Heide- und Teichgebiet (Saxony, Germany). This unique cultural landscape stretches across an area of about 1,300 km² and is the stronghold of the bittern in Saxony with about 45–50 booming males recorded (Ulbricht 2003 and unpublished data). The LIFE project has focused on the area where the bittern density is especially high. The project area extends to 24 km² and comprises 35 fishponds located as groups and covering 273 ha. The largest pond (Zschark-Teich) covers 23 ha. The area is named from the river 'Doberschützer Wasser' that flows through the area and provides most of the ponds with water.

The project aimed to protect and restore the bitterns habitat. Without protection of this core population, occurrences in adjacent districts are likely to decline. At the beginning of the project there were a number of unfavourable conditions:

- the hydrological situation was characterised by extreme situations in summer (droughts) and winter (long periods with frost and lack of food)
- the future development of the extensively managed fishponds was threatened by changes in ownership
- the quality of the reed and Typha beds was poor
- the abandonment of certain fishponds resulted in a loss of habitat
- connectivity between some of the pond groups had been lost
- the food for the bittern was not available all through the year
- the necessity for large undisturbed areas was not generally accepted.

The project aimed to improve these conditions through appropriate planning procedures and measures in the short, mid and long term.

Approach

The most important land parcels and fishponds (totalling 180 ha) were acquired in order to establish ecologically sound management of these ponds in cooperation with the local fishing companies. In some ponds, stocking with fish has been reduced or stopped. Two pond areas (Commerauer Teichgebiete) are managed in a less intense way, where the harvesting is carried out biennially and fertilisation is reduced. The stocking with small fish was promoted amongst pond tenants.

Two ponds in the nature reserve 'Caßlauer Wiesenteiche' were restored by re-building a dam destroyed in the 1970s, re-establishing a water reservoir function and thus preventing drying of the upper pond. The 'Steindammteich' (3 ha), a pond abandoned in 1972, has been restored by removing recently established pine trees and extending shallow water zones for reedbed creation. By the second year after restoration, several amphibian species (*Hyla arborea, Bombina bombina, Bufo viridis, Rana arvalis*) returned to the pond. A 1,000

Graham White

Plate 7.26
The restored ponds benefited a number of amphibian species, including the fire-bellied toad *Bombina bombina*.

m long pipeline that connects the Steindammteich with the Doberschützer Wasser was re-constructed as an open ditch. Bittern food availability was improved by these measures; the ponds offering higher populations of amphibians and good numbers of small fish.

The project also aimed to improve the wintering habitats for the bittern. Some of the fishponds are emptied during autumn and remain dry in winter and others freeze quickly. In consequence there are only small sections at the inflow of the ponds that remain open and available for feeding bitterns. Fringes of reed along the margins of the Doberschützer Wasser were developed, with steep banks re-profiled and shallow water zones established. The structure of the river course itself was improved by constructing pools and riffles in order to create dynamic sections that remain unfrozen longer. Furthermore, weirs and a circulating ditch were created to raise the ground water table in surrounding alder carrs and wet meadows.

Results

With a density of 2.5 booming male bitterns per 10 km² the project area is one of the most densely populated areas in Saxony. The fishponds near Commerau-Truppen in the northern part of the area form an optimal habitat for 2–3 males and 2–5 breeding females every year (Plate 7.27). In this area, bittern ecology is studied by the Saxonian office for bird protection, with some results from 2001–2005 (Fabian 2005) presented below.

In the Commerau-Truppen fishponds the mean reedbed area per pond was 1.8 ha (0.1–8.1 ha). Therefore, fishponds are highly fragmented habitats for bitterns. Each male, studied using sound analysis, utilised a number of different booming sites, sometimes several hundred meters apart. Home range sizes of 25 ha and 31 ha including open water were estimated for two males in 2003. The total area of reedbed used was 10 ha and 7 ha.

Nests found in the study area (2001–2005; n = 16) were situated in reedbeds between 0.3 and 1.25 ha in size. Females regularly undertake foraging flights to reedbeds several hundred meters away from the nest. For example, one female that was studied intensively had a home range of 50 ha (Fabian 2005). The observations showed that bitterns are able to cope with fragmented habitats, if all their requirements are met for booming, nesting and foraging sites. In the project area, bitterns use common reed as well as reedmace. However, reedmace is regularly not used until the new leaf growth from May onwards, and thus are of importance for late broods only. About 50% of active nests were located in reeds, 20% in reedmace and 30% in mixed stands. Studies confirm the importance of water level. The mean water depths at booming, nesting and female foraging sites were 40–50 cm. Since the water level of fishponds is

Plate 7.27
Fishpond in the project area with a small belt of reedmace and common reed in the background showing a regular breeding site of 1–2 bitterns.

Dorit Fabian

adjustable, it is possible to ensure an optimal level if enough water is available. Predation has a significant impact on breeding success: 30% of the observed broods (n = 21) were predated either in the egg or chick stage (<14 days of age). In one case, an adult female was killed on the nest (Fabian and Ulbricht in prep.). American mink, which is common in the project area, probably plays an increasing role as a predator. The NGO Grüne Liga holds the shooting rights and encourages hunting activities to achieve better mink control.

Lessons learned

The promotion of ecologically sound management of the fishponds is crucial for bittern conservation. The project achieved this by purchasing the most important fishponds, with the Grüne Liga influencing fishpond management through conditions in the leasing contracts. In order to guarantee sustainable conservation, particular attention was given to maintaining good cooperation with the local fishing enterprises. Although the project has been successful, some problems remain. In some areas, reed cutting has a negative impact and the river bed levels in the Doberschützer Wasser could be higher.

At a regional level, the lowering of groundwater levels during the 1960s is a general problem. In the future, water supply to the whole 'Oberlausitzer Heide- und Teichgebiet' landscape might be threatened by droughts in dry periods. In addition, some fishponds are still in unfavourable condition for bitterns. These issues will pose a future challenge to conservationists aiming to improve the area for bitterns (Zimmerman 1929).

Case study contributed by Joachim Ulbricht, Dorit Fabian and Rolf Kubenz

Case study 7.17
Threats and opportunities for the bittern within fishpond management in Poland

Featured technique: Fishpond management: conservation measures for bitterns
Location: The Lublin region of eastern Poland
Contacts: Marcin Polak, Department of Nature Protection, Institute of Biology, University of Maria Curie-Skłodowska Akademicka 19, Lublin
E-mail: mpolak@hektor.umcs.lublin.pl
Local status of the bittern: 1–7 booming males per 100 km^2
Designations: None
Date of featured work: 2003–2005
Management objectives: An ecological study of bittern populations at fishponds in the Lublin region of Poland, leading to the implementation of positive conservation measures

Background

The importance of fishpond habitats for bittern in Poland

Fishpond complexes are an important habitat for birds, especially in those regions that lack natural wetland habitats. In Poland, carp are reared at about 4,660 fishponds in 835 complexes (Plate 7.28). They cover 43,000 ha, about 0.14% of the total area of Poland. In the past, the bittern was typically a bird of the margins of eutrophic lakes and flooded river valleys. However, over the years, it has colonised artificial wetlands, such as fishponds, where they provide good feeding conditions during the breeding season. Where present, natural eutrophic lakes provide the prime breeding habitat, but in the regions without lakes (central and southern Poland), fishponds form the

Marcin Polak

Plate 7.28
A Polish fishpond.

main habitat for bitterns. For example, in the Śląsk and Świetokrzyski regions, 80% of the bittern population breed on fishponds. In Poland, two kinds of fishpond can be distinguished: trout and carp ponds. However, only carp farms provide suitable conditions for breeding bitterns.

Study site

Studies into bittern breeding ecology and habitat preferences were carried out from 2003–2005 on fishponds in the Lublin region (eastern Poland) (Plate 7.29). Booming bitterns were monitored in the following complexes: Samoklęski (5–7 males), Garbów (3–4 males), Kraśnik (3 males), Orlicz (2 males), Uścimów (1 male), Antopol (1 male), Niedrzwica (1 male), Czesławice (1 male), Opole Lubelskie (1 male), Piaski (1 male). Common carp is the main cultivated species (95% of production in Polish fish farming). The studied ponds are located mostly in agricultural areas and the surface areas of the pond complexes varied from 14–185.5 ha, with the individual ponds from 2–13.5 ha. The proportion of each pond covered by reedbed varied from 0–90%. Fish rearing in Poland is characterised by extensive management. However, due to the privatisation of fishponds, the situation is rapidly changing to more intensive production. Currently, there are three types of ownership: state-owned, cooperative-owned and private fishponds. The carp production output ranges between 200–300 kg/ha (in the Lublin region) and 1,000–3,200 kg/ha (Wrocław and Łódź regions).

Marcin Polak

Plate 7.29 Ringing of bitterns has assisted the understanding of their habitat requirements.

Habitat use by bitterns in the breeding season in the Lublin region

Male bitterns occupied small, isolated patches of vegetation around ponds, which are dominated by common reed, lesser reedmace and sedges. Females build nests mainly within the booming home ranges of the males. Bitterns nesting on fishponds are very adaptable and may require only small reedbeds. The smallest with an active nest in the study area was 15 m × 15 m, but usually females choose reedbeds between 1 and 4 ha in size. Vegetation structure plays an important role in determining nest choice. Sites with a greater density of old reed stems are most suitable as only such areas provide enough cover for the nest at the beginning of the breeding season when the birds return from their winter quarters. Nests were located mainly in common reed and reedmace. Water depth at the nest during egg-laying varied from 10–97 cm. In the study, all nests (N=60) were in reedbeds standing in water. This is a very important, anti-predator factor which determines nest site selection. Although females mainly feed near the nest site, they can fly up to 2 km from the nest to find food for the chicks. Extensive fish farming, where the reedbeds are uncut, are very suitable for bitterns, as these shallow ponds have a very high productivity and contain almost unlimited feeding resources.

