THE CONSERVATION AND MANAGEMENT OF AMPHIBIANS IN UK TEMPORARY PONDS, WITH PARTICULAR REFERENCE TO NATTERJACK TOADS

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Introduction

Amphibians have complex life cycles which involve the use of terrestrial and aquatic habitats and, whilst the adults spend most of their time on land, they return to water each spring to breed. The conservation of these species requires not only the maintenance of their breeding ponds but also the surrounding terrestrial habitat. All native species make use of temporary ponds to a greater or lesser extent (Griffiths 1997). Typically, the breeding ponds fill with water during the autumn and winter months and gradually become shallower during the spring and summer, drying up completely in some years. The amphibian larval stage has evolved to take advantage of the flush of food which follows the filling of a temporary pond but it has to grow and develop rapidly to metamorphose into the adult stage before the pond dries up. It is only by drying out that such ponds remain fish-free and usually support fewer invertebrate predators than permanent ponds.

General characteristics of native amphibian habitats

The breeding-site characteristics of British amphibians are relatively well known (e.g. Smith 1964; Frazier 1983; Griffiths 1996; Beebee & Griffiths 2000). Ponds in which amphibians breed successfully are referred to as "source ponds" and others, from which there is no metamorphosis, are called "sink ponds". Sink ponds are important not only because they provide important habitat for juveniles and adults outside the breeding season but also because, in some years, they can act as source ponds. A population of amphibians which has to rely on a single pond is doomed to extinction sooner or later when a catastrophe or series of catastrophes results in the loss of the breeding site. A cluster of ponds, sources and sinks, linked by suitable terrestrial habitat, is needed to support a viable metapopulation of a species. In such a situation, individuals can disperse from one pond to another to re-colonise after a local extinction or simply to take advantage of a breeding opportunity. The most successful sites for natterjack toads *Bufo calamita*, for example, are those with a high density of pools, because at least some of the pools will hold water long enough to allow successful breeding (Beebee et al. 1996).

Common frogs *Rana temporaria* breed early in the year, typically in small, shallow ponds. The tadpoles stand a good chance of completing development and metamorphosis before the pond desiccates. Common toads *Bufo bufo,* on the other hand, breed later in the year and use pools which, being larger and deeper, dry out far less often than typical frog ponds. The native pool frog *Rana lessonae,* before its extinction during the last decade (see later), also bred in large pools which dried out only infrequently.

Newts, unlike the common frog and toad, have a prolonged breeding season and use a variety of waterbodies for breeding. Early cohorts of larvae may have time to metamorphose before the pond desiccates, while later ones perish. If the pond does not dry out, later cohorts of larvae may overwinter in the pond and metamorphose in the following spring. The great crested newt *(Triturus cristatus),* with its pelagic larvae, is particularly vulnerable to fish predation and cannot co-exist with most fish species. Whilst it is possible for newt larvae to survive in parts of a pond where fish rarely penetrate, it is better for amphibian populations if their ponds desiccate occasionally to prevent the establishment of fish populations.

The natterjack toad also has a prolonged breeding season, but starts later in the year and uses shallow ephemeral ponds which are very prone to desiccation. Large numbers of natterjack tadpoles are often lost when a pond dries up, but metamorphosis from the same pond, in a year with a different pattern of rainfall, can be spectacularly successful.

The ultimate aim of the conservation and management of ponds for amphibians is to maintain an "amphibian-friendly" landscape in which the creation of ponds and their loss through a natural succession is in balance. Ideally, pond management would not be directed at trying to stabilise ponds at one point in time, but rather be just a small part of a semi-natural dynamic system of pond creation and pond loss. Unfortunately, it is not an ideal world and amphibian conservation is still at an early stage. In the short-term it is necessary to manage ponds and the surrounding land specifically for these species, whilst seeking long-term solutions in natural processes to provide for their future needs.

The natterjack toad's habitat requirements

The natterjack toad is a species which relies on ephemeral ponds in open, early-successional habitats, and has been the subject of considerable research and conservation effort. During the last glaciation its refuge was the Iberian Peninsula; afterwards it spread rapidly northwards to colonise western Europe before tree cover became extensive and closed habitats developed. In Spain, natterjacks still breed in shallow pools on river floodplains, and they may have followed such corridors and coastal routes northwards as the climate ameliorated, before woodland developed. It appears that the species used two routes to cross into England, and colonised the east and the west separately (Beebee & Rowe 2000).