Threats

Threats to the bittern in fishpond habitats are:

- The privatisation process on fishponds is leading to more intensive management. Bitterns avoid ponds with intensive fish production, which are characterised by a lack of emergent vegetation, by re-profiling works, and 'improved' ditches and dams etc.
- The elimination of emergent vegetation.

Cutting reedbeds can destroy both the bitterns' nests and the habitat. The key factor for nesting at fishponds is the presence of reed or reedmace stands to provide cover for fish foraging, nesting and roosting.

- Illegal hunting due to conflicts between fishermen and herons. The bittern is included in the Polish national species conservation list and in the Red Data Book. However, there are cases annually of illegal shooting of bitterns (usually because of mis-identification with grey heron).
- Inappropriate water level management; usually emptying of ponds during the breeding season or lower water levels due to lack of water. In Poland generally, there are regions where water deficits occur and only 56% of ponds are guaranteed to have enough water. The highest water levels at fishponds occur in March, and then due to lack of water, they slowly decline. By June or July, water levels may be very low around the nests, resulting in a higher predation risk.
- Illegal burning of reedbeds and removal of islands with reedbeds.
- Re-building of ponds in order to raise water levels.
- Increased impact of predators, mainly non-native species such as American mink.
- Excessive eutrophication of water (toxic algal blooms) and chemical contamination of ponds, resulting in a decline in food abundance.

Proposed conservation measures

Practical proposals for bittern conservation on fishponds include:

- Introducing a 'green' auditing system and associated logo for commercial fishponds, showing that the fish are from a 'nature friendly' pond system. By launching a well-organised scheme, fish farmers complying with the system should achieve an economic advantage.
- Introducing a subsidy system to maintain extensive fish farming as a package of measures within the agri-environment programme.
- A legal ban on reed cutting in the breeding season (1 March–1 September) should be introduced. (Plate 7.30.)
- Education and awareness raising of bittern conservation issues, using publications and training for fishpond owners.
- Promotion of appropriate habitat management such as high water-levels and the retention of at least 30% of old reedbed on some ponds within the complex. Mainenance of ditches and pools within reedbeds as they provide ideal foraging habitat.
- Avoid pond emptying during the breeding season.
- Further research and monitoring is required (for example, establishing standardised census methods allowing population monitoring over the whole country, the impact of removal and burning of reedbeds for nest selection, the effects of predation, and productivity in relation to different habitats).
- The creation of buffer strips through agri-environment schemes to protect water body quality. The production of fish and other wildlife on fishponds are dependent on high water quality. This is influenced by the management of the surrounding areas, including use of manure, pesticides, fertilisers etc.
- Management suitable for amphibians should improve foraging opportunities for bittern.
- Legal predator control could also be considered.

Marcin Polak

Plate 7.30 Cutting reed during the breeding season is a highly detrimental action.

Case study contributed by Marcin Polak and Jarosław Krogulec

8 CONCLUSIONS

Conclusions

The bittern is a target species for conservation in many European countries. Particularly since the mid 1990s, research studies have provided a much better understanding of bittern ecology and led to the development of specific techniques to benefit this species. The EU Species Action Plan (SAP) for Bittern, published in 1999, provided a framework for conservation action. In accordance with the SAP, many LIFE-Nature projects have been concentrated in those countries where the bittern was highly threatened. These projects enabled both the launching of scientific programmes to obtain basic knowledge on bittern ecology, as well as the implementation of restoration and protection measures on a local, regional and national level. By funding different types of conservation projects, the LIFE programme addresses a wide range of threats to the bittern. The results of these projects have proved that it is possible to stop and reverse the decline in bittern populations. It seems safe to say that conservation action has contributed significantly to stable or increasing bittern populations. At the same time, it has benefited many other wetland species.

The following sections summarise the key points arising from the previous chapters, focusing on new knowledge and experience in particular. Finally, this Handbook's relationship with the updating of the SAP is discussed.

Biology

- The investigation of bittern breeding and feeding behaviour revealed that bitterns are more adaptable than previously thought. Bitterns look for tall vegetation standing in water – this is their basic requirement. This can take the form of dense stands of reeds covering many hectares but, if extremely favourable feeding habitats are available (eg Wormer and Jisperveld in the Netherlands, Pripyat floodplains in Belarus), then they can use very small patches of reedy vegetation. They are not restricted to reeds – different types of vegetation are used, including saw-sedge and even rice fields. They can also cope with fragmented habitats, if distances in between are kept to certain limits, as examples from Italy and the Netherlands show.

Jan van der Geld

Plate 8.1
A feeding bittern.

- The availability of food seems to be the most important issue/factor for successful breeding, provided that other basic requirements are given. The bittern is more an unselective consumer of available prey than a specialised hunter. Studies have shown that the main prey varies from site to site – fish, crayfish, amphibians and invertebrates are particularly important but small mammals and birds will also be taken.

- Access to prey seems to be of special importance, following on from the bittern's foraging techniques. If fish are the most important prey, the relationship between water depth and vegetation density is crucial as it determines fish penetration into the reedbed. Where reed density is high and water depths are shallow, the reed interface with open water is crucial for access to the prey.

- There is a complex relationship between water levels, laying date, food availability, predation and the survival of chicks. Water levels usually drop in the course of spring and summer. Where this is excessive, this can reduce food availability and access, forcing the female to leave the nest for longer, increasing the likelihood of chick mortality from starvation and giving predators easier access. In this situation, predation has probably been underestimated as a threat in the breeding season.

- Radio-tracking and ringing studies in the UK, Italy, Poland and Belarus have increased our knowledge of movements and site fidelity. Males appear to be mainly site faithful between years, but may move to other sites during the winter. There is less information on females.

- Young bitterns disperse in their first winter. Therefore, conservation efforts in some countries have focused on increasing habitat in appropriate locations for these birds to find and colonise. Overall, the migration pattern and wintering distribution are not very well known so far – and they even might change in the near future due to the effects of climate change.

Habitat management

- Bittern habitats are generally difficult and expensive to restore once lost. The considerable efforts to restore bittern habitats in some EC countries, where much wetland has been lost, demonstrates the critical importance of maintaining such habitats in the countries where large areas still exist. Therefore, the maintenance of existing reedbeds is a priority for conservation action.

- It is clear that where the restoration or creation of wetland habitats is necessary, a strategic approach is essential. Notably, the importance of passage and wintering sites is perhaps underplayed and requires consideration. In general, the results and experiences of the bittern LIFE projects underpin the importance of a resilient habitat network with a sufficient density of sites.

- There is considerable knowledge regarding the various options for reedbed management, involving water regimes, and then techniques such as cutting, burning or grazing. However, many are costly and time consuming. Where possible, conservation action should seek to maintain or restore larger wetlands, where natural dynamics can play a larger role and management can be on a larger scale and overall be more cost effective. Populations of key species will also be more secure in such sites.

- Commercial reed cutting is a key issue in many countries, with the response of bitterns to such management investigated in several studies, notably in France and the Netherlands. Removal of excessive reed is clearly detrimental to reedbed wildlife but cutting does provide some benefit in increasing structural diversity and perhaps limiting natural succession. Good-practice guidelines may suggest that, in intensive reed harvesting areas, at least 20% of reed should be left uncut. However, this will not be the case on nature reserves, where a greater proportion of habitat features will

support more birds. Here, the figure of at least 50% retained reed as suggested by Hawke and Jose (1996) may be more appropriate.

- Similarly, the intensification of management of fishponds, a key bittern habitat in central and eastern Europe, is a threat. The development and implementation of good practice guidelines will also be beneficial in this case.

- Reedbeds that require restoration may have become degraded through human actions or through natural succession. In some cases, for example where drainage has been undertaken, simply 'undoing' the drainage and raising water levels can be a relatively simple and cost effective measure. Where more permanent changes have occurred, special equipment and experience may be needed to undertake scrub removal, bed lowering or significant hydrological work. These techniques are now well-tested.

- The awareness that food availability is critical for the bittern has led to the development of techniques for micro-habitat enhancement. For example, the creation of open water within reedbeds, increasing reed/water interface, re-profiling of ditch margins, increasing water connectivity and generally improving reedbed habitat quality for all species (including the prey). However, if such measures are undertaken for bitterns, it is essential that the local ecology is understood, as the prey and therefore the bitterns requirements will vary from site to site and certainly from country to country.

- Reedbed creation may be undertaken where the local reedbed resource has become depleted, and there are opportunities for wetland creation in redundant mineral workings, on ex-agricultural land or in floodplain restoration. Again, the techniques for creation are well understood, but the longer-term development of such wetlands may require further study.

- LIFE projects have demonstrated that re-colonisation of abandoned or new sites will occur. However, the rate of colonisation may be slow where bittern populations are sparse. In the UK, completely new reedbeds seem to attract bitterns showing some interest in breeding after around ten years.

- Although much information has been gained, further study and monitoring of restored and created wetlands will continue to contribute to our understanding. Likewise, further investigation into reedbed management, including the use of reedbeds for harvesting sustainable products such as thatching materials, biofuel, and compost, is required.

Public awareness raising

- The bittern is a brown, 'invisible' bird, which most people have never heard of, let alone seen! However, it can be presented as a charismatic and intriguing bird, catching people's interest and gaining support for its conservation. It has also been successfully used in campaigns in various countries as an 'ambassador of marshlands'.

- The population status of bittern is a good indicator of the presence of significant wetlands in a country. Its absence can be related to a loss of natural hydrological processes and environmental degradation. In this way, it is a flagship species for conservation and a useful lever for funding and public support. However, it is not necessarily an indicator of 'pristine' habitat, as it can

De Gelderlander

Plate 8.2
Boom boom boom.

tolerate eutrophic conditions, which favour some prey species, and may feed on introduced species.

Policy

- The bittern benefits from a strong legal framework, giving the species and many of the sites it depends upon protection. Natura 2000 is the cornerstone of bittern conservation. Verification of the 'completeness' in the EU 15 countries is still provisional and needs to be extended to the EU 25 quickly.

- The LIFE grant fund has played a major role in securing a more certain future for the bittern; the bittern is the species most often targeted by LIFE projects.

- Some countries have taken a strategic approach to bittern Conservation eg the UK Species Action Plan, the French LIFE project, etc. These national plans have been a useful tool in building up partnerships and implementing action.

Recommendations for the update of the SAP

A new format of action plan has been set up by BirdLife International (Nagy pers. comm.) and has been adopted by the EC. The European Bittern SAP has to be updated in this new format, together with data from the ten new member states. The current handbook has hopefully established a favourable climate for updating the plan as there has been considerable contact between bittern experts across Europe. Moreover, the national inventories of Important Bird Areas and the Natura 2000 sites database have been updated.

Although the European bittern population is currently stable overall, differing population dynamics can be observed at the local and regional level. For example, in northern Germany and the Netherlands, bittern numbers have increased in several areas mainly due to the colonisation of large wetlands that have been either recently created or restored. However, in the same regions many 'traditional' breeding sites in floodplains or along lake shorelines were abandoned due to the progressive deterioration of breeding habitats. Bittern decline is continuous in many natural primary habitats in floodplains and lakes. In addition, the fragmented small populations in some countries in Western and Southern Europe are still threatened by local or regional extinction.

The major goal for the new SAP will be to maintain a sustainable, stable and growing bittern population in all member states. Top priorities are the protection and appropriate management of existing natural or semi-natural large reedbeds and associated wetland. Among the new challenges for bittern protection that will have to be considered are the following:

- Climate change and sea level rise: with new wetlands created away from the vulnerable coasts.

- Improvement of a resilient Natura 2000 network of protected areas.

- The migration patterns of bitterns are still relatively unknown on a European and transcontinental scale.

- Good practice guidelines for reedbed and fishpond management need to be promoted especially among new member states, including possibly the development of eco-labelling. Appropriate agri-environment schemes need to be developed and implemented.

- There are several non-conservation EU policies and practices which may have an adverse impact on wetlands and therefore bittern numbers, particularly in EU Accession countries. It remains to be seen whether the introduction of the CAP will lead to a similar intensification of farming, with attendant draining of wetlands, that western Europe has seen. The impact of large infrastructure projects on Natura 2000 has already become an issue in some countries. These must be reconciled with the need to conserve and create semi-natural habitat for its own sake and to address significant environmental threats.

Appendix 1 Country profiles and LIFE projects

A brief description of the status of the bittern in each country is followed by details of LIFE projects already implemented or under way. The project reference, official title and dates are in the heading with contact details at the end. Further information is available from the EC's LIFE projects database, available on the website http://www.ec.europa.eu/comm/environment/life/project/Projects/index-cfm.

1 Austria

The bittern now breeds only in the eastern part of Austria, in the extensive reedbeds of the Neusiedlersee and neighbouring smaller reed fringed lakes. There have been very rare observations during the breeding period from the Morava and in side-channels of the Danube but breeding has never been confirmed. The breeding population fluctuates widely depending on the water level of the Neusiedlersee. During recent years, successive droughts have caused a severe decrease, down to approximately 10 'pairs' in 2003. It is open to question as to whether the ecosystem can naturally recover (extreme weather conditions are usual here) or whether this is the start of a sustained trend. Furthermore, it is remarkable that other herons (grey heron, egret and little egret) and the spoonbill have not suffered a similar decline. (data from BirdLife Austria – Dvorak, pers. comm.).

Reedbed management does not take into account the specific requirements of the reedbed fauna. Nevertheless, reed cutting and access to reedbed is prohibited after the 31 March. Commercial reed cutting for thatching materials is completely prohibited in the core area of the National Park Neusiedlersee. Currently investigations are being carried out on the pros and cons of reedbed burning.

No LIFE bittern projects have been implemented in Austria, although WWF Austria was the lead partner for A/7051 Tisza, which was actually implemented in Hungary (see below).

2 Belgium

All breeding locations are in the Flemish region, Northeast Belgium. Following a decrease in numbers (1975: 60, 1982: 30), the population has been relatively stable with 12–20 'pairs'.

Bittern occurs in high numbers during the winter. It is benefiting from habitat restoration but there has only been a slow re-colonisation of once abandoned territories. Reedbeds are highly fragmented – the largest reedbed in Flanders is 70 ha.

Four LIFE projects have targeted the bittern.

B/7148 Bassin de la Haine: **2001–2005**
This project included scientific monitoring, creation of new protected areas, management and restoration of habitats (scrub removal, ditch digging/excavation, water table management), communication and public awareness actions. (See Case study 7.2.)

Contact: Vincent Swinnen – vincent.swinnen@natagora.be

B/4298 Pond complex Midden-Limburgh: 2001–2005
Work to increase the capacity of this fish pond complex for bitterns – it currently has two booming bitterns. It includes an assessment of the social and economic benefits of the project, looking at the job-market and income from visitors.

Contact: geert.lejeune@wwf.be and david.buyen@limburgs-landschap.be

B/5168 Aquatic habitat in de Kempen: 1998–2002
Breeding population at the site 'De Maten' increased (from one to three booming males; seven wintering birds) due to the project. Trees growing on the dykes were cut to create an open marsh landscape with open water and reedbeds. Other actions included rotational management of the ponds, reed cutting and water level management.

Contact: tom.andries@natuurpunt.be

B/5171 Dijle Valley: 1998–2002
Bittern winters but do not yet breed in the area. The banks of lakes were modified, poplar plantations were cut and reedbeds are managed by rotational reed cutting. The beneficiary is continuing to buy or lease land after the project's end to optimise reedbed management.

Contact: iris.verstuyft@natuurpunt.be

3 Denmark

A third national survey on the breeding bittern status was carried out in 2004 by the Danish BirdLife International partner Dansk Ornitologisk Forening (DOF). The results are published in Fugle I Felten (2005, in Danish) and confirm a positive population trend. In 1970 it was estimated to be 10–20 'pairs', then 24–40 'pairs' in 1978–81, followed by a rapid increase to 150–200 'pairs' during 1993–96. In 2004, 397 booming males were counted. Reasons for this trend include higher and more stable water levels in reedbeds, habitat creation and restoration, and relatively mild winters.

The population is still concentrated in a few areas, all of which are SPAs. The recent substantial increase has mainly occurred within these key sites. At Vejlerne in the Northern part of Jutland, for example, (see Box 5.2), 204 out of the 397 boomers were counted in 2004 (51% of the Danish population).

Two LIFE projects targeted the bittern.

DK/8588 Trygglev Nor – IMAGE: 2002–2006
Restoration of the coastal lagoon area, Tryggelev Nor, on the island of Langeland, (the southern-most tip of Denmark), which suffered from hyper-eutrophication, reduced retention capacity and drainage of the catchment. Several reedbeds are being restored, e.g. at a fresh water lake (56 ha). It is intended to reduce the nitrogen load in the whole wetland area by about 70%. As the project is not yet finished, the effect on the bittern can not yet be evaluated (1–2 boomers at the beginning of the project).

Contact: Claus Pawdan, cpa@anv.tyns-amt.dk

DK/7116 Skjern River: 2001–2004
Large scale river restoration project of national and European importance (total LIFE budget over €7 million, covering just part of costs. Bittern numbers increased from zero to four booming males due to an increase in reedbed area. (See Case Study 7.5)

Contact: Niels Dahlin Lisborg, ndl@sns.dk

4 Estonia

The distribution of the bittern in Estonia is patchy. The population is densest on bays and relict lakes along the coast of western and north-western Estonia as well as Saaremaa. The species inhabits also some lakes and reedy shores of some rivers. The inland distribution is mainly in central and south-eastern Estonia (Polma in Leibak *et al*. 1994). Important concentrations can be found (Kuus and Kalmees 2003) at the IBA Mullutu (Sarenmaa, 10–20 pairs), at IBA Võrtsjärv (Central Estonia, 25–35 pairs) and at the IBA Väinameri (Coastal site, 50 pairs).

The population trend has varied greatly. After a positive trend during 1970–90 ending up with a population size of 200–300 booming males, the population decreased to a level of 100–150 booming males by 1998 and increased up to 300–500 males by 2002 (Elts *et al*. 2003). The previous population size was probably underestimated.

Reed cutting for thatching is becoming a problem and provisions/guidelines for ecologically sound harvesting are needed. Disturbance by fishing and recreational activities has increased in the last few years.

One LIFE project with some relevance for the bittern has been implemented.

EE/7082 'Häädemeeste wetland': 2001–2005
The project deals mainly with the removal of invasive reed from coastal meadows and managing wet reedbeds e.g. at an abandoned fishpond of 125 ha. Trees and shrubs were cut in order to improve the bittern habitat. In winter 2005, stormy weather caused flood waves to sweep over into the fishpond so there is currently sufficient water in the pond. The money for a more long-term solution of polders still has to be found. Bittern occurs in low numbers here (1–2). During the winter 2004/05 one wintering bittern was seen (only the 6th time that a bittern has been observed in winter in Estonia). A diving hole of a pair of otters helped it to survive temperatures of -20°C and it was also fed.

Contact: mati.kose@eoy.ee

5 Finland

The bittern population is distributed across Southern and Central Finland up to the northern Bay of Bothnia. (Only rarely inland this far north). The bittern colonised Finland at the end of the 19th century with numbers very slowly increasing until the 1980s, when it was set back by a series of cold winters. Since then, the population has continued to grow. The Finnish BirdLife International partner, BirdLife Finland, conducted a national count on the occasion of the designation of the bittern as 'Bird of the Year 2005'. (http://www.birdlife.fi/suojelu/lajit/kaulushaikara.shtml#kanta-eur). The results of this first specific national survey confirmed the positive trend, with a total number of 982 booming males. These results suggest that the population had been underestimated previously. Important concentrations can be found in the regions of Norther-Savo (113 'pairs'), Päijät-Häme (99 'pairs') and Kymenlaakso (85 'pairs').

The main reasons for the positive trend (Väänänen 2005) are considered to be:
- the development of more reedbeds due to nature conservation work (restoration and habitat creation),
- eutrophication, and
- the abandonment of cattle grazing in shore meadows.