Throughout their range natterjacks need unshaded, shallow pools with gently sloping margins. The toads spawn in water that is less than 10 cm deep and the tadpoles aggregate in the very shallow, warm water for optimum development. The broad drawdown zone of such ponds provides ideal conditions for the toadlets to complete metamorphosis, and feed and grow, before dispersal. The pH of the water needs to be greater than 6 for good tadpole development and, because the natterjack tadpoles are competitively inferior to those of the common toad and common frog, it is important that these species are absent from natterjack pools.

On land natterjacks need very short- or minimally-vegetated, bare areas to hunt over after dusk, and a suitable substratum, usually sand, in which to burrow to avoid extremes of temperature and predators.

Habitats used by natterjacks in Britain

Natterjacks have always had a restricted distribution in Britain: because of their exacting requirements, only a few habitats can provide suitable conditions. The sand dune systems of the west and east coasts of England are the classic habitat of the natterjack toad and still the species' stronghold.

The importance of upper saltmarsh or merse pools was not at first recognised, but such sites can support thriving colonies on the Solway Firth (Fig. 1) and in north Cumbria. The tadpole of the natterjack is no more tolerant of sea water than those of other amphibians, and only pools in which the water is diluted sufficiently by fresh water are used (Beebee et al. 1993). The terrestrial habitat is still maintained by grazing and the large number of pools at different heights on the shore ensures that at least a few are ideal for breeding. It is important that these sites continue to be grazed and that any attempts to infill pools or disrupt the flow of fresh water onto the merse are resisted.

The use of temporary ponds in fields inland from coastal colonies of natterjack toads has largely disappeared. Land drainage has led to the conversion of uneven rough pastures into leys or arable land. At only a few sites in Cumbria and beside the Scottish Solway are temporary field ponds still used by natterjacks.

The use of heathland in the south-east of England by natterjacks is well recorded. The decline of these colonies has been much more marked than those on sand dunes. The loss of heathland colonies is the result of habitat