In addition, the ending of muskrat hunting at the beginning of the 1980s, which had caused a high level of disturbance during spring, and the relatively mild winters have benefited the bittern. The main threats for the bittern (Väänänen 2005) arise from the fragmentation of reedbeds caused by owners of summer cottages and fishery collectives and from predation. In Finland, commercial reed cutting for thatching is not known.

In Finland three LIFE projects have benefited the bittern.

FIN/0039 Gulf of Finland migratory flyway: 2003–2007
This is a large project with a network approach. The restoration and management of 12 protected wetland areas along the northern coastal Gulf of Finland flyway is under way. The bittern is one target species among others. An intensive monitoring scheme is being carried out with a particular emphasis on migratory birds. Actions undertaken for the bittern include the removal of aquatic vegetation in order to increase the open water area and the creation of ponds and channels. The technical know-how for this work was derived from the Siikalahti project. Small predators (mink and racoon dogs) are also being controlled.

Contact: ilpo.huolman@ymparisto.fi

FIN/8468 Management of urban areas in south-west Finland: 2002–2005
The projects aims to guide and channel visitors from growing urban areas, close to Natura 2000 sites, which include bittern habitats. Awareness raising has been very effective, with up to 100 participants on public field trips.

Contact: kimmo.savonen@turku.fi

FIN/7061 Siikalahti: 2001–2004
Intensive and complex restoration work at one project site (450 ha), which is located in SE Finland, 5 km far from the border with Russia. One of Finland's bittern strongholds, the area's logo shows a flying bittern! (See Chapter 6.) The project tackled the main threats: the ongoing reduction of open water areas due to invading bulrush, reed, water mosses and overgrowth of the surrounding wet meadows by willows. The planning process was managed by four working groups (water, agriculture, nature tourism and monitoring), which have played an important role in the project's successful implementation.

Contact: tiina.niikonen@metsa.fi

6 France

The bittern is patchily distributed across France with a stronghold of approximately a third of the national population on the Mediterranean coast, that is the Camargue and coastal ponds outside the Camargue. Further important concentrations are found in the Seine estuary (25–30 males), the Brenne (15 males), the Loire-Atlantique and the Picardy area. The national count, carried out in 2000, confirmed that the population has nearly halved during the last 20–25 years and now stands at approximately 250–300 booming males. Along the Mediterranean coast and the Normandy, numbers have increased. However, this might been due to improved census techniques.

Therefore in 2000 the Ligue pour la Protection des Oiseaux, BirdLife representative in France, and partner organisations set up a national programme for the restoration and management of bittern habitats (2001–2006). Threats on a national level were to be tackled, such as inadequate water management (causing a degradation of reedbeds and loss of habitats), inappropriate changes in habitat management (reed cutting for thatching, fish pond management), homogenisation and drying up of reedbeds and insufficient knowledge of bittern ecology. This programme was the subject of a major LIFE project and three other LIFE projects in France have benefited the bittern.

F/7269 Programme for the restoration and management of habitats used by bittern in France: 2001–2006
The main areas of work include:
1. Restoration and management of bittern habitats at six key sites, covering 25% of the breeding population,
2. Partnering actions with local agents for the protection of the bittern
3. A scientific programme (bittern survey on each project site, research on habitat selection during breeding season, reproductive and feeding biology), coordinated by CNRS Chizé (Centre National de la Recherche Scientifique) (see Chapter 2).
4. Raising of awareness of local people and creation of tools for environmental education (see Chapter 6), including a six-monthly newsletter.

The management actions have included resolving conflicts in water management and salinity (Etangs de Vendre), reed cutting experiments (see Case studies 7.11 and 7.12), management of fish ponds and compensation of fish farmers (see Case study 7.15) and creation of reedbed on pasture land.

Contact: estelle.kerbiriou@lpo.fr

F/2003 Lake Bourget: 2000–2004
At Lake Bourget, reedbed has severely declined over the last 50 years. An urgent plan for reedbed re-creation and protection was developed and measures (anti-wave devices, sediment manipulation and helophyte planting) were carried out. In the long term, an improved management of water levels leading to an increase of the fluctuating span is intended (Miquet 2003).

Contact: cpns@wanadoo.fr

F/0834 Petite Woevre Wetlands: 1994–1997
Management measures were to be taken to improve and re-connect the biological richness and coherence of the Petite Woevre wetlands.

Contact: none available

F/0854 Dombes: 1995–1997
Despite some reedbed conservation measures, this habitat has degraded. Bittern numbers reduced from 10–12 at the beginning of the project to 1–2 in the last few years.

Contact: mbenmergui@oncfs.gown.fr

7 Germany

The bittern is distributed continuously in the lowlands across North-Eastern Germany and occurs patchily in the South (Bavaria) and West (Lower-Saxony). The strongholds of the German bittern population are in Schleswig–Holstein (70–190 'pairs'), Mecklenburg-West Pomerania (100–150 pairs) and Brandenburg (100–150 pairs). These three federal states hold about 80% of the German bittern population (360–620 pairs). Smaller and fragmented populations occur in Saxony-Anhalt (25–35 pairs), Saxony (35–45 pairs) Lower Saxony (10–15 pairs) and in Bavaria (15–25 pairs). Habitats are reedbeds of lakes and ponds and in wide river valleys, as well as marshland at the Wadden Sea and reedy peatlands and fishponds.

Due to the federal constitution of Germany, no national count has been coordinated so far. Bittern numbers are provided separately for each federal state.

Overall, the population trend of the breeding population is estimated to be declining for the period 1990–2000 (BirdLife International 2004). However, the picture varies between states. The main threats are unfavourable water management, lack of food availability due to fragmentation of habitat, commercial reed cutting and disturbance.

Research on the bittern was carried out during the Schorfheide-Chorin LIFE project and by the Office for Bird protection in Saxony (see Case studies 7.1 and 7.16). Recently, a research programme on the restoration of reedbeds in Schleswig-Holstein, focused on the impact of grazing geese.

There have been a number of bittern LIFE projects, especially in north and north-east Germany.

D/8457 Elbe Estuary Borghorster Elbwiesen: 2002–2006
No bitterns recorded at start of project. 10 ha of suitable habitat are to be developed within this tidal estuary.

Contact: gabriele.meusel@bsu.hamburg.de

D/5085 and D/8456 Two Projects at the Lake Dümmer in Lower Saxony: 2002–2006
These projects demonstrated large scale re-wetting over 1,000 ha, including the installation of adjustable weirs. The recovery of breeding bitterns to this former stronghold has not yet been observed, although several individuals occur regularly over-winter. English spoken film on DVD available. (See Case study 7.10.)

Contact: heinrich.belting@nlwknol.niedersachsen.de

D/7038 Galenbecker Lake: 2001–2007
This involved the large-scale (565 ha) re-wetting of a site with three booming males at the beginning of the project. Measures leading to re-inundation by 2008/09, include the construction of 7.3 km dam to hold in water and protect the surrounding cultivated grassland. The objective is to create a macrophyte-rich clear lake that serves as a reservoir for the adjacent fens and provides visual hunters, such as pike and bittern, with suitable feeding grounds. It was made possible by the purchase of land and compensation of former land-users.

Contact: alexander.harter@stauneum.mv-regierung.de

D/7057 Lake Stechlin: 2001–2005
Bittern was not a target species but it benefited from various measures, such as the negotiations with anglers and their associations to eliminate disturbance, which resulted in a leaflet for anglers.

Contact: mario.schrumpf@lua-brandenburg.de

D/5936 Rambower Moor: 1999–2003
This project targeted bittern with actions such as re-wetting and raising public awareness. (See Case study 7.8 on the re-wetting actions and Chapter 6 for communication with stakeholders.) Bittern increased from one to four boomers at this important stepping-stone site.

Contact: heike.garbe@lua-brandenburg.de or hfilodo@t-online.de

D/5943 Schorfheide-Chorin: 1999–2003
Targeted bittern project, carrying out work at 10 sites in the Biosphere reserve. Key actions include re-wetting, reconciling the interests of habitat protection and land users, research and a public awareness-raising programme. (See Case studies 7.6 on gaining water rights and 7.14 on buffer zones.) There was an increase in bitterns numbers following project implementation.

Contact: ruediger.michels@lua.brandenburg.de or sebastian.koerner@t-online.de

D/5061 and D/0016 Recknitz and Trebel valley fens: 1994–1998 and 1998–2001
Two successful projects to restore riverine fens in the lowlands in north-east Germany. Together the projects restored 21.7 km of the rivers Recknitz and Trebel and their floodplains. The former course of the rivers was re-established by building dams and re-profiling natural meanders, with the abandonment of a former pump station to re-wet the fens. Reedbed spread naturally from existing remnants. Although not directed at the bittern there were increasing numbers in 2004 at the Trebel river (seven boomers compared to one at the project's start). LIFE projects initiated further actions on fen restoration.

Contact: katrin.runze@lung.mv-regierung.de

D/5081 Upper Havel: 1998–2002
Water right approval was gained despite strong local resistance. Within the federal state of Mecklenburg-West Pomerania, this LIFE project has set a very important precedent for similar actions in the projects D/7038 and D/0016.

Contact: v.spicher@nationalpark-mueritz.de

D/4231 Schaalsee: 1998–2002
Project has been suspended because the water right approval could not be gained. The legal procedure is still going on.

Contact: b.gebhard.br@schaalsee.de

D/4222 Bavarian fishponds: 1997–2001
Bittern project focused on fishpond management. Measures undertaken should safeguard the last remnants of the Bavarian bittern population, which is almost isolated, being 400–600 km away from the next population. Although increased fish prices prevented the purchase of bigger land parcels/ ponds (to create suitable reedbeds) as foreseen in the application, the project succeeded in improving the habitat conditions for the bittern at other places (eg re-shaping of ditches, lowering of fishponds, shrub and tree-felling). It led on to a study to identify where further work could be done to reduce the isolation of the Bavarian bittern population. (See Chapter 1.)

Contact: a.pille@lbv.de

D/0236 Doberschützer Wasser: 1994–1997
This project improved the habitats within a fishpond complex, with a resulting increase in bittern numbers. The beneficiary, the regional NGO 'Grüne Liga', bought about 180 ha of fishpond and now manages them for nature conservation through regular contacts with their pond tenants. The natural hydraulics of a small river (Doberschützer Wasser) have been restored to establish faster currents and open water areas during wintertime. (See Case study 7.16.)

Contact: joachim.ulbricht@vogelschutzwarte-neschwitz.de or oberlausitz@grueneliga.de

8 Greece

The bittern is a rare breeder in Greece but occurs in times of hard winters in remarkable numbers. Historical records and recent research indicate that the species' strongholds were in the coastal wetlands of western Greece, with irregular occurrence in the reed-dominated wetlands of northern Greece. Wintering habitats are situated throughout southern Greece and at many of the islands, including Crete. Now, many extensive areas of apparently suitable habitat remain unoccupied. The first breeding bittern in Greece was confirmed in the LIFE project at Amvrakikos Wetlands. The population trend is stable at a low level (10–15 'pairs').

Five LIFE projects in Greece are targeted at wetlands where the bittern occurs.

GR/0092 Agras wetland: 2003–2006
At this reed-dominated wetland of 600 ha, the aim is to implement integrated management measures for its restoration, involving the key stakeholders. Vegetation management together with restoration of hydrology are expected to improve habitat conditions for waterbirds (bittern included), in the mid-term. Vegetation management includes reed cutting, with specialist machinery, and grazing. Implementation of reedbed management started in 2005, so an evaluation is not yet possible. Site monitoring over the last eight years has recorded bitterns irregularly, during winter and early spring.

Contact: adimal@tee.gr

GR/8491 Stofylia-Kotychi: 2002–2005
This wetland complex includes the Kotychi lagoon, the largest remaining lagoon in the Peloponnese, and the Prokopos lagoon. The two lagoons are to be restored by reduction of sedimentation, and installation of a water monitoring system. There are historical records indicating the presence of bittern several decades ago. It is expected the lagoon restoration will improve habitat conditions for the species.

Contact: nkar@oikos-nature.org

GR/7242 Cheimaditida-Zazari Wetlands: 2001–2004
This is a reed-dominated wetland system, situated in the central North of Greece. The project intends to restore abiotic conditions in two lakes, to restore the reedbeds and to introduce a water monitoring system. Monitoring from 2001 until 2005 recorded bitterns every year in winter and early spring. The species was also recorded in the adjacent lake Petron, another reed-dominated wetland of the region. Although the LIFE project did not implement all of the management measures foreseen, efforts are being made to fund reedbed management at both wetlands.

Contact: M. Athanasiadis

GR/6475 Conservation management of Amvrakikos Wetlands: 1999–2003
The site comprises the most extensive coastal wetland in western Greece and one of the country's largest wetlands, with non-marine inland wetlands at 22,000 ha. This unique area, with its diverse semi-aquatic habitats is an outstanding area for waterbirds, including Greece's only known breeding bittern population. (See Case study 7.7.) The project carried out actions to re-establish riverine, freshwater influence in degraded freshwater reed-swamp and other habitats.

Contact: zogaris@ath.hcmr.gr

GR/8494 Conservation of Priority bird species in Lake Mikri Prespa: 2002–2006
The extensive reedbed of Lake Mikri Prespa (600 ha in total at the Greek part of the lake) comprises an excellent breeding ground for many aquatic bird species. However, the encroachment of the reedbed has reduced other important habitats. These include wet meadows, which act as spawning grounds for many fish species and feeding grounds for important bird species, such as the pygmy cormorant and Dalmatian pelican. The project introduced water and vegetation management, such as cutting, grazing with water buffaloes or a combination of the two in 11 littoral areas (total of 70 ha). This created open areas, free of high emergent vegetation during spring, when the high water level allows their flooding. The evolution from open areas to wet meadows is gradual. The re-introduction of water buffaloes greatly improved the wet meadow habitat, and opened up the reedbed margins. This form of management can be beneficial for bitterns, as it provides bitterns with the extensive, shallow margins needed for feeding. In March 2005 a bittern was observed feeding in very shallow waters close to the reedbed edge in one of the 11 managed sites.

Contact: Yannis Kazoglou and Irene Koutseri (Society for the Protection of Prespa), spp@line.gr

9 Hungary

The bittern breeding population is estimated at 700–1,000 'pairs', based on reliable data from a new common breeding bird monitoring scheme in Hungary (MMM, Mindennapi Madaraink Monitoringja), implemented during 1999–2000 (Szep and Nagy 2002). The population trend is stable. The Hungarian strongholds are Lake Balaton, Lake Fertõ, the Hungarian Lowlands with Tisza and the Danube Basin and fishponds.

The first national AEWA report of Hungary, submitted by the Ministry of Environment and Water in 2005, provides a comprehensive up-to-date report on specific actions of wetland protection and restoration for migratory waterbirds, including the bittern. Among these actions are two LIFE projects.

H/8643 Hortobágy National Park: 2002–2005
The project improved the priority habitat Pannonic salt steppes and marshes by taking out agricultural drainage systems to restore the natural hydrology of the area. The National Park is a stronghold of the bittern in Hungary and it has benefited from various measures aiming to ensure optimal water level in breeding habitats. (See Case study 7.9.)

Contact: gori@www.hnp.hu

A/7051 Management of floodplains on the Middle Tisza: 2001–2005
Four catastrophic floods between 1998–2001 and mining spills in 2000 caused a drastic decrease in water quality. The project aimed to assist the recovery of the ecosystem by further restoring the floodplain. Five different sites along a 130 km stretch of the river Tisza were tackled and there has been a fruitful cooperation with local stakeholders. Bittern benefits from the creation of about 100 ha of waterbodies (the largest is about 60 ha) with natural reed regeneration. The project has been officially submitted by WWF Austria, but the implementing partner is WWF Hungary.

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10 Italy

The bittern is a rare breeder in Italy, migrant and winterer. The breeding range is in two main areas: the Po plain and the Adriatic coast (northern Italy), and Tuscany and Umbria (central Italy). Some booming males are occasionally present in Apulia (south-eastern Italy). In the western part of the Po plain and Adriatic coast, where rice-fields extend over huge areas, bitterns settle in very small reed patches (less than 3 ha in extent) or even in the paddy fields. In the eastern part, this situation is rather uncommon and bittern occupies a system of medium-sized sites (10–40 ha). In central Italy, the range is more discontinuous and the bittern occupies a few medium to large sites (80–1,800 ha). Overall, the breeding population has increased during the last 20 years (Puglisi 2004), although with local fluctuations. In the late 1980s, 20–30 booming males were found in about 20 sites, while 75–95 booming males occupied 35 sites in 1998 (Puglisi 2002). The current figure is probably around 100 booming males. The reasons for this positive trend are not clear, although the earlier end of the hunting season (31 January) has probably contributed. In addition, habitat has been created/restored – for example, 4,400 ha were restored in Emilio-Romagna, using agri-environment measures, 1994–2004. (Tinarelli pers. comm.)

The main threats are habitat reduction and fragmentation, (half of the total number are concentrated in a few sites, whilst most sites are occupied by a single booming male), habitat transformation and degradation, deterioration of water quality (salinity and probably pollution), inadequate management of vegetation and water levels, early harvesting of rice, and the alteration of prey populations (Puglisi *et al*. 2003a, Puglisi 2004).

In winter the bittern is much more common, especially in the northern regions where it occurs in a large variety of wet areas, including very small reed-bordered sites, rivers, etc. During spring migration, very high numbers move through. It is estimated that there can be more than 300 migrating birds at two coastal Tuscan sites (Puglisi and Baldaccini 2000), and possibly even more at sites in south-eastern Italy.

Studies and monitoring projects on the Italian bittern population include census work (1991–2004), a radio-tracking study (1997–2000) and analysis of habitat use and preferences (1995–2001) carried out by the University of Pisa (Puglisi *et al*. 2003a, Adamo *et al.* 2004, Puglisi *et al.* 2005). Their use of rice-fields has been studied in Lomellina (Province of Pavia). (Longoni 2004)

Nearly 20 LIFE projects are benefiting wetlands where the bittern occurs, as a breeding or wintering species.

IT/7142 Habitat Restoration and transformation of electric plants in the Po Delta Park: 2001–2005
Actions were to be taken in 20 areas, following a spatial analysis of where the death rate from electrocution and collision with power lines is highest. This covers 120 km of power lines.

Contact: parcodeltapo@parcodeltapo.it

IT/6248 Foligno area (Colfiorito marsh): 1999–2002
This reedbed of *Phragmites* and *Scirpus* in Umbria, situated among mountains (750 m above sea level) is an important breeding and wintering site (eight booming males, 10–18 wintering birds). Agri-environmental measures have been used to implement a more sympathetic cutting and reedbed management regime. The beneficiary tried to buy the most important areas. The number of booming males reduced by 50% in 2003 due to an exceptionally severe drought in 2002.

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IT/5138 Taro fluvial habitats: 1999–2001
This involved the restoration of the riverbed seepage areas, where reed is dominant, to provide staging and wintering opportunities for the bittern.

Contact: prnparks@regione.emilia-romagna.it

IT/5032 Lake Caldaro: 1999–2001
The lake is an oasis for migratory birds in the middle of the Alps. Bittern occurs during migration, especially in March, but does not breed. Actions included the maintenance of reedbeds (mowing and shrub removal) and creation of ponds.

Contact: marieluiese.kiem@provinz.bz.it

IT/5117 Maremma Park: 1998–2001
This is an important wintering site, where actions were taken to address the threat of coastal erosion of marshy wetlands.