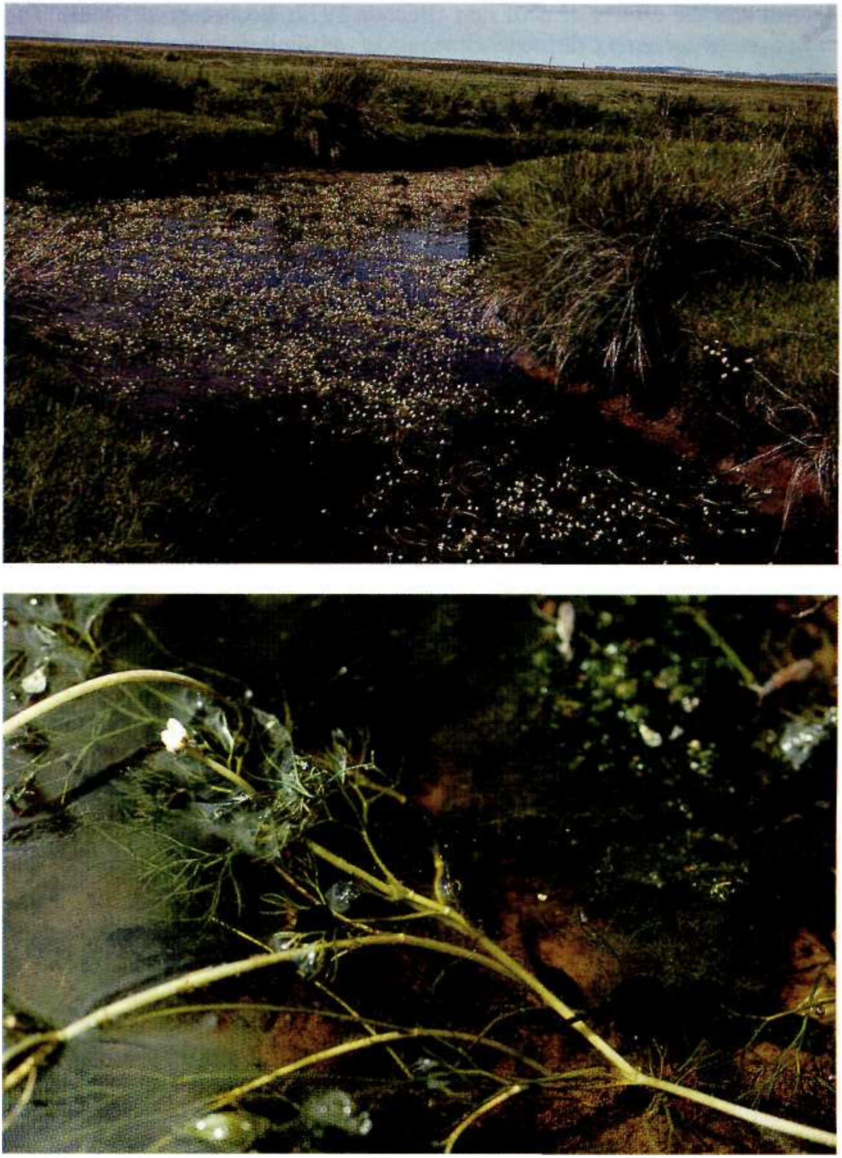

FIG. 1. *Above: A* salt-marsh pool (Priestside Merse, Dumfriesshire) used for breeding by natterjack toads. *Below:* Natterjack tadpoles in the same pool.

neglect and the effects of acid rain (Beebee 1977; Beebee et al. 1990). The cessation of grazing, through changes in agricultural practices and the reduction in rabbit populations by myxomatosis, has resulted in the loss of foraging habitat and the shading of ponds by scrub. Even when the heathland habitat has been restored by conservation measures the pond may be too acid for spawn and tadpoles, and require liming to raise the pH.

Conservation of aquatic and terrestrial habitats

Unlike the ephemeral pools on river floodplains used in southern Spain, which are self-maintaining provided that winter floods periodically wipe the sandy tracts free of vegetation, most natterjack habitats in Britain require some degree of conservation management. Even apparently natural habitats have been heavily modified by past human intervention and it is necessary to continue with former management practices, such as grazing, which maintain the habitat. Equally important is to allow natural processes, such as "blow-outs" by strong winds, to proceed largely unchecked.

In the early days of natterjack toad conservation on the Sefton coast, slacks were over-zealously deepened and new pools created in the dry years of the 1970s, with catastrophic results. At first the breeding pools were spectacularly successful: natterjacks are said to have started to use them as they were still being excavated! Unfortunately, within a few years the ponds were clearly less productive for natterjacks, as populations of common amphibians, notably the common toad, and invertebrates increased. The situation was exacerbated by the change in the terrestrial habitat through natural succession, thus allowing common toads to survive more easily in the less demanding micro-climate provided by trees and bushes. Also, the failure of new dunes and slacks to form on the seaward side of the system meant that there was nowhere new for the natterjack to colonise.

Fortunately the problems were recognised by the landowners and site managers, and much time and resources have since been devoted to restoring the dynamic dune system. New dune ridges could not develop because embryo dunes were destroyed by cars driven onto the beach and by beach-cleaning operations, so beach-cleaning procedures were modified and car access was restricted to allow the development of new dunes. Major scrub-clearance programmes were designed and implemented to restore the dune habitats and were followed up, in some places, by grazing schemes to prevent habitat deterioration occurring again (Rooney 1998). In the frontal dune slacks, which are not grazed, mowing is an effective way of removing plant growth every autumn. Gradually, the over-deepened slacks and ponds of earlier days are being partially infilled and re-profiled using earth-moving machinery (Simpson 1998).

Over-deepening of ponds has not been confined to the Sefton Coast. After the over-deepening of two ponds during a dry phase at a site in Norfolk, for example, it was necessary to bring in material to partly infill them as they had inadvertently been made into common toad breeding sites. As at all natterjack toad sites where common toads have colonised, it is necessary to remove them and their spawn to sites away from the natterjack breeding pools until their numbers are greatly diminished.

Nowadays pools are created more sensitively, as part of a series of pools, in the knowledge that modification might be necessary to achieve the desired balance between drying out too soon and holding water for too long. Dry years, when no breeding can take place, are no longer considered a disaster for natterjacks if simply due to low over-winter rainfall. Such years also prevent common toads from breeding and probably reduce their populations because they are not as well adapted as natterjacks for surviving in dry conditions.