Contact: none available

IT/4127 Massaciuccoli: 1997–2000
The LIFE project focused on experimental methods to improve water quality. Measures were continued after the LIFE project (land purchase, reed cutting). Vegetation cover consists of *Cladium* and *Phragmites*. Human activities include vegetation burning and cutting. About 14% of the marsh is burnt every year and therefore, the vegetation cover is a mosaic of patches of different age and density. Bittern distribution patterns alter year by year, according to the distribution of young vegetation beds. Bittern breeding numbers increased until 1997 (24–25 booming males), and then markedly decreased, possibly due to water pollution and alteration of prey populations.

Contact: conservazione@sanrossore.toscana.it

IT/3170 Palude Brabbia: 1997–1998
This is an important site (500 ha of peat bog, open water and reedbed) for bird migration in Lombardia. Work involved pond creation and rehabilitation, visitor guidance and environmental education.

Contact: lipusede@tin.it

IT/0538 Po Delta first and second phase: 1994–1996 and 1995–1998
The Po Delta is the most important wetland in Italy. Overall aim of the project was to determine the degree of legal protection for the area and draw up a management plan. Proposals included improved reedbed management and pond excavation to vary the vegetation texture. (See also further project 8526 and 5130; 7142.)

Contact: mcosta@mail.provinca.ra.it

IT/8526 Ecological balance for species of Community interest: 2002–2005
This project carried out work in part of the Po Delta, including improvement of water circulation by dredging channels and reactivating a sluice gate and pond excavation.

Contact: scorazza@lbc.regione.emilia-romagna.it

IT/8556 Habitat restoration and conservation of Ardeidae on Lake Trasimeno: 2002–2005
This project has not yet finished and actions to improve bittern habitats have not yet been implemented. The project plans to create three hectares of ponds, contiguous to the reedbed, filled with indigenous fish and amphibians, to improve food availability for bittern. The scarce food supply and suitable nesting habitat are considered to be the reasons for its absence in the breeding season.

Contact: uff.programme@monitrasimeno.it

IT/7209 San Genuario Wetland: 2002–2004
The project includes various measures to maintain and improve the biodiversity in an area of abandoned fishponds within rice-fields, such as stabilising the water level in the ponds and to prevent reedbeds from destruction.

Contact: parpoai@tin.it and see www.parcodelpo-vcal.it/life.htm

IT/5130 Safeguard of habitat and nesting places in Delta of the Po: 1998–2001
Bittern winters here and the project improved management of water level to benefit reed growth. The creation of Delta Po park (1997) led to the end of hunting activities.

Contact: boschetti.eddy@aliceposta.it

IT/7161 Paludi di Ostiglia: intervention for the protection of priority birds
Actions include ecosystem studies and monitoring, the definition of a minimum viable water level and of an annual water levels calendar, development of management plans for habitats and species. Management proposals include yearly cutting and harvesting of a quarter of the entire reedbed surface to benefit booming bitterns. Other basic actions are the dredging of weed in open water and the creation of buffer zones to ameliorate the impact of farming crops.

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11 Latvia

The bittern is a fairly common breeder with small numbers overwintering. It breeds in wetland reedbeds in lakes, fish-ponds, abandoned peat extraction quarries, beaver ponds, ox-bow lakes etc. (Priednieks *et al*. 1989). The breeding population is estimated to be 300–500 'pairs', an increase on the previous estimate of 200–300 pairs (1970–1990) (Strazds *et al*. 1994, Tucker and Heath 1994, Lob 1999). The larger recent estimate is considered by some experts to indicate better knowledge rather than an actual increase in numbers. The population trend is estimated to be stable during 1990–2000, although there is no national monitoring or census data. However, the longer term trend since 1970s or 1980s may have been positive, as the expanding reedbeds in Latvia should accommodate population growth.

Seven Important Bird Areas have been identified as the best breeding sites for bittern in Latvia (Račinskis 2004), holding a total of 116–196 pairs: Engure lake (30 pairs), Ķemeri National Park (16–21 pairs); Liepāja lake (15–30 pairs), Lubāns and fish-ponds (10–30 pairs), Pape (25–35 pairs), Rāzna (10–30 pairs), Seda marsh (10–20 pairs). There are 39 protected areas with a total of 148–268 pairs of bittern, covering roughly one half of the estimated national breeding population.

Within the national biologist community, reed expansion is generally considered as a threat to

wildlife and biological diversity, as reed stands locally take over other types of open water or grassland habitats (eg Reinvalds 2002, Mednis 2002). This effect is caused mostly by a widespread abandonment of traditional grassland management practices (hay mowing, grazing) during the last few decades. As a result, there are several site management projects that promote restoration of open water and meadow habitats by cutting reeds, including several LIFE-Nature projects. The nature conservation value of reedbeds is recognised at a site scale, for instance within the management plans of individual protected areas. Powers also exist to designate 'micro-reserves' (2–10 ha in size) at bittern breeding sites. However, no such reserve had been established up to this date and no projects have targeted the bittern.

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12 Lithuania

Lithuania contains a wealth of natural wetland resources (Švažas *et al*. 2003) from mires and bogs to 2,834 lakes larger than 0.5 ha in area, over 10,000 smaller ponds and reservoirs and about 17,000 km unregulated natural rivers and streams. As a result bitterns are at the highest national density of all the EU member states (800–1,000 booming males/ 65,200 km²). The bittern has not been the target species of any LIFE project or been promoted by a national species action plan. But, due to the compilation of field data in various projects (Atlas of Breeding Birds (1995–2000), selection and designation of SPA (2001–2004), investigations on water birds financed by OMPO 2000–2001), there exists reliable data on the breeding population (Stanevicius and Raudonikis 2005). The bittern occurs in 221 of 10 × 10 UTM squares, following the pattern of wetland distribution. An analysis of wetland types used by booming males revealed the importance of eutrophic and mesotrophic natural lakes, fishponds and lagoons. Nearly 20% of the breeding population occurs in SPAs.

Overall, the population trend is increasing, despite the loss of suitable habitat as reed marshes were claimed for agriculture (1960–1980) and fish ponds abandoned (15% of area during 1993–97). The main current threat is the disturbance from leisure activities. The recent political and economic changes in Lithuania mean that land is being privatised, which might cause problems in the future. On the other hand, the bittern benefits from the eutrophication of lakes (causing reed to spread across the littoral zone of large mesotrophic lakes), from the establishing of fish pond networks in the 1950–70s and from ongoing extraction of peat from former raised bogs (restricted to old sites).

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13 The Netherlands

A national plan for marshland birds has been drawn up, which includes actions for bittern conservation. (See Box 1.1)

In addition, a number of restoration/development projects have been carried out by Vogelbescherming Nederland in cooperation with reserve management organisations. These include:

Habitat restoration at Het Twiske, Zaandam (Recreatieschap Het Twiske, Landschap Noord-Holland). 2001–2005
Het Twiske is situated north of Amsterdam and a large proportion of the 650 ha area is zoned for recreation. However, there is about 40 ha of reed and marsh, holding bittern, water rail, Savi's warbler and (formerly) bearded tit. After reed management (cutting) was phased out gradually, marshland birds increased. In recent years however, the reedlands have deteriorated due to vegetation succession (willow scrub). Over three winter seasons (the last in 2004–2005), actions including the cutting of dry reed stands, removal of willow scrub, bed-lowering, digging of ditches, connecting ditches to allow fish migration have been undertaken. Water levels are allowed to follow seasonal fluctuations. Bittern used the restored areas for feeding, but did not nest in the new reedbed areas. Ditches are quickly covered with *Phragmites*, and by the time the reeds have aged sufficiently for breeding, the foraging opportunities may have decreased. It was advised to keep winter water levels high, make deeper and broader ditches in the last project area, carry out reed management in phases and continue monitoring.

Habitat restoration at Kockengen reedlands (Stichting 'De Roerdomp'): 2003–2005
These reedlands, although comparitively small in size, used to harbour several breeding pairs of bittern in the past. Due to ageing reed stands and stable water levels, the vegetation changed (ruderal plants, bushes, trees) and old ditches were grown over, affecting the reed-water edge length. Although bittern was still present as a winter visitor, no breeding has taken place in recent years. Measures included tree felling and removal of bushes, opening up old ditches (640 m) and connecting to main watercourse, introducing a cyclic, phased reed cutting management. Already after the first phase of measures, breeding numbers of Savi's warbler (the first since many years), sedge warbler, reed warbler and reed bunting increased markedly.

Creation of breeding habitat, Eilandspolder, near Alkmaar (Landschap Noord-Holland): 2004–2006
The Eilandspolder is an open area of wet peat meadows and marshland, which is affected by eutrophication and unnatural (stable) water levels. Restoration measures to set back natural succession (on 3 ha), included the removal of bushes, removal of eutrophic topsoil to 10–40 cm water depth and to 1–1.3 m in some areas. A similar project in the same area, carried out in 1992, was used as an example. This project yielded new breeding pairs of bittern, spotted crake, water rail and bearded tit.

Makummer Noordwaard, Friesland (It Fryske Gea): 2004
This area contains 115 ha of reedbeds with 1–4 pairs of bitterns over the last few years. The application of the habitat-model (see Box 1.1) suggested that the

area could support up to nine pairs, and that foraging opportunities were the limiting factor. Although many ditches criss-cross the area, the edges are not suitable for feeding bitterns. One side of 2.3 km of ditch was dug out to a breadth of 10 m, sloping gently into the surface water. Connectivity between ditches was improved to allow fish migration. Reeds grew back quickly and shortly afterwards a bittern has been observed foraging in the new edges.

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NL/8486 SPA Ilperveld; Restoration of biotope for bittern, wigeon and black-tailed godwit: 2002–2005
Re-excavating former peat diggings, raising water levels and tackling rush on water meadows. See Box 5.4.

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NL/5159 Nieuwkoopse Plassen: 1998–2004
Aimed to re-juvenate reedbeds by bed-lowering and to create new reedbed as a filter for incoming water.

Contact: astoker@natuurmonumenten.nl

NL/0202 Tiengemente/Haringvliet estuary: 2003–2007
Transforming agricultural land into a natural estuarine system over 100 ha. Bittern is one target species among others and does not yet occur.

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NL/6282 De Wieden and De Weerribben: 1999–2005
Second 'best' bittern site in the Netherlands with 33 and 11 bittern territories respectively. Project included the excavation of peat and creation of open water areas; cyclic management to rejuvenate older stages of succession and a buffer zone. Also carried out experiments on the use of reed as a biofuel and a solar/wind powered pump.

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14 Poland

The bittern is a widespread breeder in the Polish lowlands. According to the latest national estimate, Poland holds almost half of the bittern population in EU 25 with 4,100–4,800 'pairs'. Winter records of single individuals are reported from all round Poland. The main breeding habitats are reedbeds at natural eutrophic lakes (9,000 lakes in Poland with a surface area of >1 ha), fishponds, river valley, fen mires, artificial reservoirs and pond, ditches and peat-holes. It is most numerous in the regions of Wielkopolska, Mazury, Western Pomerania, and Polesie Lubelskie (Dombrowski 2001). Important breeding concentrations were noted in the Biebrza; Narew, Noteć and Barycz river valley and in the Łęczna-Włodawa Lake District.

The numbers of the breeding population fluctuate strongly. Recently, a positive trend has been observed, but as the breeding population has been estimated during the last 15 years by various methods, the positive trend (doubling of the population) should be used carefully.

Dry summers and severe winters, drainage of wetlands, cutting and burning of reeds are the main threats for the species but the threats vary according to the habitat. So habitats in river valley are threatened by river regulation measures to meet the demand for flood control and navigation. Natural eutrophic lakes are under threat from recreation/leisure activities and water abstraction. Habitats at fishponds are threatened by privatisation leading to an intensification of the enterprise or conversion to other uses. Power-lines have been responsible for the deaths of bitterns in fishpond areas, too. Reed cutting during the breeding season is an important factor in breeding losses. Large reedbeds (generally concentrated in western Poland) are cut commercially and often too large an area is cut every year, whilst there is a lack of sufficient dykes and feeding areas.

To combat these threats, given the extent of fishponds and commercial reedbed areas and their importance for the European bittern population, the introduction of an auditing system and eco-label both for fish farming and reed harvesting to reward environmentally-friendly management, is proposed. Polak and Krogulec (pers. comm.)

Almost 70% of all habitats (hosting 50% of the population) are protected by law. Currently a research programme on bittern ecology in fishponds in the Lublin area is being run by the University of Lublin. (See Case study 7.17.) Life projects on bittern have not been implemented in Poland and a specific conservation programme for the bittern does not exist.

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15 Spain

The bittern is a rare breeder in Spain and distributed patchily. The fragmented Spanish population occurs in the regions of Andalucía (Marismas del Guadalquivir), Aragón, Baleares (S'Albufera de Mallorca), Castilla-La Mancha (Tablas de Daimiel, El Taray-Masegar y Azután), Cataluña (Aiguamolls de l'Empordà, Delta del Ebro), Navarra (Pitillas) and Valencia (Prat de Cabanes-Torreblanca, Marjal del Moro). The strongholds of the bittern are situated at the Delta del Ebro (10 males), Marismas del Guadalquivir (eight males) and Aiguamolls de l'Empordà – a series of freshwater and saline lagoons in northern Catalonia, which were restored in the 1980s (five to six males).

The population fluctuates. At the beginning of the 1990s, the population recovered from near extinction during at the 1980s. The bittern is vulnerable because of the fragmented distribution and loss of favourable habitats. Among the threats are persecution and disturbance, negative impacts through use of pesticides and losses through

collision with traffic and power lines.

Recently two LIFE projects have targeted the bittern. A third project, tackling the impact of power lines in Aragon, is also relevant.

ES/4179 Conservation of the bittern in the Endorreic Wetlands of the Ebro valley in Navarra: 1997–2001
This aimed to increase the bittern population in the middle range of the Ebro by restoring its natural habitats and eliminating threats. The overall objective was to build up a network of reserves and draw up a conservation plan. Measures included reedbed and water level management, restoration of lagoons and creation of channels and open water within the reedbeds. Water quality and associated degeneration of the reedbeds were to be controlled.

Contact: none available

ES/3118 Conservation of Priority Species in Mediterranean marshes: 1996–2000
The project tackled habitat restoration at three Coastal wetlands in Catalonia where the bittern is threatened by extinction. Key measures included opening up ditches and channels in reedbeds, making the edges of a lagoon and canals slope more gently, water level regulation and monitoring, water quality management, and the rejuvenation of old reedbeds. Leaflet in Catalan with a bittern portrait published to raise public awareness in urban areas. (www.gencat.net/mediamb/fauna/conserva/cespro32.htm). Actions and monitoring were continued after the project (acquisition of 40 ha of reedbed 2005, creation of shallow water areas).

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ES/0034 Adaptation of electric power lines in the SPAs of Aragon: 2004–2007
To reduce bird deaths from electrocution and collision, correction measures will be carried out on 352 km of power lines in 16 SPAs. The bittern (project area held seven singing males and 15 wintering bitterns in 2003) will benefit from these measures.

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16 Sweden

A third national survey was carried out by volunteers in Sweden in 2000. A total of 652 booming males in about 250 lakes were reported from the South Central Sweden. One male was heard in Northern Sweden, in Norrbotten, on 65.47 N. The more conservative estimate in Birds in Europe (360–400 pairs) is explained by the fact, that not all booming males result in breeding (Welander, pers. comm.). Important concentrations were observed in the regions of Sörmland 149 (males), Uppland (87 males), Värmland (78 males), Östergötland (75) and Västergötland (64). Among the Swedish lakes the following large lakes hold the highest numbers: Lake Vänern (92 booming males), Mälaren (90), Tåkern (43), Hjälmaren (27), Långhalsen in Sörmland (17), Hornborgasjön (11) and Tämnaren in Uppland (10) (Broberg 2005).

Overall, the bittern is increasing in Sweden. The last population dip occurred in 1996 after a long and cold winter. There is no national plan for protection of the bittern in Sweden but it is listed as vulnerable on the red list. Many localities are protected as nature reserves. The reasons for the positive trend in Sweden are probably legal protection in western Europe and corresponding restoration measures.

Long term research on bittern ecology has been carried out at Sörfjärden, a part of lake Mälaren, since 1945. Lars Broberg has been responsible for this research programme, based at the bird field station 'Rördrommen' in Sörfjärden.

Restoration work was implemented at lake Hornborga (late 1970–mid 1990), which was initially successful. Bittern numbers increased from two in 1969 to 14 in 1995. But now, with a higher water level, the reduced reedbeds have been eaten by greylags and the bittern population is falling again (Broberg pers. comm.) There is one LIFE project:

SE/0230 Improvement of habitats for wetland birds in Askö-Tidö: 2004–2008
Asköviken is a shallow bay of Lake Mälaren, surrounded by a reedbelt with an area of approximately 145 ha. About 2–3 singing males are recorded yearly. The main problem today is that the reedbelt has become increasingly homogenous during the last decades and the border zone between reed and open water is decreasing. There is concern about this problem since the border zone is an important feeding area for bittern and other wetland birds. The main actions include cutting reed to create irregular fringes to increase the area of water/reed interface and the creation of lagoons and channels within the reedbed.

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17 United Kingdom

The bittern became extinct in UK in 1886. It re-colonised early in the early 20th century and by the 1950s, numbers increased to an estimated maximum of 80 booming males. It reached a low of only 11 booming males in 1997. Intensive research into its ecology has identified natural succession as the main cause of the decline. A number of management actions are now carried out to counter this process at existing sites, such as bed-lowering, and new reedbed sites are being created. National biodiversity action plans for bittern and reedbeds have been published by the government department for Environment, Food and Rural Affairs (Defra). (www.ukbap.org.uk) There has been considerable work around the country and bittern numbers increased to 46 in 2005. The main breeding areas are concentrated along the east coast of England with a small population on the north-west coast. There has been no confirmed breeding in Northern Ireland nor Scotland since the nineteenth century. The main threat is the loss of breeding sites to sea level rise.

There have been two LIFE projects.

UK/3057: Urgent action for bittern in the United Kingdom: 1996–2000
This project saw work at 14 sites in England and Wales to restore and create reedbeds. Actions included bed-lowering, scrub removal, flooding agricultural land to create new reedbeds. All sites are still being evaluated to assess how well the work achieved its objectives. Some sites have not developed as quickly as envisaged – especially the reedbed creation sites. But a number have been outstanding. For example, the restoration of about 40 ha of old reedbed at Minsmere has seen numbers go from one booming bittern in 1996 to 10 in 2005.

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UK/8527: Developing a strategic Network of SPA Reedbeds for bittern: 2002–2006
The aim is to provide a strategic network of sites, which will spread the population away from the east coast and end the isolation of the north-west population. Work at 20 sites has included further restoration work, such as pool and ditch creation, and the creation of new reedbeds. By 2006, 141 ha of land had been bought for nature conservation, 20 km of ditches or lake edge re-profiled, 11.5 km of new ditches created, 300 hectares of new reedbed created and 52.5 ha of reedbed were restored. Monitoring and awareness raising were also undertaken.

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See Case studies 7.3, 7.4 and 7.13.

18 Portugal

The breeding status of the bittern fluctuates in Portugal from between nought and three pairs. Observations during breeding time were reported from a site in Algarve in the early 1990s. No specific conservation projects have been implemented. A Life project at the Marsh of Arzila in the Lower Mondego River Valley close to Coimbra (Reis 2003), has implemented measures to increase the habitat diversity of the marsh ecosystem and focused on raising public awareness of the value of wetlands. The traditional use of *Scirpus lacustris* collected by local people to make baskets and large mats, has been highlighted by the beneficiary.