At large sites on the west coast, managers are working towards a situation where grazing, erosion and dune formation can create and maintain the natterjack habitat. On the east coast, where there is little dune activity, it has been necessary to slightly deepen slacks with machinery to provide breeding sites. Such slacks become less productive for natterjacks as years progress and can be rejuvenated by re-digging late in the season, to just above the water table. The new scrape is made slightly to one side of the original one which is back-filled -as the process progresses. At smaller, isolated sites where terrestrial habitat is restricted and fewer ponds exist, there is no chance of re-colonisation after an extinction. At these sites more time needs to be spent maintaining the natterjack population through conservation management of the pools and terrestrial habitat.

Concrete ponds are used successfully by natterjacks at a few heathland re-introduction sites. Ponds with butyl liners have also been used at sites where the chances of deliberate damage is low. The most sophisticated one developed to date has a drainage system which allows the pond to be drained down from late summer until the spring, thus preventing a build-up of populations of predatory invertebrates (Simpson 2000).

Fortunately, natterjack toads live in exciting and often spectacular places, many of which are nature reserves where maintaining the species is an important part of management implementation plans. Unfortunately, even on nature reserves, there is a short-fall of funding. In the country as a whole, the annual budget to pay for specific natterjack conservation work is less than half of the amount needed to restore the species to its former numbers and range.

The pool frog

Always rarer and more restricted in range than the natterjack, the native pool frog *Rana lessonae* probably relied on ponds that were at the opposite extreme to those favoured by natterjacks. Within historical times it has been recorded at just two sites: Foulmere Fen in Cambridgeshire and Stow Bedon/Thompson Common in Norfolk (Bell 1859; Boulenger 1884). It has also been identified from bone material collected by archaeologists at a Middle Saxon site in Gosberton, Lincolnshire (Gleed-Owen 2000), and at a Late Saxon site in Ely, Cambridgeshire. Thus it may have been widespread in The Fens of East Anglia before drainage of the area for agricultural purposes. At both sites where it was found in the 1800s, pond systems are very ancient and include upwellings from the chalk at Foulmere and pingos at Thompson (Bond 1844; Buckley 1986).

The former land-use of the area would also have been important in keeping the terrestrial habitat at these sites open following clearance of trees. Both sites have a history of being grazed. It seems probable that the ponds would have dried out naturally at both these sites in some years, to prevent their in-filling and subsequent loss by the accumulation of organic material.

Recent studies have shown that the pool frogs which were formerly found in the Thompson area of Norfolk are closely related to those still found in Scandinavia (Zeisset & Beebee 2001) and it appears that they colonised Britain after the end of the last glaciation whilst the Baltic region was dry land, with associated freshwater habitats. In colouration, the Norfolk pool frogs most closely resembled animals found today in Norway and Sweden, and this research confirms that Scandinavian animals would be a good source of material to re-introduce into Britain.

Like the natterjack toad, the pool frog is subject to a Species Action Plan (SAP) which has targets for restoration of habitat at historical sites and sites within its former range, and for the re-introduction of the species. Members of the Pool Frog SAP Steering Group are currently udertaking research, with the help of European herpetologists, to ensure that the re-introduction programme will be designed using the best possible data and then implemented at release sites previously prepared to an optimum state.

Conclusions

Amphibian conservation has moved on a long way from the days when it was thought that all you had to do was dig a pond. Conservationists are now working towards sustainable management, whilst ensuring that species are maintained in the short-term by conservation management of their breeding pools and terrestrial habitat.

During the last three decades much research has been undertaken to understand the ecology of the natterjack toad whilst, at the same time, knowledge of their habitats and how to manage them have also increased. The rationale of natterjack conservation work is now on a very sound footing and the rate of progress towards achieving the targets of the SAP is largely determined by funding.

Rapid progress is also being made in understanding the pool frog's habitat requirements and it should be possible to start a re-introduction programme in the next year or two.

Conservation of the more widespread species is more daunting as it concerns a large number of sites, the vast majority being outside nature reserves. Schemes to give ponds protection at a landscape level need to be developed and implemented. Meanwhile, real progress will be made as more sites for great-crested newts are designated as county wildlife sites, not just a select few as is too often the case.

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