19 Czech Republic

The species is very rare and, since the early 1980s, its numbers have dramatically declined. The total population was estimated at only 20–30 breeding pairs for the period 1970–1990 (Tucker and Heath 1994). Recently, the population increased to 30–40 pairs. In addition to large fishpond systems (Trebon Basin, České Budejovice/Budweis, Pardubice regions), where the bittern has occurred for a long time, it has also occupied some single water bodies, e.g. in central and east Bohemia where the species has been recently found. It looks like it has been disappearing from traditional nesting areas, whilst some individual pairs are colonising new sites or re-colonising former sites.

The main threats are the removal of vegetation from fishpond banks, wetland drainage, reedbed fragmentation caused by eutrophication and high water levels, lack of food due to eutrophication and water level fluctuations resulting in flooding nests or, when very low, making them more accessible to predators. At the area of the fishpond system near Opatov in the Svitavy district (eastern Bohemia), the bittern is threatened by illegal hunting (Jetmar 2000).

20 Slovakia

The species occurs in fishponds or on river branches, where suitable sizeable reed stands are present sporadically throughout the country (Government report for the meeting of Group of Experts on Conservation of Birds of the Bern convention at Wageningen 2002). Bitterns are found in the areas of Danube, Vah, Hron and Ipel river basins in southern and south-western Slovakia and east Slovakian and Kosicka lowlands in eastern Slovakia (Hudec *et al.* 1994). The population is estimated at 50-100 with a decreasing trend. The loss and fragmentation of nesting habitats are the main threats, and are caused by the cutting and burning of reedbeds.

The bittern is legally protected, according to the Regulation of MoE No. 93/1999, and is classified as critically endangered. However, hunting legislation does not consider the species at all. Approximately 80% of breeding and probable breeding population of bittern is covered by protected areas. The same percentage of population is covered by IBAs as well.

There is a special group within the State Nature Conservancy of the Slovak Republic that provides research on distribution and population dynamics of the species. State Nature Conservancy of the Slovak Republic is also responsible for main part of conservation work on the species because 80% of the population occurs in protected areas. It is planned to carry out a recovery plan for bittern in Slovakia.

21 Slovenia

The bittern is an occasional breeder in Slovenia (0–2 'pairs'). The breeding site is situated south of Ljubljana. It is occasionally heard booming at Lake Cerknica, but not annually. For the last two years booming was also heard at Lake Medvedce but nesting was not confirmed (Figelj pers. comm.).

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Many scientific reports can be downloaded from: www.moerasvogels.nl with instructive illustrations on reedbed development and bird communities in reedbeds.

Appendix 3 Scientific names of species mentioned in the text

Alder *Alnus glutinosa*
American mink *Mustela vison*
Avocet *Recurvirostra avocetta*
Bearded tit *Panurus biarmicus*
Bittern *Botaurus stellaris*
Black-headed gull *Larus ridibundus*
Black-necked grebe *Podiceps nigricollis*
Black-tailed godwit *Limosa limosa*
Black tern *Chlidonas niger*
Bluethroat *Luscinia svecica*
Bog myrtle *Myrica gale*
Bream *Abrades barium*
Brown bullhead *Ictalurus nebulosus*
Brown hare *Lepus europaeus*
Brown rat *Rattus norvegicus*
Common carp *Cyprinus carpio*
Carrion crow *Corvus corone*
Common crane *Grus grus*
Common frog *Rana temporaria*
Common tern *Sterna hirundo*
Coot *Fulica atra*
Coypu *Myocastor coypus*
Crucian carp *Carassius carassius*
Dace *Leuciscus leuciscus*
Dalmatian pelican *Pelecanus crispus*
Edible frog *Rana esculenta*
Eel *Anguilla anguilla*
Fox *Vulpes vulpes*
Gadwall *Anas strepera*
Glossy ibis *Plegadis falcinellus*
Grasshopper warbler *Locustella naevia*
Great crested grebe *Podiceps cristatus*
Great reed warbler *Acrocephalus arundinaceus*
Great white egret *Egretta alba*
Greater reedmace *Typha latifolia*
Grey heron *Ardea cinerea*
Greylag goose *Anser anser*
Large copper *Lycaena dispar*
Lesser reedmace *Typha angustifolia*
Little bittern *Ixobrychus minutus*
Little crake *Porzana parva*
Little grebe *Tachybaptus ruficollis*
Mallard *Anas platyrhynchos*
Marsh harrier *Circus aeruginosus*
Mediterranean killifish *Aphanius fasciatus*
Moorhen *Gallinula chloropus*
Montagu's harrier *Circus pygargus*
Mute swan *Cygnus olor*
Nine-spined stickleback *Pungitius pungitius*
Otter *Luta lutra*
Perch *Perca fluviatilis*
Pillwort *Pilularia globulifera*
Pike *Esox lucius*
Pochard *Aythya ferina*
Purple heron A*rdea purpurea*
Pygmy cormorant *Phalacrocorax pygmeus*
Raccoon dog *Nyctereutes procyonoides*
Red-necked grebe *Podiceps grisegena*
Red swamp crayfish *Procambarus clarkii*
Reed bunting *Emberiza schoeniclus*
Reed warbler *Acrocephalus scirpaceus*
Roach *Rutilus rutilus*
Rudd *Scardinius erythrophthalmus*
Ruff *Philomachus pugnax*
Saw-sedge *Cladium mariscus*
Savi's warbler *Locustella luscinioides*
Sedge warbler *Acrocephalus schoenobaenus*
Short-eared owl *Asio flammeus*
Shoveler *Anas clypeata*
Snipe *Gallinago gallinago*
Spoonbill *Platalea leucorodia*
Spotted crake *Porzana porzana*
Soft rush *Juncus effusus*
Tench *Tinca tinca*
Three-spined stickleback *Gasterosteus aculeatus*
Tufted duck A*ythya fuligula*
Water rail *Rallus aquaticus*
Water vole *Arvicola terrestris*
Water pipit *Anthus spinoletta*
White-tailed eagle *Haliaeetus albicilla*
Wild boar *Sus scofa*
Wren *Troglodytes troglodytes*

Index

Notes: *Italic* page numbers refer to photographs and **bold** numbers refer to figures and tables.

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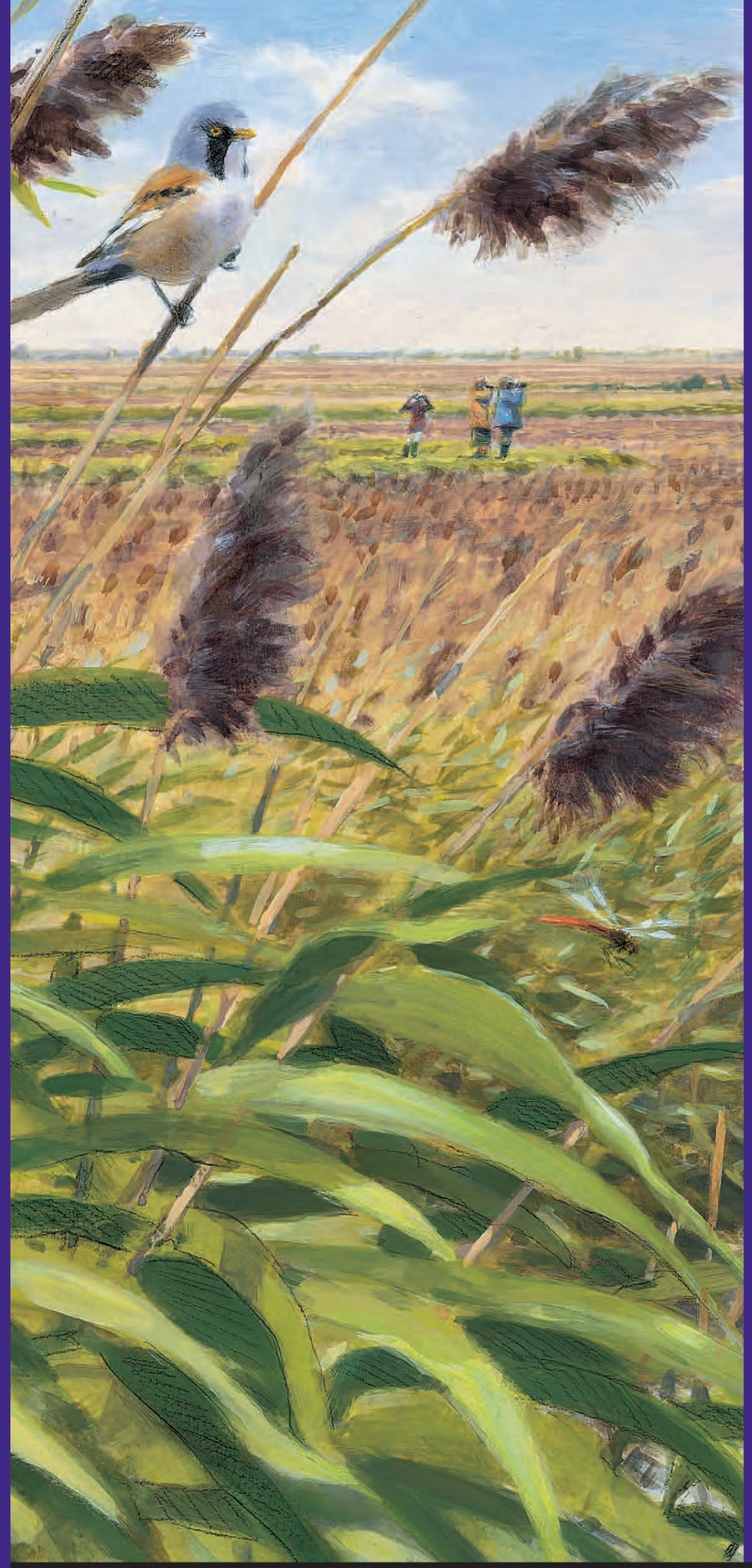
Cover illustration:
A vision of the Hanson-RSPB wetland project at Needingworth, Cambridgeshire, UK *Bruce Pearson*
A new wetland of over 900 ha with extensive reedbeds is being created from sand and gravel workings over the next 25 years.



The bittern in Europe

The bittern in Europe:
a guide to species and habitat management